整合新式多評準決策模式建構科技產業之評估模式與發展策略

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摘　　要

本研究主要以三個實證研究來說明如何運用新式多評準決策與網路結構關聯圖技術來解決科技產業的產業評估與發展策略議題，本研究透過整合結構關聯與權重技法來建構改善策略圖，以達新世代最佳價值創造典範。

在廠商區位選擇與園區發展策略研究中，在全球化效應影響下，企業必須因應市場環境的改變而在世界各地找尋合適的生產、研發與行銷群聚之據點，也造就了各種類型的產業聚落形成；因此本研究欲探討企業在全球化的過程中究竟依據哪些因素(準則)以及那種方式來評估其生產、研發與行銷群聚據點的選取，以及園區開發與管理當局應該採取何種發展策略與經營模式來提升科學(科技)園區價值創造功能，故本研究對於不同類型的產業群聚結構進行比較分析，運用決策試驗與實驗評估法(Decision Making Trial and Evaluation Laboratory, DEMATEL)來建立產業群聚結構，並利用人力資源、技術資源、投資環境與市場發展之四個群聚形成構面與 28 個評估準則來找出群聚形成原因，接著以台灣北部兩個著名的產業群聚實例來說明與驗證本研究之論證，在台灣北部從內湖到新竹有很多國際知名的資訊科技廠商群聚，最為著名的兩個產業聚落是內湖科技工業園區與新竹科學工業園區，內湖科技工業園區是以研發與行銷廠商(單位)為主的產業群聚，而新竹科學工業園區則是以生產與製造(單位)為主的產業群聚，本研究運用 DEMATEL 的研究模式來找出園區價值創造評估準則之間的關聯性並建構出產業群聚價值創造結構，透過分析產業群聚價值創造結構可以讓園區開發與管理當局了解產業聚落形成的原因與過程，進而可運用這些關係結構來找出關鍵的影響準則並加以改善。藉由本研究可以協助園區開發業者與園區管理當局提高科學(科技)園區價值創造功能，也有助於擬定園區整體發展策略與相關經營方針。

在車載資通訊系統的系統發展策略研究中，隨著資通訊科技的快速進步與滿足消費者的需求，結合資通訊科技與車輛技術的車載資通訊系統(Telematics system, TS)便油然而生，使汽車成為多功能行動服務平台，除了核心運輸價值之外，增添了導航、安全、保全、資訊、通訊、娛樂等附加價值，讓使用者可以透過 TS 系統來與支援中心(Call center)聯絡，取得所需的服務與資訊，提高其使用的便利性，也確保在適度監控下，車輛操作能夠更安全。因此如何發展出符合使用者需求的 TS 系統已成為車廠最關心的議題，因為攸關汽車銷售業績，更直接影響到加值服務市場規模。故本研究想找出新 e 世代車 TS 系統該提供那些功能，同時瞭解不同屬性的使用者對 TS 系統的需求差異，之後再依據不同的消費者屬性來規劃新 e 世代 TS 系統的功能組合。本研究以導航與地圖服務、安全與保全服務、資訊與系統服務、影音與娛樂服務、費率與付款方式、產品形象之六個評估構面以及 25 個評估準則來找出使用者對於新 e 世代車載資通訊服務系統之需

求，並利用 DEMATEL 法找出構面間準則關聯結構(relation structure)，並利用 ANP 法來找出權重關係，並以 TOPSIS 法評估各種類型車載資通訊系統距離的落差，依據客戶屬性來找出其對各種 TS 系統的偏好，以此來提供車載資通訊系統服務供應商(Telemetics Service Provider, TSP)相關改善策略以創造最大的客戶價值。

在數位音樂服務平台發展策略研究中，隨著音樂數位化技術的普及化與音樂儲存播放裝置的微型化，傳統以唱片型式的儲存方式逐漸被數位儲存裝置所取代，音樂的傳播已不再倚賴唱片，反而是由網站下載或是直接線上收聽，讓音樂隨身攜帶的現象越來越普遍。由於音樂網站的普及以及服務模式的多元化，從網路上取得數位音樂非常容易，然而相對於此，實體 CD 的銷售卻節節下降，唱片公司如何在版權保護與服務擴散間取得平衡發展是目前亟欲面對的挑戰。而在近幾年透過音樂網站提供數位音樂服務的營收呈倍數成長，唱片出版商在數位音樂中看到新的獲利模式，然而從在實體轉換到數位的線上音樂平台應該提供什麼樣的服務與功能才能創造價值以滿足消費者需求，為企業增加營收呢?本研究試圖由解構音樂服務對消費者所創造的價值為出發點，試圖為唱片公司找出一些可行的市場發展策略與經營模式。藉由探求消費者對音樂服務的需求動機以找出消費者對音樂服務的評選準則，透過平台構面關聯圖的建構來分析準則關聯結構，其次運用主成份分析來將準則依其屬性加以分類，運用多評準決策評估模式來找出減少服務落差的服務創新策略，並以此擬出合適的產業發展方向。因此本研究係藉由音樂服務創新策略的擬定來加速數位音樂服務平台的功能與價值提升，進一步帶動產業服務品質的全面改善與加速音樂內容價值創造的契機。

關鍵字: 新式多評準決策模式、科技(科技)園區、車載資通訊系統、音樂服務平台、DEMATEL, PCA, ANP, TOPSIS, VIKOR

Integrating the novel MCDM techniques for strategy improvement of technology industry

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Abstract

The research shows the novel MCDM method and explains the process of network relation map (NRM) by three empirical real cases of industrial evaluation and development strategy issues for technology industry. The study combined a novel MCDM with structure-relation and weighting techniques for building improvement strategies-map to achieve the best value-created paradigm of enterprise in new generation.

In the research, the value-created systems of science (technology) parks are proposed. Under the impact of globalization effects, enterprises tackle the rapid change of market circumstances and find suitable places for production, R&D and marketing, which contribute to the creation of clusters of various industries. In this study, we differentiate the decisive factors effecting enterprises in choosing the right places for production, R&D and marketing. We also provide proposed development strategies and operation models for the authorities of science (technology) park to advance the parks' value. This study compares various industrial clusters using the DEMATEL (Decision Making Trial and Evaluation Laboratory) technique to establish industrial structures. To do this, four aspects are considered: human resources, technology resources, invest environments and market development. These aspects encompass 28 evaluation criteria to determine the establishment attributes of clusters. Two well-known industrial cluster parks, the Neihu technology park and the Hsinchu science park as example, both in Northern Taiwan, are our case studies for this project. The Neihu technology park is the industrial cluster of R&D and marketing. The Hsinchu science park is the industrial cluster of production and manufacture. The DEMATEL technique is used to determine the relationship between the evaluation criteria and establish their value structures. The key performance criteria could be sieved out and shall be further improved. The conclusions shall propose development strategies and operation models for vendors or the authorities of science (technology) parks to advance the parks' value.

In the research, the improvement strategy for vehicle telematics system is proposed. As the advanced integration of communications, information and vehicle technologies, VTS (**V**ehicle **T**elematics **S**ystems, VTS), have been initiated for satisfying consumers' needs with respect to automobile movement. Importantly, VTS enables the vehicle to become a multi-functional mobile-services platform. Cars are now designed not only for transportation, but also to provide value-added services covering navigation, safety, security, information, communications and entertainment. Drivers or passengers can contact a call center via VTS to access aspired/desired services and information online. Therefore, VTS increases both the

utility/functions and the safety of driving. Developing the optimal VTS that complies with consumers' needs has become the foremost concern of automobile producers. This study will attempt to identify the required VTS utilities between distinguishing characteristics/features of consumers and propose the ideal service combinations for the next e-era generation VTS. An evaluating model by six aspects to be considered/constructed, which encompass twenty-five criteria are built to identify consumers' needs for the next e-era generation VTS. The DEMATEL (Decision-Making Trial and Evaluation Laboratory, DEMATEL) is used to contract the network relation-map (NRM) among the criteria of each aspect. Additionally, the ANP (Analytical Network Procedure, ANP) is used to determine the relative weightings among those criteria according to NRM. Moreover, the TOPSIS (Technique for Order Preference by Similarity to Ideal Solution, TOPSIS) is used to determine and improve the gaps among the distinguishing characteristics/features of consumers' desired utilities with respect to services/provide the decision-maker of TSP for improving existing functions or planning further utilities in the next generation VTS. Based on above NRM those results can be served as a suggestion for the TSP (Telemetics Service Provider, TSP) to improve the existing functions or plan further utilities/functions for reducing the gaps and satisfying the users' needs in next e-era generation VTS.

In the research, the service selection model of service platform of digital music is proposed. The digital music service has been expanded wildly. The number of people purchasing music downloads are on the rise. Digital music files (mainly in MP3 format) have become widespread on the internet. However, downloading digital product for free may harm creators and music publishers because it is very easy to obtain free-music through peer-to-peer sharing technologies over the internet. At the same time, portable entertainment devices and mobile phones are now able to carry music files, leading people to access music much more easily. On the other hand, with the coming of the 3.5G in telecom infrastructure, the rise in downloading music using mobile devices becomes possible. People can access online-music service platforms either through cable/ADSL with their PCs or through telecom services accompanying with their mobile devices. Therefore, a critical issue for the records publisher or digital music service provider is now how to provide services to create values as well as to fulfill customers' needs. By discovering the customers' needs and intentions of the music service, this study concludes the selection criteria for customers to evaluate and select music services. A novel MCDM (Multiple Criteria Decision Making) technique, which integrates the four MCDM technique (Decision-making Trial and Evaluation Laboratory, DEMATEL; Principal Component Analysis, PCA; Analytical Network Procedure, ANP; and VlseKriterijumska Optimizacija I Kompromisno Resenje, VIKOR), and applied to rank and improve the four digital music service platforms for getting the best win-win service selection.. This paper will propose the key driving aspect of four service platforms of digital music and rank them by using the model proposed. Not only can the conclusions be served as some suggestions for service providers to improve existing functions but also to plan further utilities for service platform of digital music in the next generation.

Keywords: Novel MCDM approach, Science (technology) park, Vehicle telematics system, Service platform of digital music, DEMATEL, PCA, ANP, TOPSIS, VIKOR

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Contents

List of Tables

List of Figures

Chapter 1
Introduction

This section is organized as follows. In section 1.1, research backgrounds of three empirical studies (science/technology parks, vehicle telematics system, service platform of digital music) are discussed. Research objectives and frameworks of the three empirical cases are proposed in section 1.2. In section 1.3, research process and methods are applied to three empirical cases of technology industry. Finally, Research organization and contents are proposed in Section 1.4.

1.1 Research background

1.1.1 The development of science (technology) park

The flourishing progress of both economic liberalization and information technologies have contributed to the trend of enterprise globalization. The enterprise faces competition against not only domestic companies, but also international companies. In order to transcend other competitors, the enterprise has to strengthen its competitive advantage by manipulating global brains and resources. The appearance is that many famous international enterprises around the world had moved their production bases into developing countries. Through resource re-allocation actions, these international enterprises can intensify their resources on R&D and marketing activities of products or service, but they still have to tackle two difficult issues: (1) to meet customers' needs, the best solution for enterprises is to produce goods fitting customers' needs/demands and to set up sales units near customers; (2) to maintain key competitive competency, these enterprises look for outsourcing of standard production procedures and services in order to reduce operating costs (Iammarino and McCann, 2006; McCann and Arita, 2006; McCann, et al., 2002; Ng and Tuan, 2003). These enterprises will not meet customer's needs/demands unless they adjust and organize their production, R&D and marketing bases opportunely. The best way to accomplish this is to consider the optimal allocation of global markets and resources, and to look for suitable production places, R&D and marketing bases around the world. Thus, enterprises can manipulate global brains and resources to reduce their production costs, raise the operating performance and enhance enterprises' competitive competency. An comprehensive literature review has revealed that studies industrial clusters formed regarding the development process of industrial parks, export processing zones, science-parks and technology-parks, has its' contributions and

backgrounds. One sentence is not enough to describe how every industrial cluster has been formed; however, we can say that contributions of parks (or various industrial clusters) change with time (Durão, et al., 2005; Guerrieri and Pietrobelli, 2004).

M.E. Porter, scholar of Harvard University, discovered studies that traditional industrial clusters are based on comparative economic interests or advantages, natural resources and cheap labor costs were the contributions to form industrial clusters. However, instead of natural resources and cheap labor costs, today, continuous innovative actions inside industrial clusters become the main contribution. Therefore, the contributions of industrial clusters are changed from natural resources and cheap labor costs to the innovation ability of clusters. This is why we want to propose the value-created system of science (technology) parks (Porter, 2000). The good industrial clusters or science (technology) parks can grow and develop continuously only basing on the value-created system. If the functions of the value-created systems of science (technology) parks are reduced or lost, the science (technology) parks will face the trouble of firms' moving-out.

1.1.2 The development of vehicle telematics system

With the extensive traffic network and the changes in lifestyles, automobile users will no longer be pleased with just a pleasant driving experience and comfortable interior. People will expect their navigational device to change from a closed system into an open intellectual communications system, in which users can communicate or transmit information to and from external systems or other people in real-time via their car's vehicle telematics device. With the remarkable advances in consumer electronic and telecommunications technologies, development in the automobile industry has progressed from the past era, in which driving mechanisms and comfortable equipment were emphasized to the telematics era, in which the interaction between users and various platforms is stressed. These currents not only push the automobile industry to extend its industrial value chain but also to represent the new definition of what the automobile should be.

Therefore, the development of the next-generation vehicle has extended from improving machine efficiency to providing communications and information services. In order to meet consumers' needs when they are on the move, VTS should integrate existing communications, information and automobile technologies for various service utilities. VTS changes the car from a closed body into an open mobile-service platform. The car will not only be designed for transportation, but will also provide value-added services regarding navigation, safety, security, information, communications and entertainment. Drivers or passengers will be able

to contact a call center via VTS to access desired services and information online. Therefore, VTS increases both the utility/function and the safety of driving. The high price of VTS hardware will be eliminated with the innovation of communications technologies, information technologies and the popularization of system services by mass production, and will also enable suppliers to attain economies of scale in production and services. Once this is achieved, VTS will become standard equipment in the vehicle. Since problems of technology and costs will be resolved in the future, the biggest challenge for the development of VTS is to discover the services and applications that the consumers really want. Therefore, how to develop VTS in order to meet the user's needs has become the main topic of automobile producers and telematics service providers (TSPs). It will influence new car sales and the scale of derived value-added service markets.

Early in 1997, European studies had proposed a solution for evaluating traffic effects of a route guidance system by dynamic simulation of an advanced transport telematics technology for easing the problems induced by traffic. They indicated that an efficient and safe infrastructure is an essential prerequisite for European economic and social cohesion. Those situations have urged the development of telematics technologies for route guidance systems to solve those traffic problems like traffic congestion. They also predicted that with the rapid development of telematics technologies it would become possible in the near future to make real-time information for real traffic situations (Chen and Stauss, 1997). In Europe, the United States and other advanced countries, car users care about and focus on the security and safety functions of automobiles. The law of strict/severe rules is also legislated regarding car safety. Accordingly, emergency services, automatic notification, stolen vehicle location assistance, security protection, vehicle diagnosis, and other safety and security-related services have been developed (Golob and Regan, 2001; Magnusson, et al., 2002). The core of VTS is communications and information services. The transmission, reception, and communication of information need to be operated via various communications and information technologies, particularly wireless technologies. Accordingly, car users can get various kinds of real-time and precise information when they have different needs such as personal e-commerce (Anker and Arnold, 1998; Golob and Regan, 2001). With the advances in telecommunications technologies, consumers can search and download video, music, and other multimedia information in real-time, via the VTS (Golob and Regan, 2001).

1.1.3 The development of service platform of digital music

The traditional music storage style of phonograph disk has been changed by digital storage, due to new e-era digital technology and micro-miniaturizing of music storage and playing devices. The dissemination of music does not rely on the phonograph any longer. Instead, people can now download music from websites or listen to music on-line. It has also become more and more common for people to carry music with them. Because of the commonness of music websites and the diversification of service model, it's easy to obtain the music from websites. As a result, the sales of CD's are declining while the dissemination of music through websites has become main-stream. The websites for new e-era digital music services and sales has also been emerging. The sales of downloading music have been steadily increasing over the past decade. The internet is now the main platform for digital music. People use their computers connecting to the internet to search, download, listen and even disseminate music. They can also store the music files they download into their PCs.

Following the commonness and powerful functions of portable devices, the evolution of transmission technology and the high penetration rate of the mobile phone in the worldwide market, the mobile phone, except the internet downloading, are expected by the publishers to be the next target market in emerging a new generation digital music of selling platforms. This trend has led the communication hardware and software companies to make cross-industry alliances. Music publishers seek cooperation with other industries, and attempt to integrate the mobile phone telecom vendors and mobile phone or portable music player manufacturers. They all try to fulfill consumers' demands/needs of enjoying the music, without the limitation of time and place, and attract consumers to pay for the service by providing a more diversified new e-era of digital music contents and services. However, from the consumers' point of view, the convenience of use and economic efficiency are the most important factors that influence their purchasing decisions. No matter whether they are downloading music from the internet or portable devices, it requires access to the music on the digital music websites. Consumers seem to prefer a better service quality, particularly when the price and other cost factors remain the same. There have been numerous studies that have evaluated service quality (Kelley and Hoffman, 1997; Zeithaml, et al., 1988; Zeithaml, et al., 1985). Due to the commonness of the internet nowadays, e-commerce and on-line shopping has become an emerging field of customer service (Walsh and Godfrey, 2000). Consumer's buying procedures, such as ordering, is much different from real purchasing behavior. There have been numerous studies on the evaluation and influence of service quality in the e-commerce market, and some fine-tuned evaluation criteria were proposed (Awan and Singh, 2006; Denguir-Rekik, et al.; 2009; Grigoroudis, et al., 2008; Hsu, 2008;

Lee and Kwon; 2008; Parasuraman, et al., 1994). The five aspects of the e-commerce service quality include: (1) obtainment and contents of information; (2) easy or suitable use; (3) privacy protection and security; (4) user friendly interface; and (5) reliability (Parasuraman, et al., 2005). These five aspects were developed to be a method for evaluating and improving the service quality of e-commerce to get the best service selection.

1.2 Research objective and framework

1.2.1 The research objective of science (technology) park

In these years, some researches which illustrate the development of industry cluster between Taiwan and China (Chen and Huang, 2004; Chen, et al., 2006; Hu, et al., 2005; Ku, et al., 2005; Lai and Shyu, 2005; Lee and Yang, 2000; Tan, 2006). These researches illustrate the innovation and development model (Chen, et al., 2006; Hu, et al., 2005; Ku, et al., 2005; Lai and Shyu, 2005; Tan, 2006), and the choice behavior of location (Chen and Huang, 2004) across the Taiwan Strait. So in this research, we try to understand the relationship of value created system of science (technology) park, and divided the value created system into four aspects (i.e., human resources (HR), technological resource (TR), investment environment (IE), and market development (ME).

1.2.2 The research objective of vehicle telematics system

This study would like to identify the required VTS utilities according to distinguishing characteristics of consumers and propose the most appropriate service combinations for the next e-era generation VTS. These following six aspects (i.e. navigational and location services, safety and security services, communications and information services, audio-video and entertainment services, fee rate and payment methods, product image), encompassing twenty-five criteria, are constructed to identify and evaluate consumers' needs for the next e-era generation VTS. Techniques of combined DEMATEL with ANP and TOPSIS are generally introduced and applied with simple examples for VTS innovation/creation. VTSs of four regions (i.e. North America, Western Europe, Japan and Taiwan) are applied for empirical analysis.

1.2.3 The research objective of service platform of digital music

How do music publishers and website service providers achieve the balance between the benefit and the expansion of this new e-era digital music service model, and then create value-added to consumers through the service platform? This study will compare the values

of the portable music services that the digital music websites provide. To understand the different preference of various users, this study analyzes young people, 21 to 30 years old, to discuss their customer satisfaction level of portable music service. Crucial distinctions between two sexes are analyzed to suggest the function combination of the service platform of digital music. Through the discovering and analyzing to the customers' demands/needs and intentions of the music service, this research concludes the selection criteria for customers to evaluate, improve, and select the best digital music service.

1.3 Research process and methods

1.3.1 The research method of science (technology) park

Eventually, this paper will generalize the whole value-created system of science (technology) from four major value-created functions and propose the overall analysis. Lin and Wu (2008) adopted the DEMATEL method as an analysis technique. The DEMATEL method is an analytic technique of relationship structure; it can find the critical aspect/criteria of the complex structure system. Tzeng, et al. (2007) illustrated that DEMATEL method can construct the evaluation dimensions and find out the key driving criteria of various science (technology) parks. The key driving criteria could be sieved out for further improvement. The conclusion could provide some development strategies and operation models for the authorities of science (technology) parks to advance the parks' value. The manufacture-oriented Hsinchu science park and the R&D, marketing-oriented Neihu technology park is applied to empirical implementation.

1.3.2 The research method of vehicle telematics system

The DEMATEL technique is used to build the NRM among evaluation criteria of each aspect. The ANP method is used to determine the relative weightings among those evaluation criteria depending on NRM. The TOPSIS is used to determine and improve the gaps between consumers' negative (the worst levels) and positive ideal solutions (aspired/desired levels) among utilities of the existing VTSs and preferences of various consumers for improving each criterion based on whole systems of NRM. The gaps are analyzed between the consumers' most appropriate and most inappropriate service of the existing/developing VTS in each criterion for achieving the aspired/desired level. Those conclusions will serve/provide the decision-maker of TSP for improving existing functions or planning further

utilities/functions for the next e-era generation VTS. Commercial VTSs of four regions (i.e. North America, Western Europe, Japan and Taiwan) are illustrated to use as empirical analysis. The result demonstrates that different user ages will influence the preference of desired utilities for VTS. Those comments can help automobile manufacturers develop new e-era generation VTS, modulize the service functions and spec-in target consumers' requirements for customized purposes. This paper suggests that TSPs could improve the current utilities or initiate new utilities/functions on the basis of Japan's or Taiwan's existing VTSs in order to shorten the time to market.

1.3.3 The research method service platform of digital music

A novel MCDM technique is used to solve these problems. First, the structure of the NRM (Network Relationship Map) among several aspects can be constructed and analyzed by DEMATEL (Decision-making Trial and Evaluation Laboratory) technique. Second, to categorize criteria by their properties, PCA (Principal Component Analysis) was conducted. Additionally, the ANP (Analytical Network Procedure) is used to determine the relative weightings among those criteria according to NRM. Finally, the VIKOR (VlseKriterijumska Optimizacija I Kompromisno Resenje in Serbian, means Multicriteria Optimization and Compromise Solution) method is applied to rank and improve the digital music service platforms sampled for getting the best service selection. An empirical case of service platform of digital music in Taiwan is illustrated to demonstrate the proposed methods. The results show that a pay service platform of digital music is better than a P2P one. However, a P2P service platform of digital music is better than a pay service one in both aspects of pricing and promotion. This is because that the operation style of the P2P music-sharing can reduce their licensing fee and cost on operation. Such operation style usually attracts students and youngsters who have lower requests in system stability and security. The results also show that the customers do not satisfy the current service quality of system stability and security of P2P service platform; so that the P2P digital music service operators would have more rooms to improve for satisfy the users' demands/needs in the future. These results will assist the digital music service providers in contents to create a better service model of new business opportunity on the mobile digital music market.

