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Japan Advanced Institute of Science and Technology

A Method for Innovation Capability Evaluation in Banking

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Master's Thesis

A Method for Innovation Capability Evaluation in Banking

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Abstract

Under the strong impact of the fourth industrial revolution, innovation happens in all sectors of the economy and is expected to change the entire production, management systems all around the world. This revolution helps the firms increase productivity, flexibility and efficiency, shorten the time to bring products to market, thereby increasing their competitiveness. Not only the manufacturing sectors, but the banking sector has also been increasingly applying the advanced technologies such as big data, cloud computing, artificial intelligence, Blockchain to change their traditional financial services and distribution channels to bring about new experiences for their customers as well as to compete with the competitors on a global scale. Besides, the banks are also facing severe challenges such as changing existing processes, recruiting and training high-quality personnel and mobilizing other resources to adapt to the digital age. If a bank does not innovate effectively, it cannot survive and develop stably in the current era of fierce competition. In order to innovate productively, the banks have to upgrade their innovation capability regularly by managing well multiple innovation practices. Therefore, measuring innovation processes in banking with various practices becomes urgent and evokes much interest from both academics and bank managers. In literature, there have been many studies related to innovation measurement in the manufacturing and service sectors, but there remain few relevant research on evaluating innovation capability in the banking sector, particularly.

This thesis focuses on developing a framework for assessing innovation capability in banking. Firstly, the evaluation indicators system was established in terms of critical innovation management practices. By conducting a comprehensive literature review on the best innovation practices and then using Pareto analysis, 11 critical innovation management practices (strategic planning, resource management, organization, idea management, process innovation, marketing, R&D, learning, portfolio management, knowledge management, and technological innovation) and their 44 sub-practices were extracted. A group of five experts in banking major was invited to answer the survey questionnaire for scoring these sub-practices in a sample group of three major Vietnamese banks. Then, an innovation capability evaluation method was developed based on Analytic Hierarchy Process (AHP) for analyzing the importance of the 11 critical innovation management practices as well as their corresponding sub-practices. The result showed that strategic planning, resource management and technological innovation were the most important practices in banking innovation nowadays. Finally, an innovation capability index was computed for each bank and used for ranking. The findings of this research could be a basis for the banks to review their innovation activities, determine the priority areas for development, thereby having reasonable adjustments in their innovation management policies intending to improve their innovation capability, reinforce their innovation outcomes and achieve superior business performance.

Keywords: innovation, innovation management, innovation capability, evaluation, banking.

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Abbreviation

AHP	Analytical Hierarchy Process	
IC	Innovation Capability	
ICI	Innovation Capability Index	
IMP	Innovation Management Practice	
CIMP	Critical Innovation Management Practice	
NPD	New Product Development	
SP	Strategic planning	
RM	Resource management	
OR	Organization	
IM	Idea management	
PI	Process innovation	
MA	Marketing	
RD	R&D	
LE	Learning	
РМ	Portfolio management	
KM	Knowledge management	
TI	Technological innovation	

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Chapter 1

Introduction

We first introduce current issues and theoretical background of our research in Section 1.1. Then, the research objectives are mentioned in Section 1.2. Section 1.3 indicates the contributions of this study. Finally, the thesis structure is illustrated in Section 1.4.

1.1 Background

In the era of increased global competition, highly diversified customer demands, along with the constant changes in sciences and technologies, every firm has to innovate continuously for taking advantages of new technologies to improve their products/services for maintaining competitiveness, retaining customers and ensuring success in business. According to O'Regan et al. (2006), one of the key drivers for enterprises to achieve sustainable competitive advantages is innovation [1]. Therefore, innovation activities are taking place forcefully in all sectors of our society. It can be seen that not only manufacturing companies but also the banks place innovation as a top priority in their strategies. Under the strong impact of the Industrial Revolution 4.0, the banks have increasingly integrated advanced technologies into their services to speed up their provision of services to their customers. They have developed new mobile applications such as mobile banking and Internet banking to enhance access to banking services for their clients from anywhere and at any time. The digital banks become popular with the extensive use of data and analytics to digitize processes. Recently, the emerging trends in banking industry are using new technologies such as big data, Blockchain, and artificial intelligence.



Figure 1.1: The business value for artificial intelligence in banking

Using big data in determining the needs of each customer through transaction histories and data from social networks is a useful tool towards personalized marketing. Then, the banks can create distinctive services for each customer segment, which will help build brand image and a good relationship with each customer. By applying Blockchain technology, interbank transactions and international transfers are operated faster and safer. Shortly, Blockchain is expected to replace existing bank transfer systems. Additionally, the banks can use artificial intelligence to assess credit quality, manage risk portfolios, and automatically interact with customers, optimize transaction execution at a higher level of accuracy and processing speed than humans. With the enormous innovative capabilities that artificial intelligence brings to banking services, the demands for artificial intelligence in banking are projected to overgrow in the future (see Figure 1.1) [2]. Another notable trend is that the banks have expanded cooperation with FinTech companies to launch new services fast and effectively. This cooperation helps take available advantages of both banks and FinTech companies. The banks have strengths on brands, customer platforms, risk management capabilities, and Fintech companies are specialized in advanced technologies, Blockchain or artificial intelligence platforms.

However, besides the opportunities open from Industrial Revolution 4.0, the bank-

ing sector also faces significant challenges in recruiting high-quality personnel, designing training programs for employees, preparing financial resources, building technology infrastructures, and planning proper strategies to catch up with the new trends of the digital age. Innovation is recognized as a very complex process that needs specific management, continuous improvements and reasonable investments into various innovation practices [3]. Thus, innovation capability (IC) evaluation methods from the perspective of an innovation process are required to pinpoint precisely areas that the banks should focus on [4]. By adjusting the efforts in innovation activities and resources dedicated to these practices regularly, the banks can upgrade their IC in order to innovate effectively.

The topics on innovation management and IC measurement have been studied extensively in the manufacturing and service sectors. The most-reported literature focuses on presenting the best innovation management practices (IMPs) in general [5-12]. Nevertheless, the use and effectiveness of IMPs will vary by sectors, so the managers should select suitable IMPs for their business contexts to achieve superior performance. Some studies are to assess innovation process in manufacturing enterprises [3, 13–17]. Despite the growing interest of innovation in banking, little attention has been devoted to innovation management in the banks. Especially, there is still a lack of a systematic method to evaluate IC for banking sector in particular. Drew (2005) benchmarked IMPs in financial institutions, including resources committed to innovation, innovative practices and approaches, and organizational factors [18]. Other existing studies of banking innovation mainly focus on a single aspect, for instance on top management [19], product [20, 21], technology [22], customer knowledge management [23]. There remains a shortcoming in systems thinking of a process of innovation management in banking. Hence, the elements that are essential for developing the banks' IC have not been fully explored. Because of the complicated nature of innovation, IC evaluation must consider a complex process of many different IMPs, not just one or two aspects of IC. In this study, we will exploit and measure multidimensional innovation process in banking sector, whereby we identify the banks' IC, and provide recommendations for the banks to improve their IC, produce better innovation outcomes and obtain higher business results.

1.2 Research Objectives

This research aims at evaluating IC of the banks, thereby filling the gap regarding innovation measurement in banking. Based on the findings, we will recommend practical actions for the banks to facilitate and improve innovation processes to innovate effectively and achieve superior performance.

To accomplish the purposes as mentioned above, the thesis focuses on four main issues as follows:

- Firstly, review theories of innovation, IC, IMPs and then determine critical IMPs (CIMPs) for the banking context.
- Secondly, synthesize methods or empirical works on IC evaluation, from which develop an appropriate method to measure the IC of the banks.
- Third, propose a framework for IC evaluation in banking, then apply it into a case study to determine IC of the banks and rank them based on their IC.
- Finally, discuss the empirical results and point out the strengths and weaknesses in innovation process of each bank. That is intended to be useful to top management of the banks in re-evaluating and adjusting their innovation management reasonably for improving their IC and business outcomes.

1.3 Research Contributions

The contribution of this thesis is as follows:

- We conduct a comprehensive survey about IMPs from many previous studies, then determine CIMPs that significantly influence the success of innovation.
- We collect primary data by asking experts for scoring sub-CIMPs to evaluate the development degree of CIMPs in the case of Vietnamese banks. Additionally, thanks to these experts, the importance weights of CIMPs and sub-CIMPs for banking context are determined.

• We propose a method for IC evaluation in banking sector where there is few research on innovation measurement. Our evaluation is based on a process of various CIMPs, not just a single aspect of innovation in banking.

1.4 Thesis Outline

The thesis is organized into six chapters as follows:

- In Chapter 1, we introduce current contexts and theoretical backgrounds regarding innovation in banking, research objectives, research contributions and thesis outline.
- In Chapter 2, we offer existing theories of innovation, IC, and IMPs. In addition, we also synthesize related works on IC evaluation methods.
- In Chapter 3, we explain in details our proposed process to evaluate IC in banking.
- In Chapter 4, we present the empirical results by applying our proposed method in a case study of Vietnamese banks.
- In Chapter 5, we discuss the research findings and some suggestions for banks to implement innovation successfully.
- In Chapter 6, we summarize the findings of this study, determine some limitations, and research directions for future works to improve the accuracy of IC evaluation in banking.

Chapter 2

Literature Review

In this chapter, we explain the terms of innovation in Section 2.1 and IC in Section 2.2. The IMPs obtained from a large body of relevant studies are listed in Section 2.3. Then, Section 2.4 offers a review on IC evaluation methods that were employed in previous research.

2.1 Innovation

Today, the concept "innovation" has been mentioned a lot in discussions among scholars, company managers, and governments. Because of its importance, many researchers have studied innovation. Thus, there are many definitions of innovation in the literature. Innovation means creating something new [24]. Rasul (2003) defined innovation as the process of developing ideas in order to create new or improved services/products, and commercialize them in the markets [25]. Rogers (1998) described innovation as the changes in business activities for improving firm performance [26]. Based on these definitions, innovation can be understood as a process of changes in the organization to create new or improved things so as to achieve higher performance.

According to Schumpeter (1947), there are several forms of innovation such as the introduction of a new or improved good, a new or improved method, exploitation of a new market, or setting a new organization [27]. Innovation does not always concern radical changes or a complete novelty. It has also been incremental innovation when adding small improvements in existing products/services. Because radical innovations are more costly

than incremental innovations, so the majority of innovations are incremental innovations.

2.2 Innovation Capability

In order to develop innovations, firms have to upgrade their IC continuously. IC refers to the regular improvements of the overall capabilities and resources that the firm possesses to explore and exploit opportunities to develop new products for fulfilling market needs [28]. According to Wang and Ahmed (2004), IC is defined as the ability to create new products through strategic orientation, innovative behaviours and technological processes [29]. Chen and Jaw (2009) described IC as the firm's ability to innovate product or process relying on processes, systems, and organizational structure [30]. From these definitions, the IC of a firm is a complex construct of innovation activities such as strategies, resources, technologies, processes, systems and organizations which support the transformation from ideas into new or improved products/services. Consequently, evaluating IC needs to consider simultaneously multiple criteria.

In an IC assessment for small and medium enterprises, Trindade et al. (2016) considered various factors about governance, organization, people and processes [31]. Boly et al. (2004) evaluated the IC of 39 French manufacturing firms based on 15 ICs that are design, project management, strategy, project portfolio management, organization, process improvement, competence management, moral support, knowledge management, technology intelligence, network management, collective learning, creativity, R&D and customer relationship management [3]. Hence, it is essential to develop a multidimensional scale to measure IC and determine critical dimensions for each context. Based on a comprehensive literature review, we will show the best innovation practices that can be used in IC evaluation in banking in the next section.

2.3 Innovation Management Practices

In this study, our approach of assessing IC relies on innovation process concerning different IMPs that foster the firms' capabilities and resources needed for successful innovation. We reviewed on a large body of prior studies related to innovation measurement by searching following keywords: innovation practices, innovation management practices, innovation management measurement, innovation capability evaluation, empirical innovation management, new product development practices. Then, 28 articles most relevant to our research were selected.

Easingwood (1986) investigated new product development (NPD) practices in a wide range of services companies in the United Kingdom. By interviewing the leading companies in this sector, they claimed the best practices that differed the successful companies from the other were strategy, organization, idea generation and market test, and assessment after launch [32]. A research conducted by Drew (1995) in benchmarking of innovation practices for financial organizations clarified the importance of resources, separate strategic plans for NPD, idea generation and transfer, and organization factors [18]. Sundbo (1997) studied innovation management in services and defined three kinds of organizations classified by their innovation activities focusing on strategic management, participation in the network, or professional recruitment [33]. According to Griffin (1997), besides a specific strategy, a stage-gate process, outcome measure, the best-practice firms focused on organization with the use of multi-functional teams in NPD programs [34]. Balbontin et al. (2000) proposed a NPD model of NPD process, organizational culture, people, marketing, learning, technology and product [35]. In the approach of Lawson and Samson (2001) to develop IC of organizations, they considered the following elements: vision and strategy, competence management, intelligence, organizational structure and culture, and technology management [36]. Human resource management, strategy, technology management, R&D, design marketing, ideas, and performance measure were mentioned by Ulusoy (2003) as IMPs in the Turkey manufacturing sectors [37]. In 2004, Cooper published a series of three articles reporting the best NPD practices that were the main differences between the best and the worst firms. These were a climate of supporting innovation, senior management who lead the road of NPD and commit resources for NPD, the way of organizing the NPD project teams, business strategy, portfolio management, resource availability, and new product process [5] [6] [7]. Researching on topics related to technological ICs in Chinese firms of Yam et al. (2004, 2011) employed the same evaluation criteria including learning, R&D, resource, manufacturing, marketing, organization and strategic planning capabilities [38] [39]. Cormican and O'Sullivan (2004) revealed that the best practices in monitoring product innovation comprise strategy and leadership, culture and climate, project planning and selection, structure and performance, communication and collaboration [40]. Guan et al. (2006) studied the impact of technological IC on the firms' competitiveness in China. The technological IC in their study was measured by learning, R&D, manufacturing, marketing, organization, and resources allocation [41]. Adam et al. (2006) reviewed diverse literature about the innovation process and summarized into 7 activities regarding input management, knowledge management, strategy, organization and culture, portfolio management, project management, and commercialization [12]. Oke (2007) classified IMPs in service companies into strategy management, idea management, portfolio management, implementation process and human resource management [11]. Koc and Ceylan (2007) investigated the main factors influencing the IC of large-scale companies in Turkey, particularly strategy, idea management, technology acquisition, teamwork, learning, management participation and delegation [9]. Rejeb (2008) employed an IC measurement system of 13 best IMPs: design tasks, projects management, strategic decisions, projects portfolio management, innovation process, working conditions, competence allocation, moral support, collective learning, knowledge management, survey tasks, technological networks, and creativity [42]. A research conducted by Wang et al. (2008) to determine the Taiwanese hi-tech firm's technological IC considers numerous quantitative and qualitative criteria measuring 5 aspects: R&D, innovation decisions, marketing, manufacturing and capital [16]. According to Brophey and Brown (2009) focused on idea management as a major IMP for small to medium-sized mechanical manufacturers [43]. In the most innovative firms, the innovativeness was dominated by the process of generating, screening, and implementing ideas.

