國 立 交 通 大 學

運輸科技與管理學系

博士論文

行動電子商務之多維度使用偏好分析

Multi—Dimensional Preference Analyses for the Diverse Usage in M—Commerce

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摘要

本論文探討不同國家的行動電子商務使用者之多維度偏好分析。為判別從不同國家取得的樣本是否存在差異，本研究提出一個基於資訊複雜度理論的新方法來進行參數模型的選擇及不同維度的變數分類。依據資訊複雜度理論所提供的參考值，可決定來自不同樣本的資料是否能以性質相同的參數模型加以描述。相似的方法將用以判別在先驗的參數模型中，不同維度內的個別變數解釋模型差異程度之能力。藉由本研究所提出的新方法判定參數模型並進行不同維度之變數分類，將可鑑別不同國家的行動電子商務使用者之偏好，以為建立相應統計模型的基礎。

灰關聯分析亦可用於判別使用者偏好，因此本論文也將探討應用這兩種方法於判別使用者偏好之特性。基本上，這兩種方法都能顯示不同樣本間是否存在差異。依據灰關聯理論的方法見長於樣本內之偏好判定，而依據資訊複雜度的方法則可提供建構最適參數模型之依據。本論文能為學術界提供兩方面的貢獻，其一為基於資訊複雜度理論的新分析方法，另外則是這個新方法與灰關聯分析的特性比較。

使用行動電子商務之服務，基本上可視為一種選擇行為的問題，由於本論文專注於行動電子商務的使用行為分析，特別是其相應的分析架構，因此由作者所倡議的相關方法，亦將一併介紹於本論文中。這些方法包括應用模糊德爾非法與狩野模型於形成電子市集關鍵因素的分析。這些進程可拓展未來相關研究的視野，且所提供的建議將指引更具體的研究方向。

關鍵字：　行動電子商務，　資訊複雜度，　模型選擇，　變數分類

Multi-Dimensional Preference Analyses for the Diverse Usage in M-Commerce

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ABSTRACT

This study is committed to conduct the multi-dimensional preference analyses for the diverse usage in m-commerce among the countries. In order to determine whether there is a discrepancy between samples, this study proposed a new approach based on ICOMP to perform model selection and variables clustering in different dimensions. According to the ICOMP criteria, the model selection may imply that there is heterogeneity between samples. The variable clustering, whatever within different dimensions, may indicate that there are differences in ranking the most relevant variables between samples. That is, results based on the proposed approach could be used to support that there were discrepancies in using m-commerce services among the countries, whatever in model selection or variables clustering.

Characters of both the ICOMP approach and the grey relational analysis in distinguishing the diverse usage would be discussed. Basically, both approaches can conclude there are discrepancies between the samples. The grey relational analysis is good to determine the preferences within a sample; and the ICOMP approach can determine the best fitting models for samples. The contribution of this work towards the field in two folds: the new approach to analyze the discrepancy; and the comparison between the two approaches.

Basically, the usage of services in m-commerce can be treated as a choice behavior problem. Since this dissertation is dedicated to the analysis of usage in m-commerce, especially the framework for the analyses, connected methodologies which were proposed by the author

during the development were also introduced, e.g. applying Fuzzy Delphi as well as the Kano model for the key factors analyzing in forming an e-marketplace. The progress may benefit further research by broadening its scope and suggestions made for more promising research directions.

Keywords: m-commerce, ICOMP, model selection, variable clustering

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考進博士班那一年，大女兒剛剛出生，我曾自我期許，在女兒幼稚園畢業時取得博士學位，沒想到中間波折重重，一晃眼十年寒窗過去，至今才有機會撰寫誌謝文，再再顯示求學之路沒有僥倖，只有不斷的努力才能堅持到最後。

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感謝論文口試暨審查委員成功大學林正章教授、政治大學周宣光教授、本校袁建中教授、任維廉教授，於口試與審查期間撥冗細審，並給予寶貴意見與殷切指正，使本論文更臻完備，在此致上學生由衷的感謝。

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Table of Contents

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1 INTRODUCTION

Although it can provide the last mile connection to an individual, mobile commerce (m-commerce), or ubiquitous commerce (u-commerce), did not bloom yet. Homogeneous services may not be able to attract the same attention from similar user groups among countries. By the gray relational analyses as well as the model selection and variable clustering with information-theoretic measure of complexity (as known as ICOMP), multi-dimensional preference analyses are conducted for the diverse usage in m-commerce among the countries.

1.1 Problem Statement

Broad definitions of m-commerce had been employed to explore the potential benefits of the wireless technology. According to United Nations Conference on Trade and Development [1], m-commerce is a new form of electronic commerce which brought about by the rapid growth of wireless communications. The most common definition of m-commerce is the buying and selling of goods and services using wireless handheld devices such as mobile telephones or personal data assistants (PDAs). A broader definition that extends m-commerce to "mobile business" may be more appropriate. This involves business-related communication among individuals and companies where financial transactions do not necessarily occur.

The foundation of m-commerce, or mobile Internet, has mostly unique strengths over the stationary Internet, because users may access the Internet wherever and whenever they want [2]. It provides a last mile connection to an individual, which implied a ubiquitous channel of communication with a person is there. M-commerce could bring new ways of interacting with others anytime and anywhere. In fact, the multi-functional use of mobile devices has lead to considerable lifestyle changes. People used mobile devices not only for talking but also for browsing news, processing email, searching information, paying bills, just like what they did on their computers with a stationary internet connection.

Basically, m-commerce could be treated as the use of wireless technology, particularly handheld mobile devices and mobile Internet, to facilitate transaction, information search, and user task performance in consumer, business-to-business, and intra-enterprise communications [3], [4]. Skiba et al. [5] defined m-commerce as "the use of mobile hand-held devices to communicate, inform, transact and using text and data via connection to

public or private networks". They specifically listed any kind of service that can be provided by the mobile device, thus expanding its mere commercial character through communicative and informative services. The definition proposed by Skiba et al. [5] is primarily followed in this study.

With all possible strengths, proponents claimed that m-commerce would surpass e-commerce in growth and scale [6]. Tsalgatidou and Pitoura [7] proposed m-commerce extends not only the benefits of e-commerce, but also allows for unique services and additional benefits when compared to traditional e-commerce applications. Keen and Mackintosh [8] note the demand side of m-commerce is a search for value and there is a need to build an understanding of the elements and special features of wireless electronic channels that are value-adding from the consumer's point of view. The key value proposition of mobility is the creation of choice, or new freedoms, for customers. That is, the main value-added feature of m-commerce includes flexibility, convenience and ubiquity. Chan et al. [9] evaluate the usability of ten wireless sites on three platforms, based on the usability pertaining to user tasks, content presentation, search, navigation systems and the design constraints imposed by form factors.

But m-commerce is still in its infancy although the rate of increase mobile phone subscribers in developed countries is gradual in recent years [10]. One reason for the infancy might be there is a lack of "killer" application(s) for m-commerce. In fact, applications in handheld devices looked quite similar in the markets all over the world. Most of them are shrank versions from those for "regular" browsers, and rare of them were designed originally for mobile devices only.

Nippon Telephone and Telegraph's (NTT) wireless operations, DoCoMo (NTT DoCoMo) might be the first one to enjoy a well-known success in m-commerce. Almost all followers imitated the "success" they admired in the industry. Such imitations agreed the theory proposed by Dimaggio and Powell [11], organizations often followed "collective norms," then headed to "homogeneity in structure, culture, and output". Anwar [12] induced some critical issues about the market expansion and global strategy for NTT DoCoMo. None of them was application-related; only one of the issues addressed that the know-how in i-mode may not be able to easily shift to the other countries because the lifestyle and demands are quite different from each other. It sketched out the problem without considering the discrepancy of demand in different user groups.

Rosenbloom and Larsen [3] showed that there is a relationship between culture and channel communication in international channels. It could also be interpreted as if a firm would like to have business with certain customers by mobile devices, then their culture will be definitely a matter. However, there is still a gap between the theory and practice since there are still similar services for different groups of user, and the subject is still at the stage of development. Lee et al. [13] first confirmed that there were differences of preference in m-commerce among countries by a grey relational approach. Grounded in the framework proposed by Lehner and Watson [14], they grouped applications into four categories then evaluated the preferences. Furthermore, the discrepancies raised interesting questions to the field: are these three samples homogeneous or heterogeneous? And, which application is the most relevant among the different countries under such a framework?

Therefore, this study is going to conduct multi-dimensional preference analyses for the diverse usage in m-commerce by ICOMP and comparing the results with those in [13] by the grey relational approach. Multi-sample clustering and variables selection with ICOMP are the approaches we used to validate whether diverse usage existed. In order to find the best-fitting model and the applications contributing most to the difference among these samples, two arguments are made in this study. They are:

1. Can these samples be a homogeneous sample? Although we already knew preference differed from each other in the previous research, to distinguish whether the data are homogeneous or heterogeneous may be a more fundamental task. Furthermore, what the best-fitting model(s) will be if they are not homogeneous?
2. The preference for applications may not necessarily represent the same rank in contributing difference among samples. Which application(s) contributed most to the difference among samples?

1.2 Research Motivation and Objectives

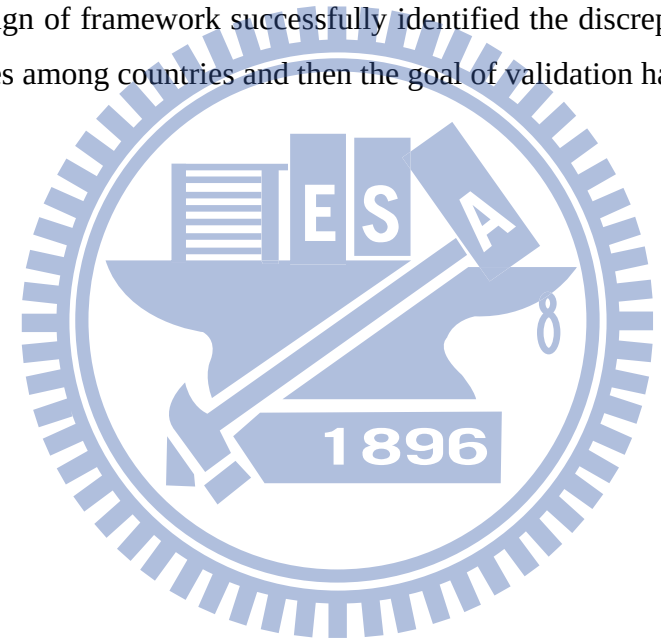
As described in the previous section, this dissertation is dedicated to the analysis of usage in m-commerce, especially the framework for the analyses. Basically, the usage of services in m-commerce can be treated as a choice behavior problem. As Meyer et al. [15] indicated, consumer choice is inherently a dynamic process. Whether we are observing routine purchases of brands at supermarkets or once-in-a-life choices of housing, choices made in the present implicitly reflect what has been learned from the past and, often,

expectations about the future. Yet while the importance of understanding the nature of dynamic influences on choice is widely recognized, our knowledge of how choice evolves over time remains highly fragmented. The view of decision making that pervades most of the literature on choice theory remains largely static, quite adept at describing the momentary relationships that exist between preferences and actions, but less able to describe the dynamics that gave rise to these relationships.

Since supply and demand in the e-commerce may not be able to simplify as that in a road network system, to learn key factors in forming an e-marketplace is worthwhile for further connected analyses. Relied on the global-wide information platform, supply-on-demand in e-commerce is a highly demanded specification. Such a specification shortens the trade distance and makes e-commerce significantly different from the other kinds of businesses. A research framework was developed to analysis the key factors in forming an e-marketplace for the flower wholesale market in Taiwan. Different from the system-wide approach for the aforementioned traffic assignment problems, the survey for key players in the market was conducted. With the Fuzzy Delphi analyses, the key factors which affect the operation modes between the retailer and the e-marketplace were "cooperation on urgent orders", "accuracy of order processing", and "order processing efficiency". The e-marketplace was expected to provide "actively placing orders", "jointly negotiating prices", and "free bidding at the same time for retailer", according to the Fuzzy Multiple Criteral Decision Making analyses.

The point of view from the supply side might be very different from the demand side in m-commerce. In e-commerce, only very limit supplier can get taste of success without asking people what they want. Most of others have to learn the needs from their customers constantly for a survival. However, the story in m-commerce seems slightly different. One of the reasons might be the limitation of handheld devices. Since there are limit number of manufacturers, similar devices are provided for the whole market. The platform specified browsers on handheld devices provided limit compatibility with the rest of internet and further prevent users from getting what they wanted over there. In order to test the hypothesis of the usage of services in m-commerce different across countries, a framework with the grey relational analysis was developed. Relied on the framework, the results suggested the usage of m-commerce services were different in Germany, USA and Taiwan and the patterns changed over areas. It also showed the framework with grey relational analyses is good enough for identifying the usage and patterns of m-commerce.

M-commerce may bloom any time once users can get what they wanted via their handheld devices. For a preparation of the emerging business, to provide a different angle of view on learning what the customers wanted may be necessary. To the practitioners, the study can help them confirming the fact of discrepancy in the usage of services. It can also help the researchers in conducting further research for the emerging business. In cooperating with a relative new statistical technique, i.e. information-theoretic measure of complexity (ICOMP) [16], an analytical framework was proposed for analyzing the usage of services in m-commerce. ICOMP takes the spirit of Akaike's Information Criterion (AIC), but it is a fundamentally different procedure than AIC in the sense that ICOMP is based on the entropic characterization of the measure of complexity of a model. A major benefit using ICOMP to choose the best model is that the samples' sizes do not necessary being the same. As expected, the design of framework successfully identified the discrepancy in the usage of m-commerce services among countries and then the goal of validation have accomplished.



CHAPTER 2 LITERATURE REVIEW

2.1 Grey Relational Analysis

The grey system theory [17] has been developed to examine the relationship among factors in an observable system where the information available is grey, meaning uncertain and incomplete (i.e. only part of the information is known). It has been successfully used in a wide range of fields, including some recent application results (e.g. [18], [19], [20], [21]) highlighting its effective handling of incomplete known information for exploring partially known information. The system that can be built for answering specific research questions in product design with respect to product form and product image is grey in essence, as there is no way to identify all the product form elements that affect a particular product image perceived by consumers. To analyze the results of questionnaires, this paper adopted an approach of grey relational analysis (GRA) which based on the grey system theory.

Grey relational analysis [17] is good at showing the preference for the applications in each sample respectively but it can hardly to tell which application is the most influential in telling difference between samples. In fact, the most popular application in each sample may not be the one contributing most to the difference between samples. Since the abundance of irrelevant variables may mask the objectives of the study, and because they effect the information in the rest of the data that can unnecessarily increase the size of the search space and accuracy of classification of the data set, the choice of variables to represent the patterns in the whole dataset affects several aspects of pattern classification. In this study, the information-theoretic measure of complexity was employed to distinguish the applications by ranking them with the contribution to the difference among samples based on the use of correlations as similarity measures, and applying the minimum pair-wise correlation as a measure of similarity between two clusters of variables.

2.2 Information-Theoretic Measure of Complexity

ICOMP, the information-theoretic measure of complexity, was proposed by Bozdogan ([22], [23]). It is based on the structural complexity of an element or set of random vectors via a generalization of the information-based covariance complexity index of van Emden [24]. For a general multivariate linear or nonlinear model which can be defined by the following relationship,

Observation = Signal + Noise (1)

ICOMP is designed to estimate a loss function:

Loss = Lack of fit + Lack of parsimony + Profusion of complexity (2)

in several ways. The third term in Equation (2) represents the interdependencies or the correlations among the parameter estimates and the random error term of a model.

ICOMP was proposed by Bozdogan [22], [23] which had broadly accepted in fields (e.g. [25], [26], and [27]). According to Bozdogan [24], a rationale for ICOMP as a model selection criterion is that it combines a badness-of-fit term with a measure of complexity of a model by taking into account the interdependencies of the parameter estimates, as well as the dependencies of the model residuals. Even though there were several approaches for determining the difference, e.g. discriminant analysis or cluster analysis [28], the primary reason for employing ICOMP to analyze the diversity here is that the sample sizes were different.

To check whether the data is homogeneous or heterogeneous is very important in many scenarios. Analytically, to group the heterogeneous samples into homogeneous sets of samples is usually necessary to reduce the dimension of variables and the number of groups simultaneously. In literatures, the Analysis of Variance (ANOVA) is a widely used model for comparing two or more univariate samples, where the familiar Student's t and F statistics are used for formal comparisons among two or more samples. For cases with multiple samples, the Multivariate Analysis of Variance (MANOVA) is a popularly used model for comparing two or more multivariate samples. However, the formal analysis involved in ANOVA or in MANOVA is not revealing or informative. For this reason, in any problem where a set of parameters is to be partitioned into groups, we may employ a practical statistical procedure or procedures that would use some sort of statistical model to aid in comparisons of various collections of comparable groups or samples, identify the homogeneous groups from the heterogeneous ones, and determine which groups or samples should be clustered together.