1.4 Research organization and contents

This thesis is organized as follows. In Chapter 2, value-created systems based on

customers' needs are discussed. The novel MCDM techniques for building the evaluation model and development strategies for technology industry are proposed in Chapter 3. In Chapter 4, the evaluation model and development strategies are applied to three empirical cases of technology industry. Finally, conclusions and further planning are proposed in Chapter 5. Then organization and contents of the thesis are showed in **Fig. 1**.

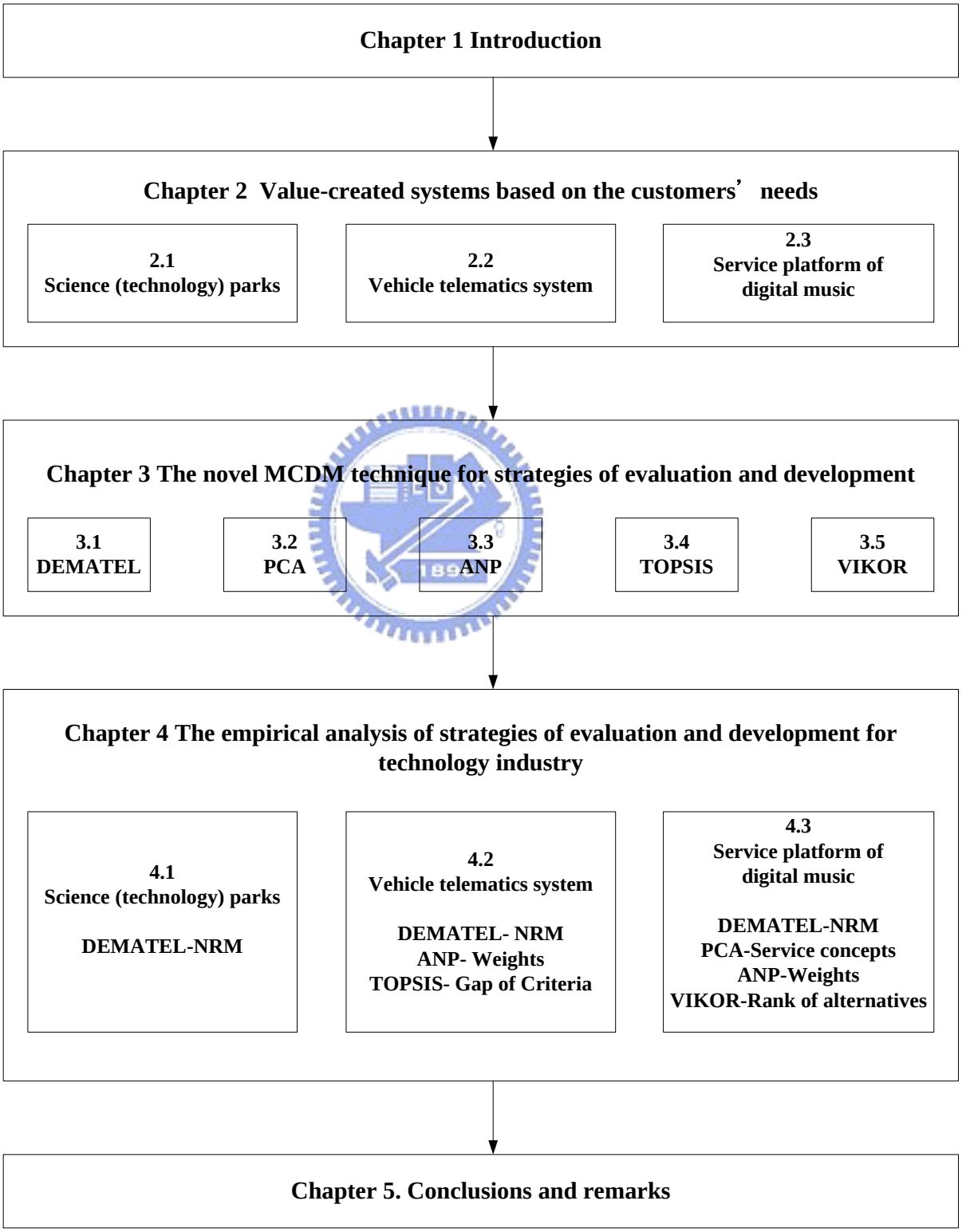

Fig.1. The figure of research organization

Chapter 2

Value-created systems based on the customers' needs

A research concept of value-created systems based on the customers' needs is reviewed and discussed in this chapter. This chapter is including three parts: 2.1 Industry clusters and value-created systems on science (technology) parks; 2.2 Vehicle telematics system based on consumers' needs; 2.3 The customers' need aspect of service platform of digital music.

2.1 Industry clusters and value-created systems on science (technology) parks

Porter (1998) discovered that industry clusters could raise the competitive advantage for enterprises resulting from clusters of productivity, clusters of innovation, and clusters of new business formation. In the clusters of productivity concept, this research extracted 5 criteria (as shown in Table 1) which could contribute industry clusters to increase productivity. In the clusters of innovation concept, Porter considered that clusters could help enterprises understand customers' needs and use clusters resources to innovate more easily. In the clusters of new business formation concept, Porter considered that clusters could help enterprises to find the gaps of needs to present products or services, and it could also help new businesses to find suitable suppliers and customers in the clusters. Furthermore, Porter (2000) generalized the sources of the competitive advantage of clusters. Furman, et al. (2002) revised Porter (2000) researches and provided the model of innovation-oriented national industry clusters with 4 evaluation aspects (as shown in Table1). Chan and Lau (2005) pointed out that technology incubator programs of the science park provided different benefits for start-up companies in different stages. In the set-up office period, the programs could provide the rental subsidy and shared general resources costs. In the start marketing period, the programs could provide training resources, market network relation, proposed customer data-base, and legal or business advice. In the start to sell period, the programs could provide public images, media relations, market networks, and venture capital. Lin, et al. (2006) elucidated the industry cluster effect from the view of the dynamic system and considered that human resources, technology, money and the market were the four major influential aspects that affected industry cluster effect. Base on those above studies, four aspects/dimensions: (1) human resources (HR), (2) technological resource (TR), (3) investment environment (IE), (4) market development (ME) are applied in our paper and illustrated in following Subsections.

Table 1 The comparative research of value-created system for industry cluster

Porter (1998)
(1) High qualified employees and suppliers, (2) Access to specialized information, (3) Complementary relationships, (4) Access to institutions and public goods, (5) Better motivation and performance measurements.
Porter (2000)
(1) Factor (input) conditions (i.e., natural resources, human resources, capital resources, the physical infrastructure, the administrative infrastructure, the information infrastructure, the scientific and technological infrastructure); (2) Demand conditions (i.e., the local demand, the future expected local demand, the maturity of local customers, and the local demand that could be globalized); (3) Firm strategies and rivalry conditions (a local context that encourages appropriate forms of investment and sustained upgrading and vigorous competition among locally based rivals); (4) The related and supporting industries (i.e., the existing capability, local suppliers and the existing industrial competition).
Furman et al. (2002)
(1) Factor (input) conditions (a) High quality human resources, especially scientific, technical, and managerial personnel; (b) Strong basic research infrastructure in universities; (c) High quality information infrastructure; (d) An ample supply of risk capital. (2) Demand conditions, (a) The demand and the maturity of local customers; (b) The future expected local demand. (3) Context for firm strategy and rivalry (a) A local context that encourages investment in innovation-related activity; (b) Vigorous competition among locally based rivals. (4) Related and supporting industries (a) The capability of local suppliers and related companies; (b) Presence of clusters instead of isolated industries.
Lin et al. (2006)
(1) Human resources, (2)Technology , (3) Money, (4) Market.
Lin and Tzeng (2009)
(1) Human resources (HR), (2) Technological resource (TR), (3) Investment environment (IE), (4) Market development (ME).

2.1.1 The human resources aspect

Many studies regarding industry cluster and science (technology) parks have pointed out that industry cluster contributions are influenced by human resources (Furman, et al., 2002; Lin, et al., 2006; Porter, 2000). Porter (2000) considered that high quality human resources could help industry clusters to raise productivity. Meanwhile, human resources were always one of the competitive advantages of the industry cluster. Furman, et al. (2002) defined clearly that high quality human resources meant brains of technology and management. Lin, et al. (2006) considered that human resources contain the demands of professional staff, the number of research institutions, the channel of personnel training, the quantity of human resources, the number of high quality personnel, the number of high quality and quantity of administrative human resources, the innovation ability, and the new business would affect the

advantage of the industry cluster.

2.1.2 The technological resource aspect

Researchers have utilized research resources to strengthen the function of the value-created in industry clusters. Fukugawa (2006) considered that the major contribution of the science park was providing new technology-based firms (abbreviated NTBF) the linkage with local higher education institutes (HEIs) and research institutes, and also provided the service of incubation for the NTBF. The science park has combined functions of the traditional industry park and incubation center, and thus NTBF could obtain research resources and desired technologies from the assistance of R&D institutes. Therefore, NTBF could easily find suitable strongholds to commercialize their technologies. This is what experts called "science park model". Hu, et al. (2005) took the Hsinchu science park (Taiwan) as an example to explain the contributions as to why the science park could form the cluster of NTBF. The research pointed out that R&D and incubation institutes could cultivate NTSF. Because these NTBF lacked enough R&D resources in the start-up period, they must rely on technology transfer and IP licenses from the R&D institute. Some NTBF even built long collaborative relationships with R&D institutes, such as collaboration and joint research. Besides, some NTBF were spin-offs from departments of R&D institutes originally, and therefore network relationships existed with R&D institutes. The network relationship could help NTBF reducing the communication cost between NTBF and R&D institutes, and the uncertain risk of technology development. Therefore, NTBF could keep the competitive advantage of technology by the close network relationship with the R&D institutes. Lin, et al. (2006) considered that the penetration of technology, the number of research institutions, the diversification of university departments, the industrial information, the entrepreneurial technology level, the entrepreneurial competitive advantage, the entrepreneurial profitability, the desire for external cooperation, and the industrial scale would influence the effect of the industrial cluster.

2.1.3 The investment environment aspect

Some studies have pointed out the importance of the investment environment for the industry cluster (Furman, et al., 2002; Porter, 2000). Three main influential contributions were: the investment infrastructure, the effective of law and policy and the economies of scale of the industry. In the investment of infrastructure, Porter (1998) considered that research institutes, the professional information and public properties could help the industry

cluster to raise productivity. The general investment of infrastructure should consider physical infrastructure, administrative infrastructure, information infrastructure, and technology infrastructure. In reference to law and policy, Furman, et al. (2002) and Porter (2000) considered that local law and policy could encourage the investment in innovation and push the industry to upgrade continuously. Lin, et al. (2006) considered that the investment environment, complete regulation, infrastructure, material supply system, investment cost, investment incentives, substantial investment, local productivity, restriction of local resources, opportunity of earning profits, loans available from financial institutions, fund raising ability, debt ratio, reinvestment ability, and innovation ability would influence the competitive advantage of the industry cluster.

2.1.4 The market development aspect

Many studies considered that the function of market development is relevant close to industrial clusters (Furman, et al., 2002; Porter, 2000). The main discussion focused on those three aspects (i.e., manufacturers and customers, manufacturers and suppliers, and manufacturers and manufacturers). In reference to manufacturers and customers, Porter (2000) considered that the cluster could help enterprises easily understand customers' needs/demands and utilize clusters' resources for proceeding with innovation activities. Therefore, enterprises could discover the gaps among existing products and/or services and customers' needs, and new enterprises could select suitable suppliers and customers in the cluster. Besides, the maturity, the needs and the anticipated needs of local customers, and the globalized needs would influence the market development of the industry cluster.

In reference to manufacturers and suppliers, Porter (2000) considered that high quality suppliers could help enterprises from the cluster to raise their productivity. The ability of the related and supporting industries and the relationship between enterprises and local suppliers would influence the market development of the industry cluster. In reference to manufacturers, he considered that existing network relationship between enterprises could also create competitive advantages for the cluster. The industry' relationship encompassed both the complementary and competitive relationship. The complementary relationship could create the new industry cooperation model, and the competitive relationship could improve production efficiency and raise the competitive ability. Chan and Lau (2005) considered that science park could provide supporting of training resources, market networks, customer data bases, legal advice, business advice, public image, media relations, the market network, and

the venture capital for NTBF during the market development period. Lin, et al. (2006) proposed that the penetration of technology, the number of research institutions, the diversification of university departments, the industrial information, the entrepreneurial technology level, the entrepreneurial competitive advantage, the entrepreneurial profitability, the desire for external cooperation, and the industrial scale would influence the effect of the industrial cluster.

2.1.5 Value-created concept, influential relationship of network structure

In this study, the value-created system is divided into the aspect level and the criteria level. Firstly, the research analyzed four main aspects: human resources, technology resources, investment environment and market development. The relationship of aspects/criteria, and eventually the value-created systems of science/technology parks are considered. Besides, DEMATEL method is used to construct the relationship structure of aspects/criteria, it can help find the critical aspects/criteria of complex structure system. The DEMATEL technique was the best suitable method for building the relevant structure map. The DEMATEL technique relieved the limitation of the relationship matrix about the assumption of the symmetrical relationship. Therefore, some recent studies considered the DEMATEL techniques for solving complicated relationship structure problems. (Hori and Shimizu, 1999; Hu, et al., 2009; Li and Tzeng, 2009; Lin and Tzeng, 2009; Liou and Tzeng, 2007; Liou, et al., 2007; Liou, et al., 2008; Seyed-Hosseini, et al., 2006; Tsai and Chou, 2009; Tseng, 2009a; b; Tzeng, et al., 2007; Wu, 2008; Wu and Lee, 2007).

2.2 Vehicle telematics system based on consumers' needs

The development experiences of VTSs in countries with advanced automobile industries (i.e. North America, Western Europe, and Japan) can be benchmarked by Taiwan's TSPs. In North America, many people work in cities but live in suburbs. Therefore, the car becomes people's main form of transportation and car users are interested in receiving correct traffic information and in driving safety. Those characteristics have influenced automobile producers and TSPs to initiate R&D plans regarding real-time traffic information, driving safety and security measures. Additionally, with increased time for enjoying leisure time, entertainment and location-based services (abbreviated LBS) have become the basic utilities for future VTSs. In the long history of Western Europe, under the circumstances of multiple languages and multiple cultures, the construction and plans of routes are denser and more

reticular than in North America, and the car density is higher than in North America. Like people in North America, the Western European consumers are also concerned about receiving correct traffic information and pursuing driving safety. The mainstream European TSPs are equipped with navigation, safety, security utilities and multi-language interfaces to meet the requirements/needs of consumers from different nations/countries. Western Europeans like to travel across different European nations/countries, and thus demands for entertainment and LBS services are becoming increasingly more important and popular.

In Japan, because of the small territory, extremely dense population, expensive real estate, heavy traffic, and complex streets, the Japanese government proposed the Intelligent Transport Systems (ITS) plan and boosted Advanced Safety Vehicles (ASV) plan. Generally, traffic jams have always happened in a megalopolis; therefore customers desire navigation products to save their driving time. Because of the flourishing development of the entertainment and electronics industry and various requirements from consumers, entertainment utilities of VTS are more stressed than those in the U.S. and Europe. In Japan, when a car breaks down, the possibility of helplessness is less than North America because of its small territory, high population density, and well-connected transport systems. Therefore, Japanese customers require fewer safety and security utilities than those in the U.S. and European markets. From the development track of foreign VTSs regarding services and utilities, whether TSPs succeed or fail depends on the degree of satisfaction of consumers' needs. The U.S. and European TSPs focus on safety and security services, while the Japanese TSPs provide navigation and location services in the beginning, followed by communications and information services, and audio-video and entertainment services in recent years. The Taiwanese TSP first provides to adjust navigation and location utilities on the basis of Japan's technologies, and further provides safety and security utilities due to a high rate of car theft and frequent storage of stolen cars in Taiwan. As a result, consumers' requirements/needs for the VTS will differ by cultures and regions/countries. Thus, referring to the market trends of Europe, U.S. and Japan's VTS industries and considering Taiwan consumer's preferences will be useful for Taiwan's TSPs to plan the product roadmap of VTS.

2.2.1 Navigation and Location Services

With the rapid growth of road networks and total numbers of cars on the road, traffic problems seem inevitable with urbanization. With the advanced development of information and communications technologies, people do not need to find roads via traditional maps, rather they just enter their desired destination into a navigation system, and the location

services of the VTS will map the routes with vocal instructions to help people reach the desired place easily and conveniently. But in addition to the way to the destination, consumers are concerned about real-time traffic situations for route planning in order to avoid areas of congested traffic (Chen and Stauss, 1997). In this paper, four commercial VTS products by different telematics service providers (TSPs) i.e. Taiwan, the U.S., Europe, and Japan are analyzed and benchmarked to discuss the required utilities/functions and services of the next e-era generation VTS. The aspect of navigation and location services will be divided into three evaluation criteria; voice-guided navigation devices, traffic information and electronic map information to find out the required utilities/functions for the next e-era generation VTS regarding navigation and location services.

2.2.2 Safety and Security Services

The Europe, the United States and other advanced countries, with nationality behaviors, automobile users are concerned about security and safety utilities/functions. The laws of strict/severe rules regarding car safety are also legislated. Accordingly, emergency services, automatic notification, stolen vehicle location assistance, security protection, vehicle diagnosis, and other safety and security related services are developed (Golob and Regan, 2001; Magnusson, et al., 2002). In this paper, four commercial VTS products of different TSPs (i.e. Taiwan, U.S., Europe, and Japan) are analyzed and benchmarked to discuss the required utilities/functions and services for the next e-era generation VTS. The aspect of safety and security services would be divided into five criteria; safety and emergency services, remote central control services, vehicle location services, car security services and vehicle diagnosis and maintenance services to find out the required utilities/functions for the next e-era generation VTS regarding safety and security services.

2.2.3 Communications and Information Services

The core of VTS is communications and information services. The transmission, reception, and communication of information need to be operated via various communications and information technologies, particularly wireless technologies. Accordingly, automobile users can get various kinds of real-time and precise information when they have different needs on moving such as personal e-commerce (Anker and Arnold, 1998; Golob and Regan, 2001). In this paper, four commercial VTS products from different TSPs (Taiwan, the U.S., Europe, and Japan) will be analyzed and benchmarked to discuss the required utilities/functions and services for the next e-era generation VTS. The aspect of

communications and information services is divided into five evaluation criteria: mobile information services, user interfaces, platform integration services, information security protection and information update frequency to find out the required utilities/functions of the next e-era generation VTS regarding communications and information services.

2.2.4 Audio-video and Entertainment Services

Traditional automobile multimedia entertainment was a closed system; people could choose their favorite form of multimedia storage, and its corresponding hardware players, such as cassette tapes, compact discs, DVDs, MP3s, etc. With the advances in development of technologies, the integrated player supporting different audio-video formats has been created. It eases the inconvenience of converting different systems, but it cannot satisfy the needs of fashion, real-time, and preference between people. With the advances in technologies, consumers can search and download video, music, and other multimedia information in real-time via the VTS (Golob and Regan, 2001). In this paper, four commercial VTS products from different TSPs (Taiwan, the U.S., Europe, and Japan) are analyzed and benchmarked to discuss the required utilities/functions and services for the next e-era generation VTS. The aspect of audio-video and entertainment services is divided into four evaluation criteria: real-time multimedia services, vehicle multimedia playing systems, game services, and personal platform services to find out the required utilities/functions for the next e-era generation VTS regarding audio-video and entertainment services. Six aspects based on the above four functions (navigational and location services, safety and security services, communications and information services, audio-video and antertainment services) with the cost consideration (fee rate and payment methods) and the image consideration (product image) use to construct the entire evaluation network of VTS systems.

2.3 The customers' need aspect of service platform of digital music

Some studies deem that the value of mobile service is to provide a seamless service of "anywhere, anytime" which can connect to the best service provider in terms of quality and price, and even let the consumer not feel the existence of the internet service provider. It means that users will evaluate and select the mobile service provider instead of the mobile network operators (Ballon, 2007). But, from the evolution of the industry value chain, the mobile network operators are taking the place of the mobile service providers, because they control the network, service platform construction and the core competence of customer

relationship management (Ballon, 2007). The Technology Adoption Model (TAM) has been applied widely in this study regarding how people become familiar with the new technology. TAM explains how people accept and use new e-era technology from technology evolution's viewpoint. It discovered that the outside variables, such as system design, were related to users' understanding of usefulness and ease of use (Kim, et al., 2007). However, some scholars deemed that TAM can not explain the phenomenon of the M-Internet, such as a user who uses the technology and also consumes the services. They emphasized that people should analyze this from the consumers' viewpoints instead of the technology users' and proposed a value-based adoption model (VAM). Consumer decision-making behavior is widely discussed in economic and marketing fields. It indicates that consumers tend to obtain the most reward from the money they pay for something. The value of products or services is generated from the process of consuming and the feeling of consumers (Kim, et al., 2007). In this study the value-created mechanism of a music website into aspects and criteria is separated (**Table 2**).

2.1 Music search & recommendation service

How can we consider the dimensions/aspects of music search and recommendations for consumers' making-decision? The recommendation provides a personal support function to lower the difficulty of making a purchasing decision; therefore, the recommendation function is more and more important. The recommendation mechanism can effectively help consumers to screen alternatives and increase their satisfaction levels. The decision-making process of on-line shopping will affect the complexity of shopping behavior. Therefore, if there is some recommendation information, it will help the consumer to make decisions by accepting the recommendation (Lee and Kwon; 2008). The most popular supporting search functions of on-line music stores are ranking, album category, and introduction of the album or signer, and real time recommendations. All of these can save time for searching on official websites. If the consumer wants to listen to some music without any idea, he (she) can select their preferred music through a recommendation service or the ranking by members (Peitz and Waelbroeck, 2006a; b). After the analysis of the music search and recommendation functions, value creation functions of the platform contents and service, this study concluded that the four most important criteria include the song recommendation service (SR1), album classification system (SR2), music search service (SR3) and billboard of download (SR4). These criteria can be used to discuss users' demands/needs of using the music search function of the mobile music service. For example, the music recommendation can guide the

customers to select interested music through the articles in a special column. The album classification system can save in searching time. The music search function can provide multiple search methods, such as letters, numbers of words or related keywords, which can help customers to obtain the correct music. The billboard of downloads can let customers understand the current modern trend.

2.2 Quality of platform design & maintenance

Data stream access speed and capability are the key factors for affecting on-line videos, music service and performance. The stability of the internet and the protection of transaction data are also key factors. The multi-media stream service relies on internet technology. The communication protocol, facilities, and workload will affect the process time. A good network quality ensures that the internet or mobile service providers can have a better pricing option (Ballon, 2007; Joo and Sohn, 2008; Seo, et al., 2008). This study analyzes the platform design and maintenance functions of Taiwan's digital music contents service websites, to find out the value of the creation function of the platform design and maintenance. They include system interface design (PM1), frequency of content update (PM3), support of device systems (PM3), system protection (PM4) and system stability (PM5). These five criteria can be used to study users' demands/needs of the platform design and maintenance aspects. The higher frequency of content refreshing can ensure that users feel fresh. The safer the system is, the more it will ensure normal operation. The more the system can support, the more customers can use different systems and devices. A good interface can lower the user barrier. The system stability can increase customer satisfaction.