Wang and Chang (2011) proposed a diagnosis system of innovation value in new project development that includes the following elements: strategy, product, process, organization and resources innovation. Their applying AHP indicated that process innovation plays the most important role in this innovation system [15]. Sánchez et al. (2011) studied key IMPs in the electronics industry by interviewing the company managers through 93 questions that detail 9 dimensions of innovation management in strategy, culture, human resources, creativity, project management, technology, process, product and commercialization. The interviewees were required to estimate the degree of using the innovation activities in their organizations using a Linkert scale from 1 to 7. Then, an exploratory factor analysis helps to derive the main factors and their elements. In addition, the authors also found evidence of a positive effect of IMPs on business performance measured by sale growth, profit per employee and ROA [44]. Türker (2012) developed an innovation scale to measure technological IC in the manufacturing industry, particularly in the automotive sector. His measurement scale refers to innovation factors belonging to input, process and output. Specifically, input factors include human resources, knowledge, strategy and entrepreneurship. Process factors consider organizational culture, control, and other related factors. Output factors consist of tangible returns and intellectual capital [14]. In an analysis of technological IC in Thailand technology firms, Sumrit and Anuntavoranich (2013) used DEMATEL method to analyze the importance and casual relationships among criteria: strategic management, organization, resource allocation, risk management, learning, absorptive capacity, knowledge management, network, technology acquisition, R&D, cross-functional team, technology change, design, manufacturing and market [45]. For measuring innovation process in French manufacturing firms, Boly et al. (2014) employed 15 IMPs from a research of Boly (2009) that are design, project management, integrated strategy, project portfolio management, organization, process innovation, competence management, moral support, knowledge management, technology intelligence, network management, collective learning, ideas research, R&D, and customer relationship management [3]. The researchers applied value test to determine the weights of 15 IMPs for each innovative class. In doing so, they identified key IMPs for each companies group. Yang et al. (2015) introduced the IC evaluation indicators system based on uncertain linguistic variables covering idea, marketing, resource, strategy, organizational structure and culture, and knowledge capability [13]. A research was conducted by Vicente et al. (2015) to study IC of exporting companies. A reliable IC construct specified 4 important dimensions: product development, innovativeness, strategy, and technology capability. Furthermore, they also investigated a significantly positive association between IC and annual performance in the case of 471 exporting firms [46]. Trindade et al. (2016) evaluated the IC of cross-sector small and medium-sized firms in terms of governance and organization, people, and processes in each firm. With the help of experts, they established inference rules to decide which innovative class (proactive, active, preactive and passive) a firm belongs to. Contributing to the literature benchmarking IMPs across sectors, Tidd and Thuriaux-Alemán (2016) presented 8 groups of IMPs including innovation strategy, idea management, resources and competence management, technology portfolio management, product portfolio management, development and launch, post-launch, and external business intelligence [8]. They also asserted that the effectiveness of using these IMPs will vary by sectors. Liu and Jiang (2016) studied the relationship between technological IC and product competitiveness [47]. They determined IC by the following elements: organization, strategies, financial, material, and human resources, R&D, knowledge, manufacturing capabilities.

From a variety of IMPs mentioned in these above articles, by grouping the related practices together based on their content described in the literature, we summarized into 25 primary IMPs that can be applied in banking sector as follows: strategic planning, resource management, organization, idea management, process innovation, marketing, R&D, learning, portfolio management, knowledge management, technological innovation, network management, project management, performance measure, product innovation, team management, moral support, commercialization, business intelligence, survey task, senior management, risk management, entrepreneurship, management participation, and delegation (see Table 2.1). We also eliminated some inappropriate practices with the context of banking such as manufacturing and design.

Table 2.1: Summary of IMPs

No	IMPs	Authors	
1	Strategic planning	Easingwood (1986) [32], Drew (1995) [18], Sundbo	
		(1997) [33], Griffin (1997) [34], Lawson and Samson	
		(2001) [36], Ulusoy (2003) [37], Cooper 2004 [6], Yam	
		et al. (2004) [38], Cormican and O'Sullivan (2004) [40],	
		Adam et al. (2006) [12], Oke (2007) [11], Koc and Cey-	
		lan (2007) [9], Rejeb et al. (2008) [42], Wang et al	
		(2008) [16], Wang and Chang (2011) [15], Sánchez et	
		al. (2011) [44], Yam et al. (2011) [39], Türker (2012)	
		[14], Sumrit and Anuntavoranich (2013) [45], Boly et	
		al. (2014) [3], Yang et. al (2015) [13], Vicente et	
		al. (2015) [46], Trindade et al. (2016) [31], Tidd and	
		Thuriaux-Alemán (2016) [8], Liu and Jiang (2016) [47]	
2	Resource management	Drew (1995) [18], Sundbo (1997) [33], Balbontin et al.	
		(2000) [35], Lawson and Samson (2001) [36], Ulusoy	
		(2003) [37], Cooper 2004 [6], Yam et al. (2004) [38],	
		Guan et al. (2006) [41], Adam et al. (2006) [12],	
		Oke (2007) [11], Rejeb et al. (2008) [42], Wang et al.	
		(2008) [16], Wang and Chang (2011) [15], Sánchez et	
		al. (2011) [44], Yam et al. (2011) [39], Türker (2012)	
		[14], Sumrit and Anuntavoranich (2013) [45], Boly et	
		al. (2014) [3], Yang et. al (2015) [13], Trindade et al.	
		(2016) [31], Tidd and Thuriaux-Alemán (2016) [8], Liu	
		and Jiang (2016) [47]	

3	Organization	Easingwood (1986) [32], Drew (1995) [18], Griffin (1997)	
		[34], Balbontin et al. (2000) [35], Lawson and Samson	
		(2001) [36], Cooper (2004) [5], Yam et al. (2004) [38],	
		Cormican and O'Sullivan (2004) [40], Guan et al. (2006)	
		[41], Adam et al. (2006) $[12]$, Rejeb et al. (2008) $[42]$,	
		Wang and Chang (2011) [15], Sánchez et al. (2011) [44],	
		Yam et al. (2011) [39], Türker (2012) [14], Sumrit and	
		Anuntavoranich (2013) [45], Boly et al. (2014) [3], Yang	
		et. al (2015) [13], Trindade et al. (2016) [31], Liu and	
		Jiang (2016) [47]	
4	Idea management	Easingwood (1986) [32], Drew (1995) [18], Lawson and	
		Samson (2001) [36], Ulusoy (2003) [37], Oke (2007) [11],	
		Koc and Ceylan (2007) [9], Rejeb et al. (2008) [42],	
		Brophey and Brown (2009) [43], Sánchez et al. (2011)	
		[44], Boly et al. (2014) [3], Yang et. al (2015) [13],	
		Vicente et al. (2015) [46], Tidd and Thuriaux-Alemán	
		(2016) [8]	
5	Process innovation	Griffin (1997) [34], Balbontin et al. (2000) [35], Cooper	
		(2004) [7], Oke (2007) [11], Rejeb et al. (2008) [42],	
		Wang and Chang (2011) [15], Sánchez et al. (2011) [44],	
		Türker (2012) [14], Boly et al. (2014) [3], Trindade et	
		al. (2016) [31], Tidd and Thuriaux-Alemán (2016) [8]	
6	Marketing	Balbontin et al. (2000) [35], Ulusoy (2003) [37], Yam	
		et al. (2004) [38], Guan et al. (2006) [41], Wang et	
		al. (2008) [16], Yam et al. (2011) [39], Sumrit and	
		Anuntavoranich (2013) [45], Boly et al. (2014) [3], Yang	
		et. al (2015) [13]	

7	R&D	Ulusoy (2003) [37], Yam et al. (2004) [38], Guan et al.	
		(2006) [41], Wang et al. (2008) [16], Yam et al. (2011)	
		[39], Sumrit and Anuntavoranich (2013) [45], Boly et al.	
		(2014) [3], Liu and Jiang (2016) [47]	
8	Learning	Balbontin et al. (2000) [35], Yam et al. (2004) [38],	
		Guan et al. (2006) [41], Koc and Ceylan (2007) [9],	
		Rejeb et al. (2008) [42], Yam et al. (2011) [39], Sumrit	
		and Anuntavoranich (2013) [45], Boly et al. (2014) [3]	
9	Portfolio management	Cooper (2004) [6], Cormican and O'Sullivan (2004) [40],	
		Adam et al. (2006) [12], Oke (2007) [11], Rejeb et al.	
		(2008) [42], Boly et al. (2014) [3], Tidd and Thuriaux-	
		Alemán (2016) $[8]$	
10	Knowledge manage-	Adam et al. (2006) [12], Rejeb et al. (2008) [42], Türker	
	ment	(2012) [14], Sumrit and Anuntavoranich (2013) [45],	
		Boly et al. (2014) [3], Yang et. al (2015) [13], Liu and	
		Jiang (2016) [47]	
11	Technological innova-	Balbontin et al. (2000) [35], Lawson and Samson (2001)	
	tion	[36], Ulusoy (2003) $[37]$, Koc and Ceylan (2007) $[9]$,	
		Sánchez et al. (2011) [44], Sumrit and Anuntavoranich	
		(2013) [45], Vicente et al. (2015) [46]	
12	Network management	Sundbo (1997) [33], Cormican and O'Sullivan (2004)	
		[40], Rejeb et al. (2008) [42], Sumrit and Anuntavo-	
		ranich (2013) [45], Boly et al. (2014) [3]	
13	Project management	Adam et al. (2006) [12], Rejeb et al. (2008) [42],	
		Sánchez et al. (2011) [44], Boly et al. (2014) [3]	
14	Performance measure	Easingwood (1986) [32], Griffin (1997) [34], Ulusoy	
		(2003) [37], Cormican and O'Sullivan (2004) [40]	
15	Product innovation	Balbontin et al. (2000) [35], Wang and Chang (2011)	
		[15], Sánchez et al. (2011) [44], Vicente et al. (2015) [46]	

16	Team management Cooper (2004) [5], Koc and Ceylan (2007) [9], Sumr		
		and Anuntavoranich (2013) [45]	
17	Moral support	Rejeb et al. (2008) [42], Boly et al. (2014) [3]	
18	Commercialization	Adam et al. (2006) [12], Sánchez et al. (2011) [44]	
19	Business intelligence	Lawson and Samson (2001) [36], Tidd and Thuriaux-	
		Alemán (2016) $[8]$	
20	Survey task	Rejeb et al. (2008) [42], Boly et al. (2014) [3]	
21	Senior Management	Cooper (2004) [5]	
22	Risk management	Sumrit and Anuntavoranich (2013) [45]	
23	Entrepreneurship	Türker (2012) [14]	
24	Management partici-	Koc and Ceylan (2007) [9]	
	pation		
25	Delegation	Koc and Ceylan (2007) [9]	

2.4 Innovation Capability Evaluation Methods

The most common approach for IC evaluation in the literature was based on multiple criteria. However, the differences exist in various aggregation techniques. Table 2.2 presents different methods used for IC evaluation in previous studies.

Rejeb et al. (2008) proposed a framework of IC measure considering 13 IMPs including design tasks, project management, integrated strategy, portfolio management, process improvement, suitable organization, competence management, moral support, collective learning, knowledge management, survey tasks, network management, and creativity [42]. These criteria are observable. If a criterion is present, its score equals 1 and 0 otherwise. The authors applied value test to determine the characteristic weight vector for each innovative group. As a result, they computed potential innovation index and classified the firms into four groups that are proactive, preactive, reactive and passive. Notice that when an IMP obtains the high level of implementation, IC will become stabilized, the authors considered the threshold effect by fitting each IMP with either S-curve model or condenser load model. In addition, they applied Principal Components Analysis to reduce the number of IMPs. After removing unimportant factors for classification, the representation of the firms is interpreted by the principal factors. Boly et al. (2014) also approached multi-criteria model and value test to determine IC of 39 manufacturing enterprises in French [3].

In the research of Wang et al. (2008), fuzzy integral method was adopted to measure technological ICs based on 5 following aspects: R&D, decision making, marketing, manufacturing, and capital [16]. Wang and Chang (2011) proposed a five-module innovation value diagnosis system of innovation in strategy, product, process, organization, and resource [15]. By using Analytic Hierarchy Process (AHP), they found the different importance roles of five modules among which process innovation was the most important module in innovation management of new projects. Cheng and Lin (2012) developed a hybrid method of fuzzy and MCDA to evaluate innovation performance and select the best supplier under fuzzy criteria of technological ICs [17].

Authors Evaluated factors		Aggregation method
	Design tasks	
	Project follow-up	
	Integrated strategy	
	Portfolio management	
	Innovation process	
Deich et al	Suitable organization	Value test
(2008)	Competence management	Data mining with Principal
(2008)	Moral support	Components Analysis
	Collective learning	
	Knowledge management	
	Survey tasks	
	Network animation	
	Research/creativity	

 Table 2.2: Review on IC evaluation methods

	R&D				
Warran et al	Innovation decision				
(2008)	Marketing	Fuzzy integral			
(2008)	Manufacturing				
	Capital				
	Strategy innovation				
Warrand Charra	Product innovation				
(2011)	Process innovation	Analytic Hierarchy Process			
(2011)	Organization innovation	(AHP)			
	Resource innovation				
	Strategic planning				
	Marketing				
Chara and Lin	Innovation infrastructure				
(2012)	Knowledge and skills	Hybrid Fuzzy-MCDA			
(2012)	TICs capabilities				
	External environment				
	Manufacturing capabilities				

	Design					
	Project management					
	Integrated strategy					
	Project portfolio management					
	Suitable organization definition					
	Innovation process improvement					
	Competence management					
Boly et al.	Moral support	Value test				
(2014)	Knowledge management	vanue test				
	Competitive technology					
	intelligence					
	Network management					
	Collective learning					
	Ideas research/Creativity					
	R&D activities					
	Customer relationship management					

Chapter 3

Methodology

In this chapter, we first introduce a framework of four steps to evaluate IC of the banks. Then, each step will be explained in details.

3.1 Research Framework

Our proposed research process for identifying IC consists of four steps, as illustrated in Figure 3.1. In step 1, CIMPs are explored by Pareto analysis based on their frequency of occurrences in the literature. Adapting from the prior studies, we establish the measurement items (sub-CIMPs) for each CIMP in step 2. Then, we ask a group of experts in banking sector for assessing the maturity level of sub-CIMPs in a sample group of banks. For step 3, we apply AHP to determine the weights of CIMPs and sub-CIMPs. Then, a composite index called Innovation Capability Index (ICI) is computed for each bank and used for ranking in step 4.