Bozdogan [29] suggested that through Multi-Sample Cluster Analysis (MSCA) as an alternative to Multiple Comparison Procedures (MCP's) and through the use of model-selection criteria, all sufficiently simple partitions of groups consistent with the data, and also the best clustering among the alternative clusters, should be found. Based on this idea, he proposed an enumerative clustering technique to generate all possible choices in clustering alternatives of groups or samples on the computer using efficient combinatorial algorithms

without forcing an arbitrary choice among the clustering alternatives. Then, a new procedure on analyzing Information Complexity was established and to apply common principal components analysis to multi-sample clustering [22].

2.3 E-Commerce

Ratchford et al. [31] discussed a model of demand for Internet and other information sources on the premise that Internet is the most efficient source of providing functions and prices. However, his empirical subject was the automobile, while agricultural products like flowers do not have clear functions, which thus require other substitutes like quality check or standard classification.

O'Keefe and Loebbecke [32] suggested that researchers should not blindly suppose that the virtual world is of interest in its own right because most of the time people live in the physical world and have already developed a mature approach to integrate the experiences they have had in both real and virtual worlds. Thus, when we analyze the business mode in the virtual world like the electronic marketplace, we should take into account the business mode in the real world.

Steinfield et al. [33] explained how organizations in the Netherlands combine the operation of the real and the virtual by proposing four points: cost savings, improved differentiation, enhanced trust, and market extension. O'Keefe and Loebbecke [32] thought that these four points could apply to other related studies on the combination of e-commerce and activities in the real world. The key factors were explored in which influenced the formation of the e-marketplaces in four aspects: logistics flow (cost savings), business flow (market extension), cash flow, and information flow.

Using Extended Web Assessment Method (EWAM), Schubert [34] discovered that, from the consumer's point of view on consumer goods and on e-commerce service of Internet banks, most websites fail to satisfy consumer expectations; on the other hand, those websites with high-quality service are not necessarily successful in their business. Schubert thought that the soundness of the Business Model and the assessment of the Website should be discussed separately. Our study analyzes the flower e-marketplace based on the soundness of the Business Model and finds the key factors in forming the flower e-marketplace based on the expectations of both supplier and retailer.

Luo and Seyedian [35] quoted the viewpoint of Kenny and Marshall [36] that contextual marketing refered to the extent to which e-businesses use the ubiquitous Internet to provide customers with relevant information in the right context and in real-time, and that contextual marketing is important because users are already overloaded with information. What they needed most was relevant information provided in real time at the point of need. This viewpoint was confirmed by our research, that is, an e-marketplace has to provide the proper business modes for both supplier and retailer.

Chen [37] in her essay “Study on the Evaluation Procedure of Selecting Airport Location” used Fuzzy Delphi and Fuzzy Layer Analysis as evaluation tools. By questionnaire, and taking the professionals familiar with transportation and delivery and the staff in Taipei Agricultural Marketing Company as research subjects, Cheng [38] used Fuzzy Multiple Criteria Decision Making to evaluate the delivery modes between the company and its 18 affiliated supermarkets; the result show that “commission delivery” is the most feasible delivery mode.

The Kano model is a theory of product development and customer satisfaction developed in the 80's by Professor Noriaki Kano [39], which was initially used to systematically deal with the demand from customer and then transfer the demand onto the improvement of products so as to improve the competitiveness of enterprises. Kano considered that the major customer demands are: must have, linear satisfier, and delighted.

In respect of flower consumption behavior, Lee and Cheng [40] in their study “The Business Environment Analysis and the Sales Channel Strategy Making of the Flower Stores (Part 2)” analyzed the current general environment confronted by flower stores, their roles in the marketing channels, and the right strategies they should take; they made strategic analysis and suggested that the flower stores should put more emphasis on their business management strategy and well employ their unique advantages and reduce threats so as to fight against external market impacts.

Lee [41] in his study of “New Sales Channel for Flowers – Application of Internet”, by questionnaire and the application of independent checking and Logit 's mode, analyzed the background of the interviewees, discussed the relationship between the interviewees' background and their purchase behavior, as well as finding out the feasible separated markets for bouquet promotion. The results showed that the feasible separated markets were

composed of consumers “who had computers with Internet access” and “whose education level is above college or graduate school (inclusive)”.

2.4 M-Commerce

Most researches (e.g. Mahatanankoon et al. [42]) found that mobile commerce (m-commerce) presents many new opportunities and challenges to carry out one-to-one customer relationship in the 21st century of e-business. For m-commerce to reach its full potential, operation modes and strategies must offer the customers maximum effectiveness through value-added, location-centric and customized m-commerce applications. It is expected that new and even more innovative applications will arise as more people are connected to the web through mobile devices.

Researchers have adopted a broad definition of m-commerce to explore the potential benefits of the wireless technology. Durlacher [43] defines m-commerce as “any transaction with a monetary value that is conducted via a mobile telecommunication network”. Similar to general traditional definitions of e-commerce, the focus lies on the exchange of products and services that is associated with a monetary value. A distinction, however, can be made in terms of the technology used. In the mobile context, mobile telecommunication networks substitute the internet as an underlying driver and enabler.

Skiba et al. [5] take a slightly different approach and define m-commerce as “the use of mobile hand-held devices to communicate, inform, transact and using text and data via connection to public or private networks”. They specifically list any kind of service that can be provided by the mobile device, thus, expanding the mere commercial character through communicative and informative services.

Basically, m-commerce can be treated as the use of wireless technology, especially for handheld mobile devices and mobile internet, to facilitate transaction, information search and user task performance in consumer, business-to-business and intra-enterprise communications (Kannan et al., [4]; Varshney and Vetter, [44]). Lehner and Watson [14]) classify m-commerce and mobile applications based on the underlying processes. They suggest that m-commerce applications support not only the transactions, but also value-added services and interaction. The base of m-commerce, mobile internet, has unique potential over the stationary internet, because users can have connection to the internet wherever and whenever they desire (Kakihara and Sorensen, [2]). With these strengths, proponents claim that m-

commerce will surpass e-commerce in growth and scale (Kalakota and Robinson, [6]). However, it has not happened yet, and the situations differ in different countries. According to Economist Intelligence Unit (EIU, http://www.eiu.com/) country indicators estimated in 2004, for example, the percentage of internet users was 37.7 in Taiwan, 66.1 in the USA and 47.6 in Germany; and the percentage of mobile subscribers was 101.4 in Taiwan, 57.7 in the USA and 84.6 in Germany (www.ebusinessforum.com).

A number of researches were dedicated to this emerging field in recent years because of the unique potential of m-commerce, but it is still in its infancy. Tsalgatidou and Pitoura [45] proposed m-commerce extends not only the benefits of e-commerce, but also allowed for unique services and additional benefits when compared to traditional e-commerce applications. Keen and Mackintosh [46] noted the demand side of m-commerce was a search for value and there was a need to build an understanding of the elements and special features of wireless electronic channels that were value-adding from the consumer's point of view. The key value proposition of mobility was the creation of choice, or new freedoms, for customers. That is, the main value-added feature of m-commerce includes flexibility, convenience and ubiquity. Chan et al. [9] evaluated the usability of ten wireless sites on three platforms, based on the usability pertaining to user tasks, content presentation, search, navigation systems and the design constraints imposed by form factors.

Although researchers had distinguished the unique strengths of m-commerce from e-commerce and the usability before 2002, there was still a heated discussion on what drives the m-commerce and the search for success factors of mobile marketing. Lee and Benbasat [47] proposed 2Ms, mobile setting and mobile device constraints, influenced the formation of each of the Rayport and Jaworski's 7C elements. They alerted developers on the unique principles of design for m-commerce and suggested that the usage environment and device constraints should be taken into account in developing the interface. Gebauer and Shaw [48] proposed a need for simple but highly functional mobile applications that complement existing information systems. They indicated that users value two things mostly: notification, especially in connection with high mobility, and support for simple activities like tracking, as opposed to handling more complex processes complete online. Poor technology characteristics, as perceived by potential users, had inhibited the application usage to a greater extent.

The Technology Acceptance Model (TAM) proposed by Davis [49] has been widely referenced and adopted by IS researchers. Wu and Wang [50] proposed a revised TAM and suggested that m-commerce providers should improve their compatibility with various user requirements, previous experience, lifestyle and beliefs to fulfill customer expectations. Mahatanankoon et al. [42] explored consumer perception of mobile applications by examining first the value proposition of mobility, then investigating m-commerce operation modes and potential consumer-based applications. One of their interesting results is that one size does not fit all. In other words, consumers had different usage objectives that focused on a single or a combination of aspects of mobility. Designing a mobile application that falls within the same aspect may increase the likelihood to promote unfamiliar applications to consumers.

Scharl et al. [51] explored the diffusion of Short Messaging Services (SMS) with content analysis by region and industry, and distinguish two categories of success factors, message and media characteristics, which influence three dependent success measures: consumer attention, consumer intention and consumer behavior. The most interesting part of their suggestions is geography and industry differences in the diffusion of mobile marketing, because SMS is just a part of m-commerce. The content was always a king either in e-commerce or in m-commerce. The success of NTT DoCoMo in Japan may not appear elsewhere in the world. Researchers should figure out whether the differences in different areas really exist for other applications in m-commerce, because the ubiquitous connection may bring about a global market.

This study proposes that SMS and other applications in m-commerce differ in different areas and adopts the framework of m-commerce proposed by Lehner and Watson [14] to analyze the differences. Six types of application in m-commerce were classified by the framework they proposed: information and data access, communication and interaction, entertainment, transactions, remote control and decision support and further applications and services. For a comparison of the results in Taiwan, the USA and Germany, only the first four types of application were used to collect data. Remote control and decision support and further applications and services were excluded because they were currently insignificant. The Grey Relation Analysis (GRA) showed the different usage patterns in the three areas, and verified the proposal that m-commerce differs in different areas. It advised the enterprises to adopt different approaches for global m-commerce markets.

CHAPTER 3 KEY FACTORS IN FORMING AN E-MARKETPLACE

Internet has quietly linked global markets, but it is unlikely to alter the trading mode and preference in each market in the short term; thus, to operate e-commerce in a certain market, what we first needed to know was the trading mode and preference in that market. E-marketplace is a form of e-commerce, supplier and the retailer deal through the e-commerce mechanism. However, they do not necessarily deal through the trading mechanism provided by the e-marketplace. This work argued that the e-marketplace for the floral industry in Taiwan aimed to meet the demand of both supplier and retailer. The technology for providing an e-marketplace was readily present. This study unfolded the criteria for joining an e-marketplace and proposed a conceptual framework to study the key factors in forming an e-marketplace. The study subject was the floral industry in Taiwan.

At the moment conducting this study, the major marketing channel for flower suppliers and retailers was the wholesale market, where the wholesalers bided for the supplier's flowers and then sold them downstream to the retailer (Figure 1). Although there were hundreds of flower retail websites on Internet and in these years e-commerce had been used extensively, most retailers still made purchases in the traditional wholesale market. However, when the retailers made purchases in the wholesale market, the wholesalers offered poor service; besides, it was inconvenient for buyers to collect information on the prices of flowers. An e-marketplace was able to solve the problem by providing retailers a new marketing channel and offering timely information on website about the production marketing of flowers so as to reduce the cost of collecting information as well as the purchase price, and to improve trading efficiency.

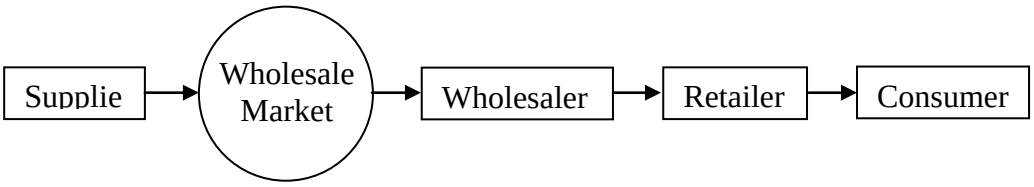


Figure 1 Flow in the floral industry in Taiwan.

Key factors in forming an e-marketplace were suggested for the floral industry in Taiwan, based on investigations by questionnaire the attitudes and interests of both supplier and retailer in selling or purchasing flowers through e-commerce, and analyzed the possible cooperation modes among supplier, retailer, and e-marketplace. The scope of the work was to

explore the possibility of an e-marketplace for the floral industry in Taiwan. The objective was to find the key factors in forming an e-marketplace for the floral industry in Taiwan. The main contribution of this work was to highlight the key factors in forming an e-marketplace for the floral industry in Taiwan.

3.1 The Methodologies

Besides using descriptive statistical method, this study employed Fuzzy Delphi to extract the key factors which affected the willingness of flower supplier and retailer to join the e-marketplace, and further used Fuzzy Multiple Criteria Decision Making [58] to choose the more feasible cooperation modes from all the possible cooperation modes. The Kano mode was also used here to analyze the supplier's attitudes towards the operation mode of the e-marketplace.

The following is an introduction of the three methods.

3.1.1 Fuzzy Delphi

Based on Kauffman and Gupta [59], Fuzzy Delphi is a variation of the Delphi method using triangular fuzzy numbers in which communication with experts is the same, but the estimation procedure is different. Some important remarks about this method can be found in Kauffman and Gupta [59]. Here, the function of this method is to list several factors in order according to their importance, which is shown in the form of a geometric mean. The equation of the geometric mean is shown as:

$$X_i = \sqrt[m]{a_{1i} \times a_{2i} \times a_{3i} \times \cdots \times a_{mi}} \qquad (3)$$

where X_i is the score of question i, m is the number of respondents, a_{ji} is the score of respondent j to question i.

3.1.2 Fuzzy Multiple Criteria Decision Making

This method evaluates the feasibility of each item; the higher the calculated figure, the more feasible is the item. This work adopted the method to evaluate all possible cooperation modes for the flower supplier who would like to participate in the flower e-marketplace, then to find out the more feasible cooperation modes. The steps were as follows:

Step 1: Decide Factor Set

Factor Set U = {u_i, i = 1,2, . . ., n}, u_i is the key factor i

Step 2: Find the weight of each factor in Factor Set

$W = \{w_i, i = 1,2, \ldots, n\}$, w_i is the relative weight of the key factor (u_i) The weight of each factor is shown by the triangle fuzzy figure, as Equation (4) shows:

$$w_i = \{w_{iL}, w_{iA}, w_{iH}\}, \quad i= 1, 2, \ldots n \tag{4}$$

where w_{iL} is the lowest of all the scores in question (i), w_{iA} is the geometric mean of all the scores in question (i), w_{iH} is the highest of all the scores in question (i).

Step 3: Find the value of each item to each factor, which is shown by r_{jk}, representing that the performance score of the factor j in the item k; the higher the score, the better the factor j performs in the item k. r_{jk} is also shown by the triangle fuzzy figure, as Equation (5) shows:

$$r_{jk} = \{ r_{jkL}, r_{jkA}, r_{jkH}\} \quad j= 1, 2, \ldots v; \quad k= 1, 2, \ldots p \tag{5}$$

where r_{jk} is the performance score, r_{jkL} is the lowest of the geometric means of the score of the factor j in the item k, r_{jkA} is the geometric mean of the score of the factor j in the item k, r_{jkH} is the highest of the geometric means of the score of the factor j in the item k.