2.3 Functionality of website platform

Construction of the digital media playing network and the integration of wireless communication technologies are affected by the significant growth of the population who use mobile devices to access the internet. Personal preference and convenience are important topics in providing on-line service to consumers (Negru, et al., 2006). There are two specialties provided by on-line music services: (1) consumers can select the music they like, no need to buy a whole album; (2) consumers can decide the storage method for storing the music file (Sandulli, 2007). In addition, the group of the network or members can exchange the information and satisfy users' demands/needs for human relationships. The real time related news update can allow users to keep using the website (Ozer, 2001; Sandulli, 2007; Wei, 2008). This study analyzes the current website functions, which include the aspects of music stream service (PF1), download service (PF2), digital broadcasting service (PF3),

personalize setup (PF4) and links of entertainment news (PF5).

2.4 Pricing & promotion (PP)

The reason consumers have changed to use P2P music is because of the high price of CDs. Therefore, the reasonable price is the key factor affecting consumers' will to download music (Sandulli, 2007). Digital music has some destroyed innovations, including single song selection, convenience of listening, ease to search, ease to carry, personalization, and, the most important, low price or even free music (Chen, et al.; 2008). The improvement of technology has made the on-line payment system more efficient and safe. Many people believe the standardization will make the on-line payment system even more successful. There are currently three types of on-line payments: bank accounts, telephone bills and credit cards (Lim, 2008). Studies have indicated the factors affected by consumers to use web TV are equipment costs, monthly fees and additional service charges (Shin, 2007). In addition, product mix and discounts also affect the attractiveness to consumers (Yang and Lai, 2006). If the service providers provide diversified payment methods or convenient payment channels, it can keep customers continuously using the service. It analyzes the pricing and promotion that current providers offer to consumers and discovers consumers' demand of the pricing and promotion aspect. In reference to trial and promotion (PP1), a well planned trial and service promotion can attract more customers. In addition, in relation to membership activity & discounts (PP2), a better member discount program and member activities can enhance the loyalty of members. The pricing and service method (PP3) is also important as a variety of pricing and service methods can satisfy customers with different needs.

2.5 Platform image & customer relationships

The brand is helpful in maintaining customer loyalty and the long term operation of a company. Having rich digital contents are positive for shaping the image of the music websites. Good service quality will increase customer satisfaction (Sweeney and Swait, 2008) and make the users willing to recommend the website to other consumers and generate the effect of public praise marketing (Casalo, et al., 2008). The higher the reputation for a website is also helpful for the image and to attract more potential customers (Casalo, et al., 2008; Ozer, 2001; Seo, et al., 2008). This study analyzes the current platform image and customer relationships of the providers to discover how this aspect can create value. In reference to the fame of the platform (IR1), the more famous a platform is, the higher intention customers are willing to try. In reference to the numbers of songs/multimedia (IR2),

the more songs/ multimedia, the higher chance the customers' needs are satisfied. When considering the customer consulting system (IR3), a better customer consulting system can enhance the customers' satisfaction. In analyzing the digital IP protection (IR4), a good digital IP protection can prevent customers from on infringing copyrights.

Table2 The descriptions of aspects/criteria for service platform of digital music

Aspects／Criteria	Descriptions
1. Music search & recommendation (SR)	
(1) Song recommendation service (SR1)	Customers can reduce time on choosing music through the recommendation of experts or music companies.
(2) Album classification system (SR2)	A better album classification system can reduce customers' time on searching for music.
(3) Music search service (SR3)	A better music searching service can help customers to find the music they want.
(4) Billboard of download (SR4)	Billboard information make customers understand more easily the trend of pop music and satisfy their needs to follow it.
2. Platform design & maintenance (PM)	
(5)System interface design (PM1)	A better web interface design can make customers more willing to use it.
(6) Frequency of content update (PM2)	Updating content frequently can make customers always feel novel about the website.
(7) Support of device system (PM3)	The more complete support the website can do to the applications used for broadcasting or storing music, the more satisfaction the customers will have.
(8) System protection (PM4)	A better security mechanism or system can give customers better protection.
(9) System stability (PM5)	A more stable system can give platform users higher satisfaction.
3. Platform Functionality of website (PF)	
(10) Music streaming service (PF1)	Music streaming services permit customers to enjoy music in the internet environment.
(11) Download service (PF2)	Music download services allow the customers to listen to downloaded music on different devices.
(12) Digital broadcasting service (PF3)	Digital broadcasting services can provide customers with various music sources to use or listen to the music.
(13) Personalize setup (PF4)	Personalize setup allows customers to build personalized features based on their personal habits.
(14) Links of entertainment news(PF5)	Links of Entertainment News can make customers easier to access entertainment news and link to related website services.
4.Pricing & Promotion (PP)	
(15) Trial & Promotion (PP1)	A well planned trial and service promotion can attract more customers.
(16) Membership activity & discount (PP2)	A better member discount program and activities can enhance the loyalty of members.
(17) Pricing & service method (PP3)	A variety of pricing and service methods can satisfy customers with different needs.
5.Platform image & customer relation (IR)	
(18) Fame of platform (IR1)	The more famous a platform is, the higher intention customers are willing to try.
(19) Number of song /multimedia (IR2)	The more songs/movies, the higher chance the customers' needs are to satisfy.
(20) Customer consulting system (IR3)	A better customer consulting system can enhance the customers' satisfaction.
(21) Digital IP Protection (IR4)	A good digital IP protection system prevents customers from infringing on copyrights.

Chapter 3

The novel MCDM technique for strategies of evaluation and development

An empirical analysis of strategies of evaluation and development is based on a novel MCDM technique for building the strategies of evaluation and development. This chapter is including five parts: (1) Decision-making trial and evaluation laboratory (DEMATEL); (2) Principal Component Analysis (PCA); (3) Analytic network procedure model (ANP); (4) Technique for Order Preference by Similarity to Ideal Solution (TOPSIS); (5) VlseKriterijumska Optimizacija I Kompromisno Resenje (VIKOR).

3.1 Decision-making trial and evaluation laboratory (DEMATEL)

DEMATEL is used to construct the structure of the network relationships map (NRM) of the shopping platform. When users are making-decisions in using shopping platforms, there are many criteria they may consider. The most common problem they face is that those criteria have impacts on one another. Therefore, before making improvements on criteria, it is necessary to know the basic criteria and then make effective improvements to enhance overall satisfaction. When a decision-maker needs to improve a lot of criteria, the best way to handle this is to determine the criteria which impact others most and improve them. It has been widely adopted for complicated problems. In the early stages, it was used on user interface of monitoring system (Hori and Shimizu, 1999), and failure sorting on system failure analysis (Seyed-Hosseini, et al., 2006). In recent years, DEMATEL has drawn lots of attention on decision and management domains. Some recent studies considered the DEMATEL techniques for solving complex studies, such as developing global managers' competencies (Wu and Lee, 2007), evaluating performance in e-learning programs (Tzeng, et al., 2007), airline safety measurement (Liou, et al., 2007), the innovation policy portfolios for Taiwan's SIP mall industry (Huang, et al., 2007), choice of knowledge management strategy (Wu, 2008), causal analytic method for group decision making (Lin and Wu, 2008); safety management system of airlines (Liou, et al., 2008); selection management systems of SMEs (Tsai and Chou, 2009), value-created system of science (technology) park (Lin and Tzeng; 2009), the expectation model of service quality (Tseng; 2009a), hotel service quality system (Tseng; 2009b), importance-performance analysis model of the computer industry (Hu, et al.; 2009) and identification of a threshold value for the DEMATEL Method (Li and Tzeng; 2009) as shown in Table 3.

Table 3 The development and application of DEMATEL technique

Techniques	Applications
Key factor &NRM approach (DEMATEL)	Monitoring system (Hori and Shimizu, 1999) Failure sorting on system failure analysis (Seyed-Hosseini, et al., 2006) Developing global managers' competencies (Wu and Lee, 2007) Airline safety measurement (Liou, et al., 2007) The innovation policy portfolios for SIP mall industry(Huang, et al., 2007) The expectation model of service quality (Tseng; 2009a) Hotel service quality system (Tseng; 2009b) Value-created system of science (technology) park (Lin and Tzeng; 2009) Identification of a threshold value for the DEMATEL method (Li and Tzeng; 2009)
Improvement approach (DEMATEL/ANP/TOPSIS)	Importance-performance analysis model of the computer industry (Hu, et al.; 2009) Vehicle telematics system based on customers' needs (our research)
Rank approach DEMATEL/ANP/ SAW/VIKOR/Fuzzy integral	Evaluating performance in e-learning programs (Tzeng, et al., 2007) Choice of knowledge management strategy (Wu, 2008) Causal analytic method for group decision making(Lin and Wu, 2008) Safety management system of airlines (Liou, et al., 2008) Selection management systems of SMEs (Tsai and Chou, 2009) Service platform of digital music (our research)

This study divides DEMATEL into five steps: (1) calculate the original average matrix; (2) calculate the direct influence matrix; (3) calculate the indirect influence matrix; (4) calculate the full direct/indirect influence matrix; and (5) analyze the structure of NRM.

Step1: Calculate the original average matrix

Respondents were asked to indicate the influence that they believe each aspect experts on each of the others, according to scoring scales ranging from 0 to 4. "0" means no influence and "4" means "extremely strong influence, between aspect/criterion; "1", "2", and "3" mean "low influence", "medium influence" and "high influence" respectively.

Step 2: Calculate direct influence matrix

We processed the "original influence matrix $\boldsymbol{A}$" by using Equations (1) and (2) and got the "direct influence matrix $\boldsymbol{X}$".

$$\boldsymbol{X} = s\boldsymbol{A}, \quad s > 0 \tag{1}$$

where

$$s = \min_{i,j}\left[1/\max_{1\le i\le n}\sum_{j=1}^{n} a_{ij}, 1/\max_{1\le j\le n}\sum_{i=1}^{n} a_{ij}\right], \quad i, j = 1, 2, ..., n \tag{2}$$

and $\lim_{m\to\infty} \boldsymbol{X}^m = [0]_{n\times n}$, where $\boldsymbol{X} = [x_{ij}]_{n\times n}$, when $0 < \sum_{j=1}^{n} x_{ij} \le 1$ or $0 < \sum_{i=1}^{n} x_{ij} \le 1$, and at least one $\sum_{j=1}^{n} x_{ij}$ or $\sum_{i=1}^{n} x_{ij}$ equal one, but not all. We can guarantee $\lim_{m\to\infty} \boldsymbol{X}^m = [0]_{n\times n}$.

Step 3: Calculate Indirect Influence Matrix

The indirect influence matrix can be derived from Equation 3.

$$\boldsymbol{IT} = \sum_{i=2}^{\infty} \boldsymbol{X}^i = \boldsymbol{X}^2(\boldsymbol{I} - \boldsymbol{X})^{-1} \tag{3}$$

[Proof]

$$\boldsymbol{IT} = \sum_{i=2}^{\infty} \boldsymbol{X}^i = \boldsymbol{X}^2 + \boldsymbol{X}^3 + \ldots + \boldsymbol{X}^m = \boldsymbol{X}^2(I + \boldsymbol{X} + \boldsymbol{X}^2 + \ldots + \boldsymbol{X}^{m-2})(I - \boldsymbol{X})(I - \boldsymbol{X})^{-1}$$

$$= \boldsymbol{X}^2(I - \boldsymbol{X}^{m-1})(I - \boldsymbol{X})^{-1}$$

$$= \boldsymbol{X}^2(I - \boldsymbol{X})^{-1}, \quad \textbf{when } \lim_{m\to\infty} \boldsymbol{X}^{m-1} = [0]_{n\times n}$$

Step 4: Calculate full influence matrix

Full influence matrix $\boldsymbol{T}$ can be derived from Equations (4) or (5). The full influence matrix $\boldsymbol{T}$, consists of multiple elements, indicated as Equation (6). The sum vector of the row value is $\{d_i\}$, and the sum vector of the column value $\{r_j\}$; then, let $i = j$, the sum vector of row value plus column value is $\{d_i + r_i\}$, which means the full influence of the matrix $\boldsymbol{T}$. As the sum of the row value plus the column value $\{d_i + r_i\}$ is higher, the relationship of the dimension or criterion is stronger. The sum of the row value minus the column value is $\{d_i - r_i\}$, which means the net influence relationship. If $d_i - r_i > 0$, it means the degree of influencing others is stronger than the degree to be influenced; otherwise, $d_i - r_i < 0$.

$$\boldsymbol{T} = \boldsymbol{X} + \boldsymbol{IT} = \sum_{i=1}^{\infty} \boldsymbol{D}^i \tag{4}$$

$$\boldsymbol{T} = \sum_{i=1}^{\infty} \boldsymbol{D}^i = \boldsymbol{D}(\boldsymbol{I} - \boldsymbol{D})^{-1} \tag{5}$$

$$\boldsymbol{T} = [t_{ij}], \quad i, j \in \{1, 2, \ldots, n\} \tag{6}$$

$$\boldsymbol{d} = \boldsymbol{d}_{n\times 1} = [\sum_{j=1}^{n} t_{ij}]_{n\times 1} = (d_1, \ldots, d_i, \ldots, d_n) \tag{7}$$

$$\boldsymbol{r} = \boldsymbol{r}_{n\times 1} = [\sum_{i=1}^{n} t_{ij}]'_{1\times n} = (r_1, \ldots, r_j, \ldots, r_n) \tag{8}$$

[Proof]

$$\boldsymbol{T} = \boldsymbol{X} + \boldsymbol{IT} = \boldsymbol{X} + \boldsymbol{X}^2 + \ldots + \boldsymbol{X}^m = \boldsymbol{X}(I + \boldsymbol{X} + \boldsymbol{X}^2 + \ldots + \boldsymbol{X}^{m-1})(I - \boldsymbol{X})(I - \boldsymbol{X})^{-1}$$

$$= \boldsymbol{X}(I - \boldsymbol{X}^m)(I - \boldsymbol{X})^{-1} = \boldsymbol{X}(I - \boldsymbol{X})^{-1}, \qquad \textbf{when } \lim_{m\to\infty} \boldsymbol{X}^m = [0]_{n\times n}$$

Step 5: Analyze the structural relationship map.

According to the aspects/criteria defined in Table 1, some experts were invited to discuss the relationships and influence levels of criteria under the same aspects/ criteria and to score the relationship and influence among criteria based on the DEMATEL technique. Aspects/criteria are divided into different types, so the experts could answer the questionnaire in areas/fields with which they were familiar. The net full influence matrix, T_{net} , is determined by the Equation (9) .

$$\boldsymbol{T_{net}} = [t_{ij} - t_{ji}], \qquad i, j \in \{1, 2, ..., n\} \tag{9}$$

The diagonal items of the matrix are all 0. In other words, the matrix contains a strictly upper triangular matrix and a strictly lower triangular matrix. Moreover, while values of strictly upper triangular matrix and strictly lower triangular matrix are same, their symbols are opposite. This property helps us that we only have to choose one of strictly triangular matrix.

3.2 Principal Component Analysis (PCA)

This study uses PCA to analyze the original data of importance degree. It can be used to simplify the large number of criteria and it also can satisfy the hypothesis of AHP/ANP on the independence/dependence of criteria included in system aspect. However, the founder of ANP, Professor Saaty, didn't explicitly define it (Niemira and Saaty, 2004). From the paper analysis of AHP/ANP, it can be figured out that the hypothesis is that criteria in aspects are independent/dependent. That's why we use this technique in this study. We can see that there are two components that can be extracted: PM (Platform design & maintenance) and the square sum (88.092%), and then named the major elements, as shown in **Table 4**. Support of device system (PM3), frequencies of content update (PM2), and system protection (PM1) can be integrated into the first major component PMP1 (Platform design & maintenance). System stability (PM5) and system protection (PM4) can be integrated into the second component PMP2 (System stability & security).

Table 4 the PCA analysis of the platform design & maintenance aspect

			Components		
Aspect	Components	Criteria	1	2	Community
Platform design & maintenance (PM)	Platform design & maintenance (PMP1)	2.3 Support of Device System	**0.940**	0.165	0.911
		2.1 System interface design	**0.878**	0.228	0.823
		2.2 Frequency of Content Update	**0.843**	0.329	0.818
	System stability & security (PMP2)	2.5 System Stability	0.160	**0.953**	0.935
		2.4 System Protection	0.348	**0.892**	0.917
		Eigen-value λ	2.512	1.892	-
		% of Variance (contribution)	50.242	37.850	-
		Cumulative contribution (%)	50.242	88.092	-

3.3 Analytic network procedure model (ANP)

Saaty (1996) proposed the concepts of ANP in 1996, to solve the issue that the AHP method is too ideal to correctly evaluate the problems. The ANP method can cope with the dependence and feedback relationships in the problems. The evaluation is, thus, closer to the actual adoption. The following three steps are undertaken to evaluate the decision problems with the ANP method (Niemira and Saaty, 2004; Saaty, 2006; Shyur, 2006; Shyur and Shih, 2006): (1) build the network hierarchical structure, (2) calculate the weighing of factors in each hierarchy, and (3) calculate the weighting of the whole hierarchy structure. In this study, the ANP steps are introduced as follows: (1) clarify the problems and build the structure based on NRM , (2) design the questionnaire and survey, (3) build the weightings of pair-wise comparisons, calculate the weightings of factors, and test the consistency, (4) calculate the super-matrix (Shyur, 2006; Shyur and Shih, 2006).

3.4 Technique for order preference by similarity to an ideal solution (TOPSIS)

The TOPSIS (Technique for order preference by similarity to an ideal solution) method is presented in(Abo-Sinna and Abou-El-Enien, 2006; Abo-Sinna and Amer, 2005; Chen and Tzeng, 2004; Deng, et al., 2000; Jahanshahloo, et al., 2006a; b; Olson, 2004; Shyur, 2006; Shyur and Shih, 2006; Tzeng, et al., 2005; Wang and Chang, 2007; Wang and Lee, 2007; Yurdakul and Ic, 2005). The basic principle is that the chosen alternative should have the shortest distance from the ideal solution and the farthest distance from the negative-ideal solution as shown in **Fig. 2**.

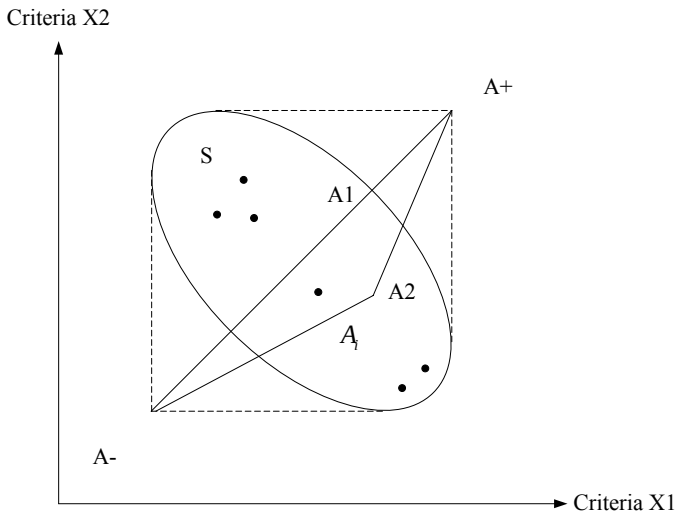

Fig. 2. The positive ideal and negative-ideal solution relationship

In this paper, four commercial VTS products of different TSPs (i.e. Taiwan, U.S., Europe, and Japan) are analyzed and benchmarked to discuss the required utilities and services of the next e-era generation VTS. The results using the TOPSIS method could determine which one is the most appropriate for consumers. The TOPSIS procedure consists of the following steps: (1) calculating the normalized decision matrix (**Table 5~Table 7**), (2) calculating the weighted normalized decision matrix (**Table 8**), (3) determining the positive ideal and negative ideal solution, (4) calculating the distance of the utility value of each criterion between the positive and negative ideal solution, (5) calculating the relative closeness to the ideal solution, and (6) improving the gaps in criteria.

(1) Calculating the normalized decision matrix

The normalized value r_{kj} is calculated as Equation (10), as shown in **Table 5**.

$$r_{kj} = \frac{e_{kj-}e_{j,\min}}{e_{j,\max-}e_{j,\min}} \quad \text{or} \quad \frac{e_{kj-}e_{j,aspireL}}{e_{j,aspireH-}e_{j,aspireL}}, j = 1,2,...,n \tag{10}$$

In this research, let $e_{j,max} = e_{j,aspireH} = 10$ and $e_{j,min=}e_{j,aspireL} = 0$

Table 5 VTS value-created evaluation (Navigation & location services)

Criterion	Items	Service Items	T VTS			U VTS			E VTS			J VTS		
			OV	BV	AVE	OV	BV	AVE	OV	BV	AVE	OV	BV	AVE
Voice-Guided Navigation Services(N_1)	Short Route	Short-cut	7.28	8.10	7.77	0.00	8.10	7.03	0.00	8.10	7.03	7.28	8.10	7.03
		Best Route	8.10			8.10			8.10			8.10		
		Alternative Route	7.02			0.00			0.00			7.02		
		Turning Navigation	5.30	7.43		5.30	5.96		5.30	5.96		5.30	5.96	
	On-driving	Route Navigation	5.96			5.96			5.96			5.96		
		Route Speed-limit	7.02			0.00			0.00			0.00		
		Speed Limit Alarm	7.43			0.00			0.00			0.00		

Note: OV and BV mean original value & the best value, AVE means average of service items

Table 6 Original value of VTS service (N)

e_{kj}	C_j	Preference	VTS A_k				$e_{j,aspireH}$	$e_{j,aspireL}$
			T	U	E	J		
Navigation & location services (N)	N1	MAX	7.77	7.03	7.03	7.03	10	0
	N2	MAX	4.57	2.84	2.84	2.84	10	0
	N3	MAX	6.89	6.85	6.86	6.97	10	0

Note: Navigation & Location Services (N) includes 3 criteria composed of N1 (Voice-guided Navigation Services), N2 (Traffic Information), N3 (Electronic Map Information). The same definition is adopted in Table 18 and Table 19.

Table 7 The normalized value of VTS

r_{kj}	C_j	VTS A_k			
		T	U	E	J
Navigation & location services (N)	N1	0.78	0.70	0.70	0.70
	N2	0.46	0.28	0.28	0.28
	N3	0.69	0.69	0.69	0.70

(2) Calculating the weighted normalized decision matrix

The weighted normalized value v_{kj} is calculated as Equation (11)

$$v_{kj} = w_j \times r_{kj} \tag{11}$$

where w_j is the weight of the *j*th attribute or criterion

Table 8 The weighted normalized value of VTS (Navigation & Location)

v_{kj}		w_j	k			
			T	U	E	J
Navigation & location services (N)	N1	0.060	0.047	0.042	0.042	0.042
	N2	0.064	0.029	0.018	0.018	0.018
	N3	0.081	0.056	0.055	0.055	0.056

(3) Determining the positive ideal and negative ideal solution

The ideal solution (A^+) and negative-ideal solution (A^-) is calculated as Equations (12) & (13)

$$A^+ = \left\{\left(\max_k v_{kj} \mid j \in I\right), \left(\min_k v_{kj} \mid j \in I'\right), k = 1,2,...,m\right\} = \left\{v_1^+, v_2^+, ..., v_j^+, ..., v_n^+\right\} \tag{12}$$

$$A^- = \left\{\left(\min_k v_{kj} \mid j \in I\right), \left(\max_k v_{kj} \mid j \in I'\right), k = 1,2,...,m\right\} = \left\{v_1^-, v_2^-, ..., v_j^-, ..., v_n^-\right\} \tag{13}$$

where I is associated with benefit criteria, and I' is associated with cost criteria.