3.2 Procedure

3.2.1 Identify Critical Innovation Management Practices

Among many IMPs, CIMPs are vital constructs which must be carefully managed for being accomplished well to ensure success for innovation. Because of these practices' more important roles, the managers must put more efforts into them with the aims of improved innovation outcome, increased business outcomes, and strengthened compet-





itive advantages. In order to determine the CIMPs, we employ a statistical technique called Pareto analysis, which is used for choosing which factors or tasks that can produce significant overall effect [48]. Pareto analysis helps to separate the "vital few" from the "use many", which is useful for making management decisions with emphasis on the most crucial problems. In the procedure of Pareto, we first conduct a comprehensive literature review to extract IMPs by searching related key words such as innovation management practices, innovation practices, innovation management measurement, innovation capability evaluation, empirical innovation management, new product development practices (as shown in Section 2.3). Secondly, we count the number of occurrences of each IMP in the literature and then rank all IMPs in the descending order of their occurrences. After that, we can compute the percentage of occurrences as well as cumulative percentage of occurrences for each IMP. Conforming to the rule 80/20 of Pareto analysis, "vital few" items (called CIMPs in this research) will occupy a considerable amount of 80 percent of cumulative percentage of occurrences, and "use many" items fill only the remaining 20 percent of occurrences. Based on this rule, CIMPs are chosen from the IMP with the highest occurrences to the IMP at the cumulative percentage of occurrences around 80 percent. The result of Pareto analysis is usually represented in a table which shows in sequence: all IMPs, occurrences (in descending order), percentage of occurrences, cumulative percentage of occurrences.

3.2.2 Measure Critical Innovation Management Practices by sub-Critical Innovation Management Practices

To measure the development degree of each CIMP at a bank, measurement items (called sub-CIMPs) were adapted from prior research, which ensures reliability and validity. Then, all the sub-CIMPs are used to form the survey questionnaire to ask the experts for scoring the maturity level of these sub-CIMPs in the banks. A Linkert scale from 1 (very bad) to 5 (very good) is used for this assessment. The experts here should be the ones who understand well the field of banking, and work independently from the banks in case study.

The score of each sub-CIMP is calculated by averaging five scores that five experts assess it, using the equation (3.1) below:

$$sp(ij)(X) = \frac{1}{k} \sum_{1}^{k} sp_{ij,k}(X)$$
 (3.1)

where $sp_{ij}(X)$ is the score of the sub-CIMP j associated with the CIMP i at a bank X, $sp_{ij} \in [1,5]$; k is the number of the experts; $sp_{ij,k}(X)$ is the judgment value of the expert k for the sub-CIMP j associated with the CIMP i at a bank X, $sp_{ij,k} \in [1,5]$. The data from this step will be used to calculate the development degree of CIMPs in step 4 after getting the weights of sub-CIMPs in step 3.

3.2.3 Determine the weights of Critical Innovation Management Practices and sub-Critical Innovation Management Practices

In this research, we target at selecting the most innovative bank from a sample of banks based on their IC evaluated by a number of CIMPs and sub-CIMPs. Because Analytical Hierarchy Process (AHP) methodology is a powerful tool widely used in multiplecriteria decision-making [49]. It provides an effortlessly proper way to decrease a complex issue into a littler steps. The implementation of this method does not take much time but still assure the effectiveness. Therefore, we employ AHP to solve our problem.

In AHP analysis, the problem is decomposed by a hierarchy tree with different levels of decision elements. The highest level of the hierarchy shows the goal that is to select the most innovative bank or ranking the banks according to their IC. The intermediate levels represent decision criteria and sub-criteria that are CIMPs and sub-CIMPs. The lowest level shows alternatives that are several banks in our case study.

AHP uses pairwise comparisons to consider the importance of a decision element over another element at the same level with respect to the element of the higher level by using Saaty scale (see Table 3.1) [50]. A group of experts is invited to conduct these comparisons. The judgments of all experts for each pair comparison are then averaged and used to make the pairwise comparison matrix. The pairwise comparison matrix is normalized by the sum of each column. Then, by averaging the values in each row, we will get a relative priority (a set of weights) of elements in a level with respect to the element of the higher level.

Intensity of importance	Definition
1	Equal importance
3	Moderate importance
5	Strong importance
7	Very strong importance
9	Extreme importance
2, 4, 6, 8	For compromises between the above

Table 3.1: Saaty scale of relative importance

Finally, the consistency ratio (CR) is calculated by equation 3.2 to check how consistent the judgments of the experts and large samples of purely random judgments are.

$$CR = CI/RI \tag{3.2}$$

where CI is the consistency index reflecting the consistency of judgments in a pairwise comparison matrix (CI is computed by using equation 3.3 in which λmax is Eigenvalue, nis the number of elements in a level); RI (Random Index) is CI of a pairwise comparison matrix that is generated randomly (see Table 3.2). In practice, the value of CR of 0.1 or less will be accepted.

$$CI = \frac{\lambda max - n}{n - 1} \tag{3.3}$$

Table 3.2: Random Index

n	1	2	3	4	5	6	7	8	9	10	11	12
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.58

3.2.4 Compute Innovation Capability Index and rank

After getting the weights of all the sub-CIMPs, we can compute the development degree of CIMPs in the bank by equation (3.4).

$$p_i(X) = \sum_{j=1}^{m_i} w_{ij} s p_{ij}(X)$$
 with $\sum_{j=1}^{m_i} w_{ij} = 1$ (3.4)

where $p_i(X)$ is the development degree of the CIMP *i* at bank $X; p_i \in [1, 5]; sp_{ij}(X)$ is the score of the sub-CIMP *j* associated with the CIMP *i* at bank $X, sp_{ij} \in [1, 5]; m_i$ is the number of the sub-CIMPs associated with the CIMP *i*; w_{ij} is the weight of the sub-CIMP *j* associated with the CIMP *i*, $w_{ij} \in [0, 1]$.

With the goal of ranking the banks according to their IC, multiple CIMPs are taken into account for IC evaluation. The IC of a bank is expressed through a composite index called Innovation Capability Index (ICI). Considering a bank X, its ICI is calculated by the following equation (3.5):

$$ICI(X) = \sum_{i=1}^{n} W_i p_i(X) \text{ with } \sum_{i=1}^{n} W_i = 1$$
 (3.5)

where ICI(X) is the innovation capability index of the bank X, $ICI(X) \in [1, 5]$; n is the number of CIMPs; $p_i(X)$ is the development degree of the CIMP i at bank X; $p_i \in [1, 5]$; W_i is the weight of the CIMP i; $W_i \in [0; 1]$. Based on the ICI of the banks, we can make a ranking from the bank with the highest ICI (the most innovative bank) to the bank with the lowest ICI (the least innovative bank).

Chapter 4

Empirical Results

By applying our proposed framework of IC evaluation introduced in Chapter 3, this chapter reports the results of evaluating the IC in a case study of three major banks in Vietnam. To maintain the confidentiality of the banks, the three banks are called as Bank A, Bank B, Bank C in this study.

4.1 Identify Critical Innovation Management Practices

The results of Pareto analysis is revealed in Table 4.1. From all the 28 selected articles mentioned in Section 2.3, we extracted totally 25 IMPs: strategic planning, resource management, organization, idea management, process innovation, marketing, R&D, learning, portfolio management, knowledge management, technological innovation, network management, project management, performance measure, product innovation, team management, moral support, commercialization, business intelligence, survey task, senior management, risk management, entrepreneurship, management participation, and delegation. These IMPs were then ranked in the descending order of their occurrences in the 28 selected articles. Next, we calculated the percentage of occurrences as well as cumulative percentage of occurrences for each IMP. Based on the rule 80/20 of Pareto analysis, the first 11 IMPs in Table 4.1 were chosen as CIMPs that occupy 80.588 percent of cumulative percentage of occurrences. CIMPs are strategic planning (SP), resource management (RM), organization (OR), idea management (IM), process innovation (PI), marketing (MA), R&D (RD), learning (LE), portfolio management (PM), knowledge management (KM), and technological innovation (TI).

			Percentage of	Cumulative
No	IMPs	Occurrences	occurrences	percentage of
			(%)	occurrences $(\%)$
1	Strategic planning	25	14.706	14.706
2	Resource management	22	12.941	27.647
3	Organization	20	11.765	39.412
4	Idea management	13	7.647	47.059
5	Process innovation	11	6.471	53.529
6	Marketing	9	5.294	58.824
7	R&D	8	4.706	63.529
8	Learning	8	4.706	68.235
9	Portfolio management	7	4.118	72.353
10	Knowledge management	7	4.118	76.471
11	Technology management	7	4.118	80.588
12	Network management	5	2.941	83.529
13	Project management	4	2.353	85.882
14	Performance measure	4	2.353	88.235
15	Product innovation	4	2.353	90.588
16	Team management	3	1.765	92.353
17	Moral support	2	1.176	93.529
18	Commercialization	2	1.176	94.706
19	Business intelligence	2	1.176	95.882
20	Survey task	2	1.176	97.059
21	Senior management	1	0.588	97.647
22	Risk management	1	0.588	98.235
23	Entrepreneurship	1	0.588	98.824

Table 4.1: Pareto analysis for IMPs

24	Management participation	1	0.588	99.412
25	Delegation	1	0.588	100
	Total	170	100	

4.2 Measure Critical Innovation Management Practices by sub-Critical Innovation Management Practices

Each CIMP was measured by four sub-CIMPs, as shown in Table 4.2. In total, the survey questionnaire for the experts to evaluate 11 CIMPs at each bank includes 44 questions (see Appendix A - Part 1), using the Linkert scale from 1 (very bad) to 5 (very good). Five experts who understand well about Vietnamese banking system were invited to join in CIMPs assessment for the case study of three Vietnamese banks. Two of them are vice directors of the banks. Two other experts are lecturers in the Banking University of Hochiminh City. And the final expert is an auditor in banking.

No	CIMPs	Sub-CIMPs	Sources
		SP1: Define clearly goals relating to innovation	
		in strategic plans	Easingwood (1986) [32],
		SP2: Innovation strategy is widely understood	Cooper 2004 [6],
1	SD	throughout the bank	Oke (2007) [11],
1	51	SP3: Top management is committed to support	Rejeb et al. (2008) [42],
		innovation activities	Wang and Chang (2011) $[15]$,
		SP4: Use decision aid tools such as SWOT to build	Boly et al. (2014) [3]
		the bank strategy	
		RM1: Provide adequate resources for innovation	Kuczmarski (1994) [51],
		RM2: Have flexible and diversified capital origins	Guan et al. (2006) [41],
2	RM	RM3: Actively hire talented employees	Yam et al. (2011) [39],
		RM4: Organize regular training programs for	Wang and Chang (2011) $[15]$,
		knowledge required for future product development	Boly et al. (2014) [3]

Table 4.2: Constructs and measurement items

3	OR	 OR1: Culture and climate encourage for innovation OR2: Reward employees for innovation OR3: Tolerate innovation failures OR4: Have open communication network in the bank IM1: Have a formalized procedure to collect ideas from different areas in the bank 	Cooper (2004) [5], Oke (2007) [11], Rejeb et al. (2008) [42], Wang and Chang (2011) [15], Boly et al. (2014) [3]
4	IM	IM2: Cooperate with external organizations such as universities, competitors, etc. for idea creationIM3: Have a fast assessment process for new ideasIM4: Use a test market before launching new products	Easingwood (1986) [32], Oke (2007) [11], Boly et al. (2014) [3]
5	PI	 PI1: Use a structured innovation process PI2: Have facilitator groups for the stages of innovation process PI3: Cary out meetings to analyze innovation activities PI4: Top management regularly reviews progress of innovation projects 	Griffin (1997) [34], Rejeb et al. (2008) [42], Boly et al. (2014) [3]
6	MA	MA1: Have close relationship with major customersMA2: Have highly efficient salesforceMA3: Track customer satisfaction level after usingthe bank's servicesMA4: Maintain a good brand image in the mind ofcustomers	Yam et al. (2004) [38], Yam et al. (2011) [39], Boly et al. (2014) [3]
7	RD	 RD1: Have a formalized R&D program RD2: Continuously improve budget dedicated to R&D activities RD3: Use cross-functional teamwork RD4: Hold regular meetings for research themes programming 	Boly et al. (2014) [3], Tidd and Thuriaux-Alemán (2016) [8]

		LE1: Have methodologies for collective learning			
		such as inter-service meetings			
		LE2: Some managers take responsibilities for			
0	LD	collective learning tasks	Guan et al. (2006) [41],		
8	LE	LE3: Hold assessment meetings at the end of	Boly et al. (2014) [3],		
		projects	Liu and Jiang (2016) [47]		
		LE4: Pass lessons learned from past experiences			
		and failures across the bank			
		PM1: Align the bank strategy with portfolio			
		PM2: Use multi-criteria analysis to supervise all			
		ongoing projects	Cooper (2004) [6],		
9	PM	PM3: Have regular reports about resource	Boly et al. (2014) [3],		
		allocation into multi-projects	Tidd and Thuriaux-Alemán		
		PM4: Balance long-versus short-term, high-versus	(2016) [8]		
		low-risk, etc. projects			
		KM1: Identify employees' knowledge and adjust			
		with required knowledge			
		KM2: Encourage knowledge exchange and sharing			
10	KM	KM3: Have a dedicated system for organizing and	Boly et al. (2014) [3],		
		storing knowledge and experience for easy access	Liu and Jiang (2010) [47]		
		by employees			
		KM4: Use knowledge dissemination methodologies			
		TI1: Technology development and application is			
		regarded as a key success factor			
		TI2: Have methodologies such as scenario planning	Cupp et al. (2006) [41]		
		to predict accurately new technology trends	Guan et al. (2000) [41], Kee and Ceylan (2007) [0]		
11	TI	TI3: Understand competitors' core technology	Sumrit and Anuntavoranich		
		competence	(2013) [45]		
		TI4: Technology acquisition from other parties			
		compatible with the infrastructures and activities			
		in the bank			

Due to the different work nature and workplaces, it is difficult to gather all the experts together to discuss the assessment. Thus, we conducted survey questionnaires

with five experts separately and then calculated the average of their judgments to get the score of each sub-CIMP, using Equation (3.1). The detailed assessment of each expert for 44 sub-CIMPs at each bank is shown in Appendix B. Table 4.3 shows the scores of 44 sub-CIMPs in three Vietnamese banks based on synthesized judgments of five experts.

sub_CIMP	Bank A	Bank B	Bank C
SP1	4.40	4.60	4.00
SP2	4.20	4.40	4.00
SP3	3.80	4.40	4.80
SP4	4.00	4.40	4.40
RM1	3.40	4.00	4.00
RM2	4.20	4.00	4.80
RM3	4.00	4.60	4.40
RM4	3.40	4.20	4.20
OR1	3.80	4.40	3.40
OR2	4.00	4.00	4.20
OR3	3.60	3.60	3.40
OR4	3.40	4.20	4.00
IM1	3.20	3.80	4.20
IM2	3.40	4.00	3.60
IM3	3.20	3.80	3.80
IM4	3.40	4.20	3.60
PI1	3.40	4.20	4.20
PI2	3.80	4.20	4.00
PI3	3.80	4.20	4.00
PI4	3.60	4.20	3.80
MA1	4.00	4.60	4.40
MA2	3.80	4.20	3.60
MA3	3.60	4.20	3.80
MA4	3.80	4.40	4.20

Table 4.3: Scores of sub-CIMPs in three Vietnamese banks

RD1	3.60	4.40	4.00
RD2	3.80	4.00	3.80
RD3	3.60	4.40	3.60
RD4	3.60	4.20	3.60
LE1	4.00	4.00	4.20
LE2	3.40	4.00	4.20
LE3	3.60	4.20	4.20
LE4	3.20	4.00	4.00
PM1	4.20	4.40	4.40
PM2	3.40	4.20	4.40
PM3	3.80	4.20	4.00
PM4	3.80	4.00	4.20
KM1	4.60	4.00	4.20
KM2	3.80	4.20	4.20
KM3	3.80	4.00	4.00
KM4	4.60	4.00	3.80
TI1	4.50	4.20	3.80
TI2	3.60	4.20	3.80
TI3	3.80	4.40	3.80
TI4	3.40	4.20	4.20

4.3 Determine the weights of Critical Innovation Management Practices and sub-Critical Innovation Management Practices

In this research, we approached AHP to rank the banks based on their IC evaluated by a number of CIMPs and sub-CIMPs. The hierarchy tree for decomposing our problem is shown in Figure 4.1. In the first level of the hierarchy, the goal is to select the most innovative bank among three Vietnamese banks. The intermediate level represents 11 criteria that are 11 CIMPs and 44 sub-criteria that are 44 sub-CIMPs. The lowest level shows three alternatives, including Bank A, Bank B, and Bank C.