The fuzzy evaluation matrix R_k of all factors in the item k, as Equation (6) shows:

$$R_k = \begin{Bmatrix} r_{1k} \\ r_{2k} \\ \vdots \\ r_{vk} \end{Bmatrix} = \begin{Bmatrix} r_{1kL} & r_{1kA} & r_{1kH} \\ r_{2kL} & r_{2kA} & r_{2kH} \\ \vdots & \vdots & \vdots \\ r_{vkL} & r_{vkA} & r_{vkH} \end{Bmatrix} \tag{6}$$

After calculation, we get the triangle fuzzy figure of the item k, which has to be positively naturalized before comparison. The process of positive naturalization is in Step 4:

Step 4: Fuzzy Compound Calculation

$$B_k = W \cdot R_k = \{w_1, \quad w_2, \quad \cdots, \quad w_n\} \cdot \begin{pmatrix} r_{1kL} & r_{1kA} & r_{1kH} \\ r_{2kL} & r_{2kA} & r_{2kH} \\ \vdots & \vdots & \vdots \\ r_{vkL} & r_{vkA} & r_{vkH} \end{pmatrix} =$$

$$[(w_{1L}, \quad w_{1A}, \quad w_{1H}), \quad (w_{2L}, \quad w_{2A}, \quad w_{2H}), \quad \cdots \quad (w_{nL}, \quad w_{nA}, \quad w_{nH})] \cdot$$

$$\begin{pmatrix} r_{1kL} & r_{1kA} & r_{1kH} \\ r_{2kL} & r_{2kA} & r_{2kH} \\ \vdots & \vdots & \vdots \\ r_{vkL} & r_{vkA} & r_{vkH} \end{pmatrix} = [b_{kL}, \quad b_{kA}, \quad b_{kH}] \qquad (7)$$

where B_k is the compatibility of the item k, also shown in the fuzzy triangle figure $[b_{kL}, b_{kA}, b_{kH}]$

Step 5: De-fuzz and Sort

After fuzzy calculation, we get a set of figures representing the triangle fuzzy function, and we use the simple triangle centering method to calculate the compatibility of each factor.

3.1.3 Kano Analysis

Zhang and von Dran [60] used Kano's model of quality to analyze the customer's quality expectation of the websites of special form (CNN.com) and discovered that Kano's model of quality could be extensively applied to many areas or many types of websites; through long-term study they discovered that customer expectation on quality changes with time, so it fails to use the same single quality checking table to evaluate quality expectation. Kano's model can be employed to identify quality expectations and time transition of quality factors; customers in the same web areas do not consider all quality factors equally important; the quality factors in different web areas have different importance, but certain factors exhibit great importance in all web areas.

This method classifies customer demand threefold: must have, linear satisfier, and delighted. "Must have" means the property or function customers consider the product must certainly have or they cannot accept the product. Kano analysis inquires customer demand by questionnaire with two questions as a set, including both a positive and a negative question. For example:

Positive: What is your opinion if Service A is included?

Negative: What is your opinion if Service A is not included?

With respect to the questions, the interviewee has five choices: (1) I like it very much, (2) It must be included, (3) I remain neutral, (4) It's so-so, and (5) I dislike it. The results are transformed and shown in Table 1; the transformed results include "must have", "the more, the better", "delighted", "there is some problem", "the contrary", and "no difference".

Suppose the interviewee thought Service A must be included (Choice 2) and disliked no Service A (Choice 5). After the transformation in Table 1, we know that Service A belongs to the function "must have".

In Table 1, "no difference" means that customer remains neutral and is not affected by the property of the product. "The contrary" means that the interviewee dislikes or does not need the property of the product. "There is some problem" means that the interviewee chooses both "I like it very much" and "I dislike it" in answering both the positive and the negative question. "The contrary and "There is some problem" indicate that the customer shows contradiction in answering the questions, but these situations more or less appear in common questionnaire investigations. After we have interviewed a certain number of customers, we tally the number of times in each grid of Table 1 and relate it in terms of percentage, to show the viewpoint of the customers.

Table 1 Kano's transformation of customer demand

Positive description	Negative description				
	I like it very much	Must have	I remain neutral	It's so-so	I dislike it
I like it very much	There is some problem	Delighted	Delighted	Delighted	The more, the better
Must have	The contrary	No difference	No difference	No difference	Must have
I remain neutral	The contrary	No difference	No difference	No difference	Must have
It's so-so	The contrary	No difference	No difference	No difference	Must have
I dislike it	The contrary	The contrary	The contrary	The contrary	There is some problem

3.2 Empirical Results for the Flower Wholesale Market in Taiwan

3.2.1 Suppliers

In respect of flower production, according to the Profile of Agricultural Suppliers in Taiwan [61], in June 1996, there were 486 groups of flower suppliers in Taiwan, mostly from the central countries of Nantou, Changhua, and Taichung. Currently the major sales channels for suppliers are the four wholesale markets in Taipei, Taichung, Changhua, and Tainan. There were two questionnaires with two parts therein both for the supplier and the retailer, respectively. The first part of the questionnaire dealt with the supplier's related sales background, including gender, age, level of education, and his/her major sales channel; the second part was about the related B2B (Business to Business) trading information of the supplier, including his/her willingness in selling flowers in the e-marketplace, and his/her preferred cooperation mode with the e-marketplace. The Delphi processes were conducted from June 28, 2002 to July 7, 2002, and the 150 interviewees (all of them were experts in this industry) were chosen by random sampling from suppliers in the central countries listed in the Profile of Agricultural Suppliers in Taiwan. One hundred and thirty five questionnaires were retrieved, with a high effective retrieve rate of ninety percent. There were five iterations in the whole Delphi processes to get the final results. On the last iteration, trained interviewers conducted personal interviews and the issue was very attractive to interviewees; besides, the questions had little to do with the business confidentiality of the interviewees, so most of them felt free to answer the questions.

Table 2 shows most interviewees were male (88.9%), over 40 years old (37.8%), with senior high level of education (40.7%), with an average of 9.29 years on flower production and their planting areas were mostly in Nantou (43%). Flower suppliers with the above characteristics were the principal research subjects of our study.

Table 2 Background of interviewees: suppliers

Characteristics of interviewees	Statistics
Gender	Male (88.9%), female (11.1%)
Seniority on flower production	9.29 years on average
Age	50 and over (20%), 45–49 (14.8%), 40–44 (17.8%), 35–39 (14.8%), 30–34 (14.8%), 25–29 (14.8%), 20–24 (3%)
Level of education	Senior high (40.7%), Vocational school (11.1%), Junior high (25.2%), College (3.7%), Elementary school (19.3%)
Planting area	Nantou (43%), Changhua (22.2%), Taichung (34.8%)

Table 3 shows the sales modes employed by the interviewees. The wholesale market was the principal sales channel (54.3%), and cut flowers (75.8%) were a major production. 94.1% of the interviewees did not deal with contract production and the usual goods-delivering period was within 7 days (50%). Most suppliers who did not deal with contract production showed great willingness to sell flowers through Internet (83%). Suppliers who did not deal with contraction product but were willing to sell flowers through Internet tended to take the wholesale price of the day as reference (40.2%) before they decided on the price of their flowers. The interviewees who did not deal with contract production and were not willing to sell flowers through Internet to flower stores thought that “on-line demand is deficient” (5.39 points), and “the sales procedures online are complicated” (5 points). It was suggested that the e-marketplace should simplify the online sales procedure as much as possible, but it was not recommended any specific standard online-sales procedure to respondents.

Table 3 Current sales modes of the interviewees

Item	Statistics
Major sales channels and ratio of sales volume to total sales volume	54.3% to wholesale markets, 22.6% to collecting centers, 10.2% to exporters, 7.9% to retailers, 3.4% to flower stores, 1.6% to other channels
Major types of flowers they supply	Cut flowers 75.8%, Potted flowers 15.8%, Others 8.4%
Dealing with contract production	No (94.1%), Yes (5.9%)
Usual goods-delivering period	Within 7 days (50%), 2 months and over (25%), 7 days to 1 month (12.5%), 1 to 2 months (12.5%)
Attitude of the flower suppliers who do not deal with contract production towards selling flowers through Internet to flower stores	Yes (83%), No (17%)
Price-deciding reference of flower suppliers who do not deal with contract production	Wholesale price of the day (40.2%), Wholesale price of three days ago (26.8%), Wholesale price of the day before (16.1%), Wholesale price of one week ago (11.6%), Others (5.4%)
Why flower suppliers who do not deal with contract production are not willing to sell products through Internet to flower stores	On-line demand is deficient (5.39 points), Classification-packaging standard is complicated (3.39 points), Sales procedures online are complicated (5 points), Production scale is small (3.26 points), Price-deciding methods are complicated (4.04 points), They show little interest (2.83 points)

Note. 7-point scale – 7 the highest, 1 the lowest.

While suppliers cooperated with the e-marketplace, the activities were categorized into four parts: logistics flow, cash flow, business flow, and information flow. There were 23 factors altogether, and the interviewees were asked to rate the importance of each of the factors based on a 10-point scale, 10 being the most important and 1 for the least important. The Fuzzy Delphi approach was used to calculate the geometric mean of each factor, and the results are shown in Table 4.

Table 4 Factors affecting the operation modes between the supplier and e-marketplace

Category	Serial number	Factor	Average
Logistics flow	1	Quality check	8.81
	2	Production project	8.52
	3	Flower-packing and staff training	7.58
	4	Efficiency of car dispatch	7.15
	5	Freight charge	7.04
	6	Form and amount of compensation	7.04
	7	Urgent order processing	6.46
	8	Quantity and capacity of cars	6.36
Cash flow	9	Trading credit investigation	8.81
	10	Whether capital is sufficient or not	7.65
	11	Trading price and trading volume	7.31
	12	Processing fee	6.19
Information flow	13	Provision and compilation of production-marketing information	8.25
	14	Volume and stability of demand	8.14
	15	Efficiency of deciding on trading price	7.53
	16	Establishing trading mechanism	7.42
	17	Price prediction	6.68
Business flow	18	Accuracy of order processing	8.91
	19	Order processing efficiency	8.19
	20	Dealing with damaged flowers	8.08
	21	Processing of customer complaint	7.58
	22	Goods tracking	6.99
	23	Frequency and degree of contact with buyers	6.6

Figure 2 shows the scores of all the factors in linear illustration. Based on the experience of "choosing no more than 7 successful key factors in a study", the factors were classified into 5 groups. The geometric meant of the first group is the highest, indicating that it was most representative of the interviewees opinions, hence the most feasible website key factors. According to this figure, the four key factors (in descending order) which affect the cooperation modes between the supplier and the e-marketplace, were "accuracy of order processing ", "trading credit investigation", "quality check", and "production project". "Order processing correctness" was under Business Flow, "trading credit investigation" under Cash Flow, and "quality check" and "production project" under Logistics Flow. There were no factors attributed to Information Flow, possibly because the suppliers seldom used related production information to make production planning, and they are not quite familiar with the application of production-marketing information.

Figure 2 Linear illustration of factors affecting the operation modes between the supplier and e-marketplace

According to the analysis, it was suggested that the e-marketplace should strengthen flower quality check to ensure flower quality stability, and take into account production-marketing information while planning production projects, cooperating with the suppliers on planned production. Besides, the e-marketplace should check the trading credit of both sides to prevent bad debts, and improve the accuracy and efficiency of order processing so as to upgrade customer service.

The major production-marketing modes for suppliers were "spot selling" and "contract production" at the moment this research conducted. "Free bidding" was also included which is now popular in Internet. The contents of the three modes were as follows:

1. Spot selling: As soon as the retailers joined the e-marketplace and place orders online, the suppliers sold their flowers based on the orders.

2. Contract production: After confirming the total volume of orders and the transaction day, the e-marketplace arranged the delivery date with the suppliers by contract.

3. Free bidding: Suppliers provided information about their products including literal description or pictures, which put on the e-marketplace for retailers to bid.

The Fuzzy Multiple Criteria Decision Making approach was used to evaluate the compatibility of the three cooperation modes. Table 5 lists the results. The evaluation shows that "contract production" was the most acceptable mode to suppliers, "free bidding" the second, and "spot selling" the last. The compatibility of "contract production" was very close to that of "Free bidding", and both higher than that of "spot selling".

Table 5 Compatibility of the operation modes of the e-marketplaces

Operation mode	Compatibility
Contract production	1.21058
Free bidding	1.20870
Spot selling	1.18955

Next, we analyzed the suppliers' attitude towards 13 operation modes with Kano analysis. Table 6 shows the results.

Table 6 Attitude of interviewees towards the operation modes of the e-marketplaces

Operation mode	Description					
	Must have	The more, the better	Delighted	No difference	There is some problem / The contrary	Conclusion
Integrating all orders and then purchasing flowers from suppliers	32 (24%)	31 (23%)	22 (16%)	44 (33%)	6 (4%)	No difference, Must have, The more, the better
Suppliers get better pricing based on their sales volume online	9 (7%)	15 (11%)	17 (13%)	78 (58%)	16 (12%)	No difference
Setting up an arbitration mechanism to deal with quality check, damaged goods, and compensation	33 (24%)	24 (18%)	11 (8%)	59 (44%)	8 (6%)	No difference, Must have
Suppliers become members, provide only registered members of suppliers can sell their products online	24 (18%)	11 (8%)	13 (10%)	75 (56%)	12 (9%)	No difference
Suppliers choose orders they prefer online	46 (34%)	18 (13%)	16 (12%)	42 (31%)	13 (10%)	No difference, Must have
Suppliers have to be shareholders of the e-marketplace or pay a fee to become members.	12 (9%)	8 (6%)	6 (4%)	88 (65%)	21 (16%)	No difference
Flowers are grown locally and/or imported	5 (4%)	5 (4%)	4 (3%)	66 (49%)	55 (41%)	No difference, There is some problem, The

						contrary
Professional transportation companies are in charge of transportation and delivery	25 (19%)	22 (16%)	10 (7%)	67 (50%)	11 (8%)	No difference
A professional computer company is in charge of the website and maintenance.	31 (23%)	32 (24%)	10 (7%)	57 (42%)	5 (4%)	No difference, Must have, The more, the better
Ranking of trading volume and sales volume by suppliers and buyers are posted on the e-marketplace	15 (11%)	10 (7%)	20 (15%)	68 (50%)	22 (16%)	No difference
On-line trading is only for flowers of large trading volume	15 (11%)	4 (3%)	11 (8%)	77 (57%)	28 (21%)	No difference
On-line trading is open to all breeds of flowers	20 (15%)	22 (16%)	17 (13%)	67 (50%)	9 (7%)	No difference
Providing members with compiled production-marketing information (price in all wholesale markets, yield in place of production, and related activities)	28 (21%)	41 (30%)	17 (13%)	46 (34%)	3 (2%)	No difference, The more, the better

In Kano analysis, the questions were addressed positively and negatively to each operation mode, giving a total of 26 questions. The following is an illustration:

Positive question: What is your opinion when the operation mode is "integrating all orders and then purchasing flowers from suppliers"?

Negative question: What is your opinion when the operation mode is “not integrating all orders and then purchasing flowers from suppliers”?

There are five options: (1) I like it very much, (2) Must have, (3) I remain neutral, (4) Its so-so, and (5) I dislike it. The opinions of the interviewees were arranged in Table 7. With reference to Table 1, the results show that 32 interviewees were for “must have”, 31 for “the more, the better”, 22 for “delighted”, 44 for “no difference”, 4 for “there is some problem”, and 2 for “the contrary”. Thus, for this operation mode, the principal attitude of the interviewees was “no difference”, followed by “must have”, “the more, the better”, “delighted”, “there is some problem”, and “the contrary”, respectively.

Table 7 Attitude of interviewees towards the operation mode

Positive	Negative				
	I like it very much	Must Have	I remain Neutral	It’s so-so	I dislike it
I like it very much	2	0	15	7	31
Must have	0	0	7	2	13
I remain neutral	1	0	12	5	7
It’s so-so	0	0	13	5	12
I dislike it	0	0	1	0	2

Note. The scores in the table represent ‘‘the number of times’’.

Table 6 shows the attitude of the interviewees towards the 13 operation modes. As “there is some problem” and “the contrary” appear sparingly, and both are negative, we put them under one heading. We summarized the number of times of all the options and then computed the percentage. For example, in the operation mode “integrating all orders and then purchasing flowers from suppliers”, 33% of the interviewees found “no difference”, 24% “must have”, and 23% “the more, the better”. Therefore, this operation mode favors “no difference”, “must have” and “ the more, the better”.

The “Conclusion” column showing that the four principal attitudes of the interviewees towards each operation mode were “no difference”, “must have”, “the more, the better”, and “there is some problem”. “No difference” appeared most frequently probably because the interviewees were not quite familiar with the current operation modes of the e-marketplace. “There is some problem” and “the contrary” showed only in the operation mode “flowers are grown locally and/or imported”. In order to get the real picture, the statistics of the two options was compiled separately, and found that 49 interviewees (36%) had chosen “the contrary” on this item and 6 (5%) for “there is some problem”. In other words, 36% of the interviewees considered the operation mode unnecessary; thus, the suppliers favored flowers which were grown locally.

Interviewees favored “must have” towards four operation modes, viz, “integrating all orders and then purchasing flowers from suppliers”, “setting up an arbitration mechanism to deal with quality check, damage goods, and compensation”, “suppliers choose orders they prefer online”, and “a professional computer company is in charge of the website and maintenance”.