(4) Calculating the distance of the utility value of each criterion between the positive and negative ideal solution.

The separation of each alternative from the ideal solution is given as Equation (14),

$$d_k^+ = \sqrt{\sum_{j=1}^{n} (v_{kj} - v_j^+)^2}, \quad k = 1,2,...,m \tag{14}$$

Similarly, the separation from the negative ideal solution is given as Equation (15)

$$d_k^- = \sqrt{\sum_{j=1}^{n} (v_{kj} - v_j^-)^2}, \quad k = 1,2,...,m \tag{15}$$

(5) Calculating the relative closeness to the ideal solution

The relative closeness of the alternative A_j with respect to *A** is defined as Equation (16)

$$C_k^* = \frac{d_k^-}{d_k^+ + d_k^-} = 1 - \frac{d_k^+}{d_k^+ + d_k^-}, \quad k = 1,2,...,m \tag{16}$$

where $\frac{d_k^+}{d_k^+ + d_k^-}$ denotes the gap that should be improved in alternative *k*. Then we will improve this gap according to the NRM among criteria.

(6) Improving the gaps in criteria

The largest value of $e_{j,aspireL}$ is the best solution theoretically. If there have been gaps

between e_{kj} and the best solution $e_{j,aspireL}$ in all criteria j, there is still much levels for improving the performance of existing solutions to attain the aspired/desired level in consumers' minds.

3.5 VIKOR (Vlse Kriterijumska Optimizacija I Kompromisno Resenje)

After establishing the evaluation model, including criteria and given weights in each criterion, the next step is to evaluate and improve the performance of benchmarked alternatives. The more utilities/functions of the service platform of digital music, the more expensive the service platform of digital music is. Thus, among the evaluation model of service platform for digital music, the functional criteria are mutually conflicted with the cost criteria. The VIKOR method is used to evaluate, improve and rank the performance of benchmarked alternatives. The VIKOR method is a multi-criteria decision making (MCDM) method, and applies to solve a discrete decision problem with non-commensurable and conflicting criteria (Büyüközkan and Ruan, 2008; Chen and Wang; 2009; Chu, et al., 2007; Opricovic and Tzeng, 2004; 2007; Sayadi, et al., 2009; Tzeng, et al., 2005; Wu, et al.; 2009). This method focuses on ranking, improving and selecting the best alternative from a set of alternatives, and determines the compromise solution for a problem with conflicting criteria, which can help the decision-makers to reach a final best decision. Here, the compromise solution is a feasible solution closest to the ideal (or closest to the aspired/desired levels in each criterion) one, and a compromise means an agreement established by mutual concessions. Thus, the VIKOR method would be applied to rank, evaluate and improve the performance of proposed the best service platforms of digital music.

The basic concept of VIKOR is to identify the positive-ideal solution (the aspired/desired level) and the negative-ideal solution (the worst level). The positive solution is the best solution that satisfies the most required criteria, and the opposite is the negative-ideal solution. The VIKOR method could rank, improve and determine the difference of negative and positive ideal solutions between services/utilities of the existing service platforms of digital music. When calculating the distance between the ideal solution and the proposed service platforms of digital music, the scores of each criterion should be summarized. The gaps between the consumers' most satisfied one and most unsatisfied one is also analyzed, with respect to services/utilities of the existing service platforms of digital music. The VIKOR method was started with the form of the $L_p - metric$, which was used as an aggregating function in a compromise programming method and it developed the

multi-criteria measure for compromise ranking (Yu, 1973; Zeleny, 1982). VIKOR provided a maximum group utility of the "majority" and a minimum individual regret of the "opponent". The compromise solutions could be the base for negotiation, involving the decision makers' preferences by criteria weights **(Fig. 3)**.

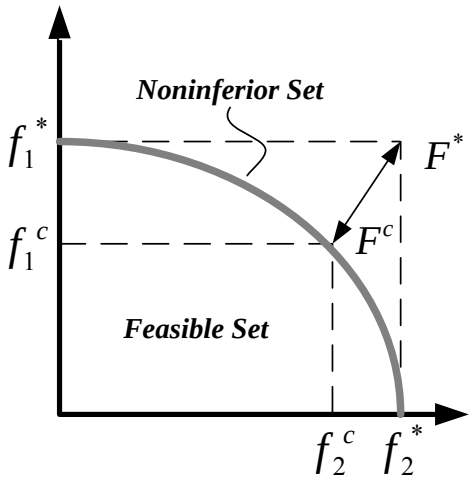

Fig. 3 Ideal and compromise solutions

where: f^* is the ideal solution. f_1^* represents the ideal value (the aspired/desired level) of criterion 1. f_2^* represents the ideal value (the aspired/desired level) of criterion 2. The compromise solution, F^c, is a feasible solution that is "closest" to the ideal F^*. A compromise means an agreement established by mutual concessions. The VIKOR method is presented with the following steps:

Step 1: Determine the best f_i^* value and the worst f_i^- value in criterion i.

$$f_i^* = \left\{ \left(\max_k f_{ik} \mid k \in I_1 \right), \left(\min_k f_{ik} \mid k \in I_2 \right); \text{or setting the aspired level for } i \text{ criterion} \right\}, \forall k \qquad (17)$$

$$f_i^- = \left\{ \left(\min_k f_{ik} \mid k \in I_1 \right), \left(\max_k f_{ik} \mid k \in I_2 \right); \text{or setting the aspired level for } i \text{ criterion} \right\}, \forall k \qquad (18)$$

where: k is the kth alternative; i is the criterion; f_{ik} is the performance value of the ith criterion of kth alternative; I_1 is the cluster of utility-oriented criteria; I_2 is the cluster of cost-oriented criteria; f_i^* is the positive-ideal solution (or setting the aspired level); and f_i^- is the positive-ideal solution (or setting the worst level).

Step 2 Compute the values S_k and Q_k, $k = 1, 2, \cdots, m$, using the relations

Let r_{ik} be $r_{ik} = (| f_i^* - f_{ik} |) / (| f_i^* - f_i^- |)$. Before we formally introduce the basic

concept of the solutions, let us define a class of distance functions by Yu (1973).

$$d_k^p = \left\{ \sum_{i=1}^{n} [w_i(|f_i^* - f_{ik}|)/(|f_i^* - f_i^-|)]^p \right\}^{1/p} = \left\{ \sum_{i=1}^{n} [w_i r_{ik}]^p \right\}^{1/p}, \quad p \geq 1 \tag{19}$$

$$S_k = d_k^{p=1} = \sum_{i=1}^{n} w_i r_{ik}, \tag{20}$$

$$Q_k = d_k^{p=\infty} = \max_k \{r_{ik} \mid i = 1, 2, ..., m\}, \tag{21}$$

where S_k shows the **average gap for achieving the aspired/desired level**; Q_k shows the **maximal degree of regret for prior improvement of gap criterion**. w_i is the weight of the criterion i and $i = 1, 2, ..., n$, expressing the relative importance value of the criteria gained via the application of the ANP method, based on NRM.

Step 3 Compute the index values R_k, $k = 1, 2, \cdots, m$, using the relation

$$R_k = v(S_k - S^*)/(S^- - S^*) + (1-v)(Q_k - Q^*)/(Q^- - Q^*) \tag{22}$$

$S^* = \min_k S_k$ or setting $S^* = 0$, $S^- = \max_k S_k$ or setting $S^- = 1$

$Q^* = \min_k Q_k$ or setting $Q^* = 0$, $Q^- = \max_k Q_k$ or setting $Q^- = 1$

where $S^* = \min_k S_k$ (showing the minimal gap is the best), $S^- = \max_k S_k$; $Q^* = \min_k Q_k$ (showing the minimal degree of regret is the best), $Q^- = \max_k Q_k$.

If we set S: $S^* = 0$ and $S^- = 1$; Q: $Q^* = 0$ and $Q^- = 1$, we also can re-write

$R_k = vS_k + (1-v)Q_k$

Step 4 Rank the alternatives

In addition, $0 \leq v \leq 1$; when $v > 0.5$, this indicates S is emphasized more than Q in Eq. (12), whereas when $v < 0.5$ this indicates Q is emphasized more than S in Eq. (12). More specifically, when $v = 1$, it represents a decision-making process that could use the strategy of maximum group utility; whereas when $v = 0$, it represents a decision-making process that could use the strategy of minimum individual regret, which is obtained among maximum individual regrets/gaps of lower level dimensions of each project (or aspects/objectives). The weight (v) would affect the ranking order of the dimensions/aspects/criteria and it is usually determined by the experts or decision making.

In this paper, R_k (here, v =0.5) is applied to determine the customers' satisfaction index

(CSI). R_k could also consider the index of the maximum group utility and the minimum individual regret of the "opponent", where R_k smaller is better and $0 \le R_k \le 1$.

Chapter 4
Empirical analyses on strategies of evaluation and development for technology industry

In this chapter three empirical cases are illustrated to demonstrate the proposed novel MCDM techniques on strategies of evaluation and development for technology industry. The contents are divided into 3 Sections. Section 4.1 deals with the value-created system of science (technology) park based on DEMATEL. Section 4.2 uses hybrid MCDM technique (DEMATEL, ANP and TOPSIS) for analyzing the gap improvement study of vehicle telematics systems. Section 4.3 uses the novel MCDM method (DEMATEL, PCA, ANP and VIKOR) for the service selection study of service platform on digital music.

4.1 The empirical case of value-created system for science (technology) park

In this Section, two empirical cases of real clustered parks will be proposed to analyze the value-created system of different industrial clusters. The contents are divided into 3 subsections. Subsection 4.1.1 deals with the history of development and progress of science(technology) parks. Subsection 4.1.2 describes results of the questionnaires and the analysis of the degree of satisfaction and importance regarding the 2 empirical cases. Subsection 4.1.3 shows the comparative analysis of the 2 empirical cases and discusses the 4 aspects of the science park.

4.1.1 Background descriptions

In this section, two empirical cases of real clustered parks will be proposed to analyze the value-created system of different industrial clusters. The Hsinchu science park (abbreviated HSP) in Taiwan (**Fig. 4**) is an important industrial cluster of production and manufacturing, while the Neihu technology park (abbreviated NTP) is an important industrial cluster of R&D and Marketing. We review the forming process of HSP, which is near universities, National Chiao Tung University (abbreviated NCTU), National Tsing Hua University (abbreviated NTHU) and R&D institution Industrial Technology Research Institute (abbreviated ITRI). Therefore, these institutions provide many high quality human resources of technology and management, and create many famous international enterprises by technology transferring, spin-offs or spin-ins. Meanwhile, the government encourages

NTBF's R&D and production activities by constructing essential infrastructure and giving preferential tax rebates. Since NTBFs have gotten the support of human resources, technology resources, and investment, they can compete with other international enterprises in the worldwide markets. These NTBFs who invest their profits in R&D and production, not only expand the scale economics of science parks which is expensive, but also attracts an international enterprises' view on the successful operation model of HSP.

The Neihu Technology park was originally the "Taipei Neihu industry park" in June.1991., while some companies of the information and software service industry, the electric component industry, and the telecommunications industry we built their headquarters and/or R&D centers there. It renamed "Taipei Neihu Technology park" in December,1991. NTP was built and invested in by private funds. Through reviewing the establishment, the key success attributes are as follows: In the initiation, many ICT companies established their headquarters and/or R&D centers in NTP. It also attracted others to do the equivalent actions for lower land cost or cheaper rental in NTP than in downtown Taipei. As more and more native or international enterprises clustered at NTP, the benefit of economies of scale appeared. NTP has gradually become the largest R&D and Marketing cluster park in Taiwan because of its excellent investment environment and closed network relationship (**Fig. 4**).

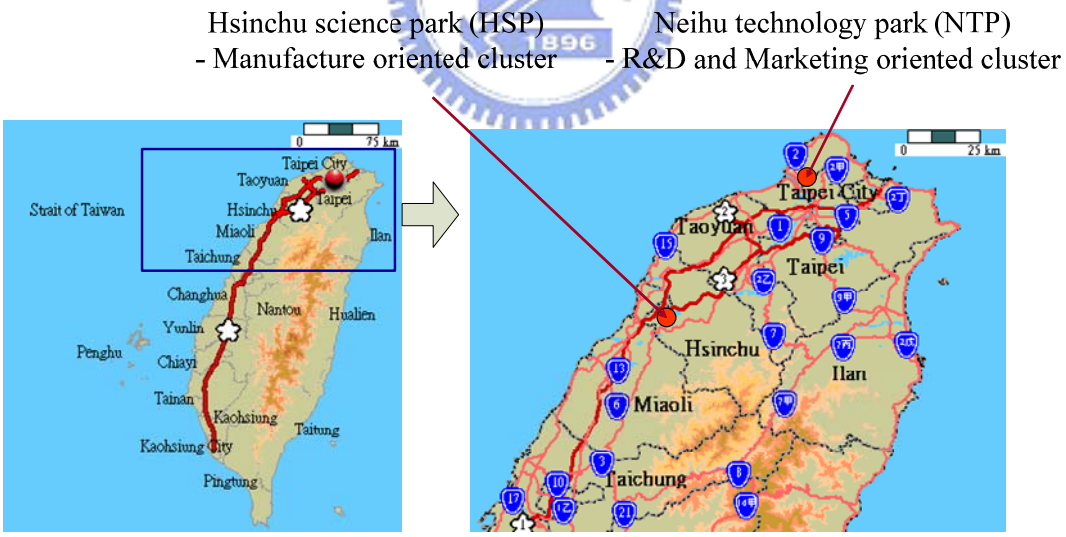

Fig. 4 Locations of HSP and NTP in Taiwan

4.1.2 The compared analysis of satisfaction and importance degree of criteria

We integrate some research and discuss these aspect/criteria with some experienced managers, senior engineers, and marketing staffs of HSP/NTP, then get our questionnaires respondents by interview questionnaires during 2007. The questionnaires respondents are

experienced managers, senior engineers, and marketing staffs of HSP, and the staffs of ITRI. There were 23 questionnaires received. Among them, 69.57% worked at the administrative level, such as company's managers or ITRI's directors, and 30.43% worked at the non-administrative level, such as company's engineers and staffers under the position consideration (**Table 9**). Under the industrial classification consideration, 4.35% were in the PC/ peripherals industry, 17.39% were in IC design industry, 4.35% were in the telecommunications industry, 8.70% were in the optoelectronics industry, 56.52% were in the integrated circuits industry, 8.70% were in the incubation and R&D service of ITRI (**Table 10**).

Table 9 The data description of HSP (by position)

Positions	Number	Rate (%)
1. Executive (company's manager and ITRI director)	16	69.57
2. Not executive (company's engineer and staff)	7	30.43
Total	23	100

Table 10 The data description of HSP (by industrial classification**)**

Classifications	Number	Rate (%)
1. PC/ Peripherals	1	4.35
2. IC design	4	17.39
3. Telecommunication	1	4.35
4. Optoelectronics	2	8.70
5. Integrated circuits	13	56.52
6. Incubation and R&D service (ITRI)	2	8.70
Total	23	100

There were 11 usable questionnaires. As show in **Table 11**, 36.36% were at the administrative level, such as company's managers and 63.64% were at the non-administrative level, such as company engineer and staffers, under the position consideration. As shows in **Table 12**, 9.09% worked in the PC/ peripherals industry, 45.45% worked in the telecommunication industry, 36.36% worked in the information & software service industry, 9.09% worked in the precision machinery industry under the industrial classification consideration.

Table 11 The data description of NTP (by position)

Appointments	Number	Rate (%)
1. Executive t (company's manager and ITRI director)	4	36.36
2. Not executive (company's engineer and staff)	7	63.64
Total	11	100.00

Table 12 The data description of NTP (by industrial classification)

Industries	Number	Rate (%)
1. PC/ Peripherals	1	9.09
2. Telecommunication	5	45.45
3. Information & software service	4	36.36
4. Precision machinery	1	9.09
Total	11	100.00

The analysis of satisfaction degree of the criteria is as follows (**Table 13** and **Table 14**). In HSP, the mean of satisfaction is 6.56 (the ceiling point=10), the maximum point is 7.43 (TR2) which is the most satisfied criterion, the minimum point is 5.57 (MD8) which is the most unsatisfied criterion, and the standard deviation is 0.45. In NTP, the mean of satisfaction 6.53 (the ceiling point=10), the maximum point is 7.18 (IE4) which is the most satisfied criterion, the minimum point is 5.55 (HR2) which is the most unsatisfied criterion, the standard deviation is 0.41. IE4 (Informational infrastructure) is the highest score (7.18) or most satisfied criterion of NTP, and HR2 (Human brain training organizations) is the lowest score (5.55) or least most satisfied criterion of NTP.

In the part of the importance degree of criteria, the average score of the importance degree of criterion is 7.46 (the perfect point =10) of HSP. The highest point is 8.64, the lowest point is 6.55, and the standard deviation is 0.51. HR1 (Supply of qualified personnel) is the highest score (8.64) or most important criterion of HSP, and IE9 (Living requirements) is the lowest score (6.55) or least most important criterion of HSP. The average score of the importance degree of criterion is 8.13 (the perfect score =10) of Neihu Technology park (NTP), the highest score is 9.09, the lowest score is 7.00, and the standard deviation is 0.49. IE3 (Incentive for investment) is the highest score (9.09) or most important criterion and TR2 (Cooperation between industries and academics) is the lowest score 7.00 or least most important criterion of NTP (**Table 13** and **Table 14**).

Table 13 Satisfaction and importance degree of value created system (HSP)

Aspects	Criteria	MS	SS	MI	SI	(SS.SI)
Human Resources	HR1.Supply of qualified personnel	7.17	1.37	**8.64**	2.29	○(+,+)
	HR2.Human brain training organizations	6.70	0.31	7.55	0.16	○(+,+)
	HR3.Quality of R&D engineers	6.70	0.31	8.36	1.75	○(+,+)
	HR4.New job creation	6.74	0.41	7.09	-0.73	○(+,+)
	HR5.Incubator resources	6.26	-0.65	6.73	-1.44	▲(-,-)
Technology Resource	TR1.Quality of research institution	6.57	0.02	8.18	1.40	○(+,+)
	TR2.Cooperation between industries and academics	**7.43**	1.95	8.00	1.04	○(+,+)
	TR3.Dispersion of industry information	6.91	0.79	7.55	0.16	○(+,+)
	TR4.Quality of enterprises	6.83	0.60	7.55	0.16	○(+,+)
	TR5.Occasion for enterprises cooperating	6.87	0.69	7.91	0.87	○(+,+)
Investment Environment	IE1.Scale of industries	7.04	1.08	7.82	0.69	○(+,+)
	IE2.Territory of science park	6.30	-0.56	7.09	-0.73	▲(-,-)
	IE3.Incentive for investment	6.39	-0.36	7.73	0.51	X (-, +)
	IE4.Informational infrastructure	6.39	-0.36	7.36	-0.20	▲(-,-)
	IE5.Legislation and government policy	6.13	-0.94	7.91	0.87	X (-, +)
	IE6.Operating cost	6.22	-0.75	7.91	0.87	X (-, +)
	IE7.Regional traffic network	5.65	-2.00	7.27	-0.37	▲(-,-)
	IE8.Regional development outlook	6.17	-0.85	7.09	-0.73	▲(-,-)
	IE9.Living requirements	6.00	-1.23	**6.55**	-1.79	▲(-,-)
	IE10.Regional infrastructure	5.91	-1.42	7.36	-0.20	▲(-,-)
Market Development	MD1. Economies of scale	7.04	1.08	7.36	-0.20	●(+,-)
	MD2.Supply networks	6.74	0.41	7.00	-0.91	●(+,-)
	MD3.Competition status	6.83	0.60	7.27	-0.37	●(+,-)

	MD4.Reputation	6.52	-0.08	7.00	-0.91	▲(-,-)
	MD5.Completion of supply chain	7.17	1.37	7.82	0.69	○(+,+)
	MD6.Bargaining power	6.52	-0.08	7.45	-0.02	▲(-,-)
	MD7.Quality of outsourcing providers	6.78	0.50	6.82	-1.26	●(+,-)
	MD8.Scale of region market	**5.57**	-2.19	6.64	-1.61	▲(-,-)
	Average	6.56	0.00	7.46	0.00	
	Maximum	7.43	1.95	8.64	2.29	
	Minimum	5.57	-2.19	6.55	-1.79	
	Standard deviation	0.45	1.00	0.51	1.00	

Note1: ○(+,+) is the criteria of high satisfied degree and high importance degree, ●(+,-) is criteria of high satisfied degree but low importance degree, ▲(-,-) is criteria of low satisfied degree and low importance degree, X (-, +) is criteria of low satisfied degree but high importance degree.

Note2: Note2: MS, SS,MI,SI which separately means satisfied value, standardized satisfied value, important value, standardized satisfied value.

Table 14 Satisfaction and importance degree of value created system (NTP)

Aspects	Criteria	MS	SS	MI	SI	(SS.SI)
Human Resources	HR1.Supply of qualified personnel	6.55	0.04	8.09	-0.09	●(+,-)
	HR2.Human brain training organizations	**5.55**	-2.40	7.27	-1.76	▲(-,-)
	HR3.Quality of R&D engineers	6.09	-1.07	7.91	-0.46	▲(-,-)
	HR4.New job creation	6.91	0.93	7.91	-0.46	●(+,-)
	HR5.Incubator resources	6.55	0.04	7.64	-1.01	●(+,-)
Technology Resource	TR1.Quality of research institution	5.73	-1.95	7.45	-1.39	▲(-,-)
	TR2.Coopertion between industries and academics	5.73	-1.95	**7.00**	-2.31	▲(-,-)
	TR3.Dispersion of industry information	6.18	-0.85	8.00	-0.27	▲(-,-)
	TR4.Quality of enterprises	6.36	-0.40	8.18	0.10	X (-, +)
	TR5.Occasion for enterprises cooperating	6.91	0.93	8.45	0.66	○(+,+)
Investment Environment	IE1.Scale of industries	6.73	0.48	8.36	0.47	○(+,+)
	IE2.Territory of science park	6.09	-1.07	8.82	1.40	X (-, +)
	IE3.Incentive for investment	6.82	0.70	**9.09**	1.96	○(+,+)
	IE4.Informational infrastructure	**7.18**	1.59	8.91	1.58	○(+,+)
	IE5.Legislation and government policy	6.55	0.04	8.73	1.21	○(+,+)
	IE6.Operating cost	6.55	0.04	8.27	0.29	○(+,+)
	IE7.Regional traffic network	6.27	-0.63	8.55	0.84	X (-, +)
	IE8.Regional development outlook	6.45	-0.18	8.45	0.66	X (-, +)
	IE9.Living requirements	6.55	0.04	8.18	0.10	○(+,+
	IE10.Regional infrastructure	6.91	0.93	8.55	0.84	○(+,+
Market Development	MD1. Economies of scale	6.82	0.70	8.09	-0.09	●(+,-)
	MD2.Supply networks	6.55	0.04	7.91	-0.46	●(+,-)
	MD3.Competition status	6.36	-0.40	7.64	-1.01	▲(-,-)
	MD4.Reputation	7.00	1.15	7.91	-0.46	●(+,-)
	MD5.Completion of supply chain	6.73	0.48	7.64	-1.01	●(+,-)
	MD6.Bargaining power	6.73	0.48	7.82	-0.64	●(+,-)
	MD7.Quality of outsourcing providers	7.09	1.37	8.45	0.66	○(+,+)
	MD8. Scale of region market	6.91	0.93	8.45	0.66	○(+,+)
	Average	**6.53**	0.00	**8.13**	0.00	
	Maximum	**7.18**	1.59	**9.09**	1.96	
	Minimum	**5.55**	-2.40	**7.00**	-2.31	
	Standard deviation	**0.41**	1.00	**0.49**	1.00	

Note1: ○(+,+) is the criteria of high satisfied degree and high importance degree, ●(+,-) is criteria of high satisfied degree but low importance degree,□ (-,-) is criteria of low satisfied degree and low importance degree, X (-, +) is criteria of low satisfied degree but high importance degree.