Figure 4.1: AHP model for ranking the banks

The different practices will have different roles in banking innovation, so we need to consider the priorities among 11 CIMPs and 44 sub-CIMPs. By using pairwise comparisons, AHP helps to determine the importance weights of CIMPs with respect to the decision problem and the weights of sub-CIMPs with respect to each CIMP. The five experts who were invited in step 2 also participated in the survey questionnaires of pairwise comparisons (see Appendix A - Part 2 & Part 3), using Saaty scale from 1 - equal importance to 9 - extreme importance (see Table 3.1). Then, we used the average of their judgments to develop the pairwise comparison matrices as displayed in Table 4.4 and 4.5.

The weight vector of CIMPs was determined to be $W = \{0.28, 0.19, 0.05, 0.05, 0.02, 0.06, 0.08, 0.05, 0.02, 0.09, 0.10\}$. When evaluating the IC of the banks, according to the viewpoints of these five experts, strategic planning (ST) is the most important practice in innovation process; resource management is the second one; technological innovation is the thirst one; knowledge management is on the fourth; R&D is on the fifth; marketing is on the sixth; organization, idea management and learning are on the seventh; process innovation and portfolio management are the last ones (see Table 4.4).

By similar calculations, the weight vector of sub-CIMPs (SP1, SP2, SP3, SP4) was identified to be $W=\{0.45, 0.09, 0.14, 0.32\}$. The weight vector of sub-CIMPs (RM1, RM2, RM3, RM4) was $W=\{0.36, 0.09, 0.34, 0.20\}$. For sub-CIMPs (OR1, OR2, OR3, OR4), their weights were in sequence: 0.35, 0.32, 0.11, 0.22. The weights of IM1, IM2, IM3, IM4 were 0.43, 0.15, 0.07, 0.35, respectively. With respect to PI, the weight vector of its

sub-CIMPs (PI1, PI2, PI3, PI4) was 0.44, 0.29, 0.12, 0.16. For sub-CIMPs of MA (MA1, MA2, MA3, MA4), their weights were in sequence: 0.17, 0.39, 0.24, 0.21. With respect to RD, the weights of RD1, RD2, RD3, RD4 were 0.39, 0.10, 0.37, 0.15, respectively. The weight vector of sub-CIMPs (LE1, LE2, LE3, LE4) was identified to be $W=\{0.11, 0.40, 0.17, 0.32\}$. For sub-CIMPs (PM1, PM2, PM3, PM4), their weights were in sequence: 0.12, 0.45, 0.26, 0.17. The weight vector of sub-CIMPs (KM1, KM2, KM3, KM4) was determined to be $W=\{0.35, 0.32, 0.11, 0.22\}$. The weights of TI1, TI2, TI3, TI4 were 0.08, 0.50, 0.27, 0.14, respectively (see Table 4.5).

As all the CR values were less than 0.1, the judgments in our research are reliable.

IMPs	SP	RM	OR	IM	PI	MA	RD	LE	PM	KM	ΤI	Weights (W_i)
SP	1	3	5	5	7	5	5	5	7	5	4	0.28
RM	1/3	1	5	4	6	3	4	4	5	4	4	0.19
OR	1/5	1/5	1	2	3	1/3	1/2	1/2	4	1/3	1/4	0.05
IM	1/5	1/4	1/2	1	4	1	1/2	1	4	1/2	1	0.05
PI	1/7	1/6	1/3	1/4	1	1/4	1/4	1/3	2	1/4	1/5	0.02
MA	1/5	1/3	3	1	4	1	1/2	2	4	1/3	1/2	0.06
RD	1/5	1/4	2	2	4	2	1	3	5	1	1/2	0.08
LE	1/5	1/4	2	1	3	1/2	1/3	1	3	1/2	1/2	0.05
PM	1/7	1/5	1/4	1/4	1/2	1/4	1/5	1/3	1	1/6	1/6	0.02
KM	1/5	1/4	3	2	4	3	1	2	6	1	1/2	0.09
TI	1/4	1/4	4	1	5	2	2	2	6	2	1	0.10
	CR=0.06											

Table 4.4: Pairwise comparisons of CIMPs with respect to IC

Table 4.5: Pairwise comparisons of sub-CIMPs with respect to CIMPs

A. Pairwise comparisons of sub-CIMPs with respect to SP						
SP	SP1	SP2	SP3	SP4	Weight (w_{ij})	
SP1	1	4	3	2	0.45	
SP2	1/4	1	1/2	1/4	0.09	
SP3	1/3	2	1	1/3	0.14	

SP4	1/2	4	3	1	0.32		
			CR	= 0.03			
B. Pai	rwise co	omparis	ons of s	ub-CIM	IPs with respect to RM		
RM	RM1	RM2	RM3	RM4	Weight (w_{ij})		
RM1	1	4	1	2	0.36		
RM2	1/4	1	1/3	1/3	0.09		
RM3	1	3	1	2	0.34		
RM4	1/2	3	1/2	1	0.20		
			CR	= 0.02			
C. Pai	irwise c	omparis	ons of s	sub-CIN	IPs with respect to OR		
OR	OR1	OR2	OR3	OR4	Weight (w_{ij})		
OR1	1	1	3	2	0.35		
OR2	1	1	2	2	0.32		
OR3	1/3	1/2	1	1/3	0.11		
OR4	1/2	1/2	3	1	0.22		
			CR	= 0.04			
D. Pa	irwise c	omparis	sons of a	sub-CIN	MPs with respect to SP		
IM	IM1	IM2	IM3	IM4	Weight (w_{ij})		
IM1	1	3	4	2	0.43		
IM2	1/3	1	3	1/4	0.15		
IM3	1/4	1/3	1	1/5	0.07		
IM4	1/2	4	5	1	0.35		
			CR	= 0.08			
E. Pa	irwise c	omparis	sons of	sub-CIN	MPs with respect to PI		
PI	PI1	PI2	PI3	PI4	Weight (w_{ij})		
PI1	1	2	3	3	0.44		
PI2	1/2	1	2	3	0.29		
PI3	1/3	1/2	1	1/2	0.12		
PI4	1/3	1/3	2	1	0.16		
	CR = 0.05						

F. Pairwise comparisons of sub-CIMPs with respect to MA					
MA	MA1	MA2	MA3	MA4	Weight (w_{ij})
MA1	1	1/2	1	1/2	0.17
MA2	2	1	2	2	0.39
MA3	1	1/2	1	2	0.24
MA4	2	1/2	1/2	1	0.21
			CR	= 0.07	
F. Pai	irwise co	omparis	ons of s	sub-CIN	IPs with respect to RD
RD	RD1	RD2	RD3	RD4	Weight (w_{ij})
RD1	1	4	1	3	0.39
RD2	1/4	1	1/3	1/2	0.10
RD3	1	3	1	3	0.37
RD4	1/3	2	1/3	1	0.15
			CR	= 0.02	
G. Pa	irwise c	omparis	sons of s	sub-CIN	APs with respect to LE
LE	LE1	LE2	LE3	LE4	Weight (w_{ij})
LE1	1	1/3	1/2	1/3	0.11
LE2	3	1	2	2	0.40
LE3	2	1/2	1	1/3	0.17
LE4	3	1/2	3	1	0.32
			CR	= 0.05	
H. Pai	rwise co	omparis	ons of s	ub-CIN	IPs with respect to PM
PM	PM1	PM2	PM3	PM4	Weight (w_{ij})
PM1	1	1/3	1/2	1/2	0.12
PM2	3	1	2	3	0.45
PM3	2	1/2	1	2	0.26
PM4	2	1/3	1/2	1	0.17
			CR	= 0.03	
I. Pair	rwise co	mpariso	ons of s	ub-CIM	Ps with respect to KM
KM	KM1	KM2	KM3	KM4	Weight (w_{ij})

KM1	1	1	3	2	0.35			
KM2	1	1	2	2	0.32			
KM3	1/3	1/2	1	1/3	0.11			
KM4	1/2	1/2	3	1	0.22			
	CR = 0.04							
J. Pa	irwise c	omparis	sons of s	sub-CIN	IPs with respect to TI			
TI	TI1	TI2	TI3	TI4	Weight (w_{ij})			
TI1	1	1/4	1/4	1/3	0.08			
TI2	4	1	3	4	0.50			
TI3	4	1/3	1	3	0.27			
TI4	3	1/4	1/3	1	0.14			
	CR = 0.09							

4.4 Compute Innovation Capability Index and rank

By using the equation (3.4), the development degrees of CIMPs in each bank were computed and the results are presented in Table 4.6.

	SP	RM	OR	IM	PI	MA	RD	LE	РМ	KM	ΤI
Bank A	4.17	3.64	3.75	3.30	3.63	3.82	3.66	3.44	3.67	4.26	3.66
Bank B	4.49	4.20	4.14	3.97	4.24	4.35	4.37	4.03	4.19	4.06	4.21
Bank C	4.24	4.21	3.79	3.87	4.10	3.95	3.81	4.14	4.26	4.09	3.82

Table 4.6: Development degree of CIMPs in three Vietnamese banks

Then, the ICIs were calculated by feeding the equation (3.5). As a result, the ICIs of the banks A, B, C were determined to be 3.80, 4.23, 4.04, respectively. Consequently, bank B with the highest ICI value of 4.23 is the most innovative bank in the sample. Bank C having the ICI value of 4.04 stands at the second position in the ranking of IC. The least innovative bank is bank A with ICI value of 3.80 (see Table 4.7).

	ICI	Rank
Bank A	3.80	3
Bank B	4.23	1
Bank C	4.04	2

Table 4.7: ICI and rank of three Vietnamese banks

Chapter 5

Discussions

5.1 Justification

The innovation measurement in banking sector has been not largely clarified in literature. Our study contributes a theoretical framework of IC evaluation in the case of three Vietnamsese banks. When a bank innovate better and faster than their rivals by continuously providing services that are new, differentiated and high-quality, this bank will attract more customers to use their services, thereby increase their performance and competitiveness. Many previous research asserted the positive association between innovativeness and firm performance [44, 52–54]. Firm performance can be considered by financial performance [44, 54, 55]. Return on assets (ROA) as a popular accounting indicator was used to measure the firm's financial performance [56]. It was employed in the study of Calantone et al. (2002) to find the correlations of learning orientation, firm IC, and firm performance [53], the research of Jen Huang and Ju Liu (2005) to investigate the effect of innovation on firm performance [52], and the study of Dibrell et al. (2014) to test the impact of strategic planning process, planning flexibility and innovativeness on firm performance in 448 multi-industry firms [54]. For this reason, in this study, we also employed ROA indicator to evaluate the performance of the banks - result from their innovation process.

A review on the financial statements of three Vietnamese banks in our sample during the last three years from 2016 to 2018 revealed that bank B had the highest averaged ROA of 1.11, the next was bank C with averaged ROA of 0.67, and bank A had the lowest averaged ROA of 0.63 (see Table 5.1). According to ROA indicators, bank B, C, A are in the ranking from the highest to the lowest ROA. That is in line with the ranking of three banks evaluated by IC. In addition, with modern and creative applications integrating various features, Bank B was awarded by a prestigious magazine in the field of finance in Asia - Asian Banking & Finance (ABF) for "Mobile banking initiative of the year - the most innovative mobile banking product in 2018". Bank B has innovated and caught up with technology trends, meeting customers' needs. Specifically, Bank B's mobile banking service have prominent interfaces, ensuring uniformity, youthfulness and brings a lot of experiences to users. Because of the facts above, our research results can be justified.

Bank	2016	2017	2018	3-year average
В	0.94	1.00	1.39	1.11
С	0.79	0.73	0.48	0.67
А	0.67	0.63	0.60	0.63

Table 5.1: ROA of three Vietnamese banks in period 2016-2018

5.2 Managerial Implications

Our research framework is useful for bank managers to evaluate the impacts of CIMPs on their banks' IC. Applying AHP indicates that strategic planning, resource management and technological innovation are the three most important CIMPs for banking innovation. Therefore, to improve the innovation process to achieve better IC and approach higher rank, the bank managers must prioritize to develop the CIMPs that have the strongest weights first. Especially, they should pay much more attention to strategic plans that are the guidelines for all activities of the banks, ensure comprehensive and synchronous development, also create breakthroughs for the banks. In addition, they also need to mobilize the whole bank from top managers to employees in the branches to realize innovation strategies. It can be noted that in our study, the most innovative bank B has the most developed strategic planning practice among three banks with a development degree of 4.45 (see Table 4.6). Furthermore, Bank B is also the most mature bank in technological innovation with a development degree of 4.25. But for resource management, bank B has a development degree of 4.20 that is slightly lower than Bank C, but still higher than Bank A. For other CIMPs (except LE, PM, KM), Bank B all have the highest development degrees compared with the other banks. In contrast, the least innovative bank (Bank A) is the weakest at all practices except KM. That results in the differences in their ranking by IC. To catch up with the competitors, the lower innovative bank should invest more in CIMPs; especially under limited resources, it can give priority to improve the most significant CIMPs first. For IMPs with low weights for IC, they can be considered as basic practices. Even they do not contribute much to IC improvement, but their realization may be necessary for the development of other IMPs.

Furthermore, the IC evaluation should be conducted periodically because of the changes in the development degree of IMPs and their roles for IC improvement in increasingly changing business environments. Besides, new IMPs are also emerging, which should also be taken into account to keep up with new trends.