Interviewees favored “the more, the better” towards three operation modes, viz, “integrating all orders and then purchasing flowers from suppliers”, “a professional computer company is in charge of the website and maintenance”, and “providing members with compiled production-marketing information (price in all wholesale markets, yield in place of production, and related activities)”.

Interviewees favored both “must have” and “the more, the better” towards two operation modes, viz, “integrating all orders and then purchasing flowers from suppliers”, and “a professional computer company is in charge of the website and maintenance”.

According to the analysis, it was worthwhile to notice that, the e-marketplace has to employ Internet marketing to increase and integrate orders and then purchase flowers from suppliers. A professional computer company should be in charge of the website and maintenance. The e-marketplace had to set up a clear and fair arbitration mechanism to deal with quality check, damage goods, and compensation. For attracting suppliers to use the website, the e-marketplace should allow suppliers to choose orders they preferred online and offer as much production-marketing information as possible.

3.2.2 Retailers

The first part of the questionnaire dealt with the retailer's background, including gender, age, level of education, frequency of Internet usage and service area (location of flower stores). The interview was conducted from June 28, 2002 to July 7, 2002. Two hundred interviewees were chosen randomly from retailers (flower stores) in the areas north of Hsinchu county whom listed in Flower Retailers in Taiwan in 1996. One hundred and ninety nine questionnaires were retrieved, with a high effective retrieve rate of 99.5%. Trained interviewers conducted personal interviews and the issue was very attractive to interviewees; besides, the questions had little to do with the business confidentiality of the interviewees, so most of them felt free to answer the questions.

Table 8 shows most interviewees were female (67.3%), under 35 years old (66.3%), with senior high and above in education level (90.5%), did not use Internet frequently to look up information (40%), and had their flower stores mainly in Taipei county/city (73.4%). Flower retailers with the above characteristics were the principal research subjects of our study.

Table 8 Background of interviewees: retailers

Characteristics of interviewees	Statistics
Gender	Female (67.3%), male (32.7%)
Age	20–24 (11.6%), 25–29 (27.6%), 30–34 (27.1%), 35–39 (10.6%), 40–44 (15.6%), 45–49 (5.5%), 50 and over (2%)
Level of education	Senior high (42.7%), Junior high (7%), Vocational school (32.7%), Graduate school (2.5%), College (12.6%), Elementary school (2.5%)
Frequency of internet usage	Not often (40%), Almost every day (5%), Never (26.3%), Once a month (5%), 2–3 times a week (12.5%), Once half a month (0.6%), Once a week (10.6%)
Service area (Location of flower stores)	Taipei city (54.3%), Taipei county (19.1%), Taoyuan county (11.1%), Hsinchu city (9.5%), Taoyuan city (6%)

Table 9 shows the purchase modes and the major business items of the flower stores being interviewed. The major purchase channels included the wholesale market, brokers, importers, flower suppliers, and others; and the wholesale market was the most popular (73%).

Table 9 Purchase modes and major business items of the flower stores

Item	Statistics
Purchase channels & ratio of purchase volume to total purchase volume	73% from wholesale markets, 13% from brokers, 7% from importers, 5% from flower suppliers, 2% from other purchase channels
Standard for purchase	Stable flower quality (6.46 points), Goodwill of the seller (6.01 points), Price of flowers (5.99 points), Sufficient breeds of flowers (5.77 points), Purchase volume (5.58 points), Transportation (5.37 points). Note. 7-point scale – 7 the highest, 1 the lowest
Business items of the flower store	Selling flower (97%), Designing bouquets (90%), Decorating meeting venues (72%), Landscaping (57%), Giving classes on flower arrangement (23%), Selling on-line (13%), Others (5%)

The standard for purchase included, "stable flower quality", "goodwill of the seller", "prices of flowers", "sufficient breeds of flowers", " purchase volume", and "transportation ". The retailers put much emphasis on quality (6.46 points), so flower brokers and wholesalers should actively and continuously provided flowers of high quality to establish goodwill and to attract flower stores to buy their products.

As for business items, "selling flowers" (97%), "designing bouquets" (90%), and "decorating meeting venues" (72.7%) rate high.

Table 10 shows that the major breeds sold by the retailers are daisies, roses, and orchids. Table 11 shows the sales and the delivery modes of the flower stores. The average number of self-owned trucks was 1.38, and flower stores with trucks were able to purchase and to deliver goods using their own trucks. When the delivery volume was very large, they entrusted the transportation companies to do the service. 55.95% of the flower stores provided delivery service, 81.56% of which were delivered by self-owned trucks and 14.46% entrusted to other transportation companies. The sales were mainly cut flowers (59.85%), and

the delivery period was mostly on the same day (43.7%) and/or 2–3 days (43.7%). 19.6% of the flowers were sold through e-commerce, 50% of which were interested in using Internet to sell their products, and 7.5% greatly interested. The interviewees whom did not use e-commerce to sell their flowers claimed that "on-line promotion doesn't work well" (5.29 points) and "no need to promote online" (4.75 points).

Table 10 Major breeds of flowers purchased and their purchase rate

	Daisy	Rose	Orchid	Lily	Tulip	Other breeds
Average purchase rate (%)	38.6	36.9	33.2	32.2	28.6	29.3

Note. Average purchase rate = purchase volume of a particular breed , total purchase volume.

Table 11 Sales and delivery modes of flower stores

Item	Statistics
Number of self-owned truck	1.38 on average
Delivery ratio	Ratio of flowers delivered to total sales volume, 55.95%
Delivery mode	Ratio of flowers delivered by self-owned trucks to total volume delivered, 81.56%. Ratio of flowers delivered by entrusted vehicles to total volume delivered, 14.46%
Sales	Ratio of cut flower sales to total sales, 59.85%. Ratio of pot flower sales to total sales, 25.74%. Ratio of accessory sales to total sales, 10.09%. Ratio of other sales to total sales, 4.32%.
Delivery period	On the same day (43.7%), 2–3 days (43.7%), 4–6 days (10.1%), 7 days–4 weeks (2%), Over one month (0.5%)
Trading through e-commerce	Yes (19.6%), No (80.4%)
Interest in trading through e-commerce	Yes (50%), No (42.5%), Yes, greatly interested (7.5%)
Reasons for not using e-commerce	On-line promotion does not work well (5.29 points), No need to promote online (5.29 points), Business scale is not large (4.75 points), Unfamiliar with computer (4.66 points)

Note. 7-point scale – 7 the highest, 1 the lowest.

Table 12 shows the feasibility and reasons for selling flowers online. All the factors affecting the feasibility of selling flowers online successfully had high scores, viz. "quality stability" (6.32 points), "quality recognition" (6.14), "freshness" (6.09), "classification-packing standard" (5.94), "transporting and delivering" (5.79), "unit price" (5.68), and "demand" (5.46). It is shown that they were all important for the successful business performance. Cut flowers scoring over 5 points included bouquet (5.72), lily (5.50), rose (5.42), carnation (5.16), and million stars (5.05). Pot flowers scoring over 5 points included compound pot flowers (5.72), lucky bamboo (5.68), Pachira Macrocarpa (5.53) and Phalaenopsis (5.42).

Table 12 Feasibility and reasons for selling flowers online

Item	Statistics
Factors affecting the feasibility of selling flowers online	Quality stability (6.32), Transporting and delivering (5.79), Quality recognition (6.14), Unit price (5.68), Freshness (6.09), Demand (5.46), Classification-packing standard (5.94)
Feasibility of selling cut flowers online	Bouquet (5.72), African Daisy (4.70), Lily (5.50) Gladiolus (3.90), Rose (5.42), Chrysanthemum (3.50), Carnation (5.16), Other breeds (0.47), Million Stars (5.05)
Feasibility of selling pot flowers online	Compound pot flowers (5.72), Begon×Semperflorens-cultorom (4.74), Lucky Bamboo (5.68), Impatiens balsamina (4.61), Pachira macrocarpa (5.53), Duranta repens (4.58), Phalaenopsis (5.42), Others (0.42), Codiaeum (4.93)

Note. 7-point scale – 7 the highest, 1 the lowest.

The questionnaire listed four possible introductions of flower products in the e-marketplace, viz. "literal description", "picture illustration", "regulated classification", and "a combination of pictures, literal description, and regulated classification". "Spot check" was also listed in order to compare the interviewees' attitude between direct spot check and online literal and pictorial description.

Table 13 Expectations of interviewees towards the E-marketplace

shows that “a combination of pictures, literal description, and regulated classification” (5.97), and “spot check” (5.81), score highest, showing that the retailers would accept pictures, literal description, and regulated classification even though they do not see the real objects.

Table 13 Expectations of interviewees towards the E-marketplace

Item	Statistics
Ideal introductions of flower products	A combination of pictures, literal description, and regulated classification (5.97), Spot check (5.81), Pictures (5.67), Literal description (5.48), Regulated classification (5.47)
Expectations towards the contents of the e-marketplace	Price in all flower markets (5.79), Yield in all places of production places (5.30), Collecting trading details of flower stores (5.11), Information about flower suppliers (5.09), Related flower activities (4.75), Related measures from the agricultural authority (4.38)

Note. 7-point scale – 7 the highest, 1 the lowest

With regard to the expectations towards the contents of the e-marketplaces, items scoring over 5 points included “price in all flower markets” (5.79), “yield in all places of production” (5.3), “collecting trading details of flower stores” (5.11), and “information about flower suppliers” (5.09).

To realize the interviewees’ ideal delivery modes, it was investigated their ideal delivery time and their evaluation of the transportation companies, and the results were shown in Table 14. The ideal delivery times were 08:00–11:59 (46.7%), and 04:00–7:59 (37.7%), showing that the retailers preferred to receive the flowers they ordered before the business hours so they had enough time to arrange or to pack the flowers. In choosing transportation companies, they paid great attention to service factors, including the quality of service (6.66), cooperation on urgent orders (6.62), punctual delivery (6.58), and efficient delivery (6.52). In fact, all 8 factors scored over 5 points, and they should all be taken into consideration.

Table 14 Ideal delivery modes for interviewees

Item	Statistics
Receiving period	08:00–11:59 (46.7%), 0:00–3:59 (4%), 04:00–7:59 (37.7%), 20:00–23:59 (1.5%), 12:00–15:59 (9.5%), 16:00–19:59 (0.5%)
Factors in choosing transportation companies	Quality of service (6.66), Attitude towards customer complaint (6.24), Cooperation on urgent orders (6.62), Freight charge (6.22), Punctual delivery (6.58), Packing (5.8), Efficient delivery (6.52), Number of self-owned trucks (5.48)

Note. 7-point scale – 7 the highest, 1 the lowest.

There were 20 factors which possibly affected the cooperation modes between the e-marketplace and the flower store, and they were categorized into four parts: logistics flow, business flow, cash flow, and information flow. The inter-viewees were asked to rate on a 10-point scale, 10 being the most important and 1 the least important. The Fuzzy Delphi approach was used to calculate the geometric mean of each factor and the results are shown in Table 15.

Table 15 Factors affecting the cooperation modes between the e-marketplace and flower store

Category	Serial number	Factor	Average
Logistics flow	1	Cooperation on urgent orders	9.2
	2	Sufficient supply	8.84
	3	Good stock management	8.77
	4	Diverse breeds	8.72
	5	Quality check	8.69
	6	Efficiency of car dispatch	8.48
	7	Form and amount of compensation	8.33
	8	Freight charge	8.3
	9	Quantity and capacity of cars	7.45
	10	Flower-packing and staff training	6.15

Cash flow	11	Trading credit investigation	8.76
	12	Whether capital is sufficient	8.37
	13	Processing fee	8.07
Information flow	14	Provision and compilation of establishing trading mechanism	8.23
	15	Production-marketing information	8.12
	16	Trading price prediction	8.12
	17	Efficiency of deciding on trading price	8.03
Business flow	18	Accuracy of order processing	9.46
	19	Order processing efficiency	9.06
	20	Goods tracking	8.63

Figure 3 shows the scores of all the factors in linear illustration and they were classified into 5 groups. The three key factors which affected the cooperation modes between the retailer and the e-marketplace were “cooperation on urgent order”, “accuracy of order processing”, and “order processing efficiency”. We suggested that the e-marketplace should put more emphasis on processing orders correctly and speedily from the retailers and should cooperate on the urgent orders by immediately dispatching cars for delivery.

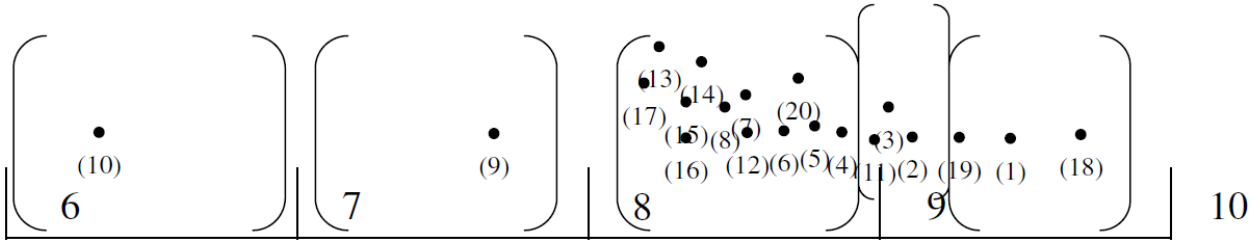


Figure 3 Linear illustration of factors affecting the cooperation modes between the e-marketplace and flower store

In order analyze the feasible operation modes that the e-marketplace should use to cooperate with the flower stores, three operation modes were listed for evaluation:

1. Actively placing orders: After becoming members of the e-marketplace, the retailers can search all production-marketing information on the e-marketplace, and then relate to the supplier's type, class, volume, trading time and place, and the ideal price of the flower products. The supplier who was interested in the order could contact the retailer directly and negotiated on the price.

2. Jointly negotiating prices: The e-marketplace first related the class, trading time, and volume of the flower products to all members so they were able to register the class, trading time, volume and place for collection; the bigger the order, the more the discount.

3. Free bidding: Suppliers offered retailers on the e-marketplace the class and the lowest bidding price of their products. Within a stipulated period of time, members placed bids on the products.

The Fuzzy Multiple Criteria Decision Making approach was employed to evaluate the compatibility of the three operation modes. Table 16 shows the results: the scores of are very close, indicating that the flower retailers found them all equally compatible, probably because there was still no e-marketplace formed based on the expectations of the retailers at the moment, and the retailers were not familiar with the modes. We suggested that the e-marketplace could employ the three modes at the same time to work with the retailers and to evaluate the feasibility of each of the modes in the process.

3.3 Discussion and Summary

The scope of the study was to explore the possibility of an e-marketplace for the floral industry in Taiwan, and it was suggested the key factors in forming an e-marketplace for the floral industry in Taiwan by analyzing the alternative modes among the supplier, the retailer and the e-marketplace. The conceptual framework to analyze the key factors affecting the formation of an e-marketplace was proposed, which was using the Fuzzy Delphi, the Fuzzy Multiple Criteria Decision Making, and the Kano Analysis to conduct the empirical research on the floral industry in Taiwan. The results suggested such a conceptual framework can be used to analyze the key factors in forming an e-marketplace with products that are difficult to standardize.

The major marketing channel for flower suppliers and retailers in Taiwan was the flower wholesale market at the moment this study was conducted. However, when the

retailers made purchases in the wholesale market, the dominant suppliers offered poor service, and the retailers found it inconvenient to collect information on the price of flowers. It was shown that the e-commerce mechanism of the e-marketplace could improve trading efficiency and lower the cost of collecting information as well as the purchase price. According to the analysis, the e-marketplace could use “a combination of pictures, literal description, and regulated classification” to introduce the quality of flower products. Based on the Fuzzy Delphi approach, the key factors which affect the operation modes between the retailer and the e-marketplace were “cooperation on urgent orders”, “accuracy of order processing”, and “order processing efficiency”. According to the three key factors founds by the Fuzzy Multiple Criteria Decision Making approach, the e-marketplace should take to work with the retailer. Retailers found the three operation modes “actively placing orders”, “ jointly negotiating prices”, and “free bidding” equally compatible, so it was suggested that the e-marketplace should provide these modes at the same time for retailer use, and the retailers should be able to select the modes later according to their business performance.

In addition, the key factors affecting the cooperation modes between the supplier and the e-marketplace were “quality check”, “ production project”, “ trading credit investigation”, and “accuracy of order processing” according to the Fuzzy Delphi approach. The Fuzzy Multiple Criteria Decision Making approach was used to evaluate the operation modes, and the e-marketplace should take to cooperate with the supplier. “Contract production” and “ free bidding” were the preferred operation modes. Using the Kano analysis, it was realized the supplier’s attitude towards all the preferred operation modes. To attract more suppliers to join and trade on the website, the e-marketplace should upgrade on-line promotion. Besides, the e-marketplace should integrate all orders and then purchase flowers from suppliers, and set up a clear as well as fair arbitration mechanism to deal with quality check, damaging goods, and compensation; and, in order to attract suppliers to surf their websites, the e-marketplace should allow them to place orders online and offered as much production-marketing information as possible.