Note2: Note2: MS, SS,MI,SI which separately means satisfied value, standardized satisfied value, important value, standardized satisfied value.

Thus, we concluded that the authorities of HSP should focus on improving IE3 (Incentive for investment), IE5 (Legislation and government policy), IE6 (Operating cost).

Under those three criteria, the importance degree is higher than the average value, but satisfaction degree is lower than the average value (**Fig. 5**). However, authorities of NTP should focus on improving TR4 (Quality of enterprises), IE2 (Territory of science park), IE7 (Regional traffic network), IE8 (Regional development outlook). Under the four criteria, the importance degree is higher than the average value, but the satisfaction degree is lower than the average value (**Fig. 5**).

This research analyzes the criteria of the value created system, and suggests and plan of improvement. In Hsinchu science park (HSP), authorities should pay attention to IE5 (Legislation and government policy), IE6 (Operating costs) and IE3 (Incentives for investment), because the three criteria were more important than the average value, but satisfied the criteria a degree lower than the average value. Then authorities should also pay attention to IE7 (Regional traffic network), IE10 (Regional infrastructure), IE8 (Regional development outlook), IE4 (Informational infrastructure) and IE2 (Territory of science park), MD6 (Bargaining power) and MD4 (Reputation), because these criteria were satisfied a degree lower than the average value, but the importance degree is higher.

In Neihu technology park (NTP), authorities should pay attention to IE2 (Territory of science park), IE7 (Regional traffic network), TR4 (Quality of enterprises) and IE8 (Regional development outlook), because the four criteria are more important than the average value, but were satisfied a degree lower than the average value. Authorities should also pay attention to HR3 (Quality of R&D engineers), TR3 (Dispersion of industry information) and MD3 (Competition status), because these criteria were satisfied a degree lower than the average value, but the importance degree is higher (**Fig. 5**).

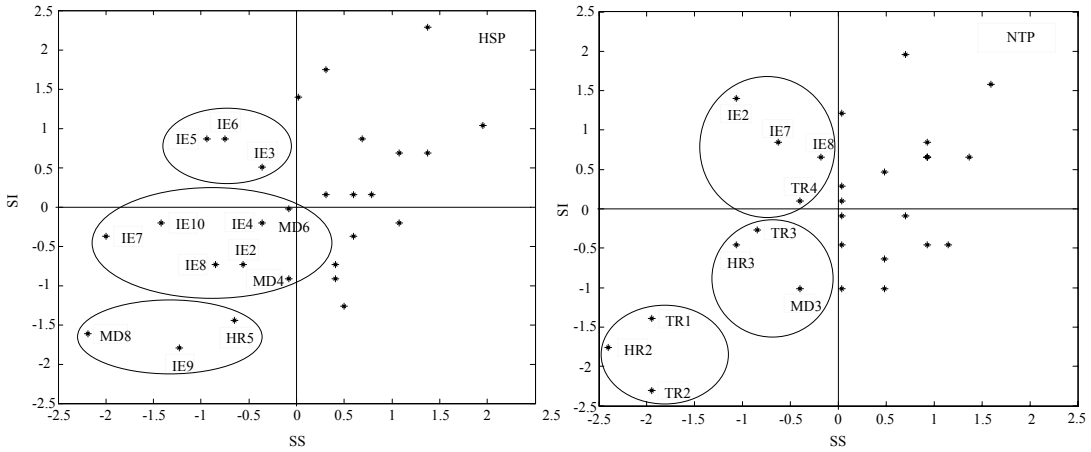

Fig. 5. Improvement strategy of value created system (HSP/NTP)

4.1.3 The analyses and discussions of network structure for value-created system

In HSP, human resource (HR) is the key performance aspect ($d - r$ is the highest) of the

value created system. The investment environment (IE) is the main aspect which is affected ($d-r$ is the lowest) by the value created system (**Fig. 6**). The aspect of the technology resource (TR) could be improved by enhancing the aspect of HR, or the aspect of the market development (MD). Therefore, the best strategy for raising the value of HSP is to improve HR.

In NTP, the aspect of MD is the key performance aspect ($d-r$ is the highest), and the aspect of HR is affected ($d-r$ is the lowest) by the value created system (**Fig. 6**). The aspect of the IE could be improved by enhancing the aspect of MD, and the aspect of IE will further influence the aspect of TR and HR. The improved IE will stimulate the MD upgrade, and the improved TR will stimulate IE upgrade. Therefore, the best strategy for raising the value of NTP is to improve MD.

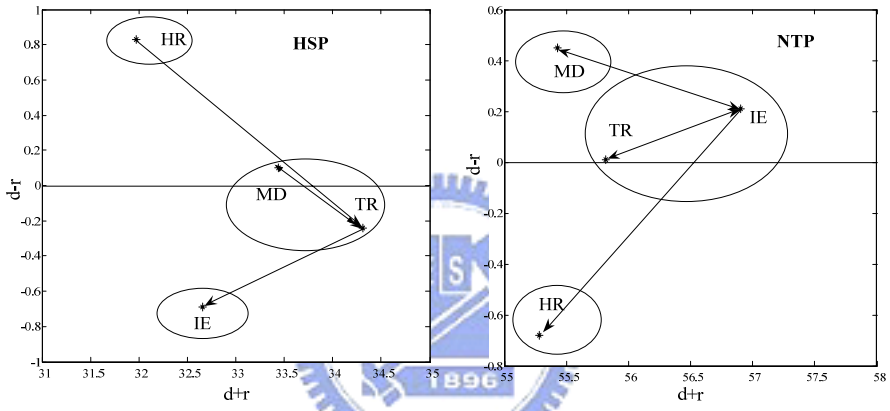

Fig. 6. Network structure of value created system (HSP/NTP)

(1)The analysis of the aspect of human resources

In reference to human resources (HR), the results of the analysis are a little bit different between HSP and NTP. Human brain training organizations (HR2) ($d-r$ =1.55) and new job creation (HR4) ($d-r$ =0.30) are the main key performance aspects of the value-created system in HSP. New job creation (HR4) ($d-r$ =1.44) and incubator resources (HR5) ($d-r$ =1.29) are the key performance aspects of the value-created system in NTP. In HSP (**Fig. 7**), human brain training organizations (HR2) will influence the quality of R&D engineers (HR3) and the supply of qualified personnel (HR1). Otherwise, the supply of qualified personnel (HR1), human brain training organizations (HR2) and quality of R&D engineers (HR3) are interworked and would positively affect incubator resources (HR5). New job creation (HR4) will directly stimulate the development of incubator resources (HR5). Eventually, improved HR5 would enhance the supply of qualified personnel (HR1) and quality of R&D engineers (HR3). Those feedback and corrections in relationship construct enhances the HR network system of HSP (**Table 15 and Fig. 7**).

The HR network system of NTP is represented in **Fig. 7**. New job creation (HR4) will influence the supply of qualified personnel (HR1), human brain training organizations (HR2) and the quality of R&D engineers (HR3). Incubator resources (HR5) will influence the supply of qualified personnel (HR1). In other words, new job creation (HR4) and incubator resources (HR5) are the core competency of NTP. They would stimulate the development of supply of qualified personnel (HR1), Human brain training organizations (HR2) and quality of R&D engineers (HR3). However in HSP, supply of qualified personnel (HR1), human brain cultivation organizations (HR2) and quality of R&D engineers (HR3) could stimulate the upgrade of incubator resources (HR5). Therefore, the human development strategies of HSP are to build good human brain cultivation organizations, such as universities and R&D institutions, and to encourage internal start-ups or spin-offs. However, the human resource development strategies of NTP are to build good incubations (industrial colleges or industrial incubator). Therefore, qualified personnel would be clustered here (**Table 16 and Fig. 7**).

Table 15 The full influence matrix of human resource aspect (HSP)

Threshold value =2.38	HR1	HR2	HR3	HR4	HR5
Supply of qualified personnel (HR1)	**2.65***	**2.50***	**2.81***	2.31	**2.87***
Human brain training organizations (HR2)	**2.90***	2.33	**2.81***	2.28	**2.85***
Quality of R&D engineers (HR3)	**2.78***	**2.43***	**2.49***	2.20	**2.78***
New job creation (HR4)	**2.38***	2.11	2.30	1.77	**2.38***
Incubator resources (HR5)	**2.56***	2.25	**2.49***	2.08	2.37

Table 16 The full influence matrix of human resource aspect (NTP)

Threshold value =3.55	HR1	HR2	HR3	HR4	HR5
Supply of qualified personnel (HR1)	3.24	3.34	3.38	3.13	3.09
Human brain training organizations (HR2)	3.36	3.11	3.30	3.05	3.04
Quality of R&D engineers (HR3)	3.48	3.43	3.21	3.14	3.14
New job creation (HR4)	**3.65***	**3.56***	**3.55***	3.11	3.27
Incubator resources (HR5)	**3.55***	3.53	3.48	3.27	3.04

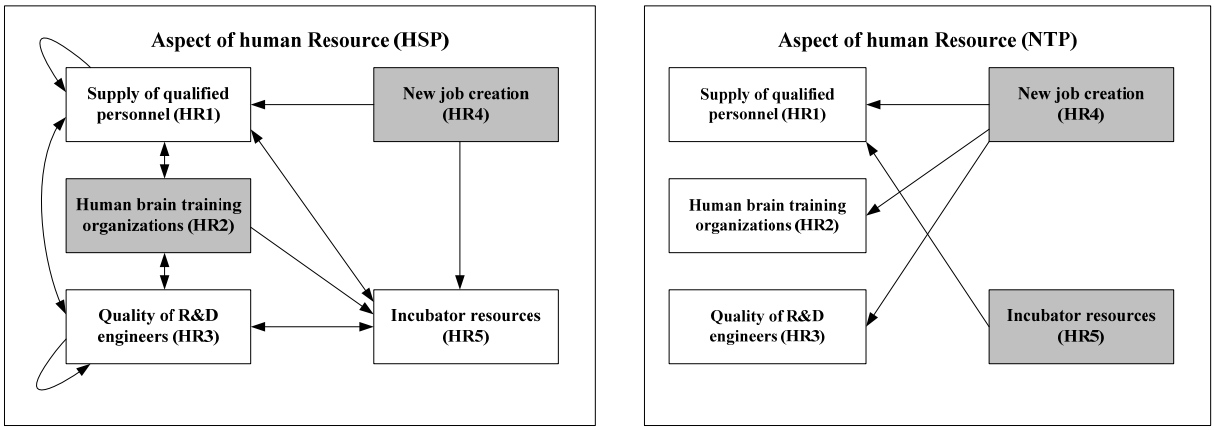

Fig. 7. Network structure of human resource aspect (HSP/NTP)

(2) The analysis of the aspect of technology resources

In relation to the aspect of technology resources, the results of the analysis were

different between HSP and NTP. Quality of research institutions (TR1) ($d-r$=0.48) and dispersion of industry information (TR3) ($d-r$=0.45) were found to be the main key performance aspects in HSP. Quality of enterprises (TR4) ($d-r$=1.21) and occasion for enterprises cooperating (TR5) ($d-r$=0.71) are the main key performance aspects in NTP. The network of technology resources of HSP is shown in **Fig. 8**. Quality of research institutions (TR1) will influence the occasion for enterprises cooperating (TR5). Quality of research institutions (TR1), dispersion of industrial information (TR3), quality of enterprises (TR4) and occasion for enterprises cooperating (TR5) will influence cooperation between industries and academics (TR2). The improved cooperation between industries and academics (TR2) will enhance the occasion for enterprises cooperating (TR5). Those feedback and correction relationships construct the TR network system of HSP (**Table 17 and Fig. 8**).

The network of technology resources of NTP is shown in Figure 9. Occasion for enterprises cooperating (TR5) was found to influence the quality of the research institution (TR1). Cooperation between industries and academics (TR2), quality of enterprises (TR4), and occasion for enterprises cooperating (TR5) will influence dispersion of industrial information (TR3). Those feedback and correction relationship construct the TR network system of NTP (**Table 18 and Fig. 8**).

HSP could strengthen the development of cooperation between industries and academics (TR2) by improving the quality of the research institution (TR1) and dispersion of industry information (TR3). Therefore, the best technology development strategies of HSP are to enhance the ability of R&D institutions, encourage R&D institutions to proceed with technology transferring and technology licensing, to develop the mechanism of collaboration between industries and academics which could contribute to the cooperation or new product development between R&D teams and enterprises. NTP could strengthen the development of TR by improving the quality of enterprises and occasion for enterprises cooperating. Therefore, the best technology development strategies of NTP are to attract the international business setting of their R&D centers and headquarters. This can be done by the preferential tax policy and investment incentive policy, to encourage enterprises of NTP improving the efficiency of dispersion of industrial information by enterprises cooperation, and to increase cooperation opportunities between NTP's enterprises and R&D centers for enhancing the opportunities and results of technology commercialization.

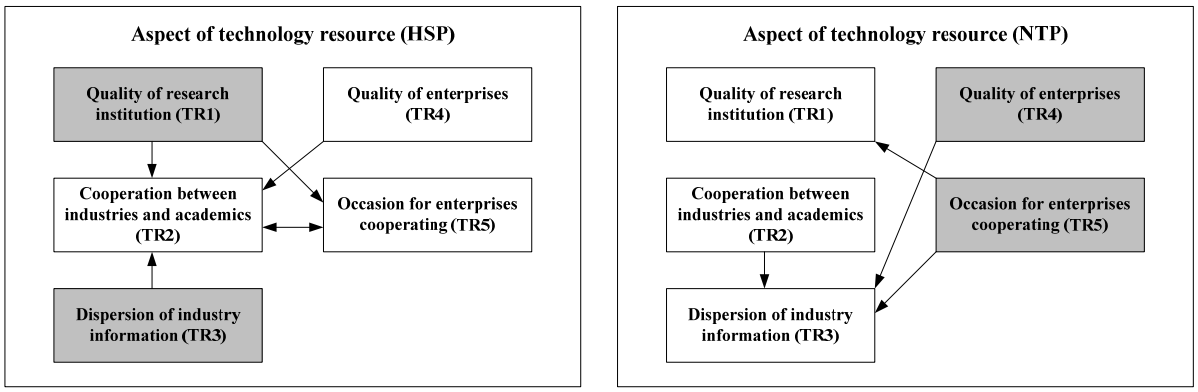

Fig. 8. Network structure of technology resource aspect (HSP/NTP)

Table 17 The full influence matrix of technology resource aspect (HSP)

Threshold value =3.80	TR1	TR2	TR3	TR4	TR5
Quality of research institution (TR1)	3.50	**3.92***	3.61	3.70	**3.80***
Cooperation between industries and academics (TR2)	3.75	3.77	3.69	3.75	**3.87***
Dispersion of industry information (TR3)	3.63	**3.84***	3.38	3.61	3.75
Quality of enterprises (TR4)	3.59	**3.80***	3.52	3.41	3.72
Occasion for enterprises cooperating (TR5)	3.58	**3.81***	3.54	3.59	3.52

Table 18 The full influence matrix of technology resource aspect (NTP)

Threshold value =2.87	TR1	TR2	TR3	TR4	TR5
Quality of research institution (TR1)	2.57	2.71	2.86	2.48	2.62
Cooperation between industries and academics (TR2)	2.83	2.55	**2.90***	2.53	2.68
Dispersion of industry information (TR3)	2.74	2.66	2.65	2.47	2.64
Quality of enterprises (TR4)	2.85	2.77	**2.97***	2.40	2.74
Occasion for enterprises cooperating (TR5)	**2.87***	2.83	**3.03***	2.64	2.59

(3) The analysis of the aspect of investment environment

In reference to the aspect of the investment environment, the results of analysis were different between HSP and NTP. The network of the investment environment of HSP is shown in **Fig. 9**. Legislation and government policy (IE5) ($d-r$ =0.88), informational infrastructure (IE4) ($d-r$ =0.37), and regional traffic network (IE7) ($d-r$ =0.26) are positively-affected criteria in HSP. However, the regional development outlook (IE8) ($d-r$ = -0.53), scale of industries (IE1) ($d-r$ = -0.43), living requirements (IE9) ($d-r$ = -0.35), and regional infrastructure (IE10) ($d-r$ = -0.05) are negatively-affected criteria. Therefore, the best improvement strategy for HSP is to improve the key criterion "Legislation and government policy (IE5)" firstly, which influences the other criteria most, and is affected by other criteria least. Secondly, HSP should improve the regional traffic network (IE7), informational infrastructure (IE4), and territory of science park (IE2) (**Table 19** and **Fig. 9**). In other words, HSP should complete the policy incentives to attract enterprises that reside

inside, and constantly construct traffic networks, informational infrastructure and sufficient land for enterprises' further expanding or developing.

The network of the investment environment of NTP is shown in **Fig. 9**. Territory of science park (IE2) ($d - r$ =1.36), legislation and government policy (IE5) ($d - r$ =0.95) and regional traffic networks (IE7) ($d - r$ =0.57) are positively-affected criteria in NTP. However, incentive for investment (IE3) ($d - r$ = -1.29), regional development outlook (IE8) ($d - r$ = -0.97), regional infrastructure (IE10) ($d - r$ = -0.45), scale of industries (IE1) ($d - r$ = -0.35), informational infrastructure (IE4) ($d - r$ = -0.34), and living requirements (IE9) ($d - r$ = -0.01) are negatively-affected criteria. Therefore, the best improvement strategy for NTP is improving the key criterion "Territory of science park (IE2)" firstly, which influences other criteria most, and is affected by other criteria least. Secondly, NTP should improve legislation and government policy (IE5), operation costs (IE6), and the regional traffic network (IE7) (**Table 20** and **Fig. 9**). In other words, NTP should expand its territory first for the enterprises' urgent demand of residing inside. The next steps to follow are listed in the next paragraph. NTP should lose the limitation for residence. Therefore, related cooperation firms and outsourcing supporting firms could reside inside the park, contributing to attain the economies of scale. Otherwise, NTP should reduce enterprises' operating costs by the benefit of economies of scale and improve the regional traffic network for better transportation.

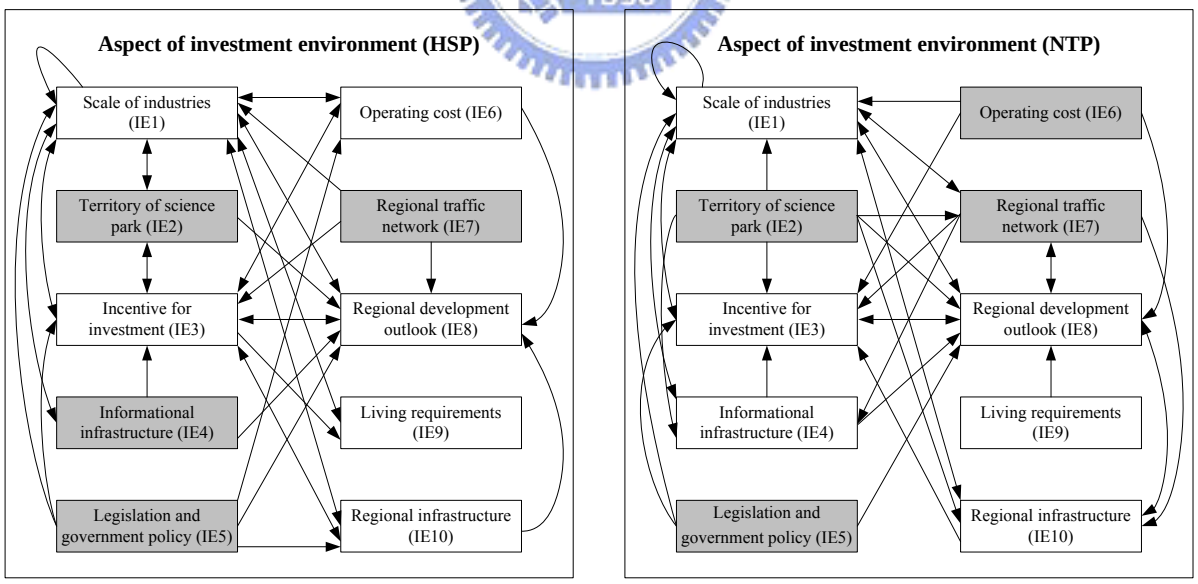

Fig. 9. Network structure of investment environment aspect (HSP/NTP)

Table 19 The full influence matrix of investment environment aspect (HSP)

Threshold value=2.01	IE1	IE2	IE3	IE4	IE5	IE6	IE7	IE8	IE9	IE10
Scale of industries (IE1)	**2.06***	2.00	**2.13***	**2.05***	1.91	1.93	**2.08***	**2.18***	1.97	**2.10***
Territory of science park (IE2)	**2.18***	1.89	**2.13***	**2.06***	1.91	1.93	**2.07***	**2.17***	1.97	**2.09***
Incentive for investment (IE3)	**2.03***	1.87	1.92	1.94	1.81	1.82	1.96	**2.05***	1.85	1.99
Informational infrastructure (IE4)	**2.07***	1.89	**2.06***	1.87	1.82	1.82	1.96	**2.07***	1.88	2.00

Legislation and government policy (IE5)	**2.03***	1.88	**2.03***	1.95	1.71	1.82	1.95	**2.04***	1.86	1.96
Operating cost (IE6)	**2.02***	1.86	**2.01***	1.94	1.79	1.71	1.93	**2.01***	1.83	1.94
Regional traffic network (IE7)	**2.16***	1.99	**2.13***	**2.07***	1.89	1.93	1.97	**2.17***	1.97	**2.10***
Regional development outlook (IE8)	**2.12***	1.92	**2.09***	2.01	1.84	1.87	**2.01***	2.00	1.92	**2.03***
Living requirements (IE9)	2.00	1.84	1.98	1.90	1.77	1.79	1.92	**2.01***	1.73	1.93
Regional infrastructure (IE10)	**2.07***	1.91	**2.06***	1.99	1.84	1.86	1.99	**2.08***	1.90	1.91

Table 20 The full influence matrix of investment environment aspect (NTP)

Threshold value=0.53	IE1	IE2	IE3	IE4	IE5	IE6	IE7	IE8	IE9	IE10
Scale of industries (IE1)	**0.55***	**0.54***	**0.61***	**0.53***	0.50	**0.55***	0.50	**0.61***	**0.53***	**0.56***
Territory of science park (IE2)	**0.58***	0.39	**0.53***	0.44	0.42	0.47	0.44	**0.55***	0.49	0.49
Incentive for investment (IE3)	**0.66***	**0.53***	0.51	0.52	0.49	**0.55***	0.49	**0.61***	**0.53***	**0.56***
Informational infrastructure (IE4)	**0.60***	0.48	**0.56***	0.39	0.44	0.52	0.45	**0.56***	0.48	0.52
Legislation and government policy (IE5)	**0.63***	0.52	**0.59***	0.49	0.39	**0.53***	0.47	**0.58***	0.49	**0.54***
Operating cost (IE6)	**0.59***	0.47	**0.54***	0.46	0.42	0.40	0.43	**0.54***	0.46	0.48
Regional traffic network (IE7)	**0.57***	0.47	**0.53***	0.43	0.42	0.46	0.36	**0.54***	0.49	0.49
Regional development outlook (IE8)	**0.61***	0.49	**0.56***	0.46	0.45	0.49	0.46	0.47	0.49	0.51
Living requirements (IE9)	0.52	0.45	0.49	0.42	0.39	0.43	0.43	0.51	0.37	0.46
Regional infrastructure (IE10)	**0.60***	0.48	**0.55***	0.47	0.43	0.50	0.46	**0.56***	0.50	0.43

(4) The analysis of the aspect of market development

In reference to the aspect of market development, the results of the analysis are a little bit different between HSP and NTP. The network of market development of HSP is shown in **Fig. 10**. Scale of region market (MD8) ($d-r$ =0.46), benefit of economies of scale (MD1) ($d-r$ =0.31), reputation (MD4) ($d-r$ =0.31), and completion of supply chain (MD5) ($d-r$ =0.30) are positively-affected criteria in HSP. However, the bargaining power (MD6) ($d-r$ = -0.76), quality of outsourcing providers (MD7) ($d-r$ = -0.37), competition status (MD3) ($d-r$ = -0.18), and supply networks (MD2) ($d-r$ = -0.07) are negatively-affected criteria. Therefore, the best improvement strategy for HSP is improving the key criterion "scale of region market (MD8)" firstly, which influences other criteria most, and is affected by other criteria least. Secondly, HSP should improve the benefit of economies of scale (MD1), reputation (MD4), and completion of the supply chain (MD5) (**Table 21** and **Fig. 10**). In other words, enterprises supply not only regional markets, but worldwide markets, with the trend of globalization. Sufficient land for houses and equipment building means sufficient opportunity for capacity expanding. Furthermore, when the industry becomes mature, enterprises of the park could attain economies of scale of the supply chain through vertical integration. Therefore, the cost of transportation and transactions could be lowered through such a logistical network, and the competitive ability of products will be raised.