Chapter 6

Conclusions

6.1 Summary

In this thesis, we have presented a method to evaluate IC in banking based on multiple criteria for successful innovation. By conducting a comprehensive investigation into the best IMPs from successful cases of innovation from previous related works, we attracted 25 primary IMPs. Then, a Pareto analysis was applied and found out 11 CIMPs for the banks: strategic planning, resource management, organization, idea management, process innovation, marketing, R&D, learning, portfolio management, knowledge management, and technological innovation. These practices were subdivided into 44 sub-CIMPs for measurement. A group of five experts who are professionals in banking major was invited to score these sub-CIMPs in the case of three major banks in Vietnam, using a Linkert scale from 1 (very bad) to 5 (very good). Then, AHP was used to determine the importance weights of 11 CIMPs and 44 sub-CIMPs. The results indicated that for banking innovation, strategic planning, resource management, and technological innovation are the most important practices with the weights of 0.28, 0.19 and 0.10, respectively. In practice, the banks should put more efforts into these practices to leverage their IC effectively. Finally, the index ICI that was representative for IC of each bank was calculated. By applying our research framework, three Vietnamese banks were ranked according to their IC. Our research findings could be a basis for the banks to determine the strengths and weaknesses in their processes of innovation management, thereby propose reasonable adjustments to improve their IC and achieve better innovation outcomes.

6.2 Limitations

This research has some following limitations. First, in this research, we only focus on the IMPs from existing research. They were benchmarked as the best innovation practices in general. Therefore, there may be new and unique IMPs for the context of banking that we have not captured. Second, the data used in this study depended much on the opinions of five experts. The judgment values might also be distorted by human emotions. In such a qualitative research, the quality of research is influenced much by the accuracy in the experts' judgments. Third, we carried out the surveys with five experts separately and then averaged their judgments. During data collection, when conflicts occurred among the experts' judgments, we must discuss them again, which was very time-consuming. Thus, it is better to gather all experts into a joint meeting for them to together discuss and make unified judgments. Forth, our IC evaluation method was conducted in a small sample with only three banks. The significance of findings might be limited in the case of these banks. Those limitations can be overcome by taking further research directions in Section 6.3.

6.3 Future Works

Each field has its unique characteristics in managing innovation. To evaluate more precisely the IC of the banks, we should conduct additional interviews with professionals in innovation and banking major with the aims of exploring and updating new IMPs in the concrete context of banking sector. That will also contribute to expanding literature about IMPs, especially for innovation measurement in banking. Additionally, we should persuade more experts to participate in a joint meeting for assessment to increase the accuracy of the data. Furthermore, a larger sample of banks is needed to check the reliability and validity of the proposed method.

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Appendices

A Survey Questionnaires

RESEARCH ON INNOVATION CAPABILITY IN BANKING

Our research aims at evaluating the innovation capability of the banks based on 11 critical innovation management practices (CIMPs) that are measured by 44 specific innovation management practices (sub-CIMPs).

Brief explanation:

CIMPs	Sub-CIMPs			
	SP1: Define clearly goals relating to innovation in strategic plans			
	SP2: Innovation strategy is widely understood throughout the bank			
Strategic Planning (SP)	SP3: Top management is committed to support innovation activities			
	SP4: Use decision aid tools such as SWOT to build the bank strategy			
	RM1: Provide adequate resources for innovation activities			
	RM2: Have flexible and diversified capital origins			
Resources Management (RM)	RM3: Actively hire talented employees			
	RM4: Organize regular training programs for knowledge required for future product development			
	OR1: Culture and climate encourage for innovation			
	OR2: Reward employees for innovation			
Organization (OR)	OR3: Tolerate innovation failures			
	OR4: Have open communication network in the bank			
	IM1: Have a formalized procedure to collect ideas from different areas in the bank			
	IM2: Cooperate with external organizations such as universities, competitors, etc. for idea creation			
Idea Management (IM)	IM3: Have a fast assessment process for new ideas			
	IM4: Use a test market before launching new products			
	PII: Use a structured innovation process			
	PI2: Have facilitator groups for the stages of innovation process			
Process Innovation (PI)	PI3: Cary out meetings to analyze innovation activities			
	PI4: Top management regularly reviews progress of innovation projects			
	MA1: Have close relationship with major customers			
	MA2: Have highly efficient salesforce			
Marketing (MA)	MA3: Track customer satisfaction level after using the bank's services			
	MA4: Maintain a good brand image in the mind of customers			
	RD1: Have a formalized R&D program			
	RD2: Continuously improve budget dedicated to R&D activities			
R&D (RD)	RD3: Use cross-functional teamwork			
	RD4: Hold regular meetings for research themes programming			
	LE1: Have methodologies for collective learning such as inter-service meetings			
	LE2: Some managers take responsibilities for collective learning tasks			
Learning (LE)	LE3: Hold assessment meetings at the end of projects			
	LE4: Pass lessons learned from past experiences and failures across the bank			
	PM1: Align the bank strategy with portfolio			
	PM2: Use multi-criteria analysis to supervise all ongoing projects			
Portfolio Management (PM)	PM3: Have regular reports about resource allocation into multi-projects			
	PM4: Balance long-versus short-term, high-versus low-risk, etc. projects			
	KM1: Identify employees' knowledge and adjust with required knowledge			
	KM2: Encourage knowledge exchange and sharing			
Knowledge Management (KM)	KM3. Have a dedicated system for organizing and storing knowledge and experience for easy access by			
()	employees			
	KM4: Use knowledge dissemination methodologies			
	TI1: Technology development and application is regarded as a key success factor			
	TI2: Have methodologies such as scenario planning to predict accurately new technology trande			
Technological Innovation (TI)	TI3. Inderstand competitors' core technology competence			
	The Tachnology acquisition from other partice compatible with the infunctivistics and activities in the back			
	114. recunology acquisition nom other parties compatible with the infrastructures and activities in the bank			

PART 1: Score sub-CIMPs in three Vietnamese banks

This part is to assess the maturity level of 44 sub-CIMPs in three Vietnamese banks. Based on your opinion, please score these practices in Bank A, Bank B, Bank C by ticking the appropriate cell. Use the following scale:



1 – Very bad, 2 – Bad, 3 – Neutral, 4 – Good, 5 – Very good.

PART 2: Pairwise comparisons of CIMPs with respect to innovation capability in banking

This part is to evaluate the relative importance of 11 CIMPs in banking innovation based on pairwise comparisons. Use the following scale:

Intensity of importance	Definition
1	Equal importance
3	Moderate importance
5	Strong importance
7	Very strong importance
9	Extreme importance
2, 4, 6, 8	For compromises between the above

Please circle one appropriate number expressing the relative importance of a CIMP against others:

	Factor weighting score				
CIMPs	More important than	Equal	Less important than	CIMPs	
	98765432	1	23456789	RM	
SP	98765432	1	23456789	OR	
	98765432	1	23456789	IM	
	98765432	1	23456789	PI	
	98765432	1	23456789	MA	
	98765432	1	23456789	RD	
	98765432	1	23456789	LE	
	98765432	1	23456789	PM	
	98765432	1	23456789	KM	
	98765432	1	23456789	TI	
	98765432	1	23456789	OR	
	98765432	1	$2\ 3\ 4\ 5\ 6\ 7\ 8\ 9$	IM	
	98765432	1	23456789	PI	
	98765432	1	23456789	MA	
RM	98765432	1	23456789	RD	
	98765432	1	23456789	LE	
	98765432	1	23456789	PM	
	98765432	1	23456789	KM	
	98765432	1	23456789	TI	
	98765432	1	23456789	IM	
	98765432	1	23456789	PI	
	98765432	1	23456789	MA	
	98765432	1	23456789	RD	
OR	98765432	1	23456789	LE	
	98765432	1	23456789	PM	
	98765432	1	23456789	KM	
	98765432	1	23456789	TI	
	98765432	1	23456789	PI	
	98765432	1	23456789	MA	
	98765432	1	23456789	RD	
IM	98765432	1	23456789	LE	
	98765432	1	23456789	PM	
	98765432	1	23456789	KM	
	98765432	1	23456789	TI	
	98765432	1	23456789	MA	
	98765432	1	23456789	RD	
	98765432	1	23456789	LE	
PI	98765432	1	23456789	PM	
	98765432	1	23456789	KM	
	98765432	1	23456789	TI	
	98765432	1	23456789	RD	
	98765432	1	23456789	LE	
MA	98765432	1	23456789	PM	
	98765432	1	23456789	KM	
	98765432	1	23456789	TI	
	98765432	1	23456789	LE	
	98765432	1	23456789	PM	
RD	98765432	1	23456789	KM	
	98765432	1	23456789	TI	
	98765432	1	23456789	PM	
LE		· •			

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	$9\ 8\ 7\ 6\ 5\ 4\ 3\ 2$	1	$2\ 3\ 4\ 5\ 6\ 7\ 8\ 9$	KM
	$9\ 8\ 7\ 6\ 5\ 4\ 3\ 2$	1	$2\ 3\ 4\ 5\ 6\ 7\ 8\ 9$	TI
РМ	$9\ 8\ 7\ 6\ 5\ 4\ 3\ 2$	1	$2\ 3\ 4\ 5\ 6\ 7\ 8\ 9$	KM
	$9\ 8\ 7\ 6\ 5\ 4\ 3\ 2$	1	$2\ 3\ 4\ 5\ 6\ 7\ 8\ 9$	TI
KM	$9\ 8\ 7\ 6\ 5\ 4\ 3\ 2$	1	$2\ 3\ 4\ 5\ 6\ 7\ 8\ 9$	TI

PART 3: Pairwise comparisons of sub-CIMPs with respect to CIMPs

This part is to determine to relative importance of 4 sub-CIMPs for each CIMP based on pairwise comparisons. Use the same scale from 1 to 9 as in PART 2. Please circle one appropriate number expressing the relative importance of a sub-CIMP against others:

G L CIMP.	Factor weighting score				
Sub-CIMPs	More important than	Equal	Less important than	Sub-CIMPs	
	With	respect t	o SP		
	$9\ 8\ 7\ 6\ 5\ 4\ 3\ 2$	1	23456789	SP2	
SP1	98765432	1	23456789	SP3	
	98765432	1	23456789	SP4	
GDa	98765432	1	23456789	SP3	
SP2	98765432	1	23456789	SP4	
SP3	98765432	1	23456789	SP4	
	With	respect to	o RM		
	$9\ 8\ 7\ 6\ 5\ 4\ 3\ 2$	1	$2\ 3\ 4\ 5\ 6\ 7\ 8\ 9$	RM2	
RM1	98765432	1	23456789	RM3	
	98765432	1	$2\ 3\ 4\ 5\ 6\ 7\ 8\ 9$	RM4	
53/6	98765432	1	23456789	RM3	
RM2	98765432	1	23456789	RM4	
RM3	98765432	1	23456789	RM4	
	With	respect to	o OR		
	98765432	1	23456789	OR2	
OR1	98765432	1	23456789	OR3	
	98765432	1	23456789	OR4	
	98765432	1	23456789	OR3	
OR2	98765432	1	23456789	OR4	
OR3	98765432	1	23456789	OR4	
	With	respect t	o IM		
	98765432	1	23456789	IM2	
IM1	98765432	1	23456789	IM3	
	98765432	1	23456789	IM4	
	98765432	1	23456789	IM3	
IM2	98765432	1	23456789	IM4	
IM3	98765432	1	23456789	IM4	
	With	respect t	o PI		
	98765432	1	23456789	PI2	
PI1	98765432	1	23456789	PI3	
	98765432	1	23456789	PI4	
	98765432	1	23456789	PI3	
PI2	98765432	1	23456789	PI4	
PI3	98765432	1	23456789	PI4	
	With	respect to	MA		
	98765432	1	23456789	MA2	
MA1	98765432	1	23456789	MA3	
	98765432	1	23456789	MA4	
	98765432	1	23456789	MA3	
MA2	98765432	1	23456789	MA4	
MA3	98765432	1	23456789	MA4	
	With	respect to	BD		
	98765432	1	23456789	BD2	
RD1	98765432	1	23456789	RD3	
	98765432	1	23456789	RD4	
L	50100402	-	20100100	1024	

DDa	98765432	1	23456789	RD3
RD2	98765432	1	23456789	RD4
RD3	98765432	1	$2\ 3\ 4\ 5\ 6\ 7\ 8\ 9$	RD4
	With	respect t	o LE	
	98765432	1	23456789	LE2
LE1	98765432	1	23456789	LE3
	98765432	1	23456789	LE4
1 120	98765432	1	23456789	LE3
LE3	98765432	1	23456789	LE4
LE4	98765432	1	$2\ 3\ 4\ 5\ 6\ 7\ 8\ 9$	LE4
	With	respect to	o PM	
	98765432	1	23456789	PM2
PM1	98765432	1	23456789	PM3
	98765432	1	23456789	PM4
DMO	98765432	1	$2\ 3\ 4\ 5\ 6\ 7\ 8\ 9$	PM3
PM2	98765432	1	23456789	PM4
PM3	98765432	1	23456789	PM4
	With	respect to	o KM	
	98765432	1	23456789	KM2
KM1	98765432	1	23456789	KM3
	98765432	1	23456789	KM4
1/1/0	98765432	1	23456789	KM3
KM2	98765432	1	23456789	KM4
KM3	98765432	1	23456789	KM4
	With	i respect t	o TI	•
	98765432	1	23456789	TI2
TI1	98765432	1	23456789	TI3
	98765432	1	23456789	TI4
TIO	98765432	1	$2\ 3\ 4\ 5\ 6\ 7\ 8\ 9$	TI3
112	98765432	1	23456789	TI4
TI3	98765432	1	23456789	TI4

B Scores of sub-Critical Innovation Management Practices in three Vietnamese banks according to each expert

Bank	Expert	SP1	SP2	SP3	SP4	RM1	RM2	RM3	RM4	OR1	OR2	OR3	OR4	IM1	IM2	IM3	IM4
	1	5	4	4	5	3	4	5	5	5	5	4	5	4	5	4	4
	2	4	4	4	5	4	3	5	4	4	5	4	3	3	3	3	4
Α	3	3	3	3	4	4	4	4	4	4	4	4	3	3	3	3	3
	4	5	5	4	3	3	5	3	2	3	3	3	3	3	3	3	3
	5	5	5	4	3	3	5	3	2	3	3	3	3	3	3	3	3
	1	5	5	4	4	4	4	5	5	4	4	3	4	4	4	4	4
	2	4	4	5	5	4	4	5	4	5	4	4	5	3	4	3	4
в	3	4	4	4	4	4	3	4	4	5	4	4	4	4	4	4	4
	4	5	4	4	4	4	4	4	3	4	4	4	4	3	3	3	4
	5	5	5	5	5	4	5	5	5	4	4	3	4	5	5	5	5
	1	4	5	5	5	4	5	5	5	4	4	3	4	4	5	5	5
	2	5	4	5	4	4	5	5	4	3	4	3	5	4	2	3	3
С	3	3	3	4	4	4	4	4	4	3	4	3	3	3	4	3	3
	4	4	4	5	5	4	5	3	4	3	5	3	4	5	4	3	2
	5	4	4	5	4	4	5	5	4	4	4	5	4	5	3	5	5
Bank	Expert	PI1	PI2	PI3	PI4	MA1	MA2	MA3	MA4	RD1	RD2	RD3	RD4	LE1	LE2	LE3	LE4
	1	4	4	5	5	5	5	4	5	4	5	5	5	4	4	4	4
	2	3	4	4	4	4	4	4	4	4	4	4	4	4	5	4	4
Α	3	4	5	4	3	5	4	4	4	4	4	3	3	4	4	4	4
	4	3	3	3	3	3	3	3	3	3	3	3	3	4	2	3	2
	5	3	3	3	3	3	3	3	3	3	3	3	3	4	2	3	2
	1	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
	2	4	4	4	4	5	4	4	5	4	4	5	5	4	4	4	4
В	3	4	4	4	4	5	4	4	4	5	4	5	4	4	4	5	4