CHAPTER 4 COMPARING USAGE OF MOBILE COMMERCE

4.1 The Survey Data

The data were collected from Taiwan, the USA and Germany in January 2004, using a similar but not an identical questionnaire as the conditions of m-commerce in each country are not quite the same. The questionnaires for Taiwan, USA and Germany are listing in the Appendix A, B, and C individually. Most questions are identical, especially those about the four types of applications in m-commerce. These three countries are chosen during the survey because they had higher percentage (over 50%) of mobile subscribers in Asia, America and Europe (www.ebusinessforum.com), respectively. In spite of a very few questions differing in these three questionnaires, other questions – especially those about the four types of applications in m-commerce, were exactly the same. There are 220 respondents from Taiwan, 201 from the USA and 150 from Germany; and there were 85 valid responses in Taiwan, 182 in the US, and 142 in Germany. All participants were university students.

4.2 Grey Relational Analysis

In the grey relational analysis, experimental data are first normalized in the range between 0 and 1, which is also called the grey relational generating. Next, the grey relational coefficient is calculated from the normalized experimental data to express the relationship between the desired and actual experimental data.

Lin and Yang [65] suggested one of the following methods should be used for preprocessing numeric attributes before the grey relational coefficient and the grey relational grade are calculated.

(1) Upper-bound effectiveness measurement (larger is better)

$$x'_i(k) = \frac{x_i(k) - \min_{\forall i} x_i(k)}{\max_{\forall i} x_i(k) - \min_{\forall i} x_i(k)}, \qquad (8)$$

where $x_i(k)$ is the value of attribute k associated with instance x_i, $x'_i(k)$ is the output value of attribute k associated with instance x_i obtained following the preprocessing phase; m is the number of instances; n is the number of attributes; i = 1, 2, . . . ,m, and k = 1, 2, . . . , n.

(2) Lower-bound effectiveness measurement (smaller is better)

$$x'_i(k) = \frac{\max_{\forall i} x_i(k) - x_i(k)}{\max_{\forall i} x_i(k) - \min_{\forall i} x_i(k)}, \quad (9)$$

where $x_i(k)$ is the value of attribute k associated with instance x_i, $x'_i(k)$ is the output value of attribute k associated with instance x_i obtained following the preprocessing phase; m is the number of instances; n is the number of attributes; i = 1, 2, . . . ,m, and k = 1, 2, . . . , n.

(3) Moderate effectiveness measurement

$$x'_i(k) = \frac{\left| x_i(k) - x_{specified} \right|}{\max_{\forall i} x_i(j) - \min_{\forall i} x_i(j)}, \quad (10)$$

where $x_i(k)$ is the value of attribute k associated with instance x_i, $x_{specified}$ is the value specified by the system developer; is the output value of attribute k associated with instance x_i obtained following the preprocessing phase; m is the number of instances; n is the number of attributes; i = 1, 2, . . . ,m, and j = 1, 2, . . . , n.

Normally, upper-bound and lower-bound effectiveness measurements have similar effects on data preprocessing in the proposed approach. This work adopted the upper-bound effectiveness measurement for data preprocessing such that all numeric attributes can be transferred into values between zero and one (the lower-bound effectiveness measurement, which has similar effects on data preprocessing, can also be adopted). As for moderate effectiveness measurement, the system developer must specify (predefine) a new value. The moderate measurement is not appropriate in the proposed approach.

As a measurement method, grey relational analysis (GRA) ([17], [66]) is proposed to determine the relationship (similarity) among a referential observation and compared observations by calculating the grey relational coefficient (GRC) and the grey relational grade (GRG). Consider a set of observations $\{x_0, x_1, x_2, \ldots, x_m\}$, where x_0 is the referential observation and $x_1, x_2, \ldots, x_m$ are the compared observations. Each observation x_i has n attributes and is denoted as $x_i = (x_i(1), x_i(2), \ldots, x_i(n))$ (Generally, all numeric attributes should be preprocessed and then have associated values between zero and one. The preprocessing methods are discussed later.) The grey relational coefficient $GRC(x_0(k), x_i(k))$ is defined as

$$GRC(x_0(k), x_i(k)) = \frac{\min_{\forall i} \min_{\forall k} |x_0(k) - x_i(k)| + \zeta \max_{\forall i} \max_{\forall k} |x_0(k) - x_i(k)|}{|x_0(k) - x_i(k)| + \zeta \max_{\forall i} \max_{\forall k} |x_0(k) - x_i(k)|}, \quad (11)$$

where

i = 1, 2, . . . ,m,

k = 1, 2, . . . , n, and

Distinguishing Coefficient, $\zeta \in [0, 1]$, for controlling the resolution scale, usually being assigned the value of 0.5.

In Equation (11), $GRC(x_0(k), x_i(k))$, which takes a value between zero and one, can be viewed as the similarity between $x_0(k)$ and $x_i(k)$. If $GRC(x_0(k), x_i(k))$ exceeds $GRC(x_0(k), x_j(k))$ then the similarity between $x_0(k)$ and $x_i(k)$ is larger than that between $x_0(k)$ and $x_j(k)$; otherwise the former is smaller than the latter. Moreover, if x_0 and x_i have the same values for numeric attribute k, $GRC(x_0(k), x_i(k))$ will equal one (i.e., the similarity between $x_0(k)$ and $x_i(k)$ is maximal). By contrast, if x_0 and x_i have very different values for numeric attribute k, $GRC(x_0(k), x_i(k))$ will approximate zero.

The grey relational grade of each comparative instance x_i(i = 1, 2,…, m) to referenced instance x_0, $GRG(x_0, x_i)$, can be expressed as follow.

$$GRG(x_0, x_i) = \frac{1}{n} \sum_{k=1}^{n} GRC(x_0(k), x_i(k)), \qquad i = 1, 2, \ldots, m. \quad (12)$$

Clearly, the GRG takes a value between zero and one. If $GRG(x_0, x_i) > GRG(x_0, x_j)$ then the difference between x_0 and x_i is smaller than that between x_0 and x_j, in other words, x_i is closer (more similar) to the referenced instance x_0 than x_j. The grey relational grade has the following properties [67]:

(1) Normality: $GRG(x_0, x_i)$ takes a value between zero and one, i.e.

$0 < GRG(x_0, x_i) \leq 1, \forall$ i; and,

when $GRG(x_0, x_i) = 1$, $x_0 = x_i$,

when $GRG(x_0, x_i) = 0$, $x_0 \cap x_i \in \varnothing$.

(2) Dual symmetry: As there are only two observations x0 and xi, then

$$GRG(x_0, x_i) = GRG(x_i, x_0) \Leftrightarrow X = \{ x_0, x_i \}.$$

(3) Wholeness: If there are three or more observations, then $GRG(x_i, x_j)$ seldom equals $GRG(x_j, x_i)$, i.e.

$$GRG(x_i, x_j) \overset{often}{\neq} GRG(x_j, x_i) \Leftrightarrow x_i, x_j \in X = \{x_i \mid i = 2, 3, \ldots, m\}.$$

(4) Approachability: $GRG(x_0, x_i)$ decreases as the difference between $x_0(k)$ and $x_i(k)$ increases (other values in Equation (8) and (9) are held constant).

Based on these axioms, grey relational analysis offers some advantages. For example, it gives a normalized measuring function (Normality)—a proper method for measuring the similarities or differences among observations—to analyze the relational structure.

According to the similarity among all comparative instances and the referenced instance, we can figure out the most likely comparative instance for the referenced one by the grey relational analysis. The procedures in the grey relational analysis involve the following seven steps:

Step 1: Pre-process the raw data series in order to satisfy the comparison with the referenced instance.

Step 2: Normalize the data series.

Step 3: Compute the differences on each attribute between the referenced instance and a comparative instance, i.e. $\Delta_{0i}(k) = |x_0(k) - x_i(k)|$.

Step 4: Find the maximum and minimum differences respectively, i.e. Calculate $\max_{\forall i}\max_{\forall k} |x_0(k)-x_i(k)|$ and $\min_{\forall i}\min_{\forall k}|x_0(k)-x_i(k)|$

Step 5: Set the distinguishing coefficient $\zeta = 0.5$

Step 6: Calculate the grey relational coefficient of the data series with $\Delta_{0i}(k)$, $\max_{\forall i}\max_{\forall k} |x_0(k)-x_i(k)|$, $\min_{\forall i}\min_{\forall k}|x_0(k)-x_i(k)|$, and ζ by Equation (11)

Step 7: Find the grey relational grade of the data series by Equation (12), then compare these values, and get the most likely comparative instance for the referenced one.

4.3 Illustration of Data Analyses with GRA

Here is an illustrative example about how to do with the grey relational analysis. Consider a small set $\{x_0, x_1, x_2, \ldots, x_8\}$ of eight instances, as listed in Table 16. Given x_0 as the referenced instance, and the rests $\{x_1, x_2, \ldots, x_8\}$ are comparison instances. Each instance x_i is represented by five numeric attributes (A, B, C, D, E) and has already been pre-processed. Each attribute has an associated value between zero and one. All the observed values of associated with instances are shown in Table 16. The problem is which comparative instance is the most similar one with the referenced instance.

Table 16 Sample instances for the illustration of data analyses with GRA

	Attributes				
Instances	A	B	C	D	E
x_0	0.3333	0.2667	0.2000	0.1333	0.0667
x_1	0.0471	0.3294	0.4941	0.1176	0.0118
x_2	0.0588	0.2588	0.5059	0.1529	0.0235
x_3	0.0706	0.1882	0.5059	0.2235	0.0118
x_4	0.1529	0.3882	0.3765	0.0824	0.0000
x_5	0.2118	0.3412	0.3176	0.1294	0.0000
x_6	0.1294	0.3294	0.4235	0.1059	0.0118
x_7	0.0588	0.2588	0.4235	0.2118	0.0471
x_8	0.0941	0.2235	0.4353	0.2000	0.0471

Based on the step 3 in the previous section, we could calculate the difference on each attribute between the referenced instance and a comparative instance with $\Delta_{0i}(k) = |x_0(k) - x_i(k)|$. Results of the computation for the sample instances were showed on Table 17.

Table 17 Computation of step 3 for the sample data

	Attributes				
Instances	A	B	C	D	E
x_1	0.2863	0.0627	0.2941	0.0157	0.0549
x_2	0.2745	0.0078	0.3059	0.0196	0.0431
x_3	0.2627	0.0784	0.3059	0.0902	0.0549
x_4	0.1804	0.1216	0.1765	0.0510	0.0667
x_5	0.1216	0.0745	0.1176	0.0039	0.0667
x_6	0.2039	0.0627	0.2235	0.0275	0.0549
x_7	0.2745	0.0078	0.2235	0.0784	0.0196
x_8	0.2392	0.0431	0.2353	0.0667	0.0196

Once Table 17 had being established, the maximum and minimum difference could be found respectively. In this example, the maximum difference (i.e. $\max_{\forall i}\max_{\forall k}|x_0(k)-x_i(k)|$) is 0.3059, and the minimum difference (i.e. $\min_{\forall i}\min_{\forall k}|x_0(k)-x_i(k)|$) is 0.0039. The distinguishing coefficient, ζ, is given as 0.5 for the sample data in step 5. Then we can calculate the grey relational coefficient of the data series with $\Delta_{0i}(k)$, $\max_{\forall i}\max_{\forall k}|x_0(k)-x_i(k)|$, $\min_{\forall i}\min_{\forall k}|x_0(k)-x_i(k)|$, and ζ by Equation (11). The results showed in Table 18.

Table 18 Grey relational coefficients for the sample data

	Attributes				
Instances	A	B	C	D	E
x_1	0.3571	0.7273	0.3509	0.9302	0.7547
x_2	0.3670	0.9756	0.3419	0.9091	0.8000
x_3	0.3774	0.6780	0.3419	0.6452	0.7547
x_4	0.4706	0.5714	0.4762	0.7692	0.7143
x_5	0.5714	0.6897	0.5797	1.0000	0.7143
x_6	0.4396	0.7273	0.4167	0.8696	0.7547
x_7	0.3670	0.9756	0.4167	0.6780	0.9091
x_8	0.4000	0.8000	0.4040	0.7143	0.9091

The grey relational grade of the instances could be computed by Equation (12). They are GRD(x_0, x_1) = 0.6240, GRD(x_0, x_2) = 0.6787, GRD(x_0, x_3) = 0.5594, GRD(x_0, x_4) = 0.6003, GRD(x_0, x_5) = 0.7110, GRD(x_0, x_6) = 0.6416, GRD(x_0, x_7) = 0.6693, GRD(x_0, x_8) = 0.6455. To compare these values, the most likely comparative instance for the referenced one could be found easily, as

GRD(x_0, x_5) > GRD(x_0, x_2) > GRD(x_0, x_7) > GRD(x_0, x_8) > GRD(x_0, x_6) > GRD(x_0, x_1) > GRD(x_0, x_4) > GRD(x_0, x_3)

The result showed the relationship between the referenced instance and comparative instances, that is, the degree of similarity for the comparative instances. What conclusion reached here is the comparative instance x_5 was the most similar instance with the referenced one, and the x_3 was the most unlikely one.

4.4 Data Analyses with GRA

As shown in the Section 4.2, all data were processed as the following procedures:

Step 1: Pre-process the raw data series as,

$$\begin{pmatrix} x_1 \\ x_2 \\ \vdots \\ x_i \end{pmatrix} = \begin{pmatrix} 12 & 34 & \cdots & 9 \\ 29 & 38 & \cdots & 13 \\ \vdots & \vdots & \ddots & \vdots \\ 5 & 11 & \cdots & x_i(k) \end{pmatrix}$$

Step 2: Normalize the data series,

Step 3: Compute the differences on each attribute between the referenced instance and a comparative instance, i.e. $\Delta_{0i}(k) = |x_0(k) - x_i(k)|$.

Step 4: Find the maximum and minimum differences respectively, i.e.
Calculate $\max_{\forall i}\max_{\forall k}|x_0(k)-x_i(k)|$ and $\min_{\forall i}\min_{\forall k}|x_0(k)-x_i(k)|$

Step 5: Set the distinguishing coefficient $\zeta = 0.5$

Step 6: Calculate the grey relational coefficient of the data series with $\Delta_{0i}(k)$, $\max_{\forall i}\max_{\forall k}|x_0(k)-x_i(k)|$, $\min_{\forall i}\min_{\forall k}|x_0(k)-x_i(k)|$, and ζ by Equation (11)

Step 7: Find the grey relational grade of the data series by Equation (12), then compare these values, and get the most likely comparative instance for the referenced one.

According to the framework of m-commerce proposed by Lehner and Watson [14], this paper primarily presented four of the most popular application groups in m-commerce. They were information and data access, communication and interaction, entertainment, transactions. Each group had several applications in it. Table 19 showed results in the group of information and data access applications. The value on each cell does not mean anything but the grey relational grade of the data series, and they shall be compared in the same column. For example, ranking applications in this group for Taiwan will get the sequence as: Traffic (0.7110), City Guides (0.6787), Corporate Information (0.6693), Stock Market Data (0.6455), Weather (0.6416), News (0.6240), Maps (0.6003), Directory Services (0.5594). It means the most important application in this group for Taiwan is Traffic, then is City Guides, third is Corporate Information, and Directory Services may be the least important one. By the same approach, the most important application in this group for USA is Maps (0.7760), second is Traffic (0.7403), third is Directory Services (0.7017), and Stock Market Data (0.6152) may be the least important one. For the Germany, the most important application in this group is Directory Services (0.7790), second is News (0.7554), third is Maps (0.7521), and Stock Market Data (0.6267) may be the least important one.

Table 19 Group of Information and Data Access Applications in M-commerce

Application	TAIWAN	USA	GERMANY
News	0.6240	0.6678	0.7554
City Guides	0.6787	0.6675	0.7106
Directory Services	0.5594	0.7017	0.7790
Maps	0.6003	0.7760	0.7521
Traffic	0.7110	0.7403	0.7221
Weather	0.6416	0.6640	0.6990
Corporate Information	0.6693	0.6183	0.6441
Stock Market Data	0.6455	0.6152	0.6267

There is a very interesting comparison in the first group of applications in m-commerce. That is the ranking of "Stock Market Data". In USA and Germany, this application was ranked as the least important one in this group, but it was the fourth important application in Taiwan. It might reflect the interesting fact that there were a lot of individual investors in stock market in Taiwan. The investment on stock market is so popular that this application could be ranked the fourth important one in Taiwan even all participants in this study were university students.