The network of market development of NTP is shown in **Fig. 10**. The benefit of economies of scale (MD1) ($d-r$ =0.80), supply networks (MD2) ($d-r$ =0.23), competition status (MD3) ($d-r$ =0.11), reputation (MD4) ($d-r$ =0.11) and completion of supply chains (MD5) ($d-r$ =0.01) are positively-affected criteria in NTP. However, the scale of regional

market (MD8) ($d - r$ = -0.57), bargaining power (MD6) ($d - r$ = -0.46) and quality of outsourcing providers (MD7) ($d - r$ = -0.23) are negatively-affected criteria. Therefore, the best improvement strategy for NTP is to improve the key criterion "Benefit of economies of scale (MD1)" firstly, which influences other criteria most, and is affected by other criteria least. Secondly, NTP should improve supply networks (MD2), competition status (MD3), reputation (MD4) and completion of the supply chain (MD5). In other words, NTP raises the economies of scale through attracting more enterprises to reside inside. Meanwhile, NTP should also contribute enterprises to mutual collaboration and lower transaction costs via the network relationship. Besides, many supporting firms reside inside for internal international companies. Those supporting firms compete with each other for worldwide orders, and therefore raise not only their global competency, but also boost the reputation of NTP (**Table 22** and **Fig. 10**).

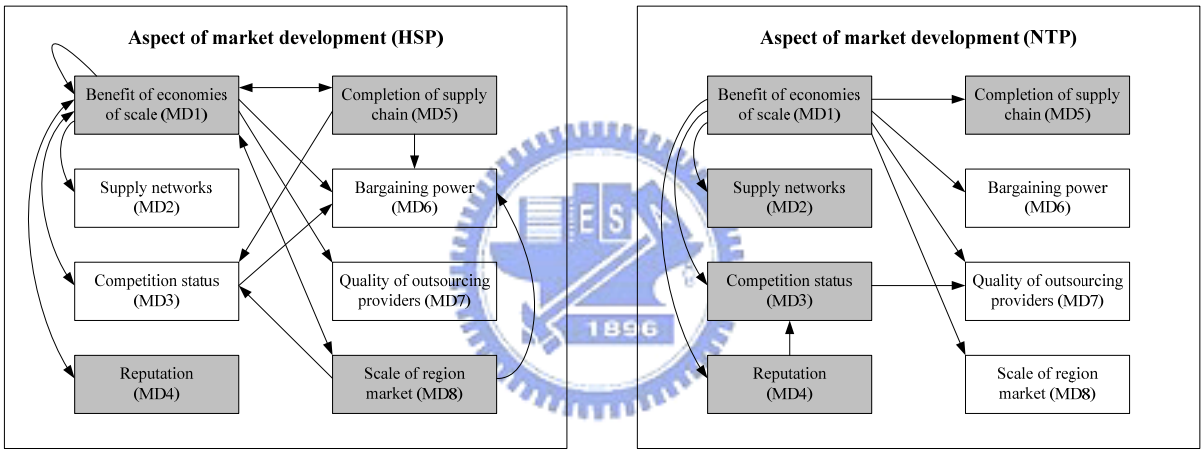

Fig. 10. Network structure of investment market development aspect (HSP/NTP)

Table 21 The full influence matrix of market development aspect (HSP)

Threshold value= 1.01	MD1	MD2	MD3	MD4	MD5	MD6	MD7	MD8
Benefit of economies of scale (MD1)	**1.03***	**1.02***	**1.10***	**1.01***	**1.08***	**1.14***	**1.05***	**1.06***
Supply networks (MD2)	0.97	0.75	0.92	0.83	0.90	0.94	0.87	0.88
Competition status (MD3)	**1.03***	0.91	0.87	0.89	0.96	**1.01***	0.95	0.94
Reputation (MD4)	**1.01***	0.87	0.95	0.76	0.92	0.97	0.91	0.91
Completion of supply chain (MD5)	**1.08***	0.96	**1.02***	0.92	0.88	**1.04***	0.97	0.98
Bargaining power (MD6)	0.99	0.86	0.95	0.84	0.91	0.84	0.88	0.89
Quality of outsourcing providers (MD7)	0.98	0.83	0.92	0.82	0.89	0.93	0.77	0.87
Scale of region market (MD8)	**1.09***	0.95	**1.02***	0.92	1.00	**1.04***	0.97	0.86

Table 22 The full influence matrix of market development aspect (NTP)

Threshold value=1.61	MD1	MD2	MD3	MD4	MD5	MD6	MD7	MD8
Benefit of economies of scale (MD1)	1.53	**1.61***	**1.66***	**1.64***	**1.62***	**1.62***	**1.69***	**1.65***
Supply networks (MD2)	1.56	1.41	1.56	1.53	1.52	1.53	1.58	1.54
Competition status (MD3)	1.58	1.56	1.48	1.56	1.55	1.56	**1.62***	1.56
Reputation (MD4)	1.55	1.52	1.57	1.42	1.51	1.52	1.59	1.54
Completion of supply chain (MD5)	1.52	1.50	1.54	1.52	1.38	1.49	1.55	1.51
Bargaining power (MD6)	1.47	1.43	1.48	1.46	1.44	1.33	1.49	1.44
Quality of outsourcing providers (MD7)	1.55	1.52	1.58	1.54	1.52	1.52	1.46	1.53
Scale of region market (MD8)	1.48	1.44	1.48	1.45	1.45	1.43	1.47	1.34

4.2. The empirical study of vehicle telematics systems

In this Section, the study is divided into 5 subsections. Subsection 4.2.1 deals with the survey of consumer preference for VTS functions. Subsection 4.2.2 uses the decision making trial and evaluation laboratory (DEMATEL) method for analysis of empirical cases. Subsection 4.2.3 uses the analytic network process (ANP) method for analysis of empirical cases. Subsection 4.2.4 uses the technique for order preference by similarity to ideal solution (TOPSIS) method for analysis of empirical cases. Subsection 4.2.5 is the discussion.

4.2.1 Finding the consumer preference for VTS functions

The priority of needs of males and females is the same (as shown in **Table 23**). The utility value from the best aspect to the last is N, S, I, V. As shown in **Table 24**, the priority of demand of the 21-30 year-old group and the 31-40 year-old group is the same. The utility value from the best to the last is N, S, I, V. The priority of demand of the 41-50 year-old group, the utility value from the best to the last one is S, N, I, V. As a result, the priority of need of services of VTS will differ by age group. TSPs could take the age factor into consideration for modulizing the VTS services. The 41-50 year-old group put stress on safety and security services, perhaps due to their wealth and concern for family members.

Table 23 The degree of demand (by gender)

Function \ Gender	Male		Female	
	#	Priority	#	Priority
Navigation & Location Services (N)	3.96	1	4.09	1
Safety & Security Services (S)	3.19	2	3.45	2
Communications & Information Services (I)	2.59	4	2.27	4
Audio-video & Entertainment Services (V)	2.96	3	2.64	3

Note: # means the degree of demand

Table 24 The degree of demand (by age)

Function \ Age	21-30 years old		31-40 years old		41-50 years old	
	#	Priority	#	Priority	#	Priority
Navigation & Location Services (N)	4.00	1	4.25	1	3.25	2
Safety & Security Services (S)	3.55	2	2.58	2	3.75	1
Communications & Information Services (I)	2.73	4	2.08	4	2.50	4
Audio-video & Entertainment Services (V)	3.14	3	2.25	3	3.25	2

Note: # means the degree of demand

4.2.2 Finding the degree of importance and satisfaction for VTS functions

As shown in Table 25 and Figure 11, the analysis the degree of importance and satisfaction of criteria is conducted and the surveyed data is normalized into equal measuring scales. According to the results of surveyed data, the criteria is divided into four categories as follows: The first category is a high degree of satisfaction with a high degree of importance

shown by the symbol ○ (+,+). The second category of criteria is a high degree of satisfaction with a low degree of importance shown by the symbol ●(+,-), and the third category of criteria is a low degree of satisfaction with a low degree of importance shown by the symbol ▲(-,-). The fourth category of criteria is a low degree of satisfaction with a high degree of importance shown by the symbol X(-, +). In this study, the strategies of the value-created system of VTS are proposed as follows; First, to improve those criteria (i.e. I5, C3) falling into the fourth category [X (-, +)]; the next immediate step is to improve those criteria (i.e. S4, S5, I1, I3, I4, V1, V2, V3, V4, P1) falling into the third category [▲(-,-)]. The fourth category criteria [X (-, +)] are key factors that affect the whole satisfaction degree of VTS. About the third category criteria [▲(-,-)], a higher degree of importance would affect the whole satisfaction degree of VTS in the short run **(as shown in Table25 and Fig. 11)**.

Table 25 Satisfaction and important degree of VTS

Aspects/Criteria		MI	SI	MS	SS	(IS, SS)
Navigation & Location Services (*N*)	Voice-Guided Navigation Services(N_1)	8.881	1.720	7.929	1.902	○(+,+)
	Traffic Information (N_2)	8.619	1.374	7.500	1.302	○(+,+)
	Electronic Map Information (N_3)	8.738	1.531	8.000	2.002	○(+,+)
Safety & Security Services (*S*)	Safety & Emergency Services (S_1)	7.905	0.431	6.857	0.401	○(+,+)
	Remote Central Control Services (S_2)	7.762	0.243	6.810	0.335	○(+,+)
	Vehicle Location Services (S_3)	8.024	0.588	6.738	0.235	○(+,+)
	Car Security Services (S_4)	7.476	-0.135	6.452	-0.165	▲(-,-)
	Vehicle Diagnosis & Maintenance Services (S_5)	6.905	-0.889	5.810	-1.066	▲(-,-)
Communications & Information Services (*I*)	Mobile Information Services (I_1)	6.952	-0.826	6.190	-0.532	▲(-,-)
	User Interface (I_2)	7.619	0.054	6.857	0.401	○(+,+)
	Platform Integration Services (I_3)	7.381	-0.260	6.214	-0.499	▲(-,-)
	Information Security Protection (I_4)	7.405	-0.229	6.381	-0.265	▲(-,-)
	Information Update Frequency (I_5)	7.595	0.023	6.500	-0.099	X (+,-)
Audio-video & Entertainment Services (*V*)	Real-Time Multimedia Services (V_1)	6.524	-1.392	5.524	-1.466	▲(-,-)
	Vehicle Multimedia Playing System (V_2)	7.000	-0.763	6.095	-0.666	▲(-,-)
	Game Services (V_3)	6.167	-1.863	5.238	-1.866	▲(-,-)
	Personal Platform Services (V_4)	5.738	-2.429	5.167	-1.966	▲(-,-)
Fee Rate & Payment Method (*C*)	Service Fee Rate (C_1)	8.000	0.557	6.643	0.101	○(+,+)
	Pricing (C_2)	8.071	0.651	6.810	0.335	○(+,+)
	Payment Method (C_3)	7.810	0.305	6.381	-0.265	X (+,-)
	Payment Channel (C_4)	7.929	0.463	6.833	0.368	○(+,+)
Product Image (*P*)	Product Design (P_1)	7.143	-0.574	6.143	-0.599	▲(-,-)
	Brand Image (P_2)	7.429	-0.197	6.738	0.235	●(-,+)
	After-Sales Services (P_3)	8.190	0.808	7.333	1.068	○(+,+)
	Privacy Policy (P_4)	8.190	0.808	7.119	0.768	○(+,+)
	Average	7.578	0.000	6.570	0.000	
	Standard deviation	0.758	1.000	0.714	1.000	
	Maximum	8.881	1.720	8.000	2.002	
	Minimum	5.738	-2.429	5.167	-1.966	

Note1: ○(+,+) is the criteria of a high degree of satisfaction and a high degree of importance;

●(-,+) is the criteria of a high degree of satisfaction but a low degree of importance;
▲(-,-) is the criteria of a low degree of satisfaction and a low degree of importance;
X (-, +) is the criteria of a low degree of satisfaction but a high degree of importance.

Note2: MS, SS, MI, SI, respectively stand for satisfaction value, standardized satisfaction value, importance value, standardized importance value.

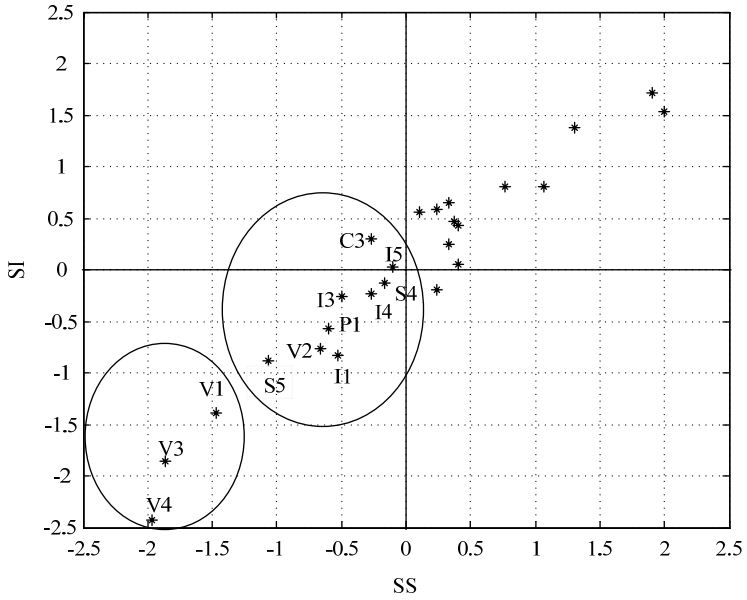

Fig.11. Improvement strategies of satisfaction and important degree of VTS

4.2.3 The empirical analysis using ANP method

The criteria weights can be gained by using the ANP method. In the process of limitation, multiples of the super matrix M for 13 squares and the weights can be obtained. The results are shown in **Table 26**. In this paragraph, the parenthetic value means the weight of aspect or criterion. The largest value of factor weights of the criterion is I5 (11.4%), the next is I1 (11.0%), P3 (8.8%), I4 (8.7%), N3 (8.1%), P2 (7.4%). From the view of aspects, the aspect of I (39.8%) is the most important weighted value, followed by P (21.7%), N (20.5%), S (7.2%), C (7.2%), and V (3.6%). With the results of using the ANP method, the key decision-making consideration factor affects the consumer's purchasing of VTS is I. Among the criteria of the aspect, I5 (11.4%), I1 (11.0%), I4 (8.7%) are the main influencing factors. Regarding the P aspect (21.7%), P3 (8.8%) and P2 (7.4%) play the key roles. About the N aspect (20.5%), N3 (8.1%), N2 (6.4%), and N1 (6.0%) are the main influencing factors.

Table 26 The weights of evaluation criteria

Aspects	***Weights***	**Criteria**	w_i
Navigation & Location Services (*N*)	0.205	Voice-Guided Navigation Services(N_1)	0.060
		Traffic Information (N_2)	0.064
		Electronic Map Information (N_3)	0.081
Safety & Security Services (*S*)	0.072	Safety & Emergency Services (S_1)	0.010
		Remote Central Control Services (S_2)	0.014

		Vehicle Location Services (S_3)	0.019
		Car Security Services (S_4)	0.015
		Vehicle Diagnosis & Maintenance Services (S_5)	0.014
Communications & Information Services (*I*)	0.398	Mobile Information Services (I_1)	0.110
		User Interface (I_2)	0.026
		Platform Integration Services (I_3)	0.062
		Information Security Protection (I_4)	0.087
		Information Update Frequency (I_5)	0.114
Audio-video & Entertainment Services (*V*)	0.036	Real-Time Multimedia Services (V_1)	0.013
		Vehicle Multimedia Playing System (V_2)	0.006
		Game Services (V_3)	0.008
		Personal Platform Services (V_4)	0.010
Fee Rate & Payment Method (*C*)	0.072	Service Fee Rate (C_1)	0.019
		Pricing (C_2)	0.016
		Payment Method (C_3)	0.016
		Payment Channel (C_4)	0.021
Product Image (*P*)	0.217	Product Design (P_1)	0.010
		Brand Image (P_2)	0.074
		After-Sales Services (P_3)	0.088
		Privacy Policy (P_4)	0.045
		Total	1.000

Note 1: W, w_i which seperatly means the weight of aspect, the weight of criterion

4.2.4 Using the TOPSIS method for improving the performance of the existing VTS

The TOPSIS procedure consists of the following steps: (1) calculates the normalized decision matrix; (2) calculating the weighted normalized decision matrix, (3) determining the ideal and negative-ideal solution, (4) calculating the distance of the utility value of each criterion between the positive ideal solution (aspired levels) and negative solution (the worst levels); (5) calculating the relative closeness to the ideal solution for improvement. In this paper, four commercial VTS products of different TSPs (i.e. Taiwan, U.S., Europe, and Japan) are analyzed and benchmarked to discuss the required utilities and services of the next e-era generation VTS. The results by using the TOPSIS method can determine which one is the most appropriate for Taiwan's consumers as shown in **Table 27~Table 32**.

(1) Calculates the normalized decision matrix

Table 27 Original value of VTS service

e_{ij}	C_k	Preference	VTS A_k				$e_{j,aspireH}$	$e_{j,aspireL}$	e_{ij}	C_k	Preference	VTS A_k				$e_{j,aspireH}$	$e_{j,aspireL}$
			T	U	E	J						T	U	E	J		
N	N1	MAX	7.77	7.03	7.03	7.03	10.00	0.00	V	V1	MAX	6.20	6.50	6.20	6.62	10.00	0.00
	N2	MAX	4.57	2.84	2.84	2.84	10.00	0.00		V2	MAX	1.24	1.24	1.24	5.04	10.00	0.00
	N3	MAX	6.89	6.85	6.86	6.97	10.00	0.00		V3	MAX	0.00	0.00	0.00	3.42	10.00	0.00
S	S1	MAX	6.00	6.81	6.07	6.00	10.00	0.00		V4	MAX	5.19	4.75	5.19	5.19	10.00	0.00
	S2	MAX	2.48	4.02	4.02	4.36	10.00	0.00	C	C1	MAX	4.74	5.26	5.26	5.26	10.00	0.00
	S3	MAX	7.24	4.23	4.63	4.23	10.00	0.00		C2	MAX	4.75	5.59	5.59	5.72	10.00	0.00
	S4	MAX	4.51	1.55	4.51	4.51	10.00	0.00		C3	MAX	5.43	6.64	6.64	6.64	10.00	0.00

	S5	MAX	3.46	5.55	4.41	4.41	10.00	0.00		C4	MAX	6.08	2.20	2.20	4.35	10.00	0.00
I	I1	MAX	5.74	5.36	4.04	5.74	10.00	0.00	P	P1	MAX	7.94	7.94	7.94	7.94	10.00	0.00
	I2	MAX	7.72	3.68	3.68	3.95	10.00	0.00		P2	MAX	6.48	6.48	6.48	6.48	10.00	0.00
	I3	MAX	4.39	5.26	5.59	5.56	10.00	0.00		P3	MAX	8.03	8.03	8.03	8.03	10.00	0.00
	I4	MAX	7.51	7.51	7.51	7.51	10.00	0.00		P4	MAX	7.89	7.89	7.89	7.89	10.00	0.00
	I5	MAX	**5.14**	**5.14**	**5.14**	**5.14**	**10.00**	**0.00**									

Table 28 The normalized value of VTS (r_{ij})

r_{ij}	C_k	VTS A_k			
		T	U	E	J
	N1	0.78	0.70	0.70	0.70
N	N2	0.46	0.28	0.28	0.28
	N3	0.69	0.69	0.69	0.70
	S1	0.60	0.68	0.61	0.60
	S2	0.25	0.40	0.40	0.44
S	S3	0.72	0.42	0.46	0.42
	S4	0.45	0.15	0.45	0.45
	S5	0.35	0.56	0.44	0.44

r_{ij}	C_k	VTS A_k			
		T	U	E	J
	I1	0.57	0.54	0.40	0.57
	I2	0.77	0.37	0.37	0.40
I	I3	0.44	0.53	0.56	0.56
	I4	0.75	0.75	0.75	0.75
	I5	0.51	0.51	0.51	0.51
	V1	0.62	0.65	0.62	0.66
V	V2	0.12	0.12	0.12	0.50
	V3	0.00	0.00	0.00	0.34
	V4	0.52	0.48	0.52	0.52

r_{ij}	C_k	VTS A_k			
		T	U	E	J
	C1	0.47	0.53	0.53	0.53
C	C2	0.48	0.56	0.56	0.57
	C3	0.54	0.66	0.66	0.66
	C4	0.61	0.22	0.22	0.43
	P1	0.79	0.79	0.79	0.79
P	P2	0.65	0.65	0.65	0.65
	P3	0.80	0.80	0.80	0.80
	P4	0.79	0.79	0.79	0.79

(2) Calculating the weighted normalized decision matrix

Table 29 The weighted normalized value of VTS (V_{ij})

V_{ij}	W_i	k			
		T	U	E	J
N	N1	0.047	0.042	0.042	0.042
	N2	0.029	0.018	0.018	0.018
	N3	0.056	0.055	0.055	0.056
S	S1	0.006	0.007	0.006	0.006
	S2	0.004	0.006	0.006	0.006
	S3	0.014	0.008	0.009	0.008
	S4	0.007	0.002	0.007	0.007
	S5	0.005	0.008	0.006	0.006

V_{ij}	W_i	k			
		T	U	E	J
I	I1	0.063	0.059	0.044	0.063
	I2	0.020	0.009	0.009	0.010
	I3	0.027	0.032	0.035	0.034
	I4	0.065	0.065	0.065	0.065
	I5	0.058	0.058	0.058	0.058
V	V1	0.008	0.008	0.008	0.008
	V2	0.001	0.001	0.003	0.000
	V3	0.000	0.000	0.000	0.003
	V4	0.005	0.005	0.005	0.005

V_{ij}	W_i	k			
		T	U	E	J
C	C1	0.009	0.010	0.010	0.010
	C2	0.008	0.009	0.009	0.009
	C3	0.009	0.011	0.011	0.011
	C4	0.013	0.005	0.005	0.009
P	P1	0.008	0.008	0.008	0.000
	P2	0.048	0.048	0.048	0.048
	P3	0.071	0.071	0.071	0.071
	P4	0.035	0.035	0.035	0.035

(3) Determining the ideal and negative-ideal solution

Table 30 The ideal and negative-ideal solution of VTS

Items		A+	A-
N	N1	0.047	0.042
	N2	0.029	0.018
	N3	0.056	0.055
S	S1	0.007	0.006
	S2	0.006	0.004
	S3	0.014	0.008
	S4	0.007	0.002
	S5	0.008	0.005

Items		A+	A-
I	I1	0.063	0.044
	I2	0.020	0.009
	I3	0.035	0.027
	I4	0.065	0.065
	I5	0.058	0.058
V	V1	0.008	0.008
	V2	0.003	0.000
	V3	0.003	0.000
	V4	0.005	0.005

Items		A+	A-
C	C1	0.010	0.009
	C2	0.009	0.008
	C3	0.011	0.009
	C4	0.013	0.005
P	P1	0.008	0.000
	P2	0.048	0.048
	P3	0.071	0.071
	P4	0.035	0.035

(4) Calculating the distance of the utility value of each criterion between the positive ideal solution (aspired levels) and negative solution (the worst levels) (**Table 31**).