	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
	5	5	5	5	5	5	5	5	5	5	4	4	4	4	4	4	4
	1	5	4	4	5	5	4	4	4	4	4	4	4	4	4	4	4
	2	4	5	3	2	4	4	5	4	4	3	3	2	4	4	4	4
С	3	3	3	3	3	3	3	4	4	3	3	3	4	4	3	4	4
	4	4	4	5	4	5	3	3	4	4	4	4	4	5	5	4	5
	5	5	4	5	5	5	4	3	5	5	5	4	4	4	5	5	3
Bank	Expert	PM1	PM2	PM3	PM4	KM1	KM2	KM3	KM4	TI1	TI2	TI3	TI4				
	1	4	5	5	5	5	5	5	5		5	5	5]			
	2	5	4	4	3	5	4	4	4	4	4	3	3]			
А	3	4	4	4	3	5	4	4	4	4	3	3	3]			
	4	4	2	3	4	4	3	3	5	5	3	4	3]			
	5	4	2	3	4	4	3	3	5	5	3	4	3]			
	1	4	4	4	4	4	4	4	4	5	5	5	5				
	2	5	4	4	4	4	5	4	4	4	4	5	4				
В	3	4	4	4	4	4	4	4	4	4	4	4	4				
	4	4	4	4	4	4	4	4	4	4	4	4	4				
	5	5	5	5	4	4	4	4	4	4	4	4	4				
	1	4	4	4	4	4	4	4	4	5	5	5	5				
	2	5	5	4	4	4	4	5	4	4	3	3	4				
С	3	4	4	4	4	4	4	4	4	3	3	3	3				
	4	4	4	4	4	4	4	4	4	4	5	3	4]			
	5	5	5	4	5	5	5	3	3	3	3	5	5]			

C Pairwise comparisons of Critical Innovation Management Practices with respect to Innovation Capability according to each expert

					Expe	rt 1					
CIMPs	SP	RM	OR	IM	PI	MA	RD	LE	PM	KM	ΤI
SP	1	3	5	5	6	5	5	5	7	5	4
RM	1/3	1	4	3	5	3	4	4	5	3	3
OR	1/5	1/3	1	2	2	1/2	1/2	1	4	1/3	1/3
IM	1/5	1/3	1/2	1	3	1	1	1	5	1	1
PI	1/6	1/5	1/2	1/3	1	1/3	1/3	1/3	3	1/3	1/4
MA	1/5	1/3	2	1	3	1	1/2	2	4	1/3	1/3
RD	1/5	1/4	2	1	3	2	1	3	5	1	1/2
LE	1/5	1/4	1	1	3	1/2	1/3	1	2	1/2	1/2
PM	1/7	1/5	1/4	1/5	1/3	1/4	1/5	1/2	1	1/5	1/6
KM	1/5	1/3	3	1	3	3	1	2	5	1	1/3
TI	1/4	1/3	3	1	4	3	2	2	6	3	1
				•	Expe	rt 2					
IMPs	SP	RM	OR	IM	ΡI	MA	RD	LE	PM	KM	TI
SP	1	2	5	6	7	5	4	5	7	5	4
RM	1/2	1	3	4	6	3	4	4	6	5	4
OR	1/5	1/3	1	1	2	1/4	1/3	1/3	3	1/3	1/4
IM	1/6	1/3	1	1	3	1	1/3	2	3	1/2	1/2
PI	1/7	1/5	1/2	1/3	1	1/4	1/5	1/4	2	1/2	1/5
MA	1/5	1/3	4	1	4	1	1/2	2	5	1/4	1/3
RD	1/4	1/4	3	3	5	2	1	3	7	1	1
LE	1/5	1/4	3	1/2	4	1/2	1/3	1	5	1/2	1/2
PM	1/7	1/6	1/3	1/3	1/2	1/5	1/7	1/5	1	1/4	1/5
KM	1/5	1/5	3	2	2	4	1	2	4	1	1/2
TI	1/4	1/4	4	2	5	3	1	2	5	2	1
					Expe	rt 3					
IMPs	SP	RM	OR	IM	PI	MA	RD	LE	PM	KM	TI
SP	1	5	7	6	7	7	7	7	8	6	5
RM	1/5	1	4	2	4	2	3	5	4	3	3
OR	1/7	1/3	1	3	2	1/3	1	1	3	1/3	1/5
IM	1/6	1/2	1/3	1	4	1	1	2	3	1	1

PI	1/7	1/4	1/2	1/4	1	1/3	1/2	1/2	2	1/4	1/4
MA	1/7	1/2	3	1	1/3	1	1/2	1	3	1/2	1/2
RD	1/7	1/3	1	1	2	2	1	2	4	1/2	1/2
LE	1/7	1/5	1	1/2	2	1	1/2	1	2	1/2	1/3
PM	1/8	1/4	1/3	1/3	1/2	1/3	1/4	1/2	1	1/6	1/7
KM	1/6	1/3	3	1	4	2	2	2	6	1	1/3
TI	1/5	1/3	5	1	4	2	2	3	7	3	1
					Expe	rt 4					
IMPs	SP	RM	OR	IM	PI	MA	RD	LE	PM	KM	ΤI
$^{\rm SP}$	1	2	4	5	7	3	4	4	6	4	3
RM	1/2	1	7	6	7	5	6	4	6	4	4
OR	1/4	1/7	1	1	3	1/4	1/2	1/2	4	1/2	1/3
IM	1/5	1/6	1	1	4	1/2	1/3	1	3	1/3	1/2
PI	1/7	1/7	1/3	1/4	1	1/6	1/5	1/2	1	1/6	1/6
MA	1/3	1/5	4	2	6	1	1	2	4	1	1/2
RD	1/4	1/6	2	3	5	1	1	2	4	1	1/2
LE	1/4	1/4	2	1	2	1/2	1/2	1	3	1	1/2
PM	1/6	1/6	1/4	1/3	1	1/4	1/4	1/3	1	1/7	1/7
KM	1/4	1/4	2	3	6	1	1	1	7	1	1/2
TI	1/3	1/4	3	2	6	2	2	2	7	2	1
					Expe	rt 5					
IMPs	SP	RM	OR	IM	PI	MA	RD	LE	PM	KM	ΤI
SP	1	2	4	3	6	4	4	3	5	4	3
RM	1/2	1	5	3	6	2	3	3	4	4	5
OR	1/4	1/5	1	2	4	1	1	1/2	5	1/2	1/3
IM	1/3	1/2	1/2	1	5	1	1/2	1	6	1	1
PI	1/6	1/6	1/4	1/5	1	1/3	1/4	1/3	1	1/4	1/6
MA	1/4	1/2	1	1	3	1	1	1	3	1/3	1/2
RD	1/4	1/3	1	2	4	1	1	5	4	1	1/3
LE	1/3	1/3	2	1	3	1	1/5	1	4	1	1
PM	1/5	1/4	1/5	1/6	1	1/3	1/4	1/4	1	1/6	1/7
KM	1/4	1/4	2	1	4	3	1	1	6	1	1/2
TI	1/3	1/5	3	1	6	2	3	1	7	2	1

D Pairwise comparisons of sub-Critical Innovation Management Practices with respect to Critical Innovation Management Practices according to each expert

Pairw	vise com	parison	with re	spect to SP
		Expe	rt 1	
SP	SP1	SP2	SP3	SP4
SP1	1	3	2	2
SP2	1/3	1	1	1/3
SP3	1/2	1	1	1/3
SP4	1/2	3	3	1
		Expe	rt 2	
SP	SP1	SP2	SP3	SP4
SP1	1	5	4	3
SP2	1/5	1	1/3	1/5
SP3	1/4	3	1	1/4
SP4	1/3	5	4	1
		Expe	rt 3	
$^{\rm SP}$	SP1	SP2	SP3	SP4
SP1	1	4	3	2
SP2	1/4	1	1/2	1/4
SP3	1/3	2	1	1/3
SP4	1/2	4	3	1
		Expe	rt 4	
SP	SP1	SP2	SP3	SP4

Pairw	ise com	parison	with res	spect to RD
		Expe	rt 1	
RD	RD1	RD2	RD3	RD4
RD1	1	4	1	3
RD2	1/4	1	1/3	1/2
RD3	1	3	1	3
RD4	1/3	2	1/3	1
		Expe	rt 2	
RD	RD1	RD2	RD3	RD4
RD1	1	3	1	2
RD2	1/3	1	1/2	1/2
RD3	1	2	1	3
RD4	1/2	2	1/3	1
		Expe	rt 3	
RD	RD1	RD2	RD3	RD4
RD1	1	4	2	3
RD2	1/4	1	1/2	1
RD3	1/2	2	1	4
RD4	1/3	1	1/4	1
		Expe	rt 4	
RD	RD1	RD2	RD3	RD4

SP1	1	5	3	3	RD1	1	5	1	3
SP2	1/5	1	1/3	1/4	RD2	1/5	1	1/3	1/3
SP3	1/3	3	1	1/3	RD3	1	3	1	3
SP4	1/3	4	3	1	RD4	1/3	3	1/3	1
	7 -	Exde	rt 5			7 -	Expe	rt 5	I
SP	SP1	SP2	SP3	SP4	RD	RD1	RD2	RD3	RD4
SP1	1	4	2	2	RD1	1	4	2	4
SP2	1/4	1	1/2	1/3	RD2	1/4	1	1/4	1/2
SP3	1/2	2	1	1/2	RD3	1/2	4	1	2
SP4	1/2	3	2	1	RD4	1/4	2	1/2	1
Pairw	ise com	parison	with res	spect to RM	Pair	wise con	parison	with re	spect to LE
		Expe	rt. 1				Expe	rt 1	
BM	BM1	BM2	RM3	B.M4	LE	LE1	LE2	LE3	LE4
RM1	1	4	1	2	LE1	1	1/3	1/2	1/3
RM2	1/4	1	1/3	1/3	LE2	3	1	2	2
RM3	1	3	1	2	LE3	2	1/2	1	1/3
RM4	1/2	3	1/2	1	LE4	3	1/2	3	1
	,	Exde	rt 2				Exde	rt 2	
RM	RM1	RM2	RM3	RM4	LE	LE1	LE2	LE3	LE4
RM1	1	5	2	3	LE1	1	1/4	1/3	1/3
RM2	1/5	1	1/4	1/3	LE2	4	1	3	2
RM3	1/2	4	1	3	LE3	3	1/3	1	1/2
RM4	1/3	3	1/3	1	LE4	3	1/2	2	1
	, -	Expe	rt 3			-	Expe	rt 3	I
RM	RM1	RM2	RM3	RM4	LE	LE1	LE2	LE3	LE4
RM1	1	4	2	2	LE1	1	1/2	1	1/2
RM2	1/4	1	1/2	1/2	LE2	2	1	3	1
RM3	1/2	2	1	, 1	LE3	1	1/3	1	1/4
RM4	1/2	2	1	1	LE4	2	1	4	1
	,	Expe	rt 4				Expe	rt 4	
RM	RM1	RM2	RM3	RM4	LE	LE1	LE2	LE3	LE4
RM1	1	3	1	2	LE1	1	1/3	1/2	1/2
RM2	1/3	1	1/3	1/2	LE2	3	1	2	3
RM3	1	3	1	3	LE3	2	1/2	1	1/2
RM4	1/2	2	1/3	1	LE4	2	1/3	2	1
	,	Expe	rt 5				Expe	rt 5	I
RM	RM1	RM2	RM3	RM4	LE	LE1	LE2	LE3	LE4
RM1	1	3	1	3	LE1	1	1/4	1/2	1/3
RM2	1/3	1	1/4	1/3	LE2	4	1	2	1
RM3	1	4	1	2	LE3	2	1/2	1	1/3
RM4	1/3	3	1/2	1	LE4	3	1	3	1
Pairw	ise com	parison	with re	spect to OR	Pair	wise com	parison	with res	spect to PM
		Expe	rt 1				Expe	rt 1	
OR	OR1	OR2	OR3	OR4	PM	PM1	PM2	PM3	PM4
OR1	1	1	3	2	PM1	1	1/3	1/2	1/2
OR2	1	1	2	2	PM2	3	1	2	3
OR3	1/3	1/2	1	1/3	PM3	2	1/2	1	2
OR4	1/2	1/2	3	1	PM4	2	1/3	1/2	1
		Expe	rt 2				Expe	rt 2	
OR	OR1	OR2	OR3	OR4	PM	PM1	PM2	PM3	PM4
OR1	1	2	4	3	PM1	1	1/4	1/3	1/3
OR2	1/2	1	3	3	PM2	4	1	3	4
OR3	1/4	1/3	1	1/4	PM3	3	1/3	1	3
OR4	1/3	1/3	4	1	PM4	3	1/4	1/3	1
		Expe	rt 3				Expe	rt 3	
OR	OR1	OR2	OR3	OR4	PM	PM1	PM2	PM3	PM4
OR1	1	1	2	1	PM1	1	1/3	1/3	1/2
OR2	1	1	2	1	PM2	3	1	2	2
OR3	1/2	1/2	1	1/3	PM3	3	1/2	1	3
OR4	1	1	3	1	PM4	2	1/2	1/3	1
		Expe	rt 4				Expe	rt 4	1
OR	OR1	OR2	OR3	OR4	PM	PM1	PM2	PM3	PM4
OR1	1	2	3	3	PM1	1	1/3	1/2	1
OR2	1/2	1	3	2	PM2	3	1	3	3
OR3	1/3	1/3	1	1/2	PM3	2	1/3	1	1
OR4	1/3	1/2	2	1	PM4	1	1/3	1	1
		Expe	rt 5				Expe	rt 5	