Ranking applications in the "Communication and Interaction" group (Table 20) for Taiwan will get the sequence as: Short Messaging (SMS) (0.7814), E-Mail (0.6825), Video conferencing (0.6635), Chat rooms (0.5915). It means the most important application in this group for Taiwan is SMS, then is E-Mail, third is Video conferencing, and Chat rooms may be the least important one. By the same approach, the most important application in this group for USA is Short Messaging (SMS) (0.8885), second is E-Mail (0.8714), third is Video conferencing (0.6753), and Chat rooms (0.6403) may be the least important one. For the Germany, the most important application in this group is also Short Messaging (SMS) (0.8172), second is E-Mail (0.8094), third is Video conferencing (0.6361), and Chat rooms (0.6361) may be the least important one.

Table 20 Group of Communication and Interaction Applications in M-commerce

Application	TAIWAN	USA	GERMANY
Short Messaging(SMS)	0.7814	0.8885	0.8172
E-Mail	0.6825	0.8714	0.8094
Chat rooms	0.5915	0.6403	0.6344
Video conferencing	0.6635	0.6753	0.6361

There is consistency among these three countries in the group of communication and interaction applications. Participants ranked Short Messaging (SMS) is the most important application in this group whichever country they are, and E-mail is the second. This result is just the same as other works (e.g. Scharl et al. [51]). It might reflect the usage of applications which are internet-enabled only is the same among these three countries.

The third group in m-commerce we analyzed here (Table 21) was the entertainment applications. Ranking applications in this group for Taiwan will get the sequence as: Download/listen to Music (0.7732), Play Games (0.7037), Download Video (0.5848). It means the most important application in this group for Taiwan is Download/listen to Music, next is Play Games, and Download Video may be the least important one. By the same approach, the most important application in this group for USA is Download/listen to Music (0.6909), second is Play Games (0.6746), and Download Video (0.6559) may be the least important one. For the Germany, the most important application in this group is also Download/listen to Music (0.6912), second is Play Games (0.6742), Download Video (0.6507) may be the least important one.

Table 21 Group of Entertainment Applications in M-commerce

Application	TAIWAN	USA	GERMANY
Download/listen to Music	0.7732	0.6909	0.6912
Play Games	0.7037	0.6746	0.6742
Download Video	0.5848	0.6559	0.6507

In this group, applications are limited to devices, and the mobile devices are similar among these three countries. It might be the reason of same rankings.

Some researches recognized transaction is the most important application in m-commerce. Ranking applications in this group (Table 22) for Taiwan will get the sequence as: Booking and reservations (0.7040), Mobile wallet (0.6761), Banking (0.6624), Auctions (0.5630), Shopping (0.5570). It means the most important application in this group for Taiwan is Booking and reservations, then is Mobile wallet, third is Banking, and Shopping may be the least important one. By the same approach, the most important application in this group for USA is Booking and reservations (0.7289), second is Banking (0.7186), third is Shopping (0.7186), and Auctions (0.6609) may be the least important one. For the Germany, the most important application in this group is Booking and reservations (0.7660), second is Banking (0.7245), third is Mobile wallet (0.7089), and Auctions (0.6794) may be the least important one.

Table 22 Group of Transaction Applications in M-commerce

Application	TAIWAN	USA	GERMANY
Banking	0.6624	0.7186	0.7245
Shopping	0.5570	0.7166	0.7083
Auctions	0.5630	0.6609	0.6794
Mobile wallet	0.6761	0.6752	0.7089
Booking and reservations	0.7040	0.7289	0.7660

The rankings in the group of transactions looked quite similar among these three countries. The most important application here was for Booking and reservations, and second is Banking in USA and Germany, third in Taiwan. It might reflect the usage of transaction were alike among these three countries to a certain degree.

4.5 Discussion and Summary

This study has several limitations, which derived mainly from the fact that m-commerce studies are still at an infancy stage. It is cross-sectional, and the model's ability to explain the temporal dynamics of m-commerce adoption is limited. In addition, the framework presented in this study is not elaborated across different types of users in m-commerce; all responses in this study are from the university students.

On the basis of the framework of m-commerce proposed by Lehner and Watson [14], this study analyses four popular application groups in m-commerce by the grey relation approach. The respective patterns of m-commerce in Germany, the USA and Taiwan are distinguished. The results showed that:

1. the patterns change over area, and thus no single application checklist is good for globalization in this industry;

2. GRA can be used as a framework for identifying the usage and patterns of m-commerce; and

3. consumers in different areas do not regard the applications as equally important.

CHAPTER 5 VALIDATION OF THE DIVERSITY

The validation of diverse usage in m-commerce services among students in the countries is conducted in this chapter. In order to determine whether there was a discrepancy between samples, a new approach based on ICOMP to perform model selection and variables clustering was proposed. According to the ICOMP criteria, the model selection implied that there was heterogeneity between samples. The variable clustering, whatever within a group or with all twenty variables, indicated that there were differences in ranking the most relevant variables between samples. That is, whatever model selection or variables clustering, all results based on the proposed approach support that there were discrepancies in using m-commerce services among students in the countries.

5.1 The ICOMP(IFIM)

A general approach to ICOMP, referred to as ICOMP(IFIM), exploits the asymptotic optimality properties of the maximum likelihood estimators (MLEs), and uses the information-based complexity of the inverse-Fisher information matrix (IFIM) of a model. For a multivariate linear or nonlinear structural model, the general form of ICOMP(IFIM) was defined as

$$\text{ICOMP(IFIM)} = -2\log L(\hat{\theta}) + 2\, C_1(\hat{F}^{-1}(\hat{\theta})), \tag{13}$$

and

$$C_1(\hat{F}^{-1}) = 0.5\dim(\hat{F}^{-1})\log(\mathrm{tr}(\hat{F}^{-1}) / \dim(\hat{F}^{-1})) - 0.5\log|\hat{F}^{-1}| \tag{14}$$

where $\hat{\theta}$ is the maximum likelihood estimator of θ, L represents the likelihood function, and C_1 denotes the maximal information complexity of $\hat{F}^{-1}$, the estimated IFIM.

The first component of ICOMP(IFIM) in Equation (13) measures the lack of fit of the model, and the second component measures the complexity of the estimated IFIM, which gives a scalar measure of the celebrated Cramér-Rao lower bound matrix, which takes into account the accuracy of the estimated parameters and implicitly adjusts for the number of free parameters included in the model.

5.2 Model Selection with the ICOMP(IFIM)

For the test of homogeneity in multi-sample models, K-sample independent data matrices $\mathbf{X_g}$ ($n_g$xp), g = l, 2, ..., K, where the rows of $\mathbf{X_g}$ are independent and identically distributed (i.i.d.) $N_p(\mu_g, \Sigma_g)$, g = l, 2, ..., K, were considered. In terms of the parameters $\boldsymbol{\theta} = (\mu_1, \mu_2, \ldots, \mu_K, \Sigma_1, \Sigma_2, \ldots, \Sigma_K)$ the models were covariances model, one-way multivariate analysis of variance (MANOVA) model, and complete homogeneity model. In multivariate data analysis, the assumption of equality of covariance matrices causes serious problems as testing the equality of mean vectors.

In order to tackle those problems, the equality of covariance matrices against the alternative that not all covariance matrices are equal should be tested first. If the groups or samples can differ in covariance matrices regardless of the mean vectors, then in terms of the parameters test of homogeneity of covariances model is

$$M_1 : \boldsymbol{\theta} = (\mu_1, \mu_2, \ldots, \mu_K, \Sigma_1, \Sigma_2, \ldots, \Sigma_K) \qquad (15)$$

with m = Kp+Kp(p+l)/2 parameters, where K is the number of groups, and p is the number of variables. If K normal populations are with different mean vectors μ_g, g = l, 2,..., K, but each population has the same covariance matrix Σ, i.e., the groups or samples can differ only in their mean vectors; then in terms of the parameters the MANOVA model is

$$M_2 : \boldsymbol{\theta} = (\mu_1, \mu_2, \ldots, \mu_K, \Sigma, \Sigma, \ldots, \Sigma) \qquad (16)$$

with m = Kp+p(p+ l)/2 parameters. In the case of a complete homogeneity model, in terms of the parameters, the model is

$$M_3 : \boldsymbol{\theta} = (\mu, \mu, \ldots, \mu, \Sigma, \Sigma, \ldots, \Sigma) \qquad (17)$$

with m = p+p(p+ l)/2 parameters.

Given the data obtained from surveys takes the following form:

$$X(n\times p) = \begin{bmatrix} X_1 \\ X_2 \\ \vdots \\ X_K \end{bmatrix} \qquad (18)$$

where

X_g = n_g observations for the gth group. $X_g \in R^{n_g * p}$, $1 \le g \le K$

K = number of groups

p = number of variables

Under the hypothesis which is a test of homogeneity of covariances models can be defined to represent the K group observations; based on Dillon et al. [62], the log likelihood of the parameters is given by:

$$\log L(\boldsymbol{\mu}_g, \boldsymbol{\Sigma}_g; \mathbf{X}) = -0.5\left(np\log(2\pi) + \sum_{g=1}^{K} n_g \log\left|\Sigma_g\right| + np\right) \quad (19)$$

5.3 Variables Clustering by the ICOMP(IFIM)

For clustering and subset selection of variables, the asymptotical inverse fisher information matrix for the multivariate normal model is as follows [63]:

$$\hat{F}^{-1} = \mathrm{diag}\left[\frac{n}{n_g}\hat{\Sigma}_g \quad 0 \quad \frac{2}{n_g} D_p^{+}\left(\hat{\Sigma}_g \otimes \hat{\Sigma}_g\right) D_p^{+\prime}\right] \quad (20)$$

where $\otimes$ denotes the Kronecher product and D_p^{+} is the Moore-Penrose inverse of the duplication matrix D_p, and that $D_p^{+} = (D_p^{\prime} D_p)^{-1} D_p$. In operating the complexity measure on the estimated inverse-Fisher information matrix, ICOMP(IFIM) is given by [63]:

$$\mathrm{ICOMP(IFIM)} = np\log(2\pi) + n^{*}\left(\log\left|\hat{\Sigma}\right| + tr\left(\hat{\Sigma}^{-1}S\right)\right) +$$

$$0.5^{*}p(p+3)^{*}\log\left(\frac{tr\left(\hat{\Sigma}\right) + \frac{1}{2n}\left(tr\left(\hat{\Sigma}^{2}\right) + \left(tr\left(\hat{\Sigma}\right)^{2} + 2\sum_{j}\left(\hat{\sigma}_{jj}^{2}\right)^{2}\right)\right)}{0.5^{*}\,p(p+3)}\right) - p\log(2)$$

$$+0.5^{*}p(p+1)^{*}\log(n) - (p+2)^{*}\log\left|\hat{\Sigma}\right| \quad (21)$$

where S = $\dim(\hat{F}^{-1}) = \mathrm{rank}(\hat{F}^{-1})$.

A major practical difficulty in clustering and subset selection of variables is the computational burden entailed in exhaustive subset search. Let p be the number of variables and k represents the number of clusters (or partitions). The number of ways of clustering a set of p variables into k nonempty clusters is known as the Stirling Number of the Second Kind (SNSK), or a Stirling set number, which can be computed from the sum [64],

$$S(p,k) = \frac{1}{k!}\sum_{j=0}^{k}(-1)^{j}\binom{k}{j}(k-j)^{p} \qquad (22)$$

For the dataset used in this paper, the total possible clustering alternatives are $5.1724 * 10^{13}$, because 20 variables were considered. It indicated that to enumerate all possible clustering alternatives is a mission impossible. The best way to handle such a situation would be the implementation of a genetic algorithm to speed up the searching process. A genetic algorithm (GA) is a stochastic search algorithm based on concepts of biological evolution, natural selection, genetics, and evolution. They are widely applied to solving problems where vast numbers of possible solutions exist. A GA treats information as a series of codes on a binary string, where each string represents a different solution to a given problem.

This study employed GA as a searching method, guided by the use of ICOMP criteria as the fitness function, along with the other criteria to help select the appropriate subset selection of variables from the vast model space. Population size represents the searching range in iteration (generation). Larger population size can converge faster; that is, the optimum will be found by less iteration (generation). A brief description of the GA-based procedure employed in this study was outlined as follows. More details can be found in [63].

Step 1: To develop the encoding scheme for the various possible combinations of variables in order to represent the possible subsets composing the genotypic space.

Step 2: Generating the initial population of subset of variables.

Step 3: To employ ICOM(IFIM) as a fitness function to evaluate the performance of any subset.

Step 4: The proportional selection mechanisms based on the ICOMP(IFIIM) was employed to select fitter models.

Step 5: Producing offspring that compose the next generation.

5.4 Data Analyses with ICOMP

In order to compare the results with Lee et al. [13], the same data were used in this study. The data were collected from three countries by the same questionnaire with appropriate translations. In considering valid responses, sample sizes differed from each other, and there were 85 valid responses in Taiwan, 182 in the US, and 142 in Germany. The results of model selection and variable clustering with ICOMP(IFIM) were performed in this section in order to validate the diversity of usage and compare the discrepancies based on different approaches.

5.4.1 Identification of the Best Fitting Parametric Model

First of all, this study examined whether the datasets are homogeneous or heterogeneous by different parametric models. That is, three parametric multivariate normal models, varying μ and Σ, varying μ and common Σ, common μ and Σ, with five combinations of sample clustering were considered, where the μ represents location parameter and Σ is the dispersion matrix. ICOMP(IFIM) is the criterion to evaluate the fitness of models with different combinations of clustering, and the smallest value of ICOMP(IFIM) represents the best fit alternative.

Based on the proposed approach, the results of model selection are listed in Table 23. According to the ICOMP(IFIM) values, the three samples are heterogeneous because the alternative 5 in model 1, clustering the three samples individually with different μ and Σ, received the smallest value in all alternatives. Therefore, according to ICOMP(IFIM) the model with varying mean vectors and covariance matrices is the best fitting model for the analysis of the m-commerce usage data. Due to the covariance heterogeneity, we cannot haphazardly assume that the covariances are equal and entertain the MANOVA model, or the test of complete homogeneity model and assume that data come from a single population.

Table 23 Identification of the best fitting parametric model

Alternatives	Clustering	M1	M2	M3
1	(1,2,3)	23633.4459	23633.4459	23633.4459
2	(1,2)(3)	22903.7839	23456.1391	23609.6701
3	(1,3)(2)	22884.6332	23579.4928	23610.3929
4	(2,3)(1)	22970.9130	23460.3975	23605.8191
5	(1)(2)(3)	22159.6383*	23355.0144	23580.3351

Note: 1. M1 (varying μ and Σ); M2 (varying μ and common Σ); M3 (common μ and Σ)
2. * Global minimum of ICOMP(IFIM), which indicate the best fitting model

5.4.2 Multisample Cluster Analyses – All Variables

On the basis of the heteroscedastic model, the most relevant variables between these samples can be determined by the proposed approach. The best subset of variables, which received the smallest ICOMP(IFIM) value, is the most relevant variables between the samples, and it contributes less to the differences between the samples.

In order to verify the discrepancy, two levels of variable clustering were performed in this study. In the first level, all twenty variables were taking into account. By removing the most relevant variable(s) from each run, the most relevant variables between samples were ranked.

Table 24 showed the five most relevant services across the multisample clustering structure. According to the results, x_{11} is the most relevant variable between samples, whatever in which pair of samples. That is, there is less heterogeneity in the means and variances / co-variances on this service (chat rooms) between samples.

Similar ranking structures can be observed in the pairs of Taiwan and Germany, the US and Germany, and all of the three countries. x_7 and x_{17}, which represented the service of corporate information and shopping respectively, contributed more to the differences between samples, except in the pair of Taiwan and the US. In the same context, x_8 and x_{12}, which represented the service of stock market data and video conferencing respectively, contributed more to the differences between Taiwan and the US only.

It is worthwhile to notice that comparing different values in different columns here is meaningless because they are computed within the combination based on the best fitting process.