Table 31 The distance to ideal & negative-ideal solution of VTS

Distance	k			
	T	U	E	J
S_k^*	0.010	0.020	0.026	0.019
S_k^-	0.028	0.040	0.038	0.041

(5) Calculating the relative closeness to the ideal solution for improvement

Calculate the relative closeness to the ideal solution and rank the priority. In this paragraph, the parenthetic value means the value of C_{k*}. As shown in **Table 32**, sorts C_{k*} in sequence, the Taiwan's T VTS (0.743) is the better one; the next ones are the Japan's J VTS (0.688), the U.S.'s U VTS (0.665), and Europe's E VTS (0.588) (gap ratio 0.412, i.e. 41.2% should be improved). As a result, Taiwan's T VTS seems be the most appropriate one for Taiwan's consumers. However, there are still gaps in the criteria between the T VTS and the consumers' ideal VTS (25.7% should be improved). There is still much ratio to improve the performance of existing solutions for satisfying customers' needs. TSP should pay efforts to improving the gap 25.7% to attain the real ideal solution shown by consumers' needs.

Table 32 The relative closeness to the ideal solution

Item	k			
	T	U	E	J
C_{k*}	0.743	0.665	0.588	0.688
Gap	0.257	0.335	0.412	0.312

4.2.5 Discussions

The analyzed results of consumer demand of VTS are as follows: the priority of demands by males and females are the same. The utility values from the best to the last, are navigation and location services (N), safety and security services (S), audio-video and entertainment services.(V) and communications and information services (I), There is no difference in demand for VTS between males and females. The priority of demand of of the 21-30 year-old group and the 31-40 year-old group is the same. The utility values from the best to the last are navigation and location services (N), safety and security services (S), audio-video and entertainment services (V) and communications and information services (I). The priority of demand of the 41-50 year-old group is different from the 21-30 and 31-40 year-old groups, in which the utility values from the best to the last are safety and security services(S), navigation and location services (N), communications and information services (I), audio-video and entertainment services (V). As a result, the priority of need of services of VTS will differ by age group. It means that as age and wealth increases, people will care

more about their family's safety and will have the ability to afford higher prices for safety and security services (S). In this paper, four VTS products belong to four different TSPs of Taiwan, the U.S., Europe, and Japan are adopted to discuss the function and services options of the VTS. The results using TOPSIS method can determine which one is the most appropriate for Taiwan's consumers. As a result, Taiwan's T VTS may be the most appropriate for Taiwan's consumers. It is obvious that Taiwan's TSP has adjusted the VTS according to Taiwan consumer preference when transferring a new system. However, it still cannot satisfy all the functions desired by Taiwan's consumers. New TSPs should refer to specifications of the existing system and improve it via enhancing those existing criteria that do not attain the S_j^+. Then a most ideal VTS for Taiwan's consumer will be initiated.

4.3 The empirical study for service platform of digital music

In this Section, the study is divided into 5 subsections. Subsection 4.3.1 deals with The PCA analysis of aspects based on needs concept of customers. Subsection 4.3.2 uses DEMATEL technique for analyzing the empirical cases. Subsection 4.3.3 uses the ANP method for finding preference of dependent criteria for the empirical cases. Subsection 4.3.4 uses the VIKOR method for evaluating and improving the empirical cases. Subsection 4.3.5 is the discussion.

4.3.1 The PCA analysis in the aspects of customers' needs

The way used to decide the number of components was by PCA. If the eigenvalue is larger than one ($\lambda_j > 1$), then the *j*th potential component is kept, otherwise, it is removed. In the PCA analysis, it can be seen that SR aspect's accumulation loading is 88.092%, which means those two components, or more, can explain 88.092% content of the criteria. However, if we want to explain more content of the criteria, we choose the threshold of accumulating loading, such as 75%~85%, and use factor loading to decide the number of components. Table 33 and Fig. 2 show that there are two components, namely PMM1 (platform design and maintenance) and PMM2 (system stability and security), respectively, can be extracted from the aspect of PM (platform design and maintenance). Only one component, however, can be extracted from each of other four aspects. These components are named as follows: SRM1 (search and recommendation), PFM1 (platform functionality), PPM1 (pricing and promotion) and IRM1 (platform image).

Table 33 Component matrix after axis-spin

Aspects/Components	Criteria	Components		
		1	2	Community
Music search & recommendation (SR)				
Search & recommendation (SRP1)	1.3 Music Search Service	0.897	-	0.805
	1.2 Album Classification System	0.882	-	0.778
	1.4 Billboard of Download	0.789	-	0.622
	1.1 Song Recommendation Service	0.774	-	0.599
	Engenvalue λ	2.804	-	-
	% of Variance	70.099	-	-
	Cumulative (%)	70.099	-	-
Platform design & maintenance (PM)				
Platform design & maintenance (PMP1)	2.2 Frequency of Content Update	0.871	-0.246	0.818
	2.3 Support of Device System	0.849	-0.436	0.911
	2.1 System Protection	0.838	-0.348	0.823
System stability & security (PMP2)	2.4 System Protection	0.816	0.501	0.917
	2.5 System Stability	0.703	0.664	0.935
	Engenvalue λ	3.341	1.063	-
	% of Variance	66.827	21.264	-
	Cumulative (%)	66.827	88.092	-
Platform functionality of website (PF)				
Platform functionality(PFP1)	3.3 Digital Broadcasting Service	0.891	-	0.794
	3.1 Music Streaming Service	0.844	-	0.712
	3.4 Personalize Setup	0.795	-	0.632
	3.2 Download Service	0.789	-	0.622
	3.5 Links of Entertainment News	0.733	-	0.537
	Engenvalue λ	3.2975	-	-
	% of Variance	65.9505	-	-
	Cumulative (%)	65.9505	-	-
Pricing & promotion (PP)				
Pricing & promotion (PPP1)	4.3 Pricing & Service Method	0.926	-	0.857
	4.1 Trial & Promotion	0.899	-	0.808
	4.2 Membership Activity & Discount	0.861	-	0.741
	Engenvalue λ	2.405	-	-
	% of Variance	80.177	-	-
	Cumulative (%)	80.177	-	-
Platform image & customer relation (IR)				
Platform image(IRP1)	5.3 Customer Consulting System	0.890	-	0.792
	5.4 Digital IP Protection	0.875	-	0.765
	5.1 Fame of Platform	0.863	-	0.745
	5.2 Number of Songs/Movies	0.850	-	0.723
	Engenvalue λ	3.025	-	-
	% of Variance	75.632	-	-
	Cumulative (%)	75.632	-	-

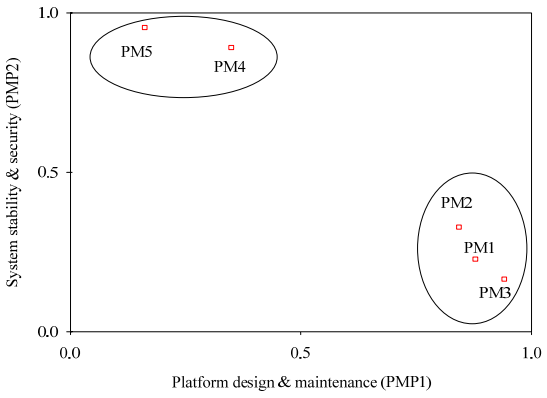

Fig.12. The PCA analysis of platform design & maintenance (PM)

4.3.2 Building the NRM of digital music service platform based on DEMATEL

This study divides DEMATEL into five steps: (1) calculate the original average matrix; (2) calculate the direct influence matrix; (3) calculate the indirect influence matrix; (4) calculate the full direct/indirect influence matrix; and (5) analyze the structure of NRM.

(1) Calculate the original average matrix

As the data shows in **Table 34**, the influence that "music search & recommendation (*SR*)" to "platform design & maintenance (*PM*)" is 2.545, which means "medium influence". On the other hand, the influence that "functionality of website platform (*PF*)" to "music search & recommendation (*SR*)" is 3.000, which means "high influence". The original influence value of aspect of PF (platform functionality of website) that influences *SR* (music search & recommendation) is the largest influence value among the original influence matrix, and the original influence value of aspect of *PP* (Pricing & promotion) that influences *PM* (Platform design & maintenance) is the smallest influence value among the original influence matrix. It means that *PF* will strongly dominate/influence *SR* and *SR* will weakly dominate /influence *PF*.

Table 34 Original influence matrix

Aspect	*SR*	*PM*	*PF*	*PP*	*IR*	Total
Music search & recommendation (*SR*)	-	**2.545**	2.964	2.709	2.727	10.945
Platform design & maintenance (*PM*)	2.491	-	2.764	2.709	2.836	10.800
Platform functionality of website (*PF*)	**3.000**	2.818	-	2.836	2.527	11.182
Pricing & promotion (*PP*)	2.527	2.436	2.491	-	2.527	9.982
Platform image & customer relation (*IR*)	2.673	2.764	2.782	2.709	-	10.927
Total	10.691	10.564	11.000	10.964	10.618	-

Note: The original influence value of aspect of *SR* that influences *PM* is 2.545, and the original influence value of aspect of PF that influences PF is 3.000.

(2) Calculate direct influence matrix

From **Table 34**, we processed the "original influence matrix (***A***)" by using Equations (1) and (2) and got the "direct influence matrix (***D***)". As shown in **Table 35**, the diagonal items of *D* are all 0, and the sum of a row is 1, at most. Then we calculated **Table 35** by adding up the rows and columns. In **Table 36**, the sum of the rows and columns for "functionality of website platform (*PF)*" is 1.984, which is the most important influence aspect. On the other hand, the sum of the rows and columns for "platform image & customer relation (*IR*)" is 1.855, which is the least important influence aspect. From the Table 5, we can understand the influenced importance between five aspects, so the aspect of *PF* (Platform functionality of website) is the most important direct influence aspect among the service platform.

Table 35 Direct influence matrix (*D*)

Aspects	*SR*	*PM*	*PF*	*PP*	*IR*	Total
Music search & recommendation (*SR*)	0.000	0.228	0.265	0.242	0.244	0.979
Platform design & maintenance (*PM*)	0.223	0.000	0.247	0.242	0.254	0.966
Platform functionality of website (*PF*)	0.268	0.252	0.000	0.254	0.226	1.000
Pricing & promotion (PP)	0.226	0.218	0.223	0.000	0.226	0.893
Platform image & customer relation (*IR*)	0.239	0.247	0.249	0.242	0.000	0.977
Total	0.956	0.945	0.984	0.980	0.950	-

Table 36 Comparison table of direct influence matrix

Aspect	Sum of row	Sum of column	Sum of row and column	Importance of Influence
Music search & recommendation (*SR*)	0.979	0.956	1.935	2
Platform design & maintenance (*PM*)	0.966	0.945	1.911	3
Platform functionality of website (*PF*)	1.000	0.984	**1.984**	1
Pricing & promotion (PP)	0.893	0.980	1.873	4
Platform image & customer relation (*IR*)	0.905	0.950	**1.855**	5

(3) Calculate Indirect Influence Matrix

The indirect influence matrix can be derived from Equation 3, as shown in **Table 37**.

Table 37 Indirect influence matrix (*ID*)

Aspect	*SR*	*PM*	*PF*	*PP*	*IR*	Total
Music search & recommendation (*SR*)	3.777	3.600	3.822	3.692	3.629	18.519
Platform design & maintenance (*PM*)	3.726	3.626	3.818	3.682	3.605	18.456
Platform functionality of website (*PF*)	3.827	3.688	3.991	3.797	3.742	19.046
Pricing & promotion (PP)	3.490	3.363	3.584	3.497	3.398	17.332
Platform image & customer relation (*IR*)	3.633	3.507	3.733	3.603	3.581	18.057
Total	18.453	18.453	17.784	18.948	18.271	

(4) Calculate full influence matrix

Full influence matrix ***T*** can be derived from Equations (4) or (5). **Table** 38 is the calculated full influence matrix. As shown in **Table 38**, the full influence matrix ***T,*** consists of multiple elements, indicated as Equation (6). The sum vector of the row value is $\{d_i\}$, and the sum vector of the column value $\{r_j\}$; then, let $i = j$, the sum vector of row value plus column value is $\{d_i + r_i\}$, which means the full influence of the matrix ***T***. As the sum of the row value plus the column value $\{d_i + r_i\}$ is higher, the relationship of the dimension or criterion is stronger. The sum of the row value minus the column value is $\{d_i - r_i\}$, which means the net influence relationship. If $d_i - r_i > 0$, it means the degree of influencing others is stronger than the degree to be influenced. As shown in **Table 39**, the ***PF*** aspect has the highest degree of full influence ($d_3 + r_3 =$ 53.109) as well as the highest degree of net influence ($d_3 - r_3$) =0.604). The order of other net influences is listed as follows: the ***SR***

aspect ($d_1 - r_1 = 0.502$), the ***PM*** aspect ($d_2 - r_2 = 0.459$), the ***PF*** aspect ($d_3 - r_3 = 0.348$), and the last one, the ***PP*** aspect ($d_4 - r_4 = -1.913$).

Table 38 Full influence matrix

Threshold value = 4.997	*SR*	*PM*	*PF*	*PP*	*IR*	Total
Music search & recommendation (*SR*)	**5.076***	**5.211***	**5.400***	**5.371***	**5.240***	26.298
Platform design & maintenance (*PM*)	**5.201***	4.969	**5.330***	**5.313***	**5.190***	26.002
Platform functionality of website (*PF*)	**5.370***	**5.309***	**5.275***	**5.463***	**5.312***	26.728
Pricing & promotion (PP)	4.893	4.841	**4.997***	4.802	4.864	24.396
Platform image & customer relation (*IR*)	**5.258***	**5.213***	**5.379***	**5.360***	**5.034***	26.244
Total	25.796	25.543	26.380	26.310	25.640	-

Note: * means the aspect is over threshold 4.997.

Table 39 Degree of full influence

Aspects	$\{d_i\}$	$\{r_i\}$	$\{d_i + r_i\}$	$\{d_i - r_i\}$
Music search & recommendation (*SR*)	26.298	25.796	52.094	**0.502**
Platform design & maintenance (*PM*)	26.002	25.543	51.545	**0.459**
Platform functionality of website (*PF*)	26.728	26.380	**53.109***	**0.348**
Pricing & promotion (*PP*)	24.396	26.310	50.706	-1.913
Platform image & customer relation (*IR*)	26.244	25.640	51.884	**0.604**

(5) Analyze the structural relationship map.

According to the defined aspects/criteria as shown in Table 2, some experts were invited to discuss the relationship and influence levels of criteria under the same aspects/ criteria, and to score the relationship and influence among criteria based on the DEMATEL technique. Aspects/criteria were divided into different types, so the experts could answer the questionnaire in areas with which they were familiar. In order to limit information loss from the DEMATEL technique's results, threshold values (*P*= 4.997) were determined after discussions with these experts and an acceptable NRM was found as shown in **Table 38 and Fig. 13**.. In Table 39**.**, it is obvious that the *PF* **(** $d_3 + r_3 = 53.109$**)** aspect has the highest full influence and the *IR* **(** $d_5 - r_5 = 0.604$**)** aspect has the highest net (received) influence, whereas the *PP* **(** $d_4 - r_4 = -1.913$**)** aspect has the weakest net influence (largest be received influence). In other words, the *IR* aspect dominates the whole value-created system. Therefore, if the service providers want to improve their service, they should consider improving the *IR* aspect first. *IR* influences all the other aspects. And then *PM*, *SR* and *PF* should also be considered. All these improvements will influence RR. **Fig. 13** illustrates the structural dimensionality of NRM among aspects in digital music platforms. **Fig. 13** also demonstrates the influence relationship that among the music service platform, the *PM* (Platform design & maintenance), *IR* (Platform image & customer relation) and *SR* (Music search & recommendation) are the main influence aspects, and these aspects influence each other. The aspect group (*PM*, *IR* and

SR) dominate the aspect of PF (Platform functionality of website) and *PP* (Pricing & promotion), so the platform function and service price are dominated by the supporting functions (the aspect group of *PM*, *IR* and *SR*) If we want the better service platform, then we should improve the supporting functions which include *PM* (Platform design & maintenance), *IR* (Platform image & customer relation) and *SR* (Music search & recommendation).

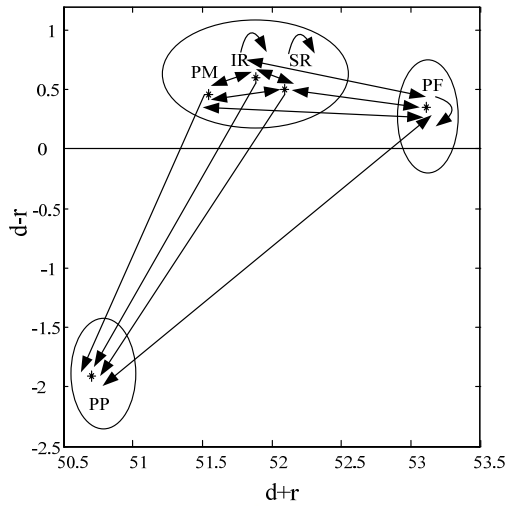

Fig. 13. The NRM for new e-era digital music service platform

We can understand the related influence structure of NRM for the new e-era digital music platform from Figure 5, the figure shows that the aspects of SR, PM, PF and IR are mainly influence aspects, and the aspect is mainly an influenced aspect. Therefore, our study wants to assist decision-makers to build an improvement process, so we conducted calculus on the net (be received) influence matrix using the full influence matrix (**Table 38**). The evaluated method can integrate the degree of influence of the aspect, so we can gain the net influence relationships of the five aspects. From **Table 40 and Fig. 14**, we can see that the IR aspect net influence of the aspect of SR, PM and PF, and then the aspect of SR net influence the aspect of PM, PF and PP. The aspect of PM net influences the aspect PF and PP, and then the aspect of PF influences the aspect of PP. So, the aspect of IR should be improved first, then the aspect of SR, PM and PF should be improved second. The aspect of PP is the least improvement item among all aspects. It's indirect for improving the service performance of the platform.

Table 40 The net influence matrix for new e-era digital music service platform

	SR	PM	PF	PP	IR
Music search & recommendation (SR)	-				
Platform design & maintenance (PM)	-0.011	-			
Platform functionality of website (PF)	-0.030	-0.021	-		
Pricing & promotion (PP)	-0.479	-0.472	-0.466	-	
Platform image & customer relation (IR)	0.017	0.023	0.067	0.497	-

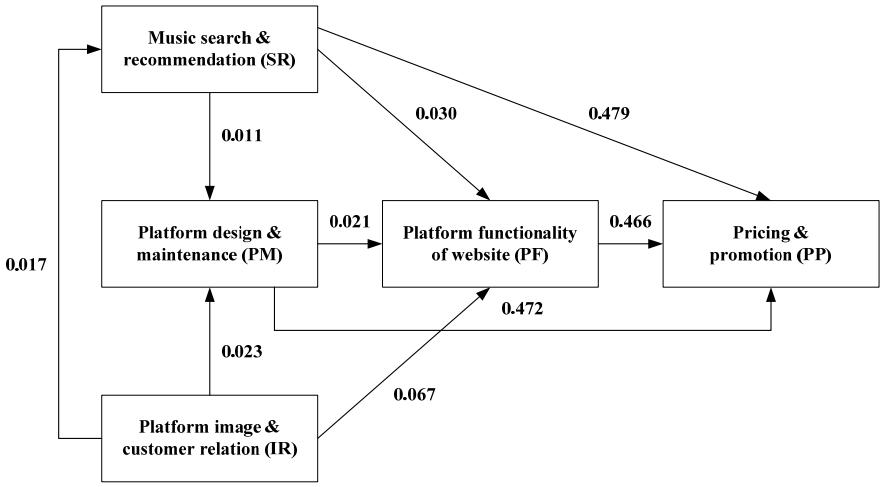

Fig. 14. The improvement strategy map for digital music service platform

4.3.3 The weights of component of digital music service platform based on ANP

The ANP method can be described as follows: 1. clarifies the questions and constructs the framework, 2. designs the questionnaires and the survey, 3. determines the relative importance of the factors by pair-wise comparisons to calculate factor weights by dependence and feedback, and checks the consistency of logical judgment, 4. calculates the supermatrix, and 5. determines the factor weights.

(1) Clarifying the questions and constructing the structure of the evaluating system

The essentialities of the questions induce all possible elements affecting the decision-making as follows. The researchers should clarify and induce all information about the questions. The researchers should propose the result composed of the goal, hierarchy, criteria and feasible solutions to the expert for reference. They should then use the brainstorming method to determine how the elements affect decision-making. When constructing the evaluating system, the relationships (including dependence and feedback) between different hierarchies should be connected as an arc, a one-way arrow or a two-way arrow, as shown in **Fig. 13**.

(2) Designing the questionnaire and surveying the effect

According to the evaluating system, the expert should make the judgment of the degree of the relative importance of the dimensions/criteria. The research should adapt the questionnaire method to produce the desired effect.

(3) Pair-wise comparison to determine the relative importance of the criteria

ANP procedures to gain the weights are described as follows:

(1) Conduct a pair-wise comparison of the relative importance of the factors and obtain an *n* x *n* pair-wise comparison matrix, in which *n* means the number of criteria. As the data shows in **Table 41,** a pair-wise comparison can be gained.