OR	OR1	OR2	OR3	OR4	PM	PM1	PM2	PM3	PM4
OR1	1	1	4	2	PM1	1	1/4	1/2	1/2
OR2	1	1	2	1	PM2	4	1	2	4
OR3	1/4	1/2	1	1/4	PM3	2	1/2	1	2
OR4	1/2	1	4	1	PM4	2	1/4	1/2	1
Pairw	ise com	parison	with re	spect to IM	Pairw	ise com	parison	with res	pect to KM
		Expe	rt 1				Expe	rt 1	
IM	IM1	IM2	IM3	IM4	KM	KM1	KM2	KM3	KM4
IM1	1	3	4	2	KM1	1	1	3	2
IM2	1/3	1	3	1/4	KM2	1	1	2	2
IM3	1/4	1/3	1	1/5	KM3	1/3	1/2	1	1/3
IM4	1/2	4	5	1	KM4	1/2	1/2	3	1
	,	Expe	rt 2			,	Expe	rt 2	
IM	IM1	IM2	IM3	IM4	KM	KM1	KM2	KM3	KM4
IM1	1	4	5	3	KM1	1	1	3	3
IM2	1/4	1	2	1/3	KM2	1	1	3	2
IM2 IM3	1/5	1/2	1	1/3	KM3	1/3	1/3	1	1/2
IM3	1/3	2	1	1/4	KM4	1/3	1/3	2	1/2
11014	1/3	5	4	1	KW14	1/3	1/2 E	4	1
114	13.61	Expe		TN 14	L'M	TAM	Expe.	rt o IZMO	TZM 4
IM	11111	11112	1143	11/14	KM		KM2	KM3	KM4
IMI	1	2	3	1	KMI	1	2	4	3
IM2	1/2	1	4	1/5	KM2	1/2	1	3	3
IM3	1/3	1/4	1	1/6	KM3	1/4	1/3	1	1/4
1M4	1	5	6	1	KM4	1/3	1/3	4	1
		Expe	rt 4				Expe	rt 4	
IM	IMI	IM2	IM3	IM4	KM	KMI	KM2	KM3	KM4
IMI	1	4	4	2	KMI	1	1	3	2
1M2	1/4	1	2	1/3	KM2	1	1	2	3
IM3	1/4	1/2	1	1/4	KM3	1/3	1/2	1	1/2
IM4	1/2	3	4	1	KM4	1/2	1/3	2	1
		Expe	rt 5				Expe	rt 5	
IM	IMI	IM2	IM3	IM4	KM	KMI	KM2	KM3	KM4
1 M 1	1	3	3	1	KMI	1	1	4	2
11.00	1 /0	1	0	3.15	1/1/0		1	0	-
IM2	1/3	1	3	1/5	KM2	1	1	2	1
IM2 IM3	1/3 1/3	1 1/3	3	1/5 1/5	KM2 KM3	1 1/4	1 1/2	2	1 1/3
IM2 IM3 IM4	1/3 1/3 1	1 1/3 5	3 1 5	1/5 1/5 1	KM2 KM3 KM4	1 1/4 1/2	1 1/2 1	2 1 3	1 1/3 1
IM2 IM3 IM4 Pairv	1/3 1/3 1 vise com	1 1/3 5 aparison	3 1 5 with re	1/5 1/5 1 spect to PI	KM2 KM3 KM4 Pairv	1 1/4 1/2 vise com	1 1/2 1 parison	2 1 3 with re	1 1/3 1 spect to TI
IM2 IM3 IM4 Pairv	1/3 1/3 1 vise com	1 1/3 5 parison Expe	3 1 5 with re	1/5 1/5 1 espect to PI	KM2 KM3 KM4 Pairv	1 1/4 1/2 vise com	1 1/2 1 parison Expe	2 1 3 with re	1 1/3 1 spect to TI
IM2 IM3 IM4 Pairv	1/3 1/3 1 vise com	1 1/3 5 aparison Expe PI2	3 1 5 with re rt 1 PI3	1/5 1/5 1 espect to PI PI4	KM2 KM3 KM4 Pairv TI	1 1/4 1/2 vise com TI1	1 1/2 1 parison Expe TI2	2 1 3 with re rt 1 TI3	1 1/3 1 spect to TI TI4
IM2 IM3 IM4 Pairv PI PI1 PI1	1/3 1/3 1 vise com PI1 1	1 1/3 5 parison Expe PI2 2	3 1 5 with re rt 1 PI3 3	1/5 1/5 1 spect to PI PI4 3	KM2 KM3 KM4 Pairv TI TI1	1 1/4 1/2 vise com TI1 1	1 1/2 1 parison Expe TI2 1/4	2 1 3 with re rt 1 TI3 1/4	1 1/3 1 spect to TI TI4 1/3
IM2 IM3 IM4 Pairv PI PI1 PI2 PI2	1/3 1/3 1 vise com PI1 1 1/2	1 1/3 5 aparison Expe PI2 2 1	3 1 5 with re rt 1 PI3 3 2	1/5 1/5 1 spect to PI PI4 3 3 1/2	KM2 KM3 KM4 Pairv TI TI1 TI1 TI2	1 1/4 1/2 vise com TI1 1 4	1 1/2 1 aparison Expe TI2 1/4 1	2 1 3 with re rt 1 TI3 1/4 3	1 1/3 1 spect to TI TI4 1/3 4
IM2 IM3 IM4 Pairv PI PI1 PI2 PI3 PI4	1/3 1/3 1 vise com PI1 1 1/2 1/3	1 1/3 5 parison Expe PI2 2 1 1/2	3 1 5 with re rt 1 PI3 3 2 1 2	1/5 1/5 1 spect to PI PI4 3 3 1/2	KM2 KM3 KM4 Pairv TI TI1 TI2 TI3	1 1/4 1/2 vise com TI1 1 4 4	1 1/2 1 parison Expe 1/2 1/4 1 1/3	2 1 3 with re rt 1 TI3 1/4 3 1	1 1/3 1 spect to TI TI4 1/3 4 3
IM2 IM3 IM4 Pairv PI PI1 PI2 PI3 PI4	1/3 1/3 1 vise com PI1 1 1/2 1/3 1/3	1 1/3 5 aparison Expe PI2 2 1 1/2 1/3	3 1 5 with re rt 1 PI3 3 2 1 2	1/5 1/5 1 spect to PI PI4 3 3 1/2 1	KM2 KM3 KM4 Pairv TI TI1 TI2 TI3 TI4	1 1/4 1/2 vise com TI1 1 4 4 3	1 1/2 1 sparison Exper TI2 1/4 1 1/3 1/4	2 1 3 with re rt 1 TI3 1/4 3 1 1/3	1 1/3 1 spect to TI TI4 1/3 4 3 1
IM2 IM3 IM4 Pairv PI PI1 PI2 PI3 PI4	1/3 1/3 1 vise com PI1 1/2 1/3 1/3	1 1/3 5 aparison Expe PI2 2 1 1/2 1/3 Expe	3 1 5 with re rt 1 PI3 3 2 1 2 1 2 rt 2	1/5 1/5 1 spect to PI PI4 3 3 1/2 1	KM2 KM3 KM4 Pairv TI TI1 TI2 TI3 TI4	1 1/4 1/2 vise com TI1 1 4 4 3	1 1/2 1 sparison Expe TI2 1/4 1 1/3 1/4 Expe	2 1 3 with re rt 1 TI3 1/4 3 1 1/3 rt 2	1 1/3 1 spect to TI TI4 1/3 4 3 1
IM2 IM3 IM4 Pairv PI PI1 PI2 PI3 PI4 PI	1/3 1/3 1 vise com 1 1/2 1/3 1/3 PII	1 1/3 5 parison PI2 2 1 1/2 1/3 Expe PI2 2/3	3 1 5 with re rt 1 PI3 3 2 1 2 rt 2 PI3 4	1/5 1/5 1 spect to PI 9I4 3 3 1/2 1 PI4 PI4	KM2 KM3 KM4 Pairv TI TI1 TI2 TI3 TI4	1 1/4 1/2 vise com TI1 1 4 4 3 7 TI1	1 1/2 1 parison TI2 1/4 1 1/3 1/4 Expe TI2	2 1 3 with re rt 1 TI3 1/4 3 1 1/3 rt 2 TI3 1/4	1 1/3 1 spect to TI TI4 1/3 4 3 1 1 TI4
IM2 IM3 IM4 Pairw PI PI1 PI2 PI3 PI4 PI PI1	1/3 1/3 1 vise com 1 1/2 1/3 1/3 PII 1 1 1	1 1/3 5 parison PI2 2 1 1/2 1/3 Expe PI2 3	3 1 5 with re rt 1 PI3 3 2 1 2 rt 2 PI3 4	1/5 1/5 1 sepect to PI 914 3 3 1/2 1 1 PI4 4	KM2 KM3 KM4 Pairv TI TI1 TI2 TI3 TI4 TI TI	1 1/4 1/2 vise com TI1 1 4 4 3 TI1 1 1	1 1/2 1 parison TI2 1/4 1 1/3 1/4 Expe TI2 1/5	2 1 3 with re rt 1 TI3 1/4 3 1 1/3 rt 2 TI3 1/4	1 1/3 1 spect to TI TI4 1/3 4 3 1 TI4 1/4 r
IM2 IM3 IM4 Pairw PI PI1 PI2 PI3 PI4 PI PI1 PI2 PI3 PI4 PI PI1 PI1	1/3 1/3 1 vise com 1 1/2 1/3 1/3 PII 1 1/3 1/4	1 1/3 5 parison PI2 2 1 1/2 1/3 Expe PI2 3 1	3 1 5 with re rt 1 PI3 3 2 1 2 rt 2 PI3 4 3 1	1/5 1/5 1 sepect to PI PI4 3 3 1/2 1 1 PI4 4 4 4	KM2 KM3 KM4 Pairv TI TI1 TI2 TI3 TI4 TI TI1 TI2	1 1/4 1/2 vise com TI1 1 4 4 3 TI1 1 5 5	1 1/2 1 parison TI2 1/4 1 1/3 1/4 Expe TI2 1/5 1	2 1 3 with re rt 1 TI3 1/4 3 1 1/3 rt 2 TI3 1/4 4 4 1 1/4	1 1/3 1 spect to TI TI4 1/3 4 3 1 TI4 1/4 5 2
IM2 IM3 IM4 Pairw PI PI1 PI2 PI3 PI4 PI PI1 PI2 PI3 PI4 PI PI1 PI2 PI3 PI4 PI1 PI2 PI3 PI4	1/3 1/3 1 vise com PI1 1/2 1/3 1/3 PI1 1 1/3 1/4	1 1/3 5 parison Expe PI2 2 1 1/2 1/3 Expe PI2 3 1 1/3	3 1 5 with re rt 1 PI3 3 2 1 2 rt 2 PI3 4 3 1 2 2 1 2 2 1 2 2 1 2 2 2 1 2 2 2 2 2 2 2 2 2 2 2 2 2	1/5 1/5 1 pspect to PI PI4 3 3 1/2 1 PI4 4 4 4 1/2 1/2 1/2	KM2 KM3 KM4 Pairv TI TI1 TI2 TI3 TI1 TI2 TI3 TI3 TY TY TY TY	1 1/4 1/2 vise com TI1 1 4 4 3 TI1 1 5 4 4	1 1/2 1 Expe TI2 1/4 1 1/3 1/4 Expe TI2 1/5 1 1/4	2 1 3 with re rt 1 TI3 1/4 3 1 1/3 rt 2 TI3 1/4 4 1 1/4 1/4 1/4 1/4 1/4 1/	1 1/3 1 spect to TI TI4 1/3 4 3 1 TI4 1/4 5 2 1
IM2 IM3 IM4 Pairw PI PI1 PI2 PI3 PI4 PI PI1 PI2 PI3 PI4 PI PI1 PI2 PI3 PI4	1/3 1/3 1 vise com PI1 1/2 1/3 1/3 PI1 1/3 1/4 1/4	1 1/3 5 parison Expe PI2 2 1 1/2 1/3 Expe PI2 3 1 1/3 1/4 Expe	3 1 5 with re rt 1 PI3 3 2 1 2 PI3 4 3 1 2 PI3 4 3 1 2 PI3 4 3 1 2 PI3 4 3 2 PI3 PI3 PI3 PI3 PI3 PI3 PI3 PI3	1/5 1/5 1 sepect to PI 914 3 3 1/2 1 1 914 4 4 4 1/2 1	KM2 KM3 KM4 Pairv TI TI1 TI2 TI3 TI4 TI TI1 TI2 TI3 TI4 TI TI1 TI2 TI3 TI4	1 1/4 1/2 vise com TI1 1 4 4 3 TI1 1 5 4 4 4	1 1/2 1 Expe TI2 1/4 1 1/3 1/4 Expe TI2 1/5 1 1/4 1/5	2 1 3 with re rt 1 TI3 1/4 3 1 1/3 rt 2 TI3 1/4 4 1 1/2 rt 2 TI3 1/4	1 1/3 1 spect to TI TI4 1/3 4 3 1 TI4 1/4 5 2 1
IM2 IM3 IM4 Pairv PI PI1 PI2 PI3 PI4 PI PI1 PI3 PI4 PI PI1 PI2 PI3 PI4 PI PI3 PI4	1/3 1/3 1 vise com PI1 1/2 1/3 1/3 PI1 1/3 1/4 1/4 1/4 PD1	1 1/3 5 parison Expe PI2 2 1 1/2 1/3 Expe PI2 3 1 1/3 1/4 Expe	3 1 5 with re rt 1 PI3 3 2 1 2 rt 2 PI3 4 3 1 2 rt 3	1/5 1/5 1 provide to PI PI4 3 3 1/2 1 PI4 4 4 1/2 1 PI4 1 PI4 PI4 PI4 PI4 PI4 PI4 PI4 PI4	KM2 KM3 KM4 Pairv TI TI1 TI2 TI3 TI4 TI TI1 TI2 TI3 TI4 TI TI1 TI2 TI3 TI4 TI3 TI4	1 1/4 1/2 vise com TI1 1 4 4 3 TI1 1 5 4 4 4	1 1/2 1 Expe TI2 1/4 1 1/3 1/4 Expe TI2 1/5 1 1/4 1/5 1 1/4 1/5 Expe	2 1 3 with re rt 1 TI3 1/4 3 1 1/3 rt 2 TI3 1/4 4 1 1/2 rt 3 1/2 TI3 1/4 5 7 7 7 7 7 7 7 7 7 7 7 7 7	1 1/3 1 spect to TI TI4 1/3 4 3 1 TI4 1/4 5 2 1 1 TI4 1/4