Table 24 Five most relevant variables among countries – all twenty variables

Rank	Among C_1,C_2, and C_3		Among C_1 and C_2		Among C_1 and C_3		Among C_2 and C_3	
	Variable	ICOMP	Variable	ICOMP	Variable	ICOMP	Variable	ICOMP
1	X_{11}	1065.9474	X_{11}	764.9074	X_{11}	502.7524	X_{11}	863.7435
2	X_{18}	1158.2619	X_{19}	772.0421	X_{18}	579.7842	X_{18}	944.1125
3	X_{12}	1185.7149	X_{18}	792.3068	X_{12}	585.3742	X_{12}	968.5244
4	X_8	1210.5263	X_7	821.3844	X_8	605.3162	X_8	971.4276
5	X_{19}	1219.8698	X_{17}	825.5734	X_{17}	625.7603	X_{19}	997.8513

Note: 1. C_1: Taiwan; C_2: the US; C_3: Germany.
2. ICOMP here is the abbreviation of ICOMP(IFIM).

5.4.3 Multisample Cluster Analyses – Variables by Groups

Four groups of services, which were defined by Lehner and Watson [14], were taking into account in the second level of variables clustering. Clustering variables by groups can distinguish the contributions in the associate group. Again, ICOMP(IFIM) served as the criterion in selecting the most relevant cluster of variables between samples. By removing the most relevant variable from each run, the most relevant variables were ranked.

The first group, for the category of Information and Data Access, included the following eight services:

X_1: News

X_2: City Guides

X_3: Directory

X_4: Maps

X_5: Traffic

X_6: Weather

X_7: Corporate Information

X_8: Stock Market Data

The five most relevant services between samples in the first group were listed in Table 25. According to the ICOMP(IFIM) values, similar ranking structures can be observed in the pairs of Taiwan and Germany, the US and Germany, and all of the three countries. The x_3, which represented the service of weather, contributed more to the differences between samples, except in the pair of Taiwan and the US. In the same context, x_6, which represented the service of directory, contributed more to the differences between Taiwan and the US only, but not in all other pairs.

Table 25 Five most relevant variables among countries – Information and Data Access

Rank	Among C_1,C_2, and C_3		Among C_1 and C_2		Among C_1 and C_3		Among C_2 and C_3	
	Variable	ICOMP	Variable	ICOMP	Variable	ICOMP	Variable	ICOMP
1	X_8	1210.5263	X_7	821.3844	X_8	605.3162	X_8	971.4276
2	X_7	1238.2291	X_1	834.2670	X_7	648.0261	X_7	1006.8904
3	X_2	1319.7880	X_2	842.4386	X_2	689.7457	X_2	1107.3679
4	X_6	1347.8789	X_8	844.0553	X_6	702.6127	X_6	1126.4945
5	X_1	1359.3833	X_3	856.3090	X_1	723.9429	X_1	1160.6323

Note: 1. C_1: Taiwan; C_2: the US; C_3: Germany.
2. ICOMP here is the abbreviation of ICOMP(IFIM)

The second group, dedicated to the category of Communication and Interaction, had four services as follows; they were:

X_9: Short messaging

X_{10}: E-Mail

X_{11}: Chat rooms

X_{12}: Video conferencing

The three most relevant services between samples in this category were listed in Table 26. An exact same ranking structure can be observed in all the pairs. It implied that the usage of e-mail contributed most to the differences between samples.

Table 26 Three most relevant variables among countries – Communication and Interaction

Rank	Among C_1,C_2, and C_3		Among C_1 and C_2		Among C_1 and C_3		Among C_2 and C_3	
	Variable	ICOMP	Variable	ICOMP	Variable	ICOMP	Variable	ICOMP
1	X_{11}	1065.9474	X_{11}	764.9074	X_{11}	502.7524	X_{11}	863.7435
2	X_{12}	1185.7149	X_{12}	817.2068	X_{12}	585.3742	X_{12}	968.5244
3	X_9	1381.9797	X_9	830.1205	X_9	756.2552	X_9	1177.6372

Note: C_1: Taiwan; C_2: the US; C_3: Germany.
ICOMP here is the abbreviation of ICOMP(IFIM).

The third group, for the category of Entertainment, consisted of the following three services:

X_{13}: Download/listen to Music

X_{14}: Play Games

X_{15}: Download Video

The two most relevant services between samples in this category were listed in Table 27. According to the ICOMP(IFIM) values, similar ranking structures can be observed in the pairs of Taiwan and Germany, the US and Germany, and all of the three countries. The x_{13}, which represented the service of download/listen to music, contributed more to the differences

between samples, except in the pair of Taiwan and the US. In the same context, x_{15}, which represented the service of download video, contributed more to the differences between Taiwan and the US only, but not in all other pairs.

Table 27 Two most relevant variables among countries – Entertainment

Rank	Among C_1,C_2, and C_3		Among C_1 and C_2		Among C_1 and C_3		Among C_2 and C_3	
	Variable	ICOMP	Variable	ICOMP	Variable	ICOMP	Variable	ICOMP
1	X_{15}	1311.2248	X_{14}	894.6963	X_{15}	646.6252	X_{15}	1068.2541
2	X_{14}	1329.8042	X_{13}	907.1277	X_{14}	664.9788	X_{14}	1099.7394

Note: C_1: Taiwan; C_2: the US; C_3: Germany.
ICOMP here is the abbreviation of ICOMP(IFIM).

Five services were classified into the forth group, the category of Transactions. They were:

X_{16}: Banking

X_{17}: Shopping

X_{18}: Auctions

X_{19}: Mobile wallet

X_{20}: Booking and reservations

The four most relevant applications between samples in the forth category were listed in Table 28. The same ranking structure can be observed in the pairs of the US and Germany, and all of the three countries. Similar but different ranking structures exist in the pair of Taiwan and the US as well as in the pair of Taiwan and Germany. It is clear that the x_{16} and x_{20}, which represented the services of banking as well as booking and reservations respectively, contributed most to the differences between each pair of samples.

Table 28 Four most relevant variables among countries – Transactions

Rank	Among C_1,C_2, and C_3		Among C_1 and C_2		Among C_1 and C_3		Among C_2 and C_3	
	Variable	ICOMP	Variable	ICOMP	Variable	ICOMP	Variable	ICOMP
1	X_{18}	1158.2619	X_{19}	772.0421	X_{18}	579.7842	X_{18}	944.1125
2	X_{19}	1219.8698	X_{18}	792.3068	X_{17}	625.7603	X_{19}	997.8513
3	X_{17}	1231.6210	X_{17}	825.5734	X_{19}	669.7088	X_{17}	1011.6916
4	X_{20}	1331.5306	X_{20}	855.0083	X_{20}	698.5459	X_{20}	1109.4955

Note: C_1: Taiwan; C_2: the US; C_3: Germany.
ICOMP here is the abbreviation of ICOMP(IFIM).

It is worthwhile to emphasize that all ranking structures are based on the heteroscedastic model recommendation. That is, there is less heterogeneity in the means and variances/covariances for the most relevant variable in each category. The general conclusion is that there are more heterogeneity in the means and variances/covariances for the other variables within the category.

5.5 Discussion and Summary

Since the ICOMP(IFIM) values indicated the three samples should be modeled individually, the realization of the results support the following three point of views. First, the recommendation based on ICOMP(IFIM) distinguishes the existence of diverse usages in m-commerce services among countries. According to the results, heterogeneous models are recommended for the three samples. The results also carried out the most relevant services in each group between countries. Second, it is interesting to compare the ICOMP approach with the grey relational analyses in telling the difference. Since both of approaches can make a distinction between samples, it will benefit researchers to discuss the pros and cons of these two approaches. Third, m-commerce differed from e-commerce in some ways. Usually, a service in e-commerce can be assumed to serve globally once it is online. The services in m-commerce may not repeat a similar success in the same way, even though they were popular in one country. In other words, the results implied that localization of services in m-commerce should be considered more seriously in its global expansion.

5.5.1 Validation the Diversity Usage

Results of model selection and variable clustering in the previous section show that Taiwan, the US, and Germany did use services in m-commerce diversely. The global minimum of ICOMP(IFIM), i.e. the model selection criteria, in Table 23 is located on the first model with varying mean vector and covariance matrices. The samples from each country must be grouped independently. That is, the global minimum indicated these three samples cannot be treated haphazardly as the covariance are equal and entertain the MANOVA model (the second model), or the test of complete homogeneity model (the third model) and assume that data came from a single population. In other words, there is heterogeneous covariance among samples, and any two or all of these three samples should not be clustered as one homogeneous group. Hence, the usage of services in m-commerce is different from each other's based on the results of model evaluation.

The smaller ICOMP(IFIM) value in a variable clustering implies it is a more relevant variable between two samples. Under the recommendation of heterogeneous models for all three samples, the most relevant variable among twenty variables is "Chat Room". It indicated this service is the most expendable variable in building individual models for the samples. When all twenty variables were taken into account for any two samples with heterogeneous models, the results of variable clustering would be slightly different from each other. Since two out of the first five most relevant variables are different from the other groups, the ranking of relevant variables between Taiwan and the US is more different than those in the pair of Taiwan and Germany as well as in the pair of US and Germany.

Originally, Lehner and Watson [14] proposed six groups of applications in m-commerce. Two of them were not used in this study because one was very rare and another was basically going to cover everything else. In the four groups used here, the differences in variable clustering among samples are slightly different according to Table 25, Table 26, Table 27, and Table 28. In the "Transactions" category (as shown in Table 28), the ranking of the most relevant variables are different in all three pairs. It indicates that the three different heterogeneous models should be used respectively in such a group of services. Even though the results of a variable clustering are the same in the "Communication and Interaction" category (as shown in Table 26), it is not necessary to have just one heterogeneous model for all three cases. More details are needed to identify whether the model for each case is the same but with different coefficients or anything else.

According to Table 25 for the “Information and Data Access” category, the most relevant variable among all three samples is “Stock Market Data”, then “Corporate Information”, “City Guide”, “Weather”, and “News” in descending order. The other three variables, “Directory Services”, “Maps”, and “Traffic”, contributed more to the differences among those three pairs of samples. The ranking of the first five variables is the same as those between Taiwan and Germany, and also those between the US and Germany. It implies that the models for Taiwan and the US samples may have more differences than that for the Germany sample in this category. And there is a similar situation in the group “Entertainment” (as shown in Table 27). An overall picture of the diverse usage in m-commerce among students in the countries is that the discrepancy between Taiwan and the US may differ more from those between Taiwan and Germany, and those between the US and Germany.

5.5.2 Comparison in Identifying Discrepancies

Since two different approaches had been used to validate the diverse usage in m-commerce services among students in the countries, it can benefit the field by distinguishing how these two approaches work. In validating diversity of the usage, the ICOMP approach provided different recommendations from those by grey relational analyses although they all ranked variables by their own ways. The concepts, computation procedures, results based on these two approaches, and also the relative pros and cons in validating the diversity were briefly compared in the following context. In general, the grey relational analyses can be used to establish the preferences that make it easy to tell the differences among samples; and the ICOMP approach will select an appropriate statistical model first, and then select relevant variables under a recommended model.

One of the most famous characters in grey theory was it can be used to examine the relationship among factors in an observable system where the information available is uncertain or incomplete. That is, a grey system can be built for answering specific research questions as there is no way to identify all affecting factors [17]. In validating the diversity, there is a seven-step procedure for getting the grey relational grades to rank the preferences [13]. All computations can be finished within an Excel worksheet because they are subtraction, addition, and comparison. Results came from the grey relational analyses show the relativism basically. Such “internal” results can tell the ranking of variables within a sample but cannot be used to compare the discrepancies among two samples.

For example, the five most important applications in Taiwan by grey relational analysis were “Short messaging”, “Download/listen to Music”, “Traffic”, “Booking and Reservations”, and “City Guides”. For the case in the US, the five most important applications were “Short messaging”, “e-Mail”, “Maps”, “Traffic”, and “Download/listen to Music”. The five most important applications in Germany were “Short messaging”, “e-Mail”, “Directory Services”, “News”, and “Maps”. Even though the “Short messaging” is the most preferred services in all of three countries, there is no information about whether the “Short messaging” is more preferred in Taiwan than in the US or in Germany. In some cases, the missing information is important because it may indicate that there are other variables more important than the listed variables.

The basic idea of ICOMP approach in validating the diversity was the use of ICOMP(IFIM) as the criteria for model selection and then variables clustering. It combined a badness-of-fit term with a measure of complexity of a model by taking into account the interdependencies of the parameter estimates as well as the dependencies of the model residuals [24]. When the number of combination of variables is large, the calculation in variables clustering is more complicated than that in model selection. A genetic algorithm will be involved to search the optimal in such cases. Results by the ICOMP approach in model selection can only indicate what kind of the parameter model it is for the data. Therefore, variable clustering is necessary for getting more information about the discrepancies.

Even though both grey relational analyses and variables clustering by ICOMP(IFIM) rank the variables, there are fundamentally different from each other. An intuitive concept about that is an ICOMP approach deals model or variables selection among samples, but what a grey relational analysis does is ranking variables within a sample. Once the relation between samples is getting interested, we may like to know which variables are important to build such models for telling the discrepancy. For example, the five most relevant variables for all twenty variables in order are “Chat Room”, “Auctions”, “Video Conferencing”, “Stock Market Data”, and “Mobile Wallet” according to Table 24. What it implied is that they contributed less to the differences between the pairs of samples. If we are going to build appropriate models in order to tell the different behavior between samples, those most relevant variables may be the most expendable. That is the reason why there is the grey relational analysis, but the ICOMP approach is still recommended.

5.5.3 The Meaning to Global Expansion in M-Commerce

M-commerce differed from e-commerce in some ways. The interface, connection, and even contents could look quite similar under e-commerce in a certain way, especially by a personal computer. The two most important characteristics of m-commerce, i.e. mobile devices and wireless network, make it different from e-commerce (e.g. [5], [4], [44]). Since m-commerce committed a ubiquitous service, the users' operating environment had more significant impact on it. Such impacts are not only on the connection or capabilities of mobile device, but also on the usage and business behavior. For example, traffic information may not be so valuable that every user in different areas will pay the wireless connection fee to get it by their mobile devices. It may be just valuable for those drivers who were stuck in traffic and hurried to find a way out.

In e-commerce, it always implied to serve globally once a service was online. It might be not true in m-commerce for many reasons. The results in this paper supported the idea about that m-commerce differed from e-commerce especially in global expansion. We believed that localized services make more sense in m-commerce because it provides the last mile connection to a person. If the discrepancy is ignored, it is hard to get success in the other country. For example, NTT DoCoMo had tried to export the i-mode abroad since 2001 [12], but it still had not achieved the success it got in Japan yet. That is, even though the services are very popular in one country, they may not be able to guarantee another success in the other countries. The validation of diverse usage in m-commerce among students in the countries suggests that when enterprises consider a global expansion in m-commerce, they have better realized that there were different usages in m-commerce among counties.

CHAPTER 6 CONCLUSIONS AND SUGGESTIONS

Although the proposed approaches are promising, it is worthwhile to notice that this study has several limitations as discussed previously, which derived primarily from the fact that m-commerce studies are still at an infancy stage. It is cross-sectional, and the models' ability to explain the temporal dynamics of m-commerce adoption is limited. In addition, the frameworks presented in this study are not elaborated across different types of user in m-commerce; all responses in this study came from the university students.

This study examined and validated the diversity of usage in m-commerce among students in the countries, by using ICOMP(IFIM) as criteria to performed model selection and variable clustering. Heterogeneous, i.e. varying mean vectors and covariance matrices, models for the three samples are recommended according to the model selection results. The results based on variables clustering show that most of the relevant variables between the samples are different. That is, whatever based on model selection or on variables clustering, the results all agree with the diversity of usage in m-commerce services among the countries.

In comparison with the grey relational analysis, the proposed approach can explain the discrepancy in a more insightful way. The usage as well as the pros and cons of both approaches were discussed. In short, the grey relational analysis is good to determine the preference within a sample; and the proposed ICOMP approach can identify the best fitting parametric model and carry out multi-sample cluster analysis for the samples.

The promising ubiquity of m-commerce got attentions but did not be carried out so far. Applications for e-commerce can always be assumed to serve globally once they are online. The same assumption may not be true in m-commerce due to the existence of diverse usage. Since it may limit an international expansion of the services, the service provider should treat the diverse usage more seriously rather than just duplicated what they had to another country.