(2) Check the consistency of logical judgment using both the consistency index (*C.I.*) and the consistency ratio (*C.R.*). The *C.I.* value is defined as $C.I. = (\lambda_{max} - n)/(n-1)$ and the λ_{max} is the largest eigenvalue of the pair-wise comparison matrix. The *C.R.* value is defined as *C.R.* = *C.I./R.I.* and *R.I.*: random index. The *R.I.* value is decided by the value of n. In general, the values of *C.I.* and *C.R.* should be less than 0.1, or reasonably consistent (**Table 42**).

(3) Use the normalized eigenvector of the largest eigenvalue (λ_{max}) as the factor weight (**Table 43**) The purpose of the ANP enquiry in this paper is to construct a hierarchical evaluation system.

Table 41 Pair-wise comparison

Criteria	PMM1	PMM2
Platform design & maintenance (PMM1)	1[1]	3/8[2]
System stability & security (PMM2)	8/3[3]	1

Note 1: In the label [1], 1 means PMM1 is as important as PMM1.
Note 2: In the label [2], 3/8 means PMM1 is 3/8 times important as PMM2.
Note 3: In the label [3], 8/3 means PMM2 is 8/3 times important as PMM1.

Table 42 The testing of consistency (C.I. testing)

$C.I. = (\lambda - n)/(n-1); n = 2$	0
Threshold value	0.1

Note: Niemira & Saaty [32] suggested the reasonable values of C.I. and C.R. should be less than 0.1.

Table 43 The factor weights (pre and post normalization)

Component		Pre-normalization	post-normalization
Platform design & maintenance (PMM1)	PMM1	0.351	0.273
System stability & security (PMM2)	PMM2	0.936	0.727
	Total	1.287	1.000

Note: Pre-normalization means the largest eigenvalue as the factor weights while post-normalization means the criteria weights.

(4) Calculating the super matrix

The super-matrix can be gained by $(\boldsymbol{M} \times \boldsymbol{M})^{2k+1}$, where k is determined by assumption. Based on the independent criteria obtained, and the reduced criteria derived, the ANP method could gain the weights of criteria and then obtain the final effectiveness of the service

platform of digital music (**Tables 44~47**).The criteria weights can be gained by using the ANP method. In the process of limitation, multiples of the super matrix ***M*** for 28 squares, and the weights, can be obtained. The results are shown in **Table 47**. In this paragraph, the parenthetic value means the weight of the aspects and components. The highest weight from PCA is the Platform functionality (51.98%), followed by the pricing and promotion model (22.79%). The component weights the music search & recommendation model (16.38%), system stability & security (3.56%), platform image (2.97%) and platform design & maintenance (2.32%) as shown in **Table 47**.

Table 44 Original super-matrix

Components	SRM	PMM1	PMM2	PFM	PPM	IRM
Search & recommendation (SRM1)	1.000	1.000	1.000	1.000	0.000	1.000
Platform design & maintenance (PMM1)	0.400	0.000	0.000	0.400	0.000	0.273
System stability & security (PMM2)	0.600	0.000	0.000	0.600	0.000	0.727
Platform functionality (PFM1)	1.000	1.000	1.000	1.000	1.000	1.000
Pricing & promotion (PPM1)	1.000	1.000	1.000	1.000	0.000	1.000
Platform image (IRM1)	1.000	1.000	1.000	1.000	0.000	1.000

Table 45 Weighted super matrix

Components	SRM	PMM1	PMM2	PFM	PPM	IRM
Search & recommendation (SRM1)	0.211	0.230	0.230	0.211	0.000	0.211
Platform design & maintenance (PMM1)	0.033	0.000	0.000	0.033	0.000	0.022
System stability & security (PMM2)	0.049	0.000	0.000	0.049	0.000	0.060
Platform functionality (PFM1)	0.376	0.409	0.409	0.376	1.000	0.376
Pricing & promotion (PPM1)	0.293	0.319	0.319	0.293	0.000	0.293
Platform image (IRM1)	0.038	0.042	0.042	0.038	0.000	0.038

Table 46 Limited super matrix

Components	SRM	PMM1	PMM2	PFM	PPM	IRM
Search & recommendation (SRM1)	0.1638	0.1638	0.1638	0.1638	0.1638	0.1638
Platform design & maintenance (PMM1)	0.0232	0.0232	0.0232	0.0232	0.0232	0.0232
System stability & security (PMM2)	0.0356	0.0356	0.0356	0.0356	0.0356	0.0356
Platform functionality (PFM1)	0.5198	0.5198	0.5198	0.5198	0.5198	0.5198
Pricing & promotion (PPM1)	0.2279	0.2279	0.2279	0.2279	0.2279	0.2279
Platform image (IRM1)	0.0297	0.0297	0.0297	0.0297	0.0297	0.0297

Table 47 The aspect/component weight with ANP method

Aspects	Component	ANP weight (%)	Weight rank
Music search & recommendation (SR)	Search & recommendation (SRM1)	16.38	3
Platform design & maintenance (PM)	Platform design & maintenance (PMM1)	2.32	6
	System stability & security (PMM2)	3.56	4
Platform functionality of website (PF)	Platform functionality (PFM1)	51.98	1
Pricing & promotion (PP)	Pricing & promotion (PPM1)	22.79	2
Platform image & customer relation (IR)	Platform image (IRM1)	2.97	5
Total		100.00	-

4.3.4 The service preference of digital music platforms based on VIKOR model

In this section, we analyze customer satisfaction degree (0~10) based on the collected

samples. The samples are categorized into two service styles and four providers: the pay music platform (A_1 and A_3) and the P2P free file exchange website (A_2 and A_4). These two groups are used to evaluate the rank of service performance of the four digital music service platforms.

(1) Determine the aspired/desired level f_i^* and the worst f_i^- value

The value of the *i*th criterion function goes from 0 to 10. In equations (17) & (18), as shown in **Table 48**, we find that *k* is the *k*th alternative of criterion *i*; f_{ik} is the performance value of the criterion *i* in alternative k; I_1 is the cluster of utility-oriented criteria; I_2 is the cluster of cost-oriented criteria; f_i^* is the positive-ideal solution (setting the aspired/desired level by decision-making based on users' needs); and f_i^- is the positive-ideal solution (setting the worst value by decision-making based on users). f_i^* is assumed to be 10 and f_i^- is assumed to be 0. This aids in discussing the gap of satisfaction degree.

Table 48 The score of f_{ik}

Components	Weight	A1	A2	A3	A4	f_i^*	f_i^-
Search & recommendation (SRM1)	0.1638	7.50	6.08	6.90	5.48	10	0
Platform design & maintenance (PMM1)	0.0232	7.19	5.44	7.27	5.46	10	0
System stability & security (PMM2)	0.0356	7.42	**4.33**	6.30	**3.77**	10	0
Platform functionality (PFM1)	0.5198	6.83	5.83	6.66	5.49	10	0
Pricing & promotion (PPM1)	0.2279	**6.50**	5.50	**6.20**	5.23	10	0
Platform image (IRM1)	0.0297	7.77	4.54	6.70	5.44	10	0

(2) Compute the values of S_k and Q_k, $k = 1, 2, \cdots, m$

In referring to equations (19) & (20), we find that w_i are the weights of the criteria, expressing the relative importance value of the criteria via the application of the ANP method. As shown in **Table 49**, among the value-oriented criteria, the lowest S_k is 0.308 of the A_1 service platform and the highest S_k is 0.463 of A_4 service platform. In addition, the lowest Q_k is 0.350 of A_1 service platform and the highest Q_k is 0.623 of A_4 service platform.

Table 49 The weighted value of the components of f_{ik}

Components	Weight	A1	A2	A3	A4
Search & recommendation (SRM1)	0.1638	0.250	0.392	0.310	0.452
Platform design & maintenance (PMM1)	0.0232	0.281	0.456	0.273	0.454
System stability & security (PMM2)	0.0356	0.258	0.567	0.370	0.623
Platform functionality (PFM1)	0.5198	0.317	0.417	0.334	0.451
Pricing & promotion (PPM1)	0.2279	0.350	0.450	0.380	0.477
Platform image (IRM1)	0.0297	0.223	0.546	0.330	0.456
S_k	-	0.308	0.430	0.340	0.463
Q_k	-	0.350	0.567	0.380	0.623

(3) Compute the value of R_k

The compromised solution is stable within a decision making process, which could be the strategy to achieve maximum group utility (when $v > 0.5$ is needed), by consensus" $v = 0.5$, or"with veto"($v < 0.5$). Here, v is the weight of the decision making strategy of maximum group utility. The v would be assumed to be 0.5 for considering a maximum group utility of the "majority", and a minimum individual regret of the "opponent". In referring to equations (20) ~ (21), $\underset{k}{\text{Min}}\, S_k$ is with a maximum group utility ("majority" rule) and $\underset{k}{\text{Min}}\, Q_k$ is with a minimum individual regret of the "opponent" for prior improvement. R_k is the indicator of gap in alternative k (the smaller is the better). As shown in Fig. 15, the R_k of A_1 ~ A_4 would be reduce as v rise form 0 to 1.

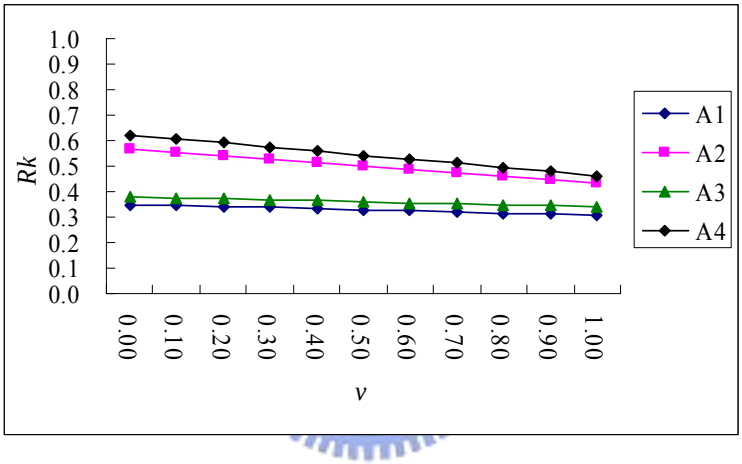

Fig. 15. The R_k under different v

(4) Rank the alternatives

The R_k under different v is shown in **Tables 50**. R_k (here v =0.5) is applied to determine the customer satisfaction index (CSI). R_k could also consider the index of the maximum group utility and the minimum individual regret of the "opponent", where R_k **means** smaller is better and $0 \leqq R_k \leqq 1$. However, this research prefers $1 - R_k$ for evaluation, which means $1 - R_k$ bigger is better. When the v value of CSI is 0.5, then V= R_k and CSI=$1 - R_k$. Therefore, CSI of different alternatives could be gained. As shown in **Table 51**, under v=0.5, R_k =0, CSI=1 of A_1 service platform and R_k =1, CSI=0 of A_4 service platform. The CSI rank of service platform are $A_1 \supset A_3 \supset A_2 \supset A_1$. The pay service platforms of digital music (A_1 and A_3) are better than P2P service platforms (A_2 and A_4) of digital music.

Table 50 R_k under different v (CSI)

v	A1	A2	A3	A4
0.00 (Q_k)	0.350	0.567	0.380	0.623
0.10	0.346	0.553	0.376	0.607
0.20	0.342	0.539	0.372	0.591
0.30	0.337	0.526	0.368	0.575
0.40	0.333	0.512	0.364	0.559
0.50	**0.329**	**0.498**	**0.360**	**0.543**
0.60	0.325	0.485	0.356	0.527
0.70	0.320	0.471	0.352	0.511
0.80	0.316	0.458	0.348	0.495
0.90	0.312	0.444	0.344	0.479
1.00 (S_k)	0.308	0.430	0.340	0.463

Table 51 The CSI ranks for service platforms of digital music

v=0.5	A1	A2	A3	A4
R_k	0.329	0.498	0.360	0.543
CSI	0.671	0.502	0.640	0.457
Rank	1	3	2	4

4.3.5 Discussion

The Table 51 demonstrates the CSI ranks of service platforms. It is clearly that $A_1 \supset A_3 \supset A_2 \supset A_1$. The pay service platforms of digital music (A_1 and A_3) are better than P2P service platforms (A_2 and A_4). Table 48 **shows** that PPM1 (pricing & promotion) is the component that gets the lowest score of satisfaction of pay service platforms of digital music (A_1 and A_3) while PMM2 (system stability & security) is the component that gets lowest score of satisfaction of P2P service platform of digital music (A_2 and A_4).

This means that customers don't satisfy the pricing & promotion of pay services platform of digital music, so the enterprises of pay service platform of digital music should provide different favorable service packages for both new users and long term users, such free service experience of new users and long term discount of long term users. Then customers don't satisfy the system stability & security for P2P service platform of digital music. So the service providers need to improve their stability & security system and reduce the possibilities of computer intoxications and system invasions to user devices. Table 9 shows that the aspects of net influence ($d - r > 0$) are platform images & customer relations (IR), music searches & recommendations (SR), platform design & maintenance (PM), and platform functionality of website (PF). This means that the most valuable utility that the music platform provides is platform images & customer relations (IR). Besides, the NRM do help in finding the improvement paths for service platform of digital music as shown in Fig.4.

Chapter 5
Conclusions and remarks

5.1 conclusions

5.1.1 The value created system of science (technology) park

In this paper, we would like to build the value-created system of science (technology) park. In the early development progress of HSP, HR is supported by technology transferring abroad and foreign cultivation. Later, NCTU, NTHU and ITRI played a role in brain cultivation and training. From the positive point of view, HSP provides a platform for spin-offs, spin-ins or product commercialization initiated by academia or ITRI. Relativity, academa and R&D institutes created well informed people. From the negative point of view, the R&D requests from HSP would disperse R&D resources of R&D institutes which should focus their resources on fundamental R&D. Therefore, those R&D institutes would hire new R&D human brains to cover the leakage on fundamental R&D. In the short run, the gap of the shortage of R&D brains seems to have vanished. However, in the long run, with the trend of globalization, R&D brains would move freely between various R&D institutes. Once the high turnover rate of R&D institutes happens, the gap of the shortage of R&D brains would be larger. That would have negative effects not only on decreasing the self R&D ability of inside enterprises, but also on weakening the penetration effect of R&D institutes. The best solution to solve the dilemma is suggested as follows. For enterprises, HSP can build its own R&D abilities. Those R&D institutes should focus on fundamental R&D and diffuse their fruitful results to enterprises for solving their R&D problems by technology transferring or collaboration. Therefore, the hit of misallocation of R&D resources could be lower down. In reference to HR, through reviewing the development progress of NTP, the human power came from various channels. Therefore, it is important to build the mechanism of brain cultivation for continuously attracting talent to work in NTP. Enterprises generally agree that they should set up their own R&D centers for brains cultivating and training, but less enterprises fulfill the ideal. The government should afford the inducements of mutual R&D for enterprises. This is especially important for small NTBFs. In the early stages, those R&D centers and incubators afford commercial R&D projects to support the operation of NTBFs. In the long run, cooperation models for enterprises and related human resources platforms should be constructed not only to gather talents and technologies but also to solve the problems of shrinking the gap of talents and technologies gradually.

In reference to TR, in the early development process of HSP, R&D and technologies services were supported by foreign technology transferring or licensing, and so far, have been replaced by NCTU, NTHU and ITRI. As enterprises have built their own R&D abilities, ITRI has changed its roles from R&D supporting to technology services and incubation services. The TR strategies of HSP should be considered thoroughly to prevent the problems of resource misallocation and wastes. Specialty oriented and shared resources are the main thought. Academa should focus on innovated R&D demanded to be implemented within 20 to 30 years. ITRI should develop industrial technologies needed to be implemented within 10 years. Leading companies of HSP should develop commercialized technologies via collaboration or cross-licensing is needed to be implemented within 5 years. Eventually, ITRI shall play the roles of technologies integration and incubation services. It will find the required technologies and patents from universities and license these technologies and patents via a fair transaction system. ITRI should utilize those licensed technologies and patents to spec-in industry products or to cultivate new start-ups. This not only relieves the concerns regarding insufficient foresight of R&D inputs but also solves the problems concerning a shortage of R&D resources for new start-ups. In HSP, R&D and technologies services derived from foreign technology transferring or licensing, and famed domestic R&D units. It is nice that multinational enterprises and domestic firms could build their own R&D abilities nearby. However, other HSP enterprises are facing a shortage of technology supporting. Though the government might not set up to national R&D institutes nearby, it can build institutes that resemble the ITRI College to execute MOEA R&D projects and plan industrial technologies sharing community. Enterprises could collaborate or share their technology information via a mechanism. New start-ups could execute partial MOEA projects for funding, and become a member in their R&D value chain. The MOEA project encourages the internationally famous enterprises to set-up R&D centers in Taiwan. Through such measures, NTBFs could cooperate with such international enterprises and enroll themselves in the regional cooperation value chain. In reference to investment environment, the investment strategy is different between HSP and NTP. HSP is backed by government's policies, so the government shall operate it actively. The government shall improve local infrastructures (information infrastructures and regional traffic networks), and enlarge the territory for larger capacity for residing inside the park. Therefore all HSP's enterprises could obtain the benefit of economies of scale through the cooperation network. NSP was formed naturally by the cluster of enterprises. The government shall enlarge the territory for the larger capacity for residing inside, lose the limitation of stationed enterprises to enlarge the scale of industries,

improve regional traffic networks to promote the transportation efficiency, and enhance regional infrastructure construction. The common strategy of HSP and NTP is of expanding its scale for pursuing economies of scale. HSP is improving its infrastructure first and enlarging its territory later. However, NTP is doing this inversely.

In reference to market development, exporting was found to be the driving force for market development in the beginning. HSP's enterprises competed with international competitors by their production and operation efficiency. Those enterprises have to be continuing re-allocating their resources, keeping high value-added products and outward low value-added ones. Therefore, HSP has changed its strategy from technologies input to technologies output. Enterprises must continuously copy the successful production models and processes to those areas of low-cost resources (land or labor), and earn high profits by expanding the scale of investment. HSP must keep actions of technology upgrades and innovation continuously, and become the benchmark park of the production process which needs lots input of human and technology resources.NSP is formed naturally by the cluster of enterprises, and then international markets are their main target. NTP which is without clusters of production and marketing attracts the information software service industry, electronic component industry and telecommunication industry to reside inside and forms its working model. The continuous residence of international firms also attracts the residence of enterprises in the industry value chain. NTP is near Taipei city which is the political and commercial center in Northern Taiwan. The information infrastructures and transportation systems were built well. Those environments and conditions are good for setting up the operations headquarters and the R&D center of international enterprises. NTP shall position its function of regional services integration center here. NTP could utilize its abilities of R&D and marketing, integrate Taipei's financial system and the production base (like HSP) and apply the local logistical systems (Taoyuan (Taipei) international airport and Keelung port). Therefore, NTP could become the regional operations center for international enterprises.

5.1.2 The improvement strategy of vehicle telematics system

The VTS industry consists of hardware suppliers, software suppliers; telematics service providers, content suppliers and telecommunications suppliers. TSP integrates the system and provides kinds of services via telecommunications networks, playing the key role. Referring to successful cases of foreign VTSs regarding services and utilities, TSPs who will succeed or fail in the market depend on the achievement of a degree of satisfaction of consumers' needs. U.S. and European TSPs focus on safety and security services, while the Japanese TSPs first

provided navigation and location services, and have added communications and information services and audio-video and entertainment services in recent years. The Taiwanese TSP first provided adjusted navigation and location utilities on the basis of Japan's technologies, and has recently begun providing safety and security utilities due to a high rate of car theft and frequent stowaway execution in Taiwan. As a result, consumers' needs for the VTS would vary across cultures and regions. Commercial VTSs in four regions (i.e. North America, Western Europe, Japan and Taiwan) were applied for empirical analysis. The results demonstrate that different ages of consumers will influence the preference of desired utilities for the VTS. Those comments can help automotive manufacturers in developing new e-era generation VTS, and in modulating the service functions and spec-in target consumers' requirements for customized purposes. This paper suggests that TSPs could improve the current utilities or initiate new utilities on the basis of Japan's or Taiwan's existing VTSs to shorten the time to market.

5.1.3 A service selection of digital music platform

In the aspect of platform images and customer relations (IR), the numbers of songs/movies, customer consulting systems and digital IP protection systems will affect the appreciation of platform images and customer relations. The first improvement should be digital IP protection. Users deemed that the importance and satisfaction level were all low for digital IP protection. This means that consumers are still unsatisfied with licensing music. The vendors should keep improving the stability of licensing sources of the music. In the aspect of pricing and promotion (PP), vendors should improve in trial, promotion, pricing and the service method. This study discovered that consumers are interested in free media player promotion programs. Users feel the trial period of current pay music service platforms is too short and doesn't provide enough service items methods by the service platform. Vendors should improve these two issues. The membership activity and discount is not helpful to promotion. If the vendors put resource into small gifts or sending autographed pictures, it may be helpful.The function of website platform is the core aspect of the service. The music streaming services are categorized as on-line and off-line listening. On-line listening is a basic function; and also provides dynamic lyrics to help consumers learn the song. So we suggest that the providers should improve this function as their first priority. It can not only improve the service quality, but also differentiate from other P2P websites. Vendors should increase the flexibility of using media carriers for off-line listening, which enables consumers to store the music in their PC, mobile phone or MP3 player and enhances their personalized

setup function. The personalized setup function includes the music list, list for sharing, link to other communities, on-line discussion and personal interface setting. The main purpose for consumers to use the music website is to download music, and, however, the on-line community operation can aggregate the number of consumers. There have been numbers of studies discussing the operation of virtual communities. Since the platform is the core, the providers need to improve the functions and use differentiated and innovative services to please customers' satisfaction.

5.2 Remarks

Three empirical industry's issues had been analyzed in this thesis. The fist issues would discuss the improvement of industrial environments. The government could manipulate industrial development policies to improve the investment environment of Taiwan's high-tech industries and further raise the competitive competence of industries in Taiwan. The second issue would discuss the innovation of products in the telecommunication industry and how to raise the competitive competence of high-tech industries via product innovations. The third issue would discuss the innovation of internet services and how to raise the competitive competence of internet services industry through improving the quality of services.

Therefore, there are three main forces supporting the growth and development of Taiwan's high-tech industries described as followings. 1. Creating the good industrial investment could support industrial developments such as science parks in Taiwan. Science parks in Taiwan create their competitive advantages by the benefit of industrial cluster. It not only creates the cluster of the semi-conductor industry, but diffuses the effect upon telematics service industry and optic-electronic industry in Taiwan. 2. Manufacturing niche products could create competitive advantages, for example, telecommunication devices (such as the vehicle navigation device). 3. The industrial innovation platform could raise the competitive competence of service industrial. By the popularity of internet, all commodities and services could be provided and accepted via internet, and therefore platform services would be the main driving force to support the growth and development of Taiwan's high-tech industries in the next generation.

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論文獲獎:

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13.**林家立**、羅應浮、陳柏宇、曾國雄，(2008)“創新多評準決策分析建構電視購物平台發展策略”，國立台北科技大學商業管理研討會，台北科技大學，台北市

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15.**林家立**、鄭卉晴、曾國雄、陳錡雄(2008)“嬰兒死亡案件無過失補償制度之經濟分析”，第三屆全國法學實證研究研討會，交通大學，新竹市

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