IM2 IM3 IM4 Pairv PI PI1 PI2 PI3 PI4 PI PI1 PI2 PI3 PI4 PI PI1 PI2 PI3 PI4 PI PI3 PI4 PI PI3 PI4 PI4 PI4 PI4	1/3 1/3 1 vise com PI1 1 1/2 1/3 1/3 PI1 1 1/3 1/4 1/4 1/4 PI1	1 1/3 5 Parison Expe PI2 2 1 1/2 1/3 Expe PI2 3 1 1/3 1/4 Expe PI2	3 1 5 with re rt 1 PI3 3 2 1 2 rt 2 PI3 4 3 1 2 rt 3 PI3 0	1/5 1/5 1 prive to PI PI4 3 3 1/2 1 PI4 4 4 1/2 1 PI4 4 PI4 2	KM2 KM3 KM4 Pairv TI TI1 TI2 TI3 TI4 TI TI1 TI2 TI3 TI4 TI TI1 TI2 TI3 TI4 TI TI3 TI4	1 1/4 1/2 vise com TI1 1 4 4 3 TI1 1 5 4 4 4 7 TI1	1 1/2 1 Expe TI2 1/4 1 1/3 1/4 Expe TI2 1/5 1 1/4 1/5 Expe TI2 1/4	2 1 3 with re rt 1 TI3 1/4 3 1 1/3 rt 2 TI3 1/4 4 1 1/2 rt 3 TI3 1/2	1 1/3 1 spect to TI TI4 1/3 4 3 1 TI4 1/4 5 2 1 1 TI4 1/4 5 2 1 1 TI4
IM2 IM3 IM4 Pairv PI PI1 PI2 PI3 PI4 PI PI1 PI4 PI PI4	1/3 1/3 1 vise com PI1 1 1/2 1/3 1/3 PI1 1 1/3 1/4 1/4 1/4 PI1 1 1	1 1/3 5 Parison Expe PI2 2 1 1/2 1/3 Expe PI2 3 1 1/3 1/4 Expe PI2 1	3 1 5 with re rt 1 PI3 3 2 1 2 rt 2 PI3 4 3 1 2 rt 3 PI3 2 2 rt 3 PI3 2 2 rt 4 3 1 2 2 rt 1 2 rt 1 2 rt 1 2 rt 2 PI3 3 2 2 rt 2 PI3 3 2 2 rt 2 PI3 3 2 PI3 PI3 2 PI3 2 PI3 2 PI3 PI3 2 PI3 PI3 PI3 PI3 PI3 PI3 PI3 PI3	1/5 1/5 1 prive to PI PI4 3 3 1/2 1 PI4 4 4 1/2 1 PI4 2 ;	KM2 KM3 KM4 Pairv TI TI1 TI2 TI3 TI4 T1 T12 T13 TI4 T1 T11 T12 T13 T14 T1 T11 T12 T13 T14 T1 T11 T11	1 1/4 1/2 vise com TI1 1 4 4 3 TI1 1 5 4 4 4 4 TI1 1 1 5	1 1/2 1 Expe TI2 1/4 1 1/3 1/4 Expe TI2 1/5 1 1/4 1/5 Expe TI2 1/4	2 1 3 with re rt 1 TI3 1/4 3 1 1/3 rt 2 TI3 1/4 4 1 1/2 rt 3 TI3 1/3 2	1 1/3 1 spect to TI TI4 1/3 4 3 1 TI4 1/4 5 2 1 TI4 1/4 5 2 1 TI4 1/2 2
IM2 IM3 IM4 Pairv PI PI1 PI2 PI3 PI4 PI PI1 PI2 PI3	1/3 1/3 1 vise com PI1 1 1/2 1/3 1/3 1/3 PI1 1 1/3 1/4 1/4 1/4 PI1 1 1	1 1/3 5 parison Expe PI2 2 1 1/2 1/3 Expe PI2 3 1 1/3 1/4 Expe PI2 1 1	3 1 5 with re rt 1 PI3 3 2 1 2 rt 2 PI3 4 3 1 2 rt 3 PI3 2 2 rt 3 PI3 2 2 rt 3 PI3	1/5 1/5 1 PI4 3 3 1/2 1 PI4 4 4 4 1/2 1 PI4 4 2 1 PI4 2 1	KM2 KM3 KM4 Pairv TI TI1 TI2 TI3 TI4 T1 T12 T13 T14 T1 T11 T12 T13 T14 T1 T12 T13 T14 T1 T12 T13 T14 T1 T11 T12 T13	1 1/4 1/2 vise com TI1 1 4 4 3 TI1 1 5 4 4 4 7 TI1 1 1 4 4	1 1/2 1 Expe TI2 1/4 1 1/3 1/4 Expe TI2 1/5 1 1/4 1/5 Expe TI2 1/4 1/4	2 1 3 with re rt 1 TI3 1/4 3 1 1/3 rt 2 TI3 1/4 4 1 1/2 rt 3 TI3 1/3 3 3 1	1 1/3 1 spect to TI TI4 1/3 4 3 1 TI4 1/4 5 2 1 TI4 1/4 5 2 1 TI4 1/2 3 4
IM2 IM3 IM4 Pairv PI PI1 PI2 PI3 PI4 PI PI3 PI4	1/3 1/3 1 vise com PI1 1 1/2 1/3 1/3 1/3 PI1 1/3 1/4 1/4 1/4 PI1 1 1 1 1/2 1/2	1 1/3 5 parison Expe PI2 2 1 1/2 1/3 Expe PI2 3 1 1/3 1/4 Expe PI2 1 1 1/2	3 1 5 with re rt 1 PI3 3 2 1 2 rt 2 PI3 4 3 1 2 rt 3 PI3 2 2 1 2 2 2 1 2 2 2 1 2 2 2 1 2 2 2 1 2 2 2 2 2 2 2 2 2 2 2 2 2	1/5 1/5 1 provide to PI PI4 3 3 1/2 1 PI4 4 4 1/2 1 PI4 2 1 PI4 2 1/3 ,	KM2 KM3 KM4 Pairv TI TI1 TI2 TI3 TI4 TI TI1 TI2 TI3 TI4 TI TI1 TI2 TI3 TI4 TI TI1 TI2 TI3 TY4	1 1/4 1/2 vise com TI1 1 4 4 3 TI1 1 5 4 4 4 4 TI1 1 1 4 3 3	1 1/2 1 Expe TI2 1/4 1 1/3 1/4 Expe TI2 1/5 1 1/4 1/5 Expe TI2 1/4 1 1/3 1/2	2 1 3 with re rt 1 TI3 1/4 3 1 1/3 rt 2 TI3 1/4 4 1 1/2 rt 3 TI3 1/3 3 1 1/4	1 1/3 1 spect to TI TI4 1/3 4 3 1 TI4 1/4 5 2 1 TI4 1/4 5 2 1 TI4 1/2 3 4 1/2 3
IM2 IM3 IM4 Pairv PI PI1 PI2 PI3 PI4 PI PI3 PI4 PI1 PI2 PI3 PI4 PI3 PI4 PI4	1/3 1/3 1 vise com PI1 1 1/2 1/3 1/3 PI1 1 1/3 1/4 1/4 1/4 PI1 1 1 1/2 1/2	1 1/3 5 parison Expe PI2 2 1 1/2 1/3 Expe PI2 3 1 1/3 1/4 Expe PI2 1 1/2 1/2 1 1/2	3 1 5 with re rt 1 PI3 3 2 1 2 rt 2 PI3 4 3 1 2 rt 3 PI3 2 2 1 3 4 3 1 2 2 1 2 2 1 2 2 1 2 2 1 2 2 1 2 2 1 2 2 1 2 2 1 2 2 1 2 2 1 2 2 1 2 2 1 2 2 2 1 3 2 2 2 2 1 3 2 2 2 1 3 2 2 2 1 3 2 2 2 1 3 2 2 2 1 3 2 2 2 1 3 2 2 2 1 3 3 2 2 2 1 3 3 2 2 1 3 3 3 2 2 2 1 3 3 2 2 1 3 3 3 2 2 1 3 3 2 2 1 3 3 2 2 1 3 3 2 2 1 3 3 2 2 1 3 3 2 2 1 3 3 2 2 1 3 3 2 2 1 3 3 2 2 1 3 3 3 3 2 2 1 3 3 3 2 2 3 3 3 3 3 3 3 3 3 3 3 3 3	1/5 1/5 1 provide to PI PI4 3 3 1/2 1 PI4 4 4 1/2 1 PI4 2 1 PI4 2 1 1/3 1 1/3 1	KM2 KM3 KM4 Pairv TI TI1 TI2 TI3 TI4 T1 T12 TI3 TI4 TI TI1 TI2 TI3 TI4	1 1/4 1/2 vise com TI1 1 4 4 3 7 11 1 5 4 4 4 4 7 11 1 1 4 3 2	1 1/2 1 Expe TI2 1/4 1 1/3 1/4 Expe TI2 1/5 1 1/4 1/5 Expe TI2 1/4 1 1/3 1/3 1/3	2 1 3 with re rt 1 TI3 1/4 3 1 1/3 rt 2 TI3 1/4 4 1 1/2 rt 3 TI3 1/3 3 1 1/4 4 1 1/4 4 1 1/4 1/4 1/4	1 1/3 1 spect to TI TI4 1/3 4 3 1 TI4 1/4 5 2 1 TI4 1/4 5 2 1 TI4 1/2 3 4 1 1/2 1 1 1/2 1/2 1 1/2
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IM2 IM3 IM4 Pairv PI PI1 PI2 PI3 PI4 PI PI1 PI2 PI3 PI4 PI PI3 PI4 PI PI1 PI2 PI3 PI4 PI PI1 PI2 PI3 PI4 PI PI1 PI2 PI3 PI4 PI PI3 PI4 PI PI1 PI2 PI3 PI4	1/3 1/3 1/3 1 vise com PI1 1 1/2 1/3 1/3 1/3 1/3 1/4 1/4 1/4 1/4 1/4 1/2 1/2 1/2 PI1 1 1/2 1/2 1/4 1/3 1/3 1/3 1/3	1 1/3 5 parison Expe PI2 2 1 1/2 1/3 Expe PI2 3 1 1/3 1/4 Expe PI2 1 1/2 1/3 Expe PI2 3 1/3 Expe PI2 3 1/3 Expe PI2 3 1/3 Expe PI2 3 1/3 Expe PI2 3 1/3 Expe PI2 3 1/3 Expe PI2 3 1/3 Expe PI2 3 1/3 Expe PI2 3 1/3 Expe PI2 3 1/3 Expe PI2 3 1/3 Expe PI2 3 1/3 Expe PI2 3 1/3 Expe PI2 3 1/3 Expe PI2 1/3 Expe PI2 1/3 Expe PI2 1/3 Expe PI2 1 1/3 Expe PI2 1 1/3 Expe PI2 1 1/3 Expe PI2 1 1/3 Expe PI2 1 1/3 Expe PI2 1 1/3 Expe PI2 1 1/3 Expe PI2 1 1/3 Expe PI2 1 1/3 Expe PI2 1 1/3 Expe PI2 1 1/3 Expe PI2 1 1/3 Expe PI2 1 1/3 Expe PI2 1 1/3 Expe PI2 1 1/3 Expe PI2 1 1/3 Expe PI2 1 1/3 Expe PI2 1 1/3 Expe PI2 1 1/3 Expe PI2 3 1/3 Expe PI2 3 Expe PI2 3 Expe PI2 3 Expe PI2 2 2 Expe PI2 2 2 Expe PI2 2 2 2 2 2 2 2 2 2 2 2 2 2	3 1 5 with re rt 1 PI3 3 2 1 2 rt 2 PI3 4 3 1 2 rt 3 PI3 2 2 1 3 rt 4 PI3 4 3 1 2 PI3 4 3 1 2 PI3 4 3 1 2 PI3 4 3 1 2 PI3 4 PI3 2 PI3 4 PI3 2 PI3 4 PI3 2 PI3 4 PI3 2 PI3 2 PI3 4 PI3 2 PI3 2 PI3 4 PI3 2 PI3 PI3 PI3 PI3 PI3 PI3 PI3 PI3	1/5 1/5 1/5 1 espect to PI PI4 3 3 1/2 1 PI4 4 4 4 4 1/2 1 PI4 2 1 1/3 1 PI4 3 3 1/4 1 PI4 2 2 2 2 1 1/4 2 2 1 1/4 1/5 1/5 1/5 1/2 1/2 1/2 1/2 1/2 1/2 1/2 1/2	KM2 KM3 KM4 Pairv TI TI1 TI2 TI3 TI4 TI1 TI2 TI3 TI4 TI1 TI2 TI3 TI4	1 1/4 1/2 vise com TI1 1 4 4 3 7 TI1 1 5 4 4 4 4 7 TI1 1 4 3 2 TI1 1 1 3 3 2 2 TI1 1 1 3 3 2 2 TI1 1 1 3 3 2 2 TI1 1 1 1 2 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	1 1/2 1 parison Expe TI2 1/4 1 1/3 1/4 Expe TI2 1/5 1 1/4 1/5 Expe TI2 1/4 1 1/3 1/3 Expe TI2 1/3 1 1/2 1/4 Expe TI2 1/3 1 1/2 1/3 1 1/4 Expe	$\begin{array}{c} 2\\ 1\\ 3\\ \text{with re}\\ \text{rt 1}\\ 1/3\\ 1\\ 1/4\\ 3\\ 1\\ 1/3\\ 1\\ 1/3\\ 1\\ 1/4\\ 4\\ 1\\ 1/2\\ \text{rt 2}\\ 1\\ 1/4\\ 1\\ 1/2\\ \text{rt 3}\\ 1\\ 1/4\\ 1\\ 1/3\\ 2\\ 1\\ 1/3\\ 2\\ 1\\ 1/3\\ 1/4\\ 1\\ 1\\ 1/4\\ 1\\ 1\\ 1\\ 1\\ 1\\ 1\\ 1\\ 1\\ 1\\ 1\\ 1\\ 1\\ 1\\$	1 1/3 1 1/3 1 spect to TI TI4 1/3 4 3 1 TI4 1/4 5 2 1 TI4 1/2 3 4 3 1 TI4 1/2 3 4 3 1 TI4 1/2 3 2 TI4 1/2 3 1 TI4 1/2 3 1 TI4 1/2 3 1 TI4 1/2 3 1 TI4 1/2 3 1 TI4 1/2 3 1 TI4 1/2 3 1 TI4 1/2 3 1 TI4 1/2 3 1 TI4 1/2 3 3 2 2 TI4 1/2 3 3 2 TI4 1/2 3 3 2 TI4 1/2 3 2 TI4 1/2 3 2 TI4 1/2 3 2 TI4 1/2 3 2 TI4 1/2 3 2 TI4 1/2 3 2 TI4 1/2 3 2 TI4 1/2 3 2 TI4 1/2 3 2 TI4 1/2 3 2 TI4 1/2 3 2 TI4 1/2 3 TI4 1/2 3 TI4 1/2 3 TI4 1/2 3 TI4 1/2 3 TI4 TI4 1/2 3 TI4 TI4 TI4 TI4 TI4 TI4 TI4 TI4

		Expe	rt 1	
MA	MA1	MA2	MA3	MA4
MA1	1	1/2	1	1/2
MA2	2	1	2	2
MA3	1	1/2	1	2
MA4	2	1/2	1/2	1
		Expe	rt 2	
MA	MA1	MA2	MA3	MA4
MA1	1	1/3	1/2	1/3
MA2	3	1	3	3
MA3	2	1/3	1	1
MA4	3	1/3	1	1
		Expe	rt 3	
MA	MA1	MA2	MA3	MA4
MA1	1	1/3	1	1
MA2	3	1	2	1
MA3	1	1/2	1	2
MA4	1	1	1/2	1
		Expe	rt 4	
MA	MA1	MA2	MA3	MA4
MA1	1	1/2	1	1/3
MA2	2	1	3	2
MA3	1	1/3	1	1
MA4	3	1/2	1	1
		Expe	rt 5	
MA	MA1	MA2	MA3	MA4
MA1	1	1/2	1	1
MA2	2	1	2	3
MA3	1	1/2	1	3
MA4	1	1/3	1/3	1