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APPENDIX

Appendix A. The context of questionnaire used in Taiwan

一、使用者資料

1. 性別：□ 男，□ 女。
2. 年級：□ 大一大二(junior)，□ 大三大四(senior)，□ 碩士班，□ 博士班。
3. 學院：□ 理，□ 工，□ 農，□ 醫，□ 管理，□ 電子電機，□ 文學院，□ 其他 ____。
4. 可支配所得(元/月)：
   □ ~5000，□ 5001~10,000，□ 10,001~15,000，□ 15,001~20,000，□ 20,001~。

5. 星座：
   魔羯座（12/22-01/20），□ 水瓶座（01/21-02/18）， 雙魚座（02/19-03/20），□ 牡羊座（03/21-04/20），□ 金牛座（04/21-05/21），□ 雙子座（05/22-06/21），□ 巨蟹座（06/22-07/22），□ 獅子座（07/23-08/23），□ 處女座（08/24-09/22），□ 天秤座（09/23-10/23），□ 天蠍座（10/24-11/22），□ 射手座（11/23-12/21）。

二、行動電話資料

6. 您目前使用行動電話的話費計算基礎為何?
   □ 以月費為基礎、□ 以資料傳輸量為基礎

7. 您目前每月使用行動電話的平均費用大約多少元?
   □ 免費，□ 1~250 元，□ 251~500，□ 501~750，□ 751~1000，□ 1001~1250，□ 1251~1500，□ 1501~1750，□ 1751~2000，□ 2001~，□ 他人代繳，□ 其他。

8. 您目前使用的行動電話是否具有上網的功能? □ 是 □ 否
9. 您目前使用的行動電話可以何種方式上網?
   □ 3G、□ GPRS、□ WAP、□ PHS、□ 不知道、□ 其他、□ 未上網

10. 您目前以行動電話上網最常使用哪類服務?
    □ 存取資訊或資料(Information and data access)；例如新聞(News)、城市導覽(City Guides)、目錄服務(Directory Services)，地圖(Maps)，交通與天氣(Traffic and weather)，企業資訊(Corporate Information)，市場資料(Market data)等。

    □ 通訊或互動(Comunication / Interaction)；例如短訊(Short messaging)、電子郵件(E-mail)、聊天室(Chatrooms)、視訊會議(Video-conferencing)等。

□ 娛樂(Entertainment)；例如聽音樂(Music)、玩遊戲(Games)、看圖(Graphics)、看影片(Video)等。

□ 交易(Transactions)；例如銀行業務(Banking)、仲介業務(Brokering)、購物(Shopping)、拍賣(Auctions)、議價(Betting)、預約訂位(Booking & Reservation)、行動錢包(Mobile wallet)等。

□ 遠端控制或決策支援(·Remote control and decision support)，例如以行動裝置當作遙控器(mobile devices as control devices)、或其他自動化的應用(Automotive applications)等。

□ 其他的應用或服務(Further applications and services)，例如搜尋與調查(Search and investigation)、加值服務(Value added services)、追蹤(Tracking)等。

11. 若您的行動電話可上網，但您未使用行動電話上網的原因為何?
□ 電信公司未提供上網服務，□ 費用太高，□ 連線速度太慢，□ 不需要

12. 若目前您的行動電話不支援上網服務，您是否想換手機以便使用上網服務?
□ 是，□ 否 (請跳答第 14 題)。

13. 請問您最希望以行動電話上網使用哪類服務?
□ 存取資訊或資料(Information and data access)；例如新聞(News)、城市導覽(City Guides)、目錄服務(Directory Services)，地圖(Maps)，交通與天氣(Traffic and weather)，企業資訊(Corporate Information)，市場資料(Market data)等。

□ 通訊或互動(Comunication / Interaction)；例如短訊(Short messaging)、電子郵件(E-mail)、聊天室(Chatrooms)、視訊會議(Video-conferencing)等。

□ 娛樂(Entertainment)；例如聽音樂(Music)、玩遊戲(Games)、看圖(Graphics)、看影片(Video)等。

□ 交易(Transactions)；例如銀行業務(Banking)、仲介業務(Brokering)、購物(Shopping)、拍賣(Auctions)、議價(Betting)、預約訂位(Booking & Reservation)、行動錢包(Mobile wallet)等。

□ 遠端控制或決策支援(·Remote control and decision support)，例如以行動裝置當作遙控器(mobile devices as control devices)、或其他自動化的應用(Automotive applications)等。

□ 其他的應用或服務(Further applications and services)，例如搜尋與調查(Search and investigation)、加值服務(Value added services)、追蹤(Tracking)等。

14. 請問您不打算使用行動電話上網的原因為何?
□ 電信公司未提供上網服務，□ 以行動電話上網費用太高，□ 具上網功能的行動電話太貴，□ 連線速度太慢，□ 不需要。

三、行動上網服務

15. 您所選用的電信公司是否提供行動上網服務?
□ 是，□ 否，□ 不清楚。

16. 若您所選用的電信公司未提供行動上網服務，您是否會因此考慮更換電信公司?
□ 是(請跳答第 18 題)，□ 否。

17. 請問不考慮因此更換電信公司的原因為何?
□ 不想換門號，□ 其他公司也未提供，□ 不需要，□ 其他，請說明___。

18. 請問更換電信公司後預計你將使用哪些行動上網功能?
□ 存取資訊或資料(Information and data access)；例如新聞(News)、城市導覽(City Guides)、目錄服務(Directory Services)，地圖(Maps)，交通與天氣(Traffic and weather)，企業資訊(Corporate Information)，市場資料(Market data)等。

□ 通訊或互動(Comunication / Interaction)；例如短訊(Short messaging)、電子郵件(E-mail)、聊天室(Chatrooms)、視訊會議(Video-conferencing)等。

□ 娛樂(Entertainment)；例如聽音樂(Music)、玩遊戲(Games)、看圖(Graphics)、看影片(Video)等。

□ 交易(Transactions)；例如銀行業務(Banking)、仲介業務(Brokering)、購物(Shopping)、拍賣(Auctions)、議價(Betting)、預約訂位(Booking & Reservation)、行動錢包(Mobile wallet)等。

□ 遠端控制或決策支援(·Remote control and decision support)，例如以行動裝置當作遙控器(mobile devices as control devices)、或其他自動化的應用(Automotive applications)等。

□ 其他的應用或服務(Further applications and services)，例如搜尋與調查(Search and investigation)、加值服務(Value added services)、追蹤(Tracking)等。

19. 請就下表勾選各類行動上網功能重要的程度。

行動上網功能類別		請勾選重要的程度				
		最不重要	不重要	普通	重要	很重要
1.	存取資訊或資料					
2.	通訊或互動					
3.	娛樂					
4.	交易					
5.	遠端控制或決策支援					
6.	其他的應用或服務					

20. 請就下表勾選各類行動上網-存取資訊或資料功能重要的程度。

存取資訊或資料功能		請勾選重要的程度				
		最不重要	不重要	普通	重要	很重要
1.	新聞					
2.	城市導覽					
3.	目錄服務					
4.	地圖					
5.	交通					
6.	天氣					
7.	企業資訊					
8.	市場資料					

21. 請就下表勾選各類行動上網-通訊或互動功能重要的程度。

通訊或互動功能		請勾選重要的程度				
		最不重要	不重要	普通	重要	很重要
1.	短訊					
2.	電子郵件					
3.	聊天室					
4.	視訊會議					

22. 請就下表勾選各類行動上網-娛樂功能重要的程度。

娛樂功能		請勾選重要的程度				
		最不重要	不重要	普通	重要	很重要
1.	音樂					
2.	遊戲					
3.	看圖					
4.	看影片					

23. 請就下表勾選各類行動上網-交易功能重要的程度。

行動上網功能類別		請勾選重要的程度				
		最不重要	不重要	普通	重要	很重要
1.	銀行業務					
2.	仲介業務					
3.	購物					
4.	拍賣					
5.	議價					
6.	行動錢包					
7.	預約訂位					

24. 請就下表勾選各類行動上網-遠端控制或決策支援功能重要的程度。

行動上網功能類別		請勾選重要的程度				
		最不重要	不重要	普通	重要	很重要
1.	以行動裝置當作遙控器					
2.	其他自動化的應用					

Appendix B. The context of questionnaire used in USA

1. Your gender: ___ Male □ ___ Female

2. Your grade level:

___ Freshman/Sophomore ___Junior/Senior ___ Master student ___ Doctorate student

3. Your College:

___Science ___Engineering ___Agriculture ___Medicine ___Management ___Liberal Art

Others:_____

4. Monthly Income (US$/Month) :

___0-150 ___150-300 ___300-500 ___500-800 ___800-1500 ___1500-300 ___over 3000

5. How is your monthly cell phone payment calculated?

___a fixed monthly fee ___by usage (minutes) ___Combination of both

6. On average, how much is your current monthly cell phone bill?

___Free ___$1-$30 ___$31-70 ___$71-100 ___$101-150 ___over $151

7. On average, how much time PER DAY are you on the cell phone?

___0-15 minutes ___15 min to 1 hour ___1-3 hours ___over 3 hours

8. Who pay for your cell phone bill?

___myself ___other family members ___work

Others, please specify _____

9. Is your CELLPHONE equipped with internet service capability?

□ ___ Yes ___ No ___Don't know

9a. If it does, what is the connection protocol?

□ ___3G ___GPRS ___WAP ___PHS ___Don't know□___Don't have internet service

Others, please specify _____

10. Does your cell phone SERVICE PROVIDER provide internet access service?

___Yes ___No ___Don't Know

11. Are you currently subscribed to internet access?

___Yes ___No ___Don't Know

12. If your cell phone is internet ready, do you use such a service?

___Yes, very often ___Yes, sometimes ___Yes, but rarely ___Never

13. If you have used mobile internet service, which of the following services have you used? (Please check ALL that apply)

□ ___Information and data access, such as news, city guides, directory services, maps, traffic and weather, corporate information, stock market data.

□ ___Communication/Interaction, such as short messaging, E-mail, chat rooms, video-conferencing.

□ ___Entertainment, such as music, games, video.

□ ___Transactions, such as banking, brokering, shopping, auctions, betting, booking & reservation, mobile wallet.

□ ___Remote control and decision support, such as mobile devices as control devices, or automotive applications.

___Other applications and services, such as search and investigation, Value added services, Tracking.

Others, please specify _____

14. If your cell phone is capable of internet access, but you never or rarely use it, why? (Please check ALL that apply)

___My service provider does not offer this service □

___Too expensive ___Too slow ___Don't know how ___No such a need

Others, please specify _____

15. When you are making a phone/service provider selection, how important is it that the phone/service has internet capability?

___Very important -- I will not purchase the phone/service if it is not internet ready

___Somewhat important -- It would be nice to have, but I will also weight other factors

___Not very important

___Not important at all

Please rate how important the following mobile internet services are to you.

	Very Important	*Least Important*
16. Information and Data Access		
News	5 .. 4 .. 3 .. 2 .. 1	
City Guides	5 .. 4 .. 3 .. 2 .. 1	
Directory Services	5 .. 4 .. 3 .. 2 .. 1	
Maps	5 .. 4 .. 3 .. 2 .. 1	
Traffic	5 .. 4 .. 3 .. 2 .. 1	
Weather	5 .. 4 .. 3 .. 2 .. 1	
Corporate Information	5 .. 4 .. 3 .. 2 .. 1	
Stock Market Data	5 .. 4 .. 3 .. 2 .. 1	
17. Communication/Interaction		
Short messaging	5 .. 4 .. 3 .. 2 .. 1	
E-Mail	5 .. 4 .. 3 .. 2 .. 1	
Chat rooms	5 .. 4 .. 3 .. 2 .. 1	
Video conferencing	5 .. 4 .. 3 .. 2 .. 1	
18. Entertainment		
Download/listen to Music	5 .. 4 .. 3 .. 2 .. 1	
Play Games	5 .. 4 .. 3 .. 2 .. 1	
Download pictures	5 .. 4 .. 3 .. 2 .. 1	

Download Video.....5 .. 4 .. 3 .. 2 .. 1

19. Transactions

Banking .....5 .. 4 .. 3 .. 2 .. 1

Trading stocks .....5 .. 4 .. 3 .. 2 .. 1

Shopping.....5 .. 4 .. 3 .. 2 .. 1

Auctions.....5 .. 4 .. 3 .. 2 .. 1

Gambling .....5 .. 4 .. 3 .. 2 .. 1

Mobile wallet .....5 .. 4 .. 3 .. 2 .. 1

Booking and reservations.....5 .. 4 .. 3 .. 2 .. 1

20. Remote Control and Decision Support

I use my cell phone as a remote control .....5 .. 4 .. 3 .. 2 .. 1

I use my cell phone for other automotive applications..... 5 .. 4 .. 3 .. 2 .. 1

Others, please specify:

_____

_____

Appendix C. The context of questionnaire used in German

1. Your gender: ___ Male □ ___ Female

2. Your grade level:

___ Freshman/Sophomore ___Junior/Senior ___ Master student ___ Doctorate student

3. Your College:

___Science ___Engineering ___Agriculture ___Medicine ___Management ___Liberal Art

Others:_____

4. Monthly Income (US$/Month) :

___0-150 ___150-300 ___300-500 ___500-800 ___800-1500 ___1500-300 ___over 3000

5. How is your monthly cell phone payment calculated?

___a fixed monthly fee ___by usage (minutes) ___Combination of both

6. On average, how much is your current monthly mobile phone bill?

___Free ___$1-$30 ___$31-70 ___$71-100 ___$101-150 ___over $151

7. On average, how much time PER DAY are you on the cell phone?

___0-15 minutes ___15 min to 1 hour ___1-3 hours ___over 3 hours

8. Who pay for your mobile phone bill?

___myself ___other family members ___work

Others, please specify _____

9. Is your CELL PHONE equipped with internet service capability?

□ ___ Yes ___ No ___Don't know

9a. If it does, what is the connection protocol?

□ ___3G ___GPRS ___WAP ___PHS ___Don't know□___Don't have internet service

Others, please specify _____

10. Does your cell phone SERVICE PROVIDER provide internet access service?

___Yes ___No ___Don't Know

11. Are you currently subscribed to internet access?

___Yes ___No ___Don't Know

12. If your mobile phone is internet ready, do you use such a service?

___Yes, very often ___Yes, sometimes ___Yes, but rarely ___Never

13. If you have used mobile internet service, which of the following services have you used? (Please check ALL that apply)

□ ___Information and data access, such as news, city guides, directory services, maps, traffic and weather, corporate information, stock market data.

□ ___Communication/Interaction, such as short messaging, E-mail, chat rooms, video-conferencing.

□ ___Entertainment, such as music, games, video.

□ ___Transactions, such as banking, brokering, shopping, auctions, betting, booking & reservation, mobile wallet.

□ ___Remote control and decision support, such as mobile devices as control devices, or automotive applications.

___Other applications and services, such as search and investigation, Value added services, Tracking.

Others, please specify _____

14. If your cell phone is capable of internet access, but you never or rarely use it, why? (Please check ALL that apply)

___My service provider does not offer this service □

___Too expensive ___Too slow ___Don't know how ___No such a need

Others, please specify _____

15. When you are making a phone/service provider selection, how important is it that the phone/service has internet capability?

___Very important -- I will not purchase the phone/service if it is not internet ready

___Somewhat important -- It would be nice to have, but I will also weight other factors

___Not very important

___Not important at all

16. Please rate how important the following mobile internet services are to you.

	Very Important	*Least Important*
Information and Data Access		
News	5 .. 4 .. 3 .. 2 .. 1	
City Guides	5 .. 4 .. 3 .. 2 .. 1	
Directory Services	5 .. 4 .. 3 .. 2 .. 1	
Maps	5 .. 4 .. 3 .. 2 .. 1	
Traffic	5 .. 4 .. 3 .. 2 .. 1	
Weather	5 .. 4 .. 3 .. 2 .. 1	
Corporate Information	5 .. 4 .. 3 .. 2 .. 1	
Stock Market Data	5 .. 4 .. 3 .. 2 .. 1	
Communication/Interaction		
Short messaging	5 .. 4 .. 3 .. 2 .. 1	
E-Mail	5 .. 4 .. 3 .. 2 .. 1	
Chat rooms	5 .. 4 .. 3 .. 2 .. 1	
Video conferencing	5 .. 4 .. 3 .. 2 .. 1	
Entertainment		
Music	5 .. 4 .. 3 .. 2 .. 1	
Games	5 .. 4 .. 3 .. 2 .. 1	
Video	5 .. 4 .. 3 .. 2 .. 1	
Transactions		

Banking .....5 .. 4 .. 3 .. 2 .. 1

Shopping.....5 .. 4 .. 3 .. 2 .. 1

Auctions.....5 .. 4 .. 3 .. 2 .. 1

Gambling .....5 .. 4 .. 3 .. 2 .. 1

Mobile wallet .....5 .. 4 .. 3 .. 2 .. 1

Booking and reservations.....5 .. 4 .. 3 .. 2 .. 1

Others, please specify:

_____

_____

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