國立交通大學

工業工程與管理學系

博士論文

應用 TRIZ 於服務品質創新之研究：

以電子商務產業為例

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with A Case Study on E-Commerce

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近年來，TRIZ 理論的獨特見解已顯示是一種結構完整且具創新價值的問題解決方法，且被廣泛地應用於科技工程與非科技領域。目前一般企業對於所進行的產品或服務品質之改善及創新，經常是依賴設計人員的靈感或過去經驗，使得創新或改善的效率及品質不佳，間接影響到顧客的滿意程度。因此，本研究應用 TRIZ 理論的創新模式，提供一個系統性的產生創新服務的架構，使得服務設計人員更有效率地解決面對的問題，以滿足顧客對服務品質的要求。

在應用 TRIZ 進行問題解決過程中，當使用到矛盾矩陣(Contradiction Matrix)時，常會發生由於 TRIZ 工程參數(Engineering Parameter)選擇的不恰當，而影響到所選取的發明原則，造成不適當的結果。本研究提出藉由建構一個 39 項 TRIZ 工程參數的對照表，提供使用者在運用 TRIZ 矛盾矩陣解決問題時，可以正確地找出合適的 TRIZ 參數。首先在確定所面臨問題所屬的產業別之後，針對該項產業服務品質的可能影響因素，廣泛地進行探索性研究，找出重要之決定因素；接著藉由影響服務品質的決定因素與 TRIZ 的 39 個工程參數之間的解釋意涵，類比配對出一個參數對照表；同時，將此參數配對結果，經由該產業與服務品質專家的問卷調查意見，確定參數配對的合適與否，並利用統計方法，檢定確認專家

對此參數配適結果意見之一致性。於是所建構的參數對照表，可作為使用者在運用 TRIZ 矛盾矩陣解決問題時，能夠經由影響該問題的主要服務品質要素，快速且正確地對照出合適的 TRIZ 參數。

此外，在應用 TRIZ 進行問題解決過程中，於探索問題本質的分析階段，對於客戶的需求，甚至問題的根本原因，常會因為溝通過程中語意的認知不同，造成無法確切分析出影響顧客滿意的真正要因。因此，本研究建議應用模糊品質機能展開(Fuzzy Quality Function Deployment)的方法，協助分析顧客需求與服務品質決定因素之間的關係，以便明確指出與顧客滿意相關的關鍵性服務品質要素，加上應用所建構的參數對照表，協助有效找出相對應的 TRIZ 工程參數，進而應用 TRIZ 矛盾矩陣，找出適切的創新原則，尋求有效的創新解決方案。

本研究以一家電子商務公司的服務創新問題改善為例，應用所提出的系統性創新服務品質方法，解決該公司所面臨的顧客滿意改善問題，其結果說明了本研究所提出架構的可行性，同時也驗證應用 TRIZ 在特定產業服務品質創新上的實用價值。

關鍵字：TRIZ，服務品質，創新，模糊品質機能展開，電子商務

A Systematic Approach for Service Quality Innovation by TRIZ with A Case Study on E-Commerce

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In recent years, TRIZ methodology with its unique thinking has proved to be a well-structured and innovative way of problem-solving in technical and non-technical areas. Up to the present time, the practice of generating new products or services has mostly depended on the brainstorming, lateral thinking, or mind mapping methodology of the experienced practitioners; thus, in the starting state of new ideas generation, especially with unknown causes and unknown search directions, it is frequently limited to overcome the psychological inertia inherent in human thinking to strive for generating creative results. With this, this study focuses on proposing a systematic approach to effectively achieve the innovative services and to improve the service quality.

When developing a systematic process integrating with TRIZ methodology, especially with applying the TRIZ contradiction matrix, the inappropriate selection of TRIZ engineering parameters will influence the inadequate reference of inventive principles, and consequently, the infeasible solutions are acquired. Therefore, a parameter corresponding table is constructed to provide practitioners with an efficient way to extract the appropriate TRIZ parameters relating to the specified problem, and enable the indication of effective inventive principles. From this, the parameter

corresponding table is first developed from extracting the determinants of service quality based on a comprehensive qualitative study on the specified sector, then second, the analogical corresponding results between the determinants of service quality in the specified sector and the 39 TRIZ engineering parameters are formulated. After this, a validity test on the parameter corresponding results is conducted by administrating a questionnaire to the experts in the fields of the specified sector, service quality, and TRIZ. Consequently, the parameter corresponding table is validated in terms of its feasibility to be used in the specified sector.

Besides, when the problem solvers focus on the process of formulating the problems, in practice, the uncertain and ambiguous expression of the opinions among them is usually occurred to impede the consensus of the discussion, and it will affect the invention levels of generated solutions consequently. Therefore, in this study, a systematic procedure is proposed to overcome this vagueness in problem formulating period by applying the relationship matrix of Fuzzy QFD (Quality Function Deployment) to analyze the imprecise and subjective problem information, and be able to clarify the dominant determinants within the essentials of the problem, and then by using the parameter corresponding table which we developed aforementioned, the appropriate 39 TRIZ engineering parameters can be effectively acquired. This consequently results to attaining the desired creative outcomes.

Finally, the effectiveness of our proposed framework is illustrated in an e-commerce company. The practical results from the studied company show the effectiveness of our approach in service quality improvement in the e-commerce industry, as well as indicate the valuable contributions of the TRIZ methodology in the service sector.

Keywords: TRIZ, Service Quality, Innovation, Fuzzy QFD, E-Commerce

誌　謝

已過不惑之年再進入校園，秉持的是對自己的承諾，並且有機會回頭再當學生，更是自己一生的福份，可是這段期間，沒有許多貴人的相助，個人是無法順利完成學業的。首先要感謝的是恩師蘇朝墩教授，在剛入學猶處於徬徨之際，有幸能與恩師結緣，讓自己找到一個研究的方向，並且在恩師不斷的協助與教導下，總算把學業告一段落，在此，衷心的感謝恩師所賜予的一切。

同時，同門師兄弟們給我的各種關照，也要在此深深地向他們表達感謝之意，包括志華、俊欽、隆昇、健炘等學長，還有同一實驗室的家任、宇翔等學弟，他們幫忙解決了自己無法常在學校裡的困擾，也幫忙自己在許多基本學科上做更進一步的鍛鍊，在此，務必再一次的感謝他們。還有與同班同學泰盛、建和、昌輔、俊穎等的並肩作戰，在學校修課的過程中，也都留下了深刻的回憶。

當然，我也要藉此表達對摯愛的妻子喬芳深深的感謝，因為有她的體諒與支持，在這三年多的日子裡犧牲自己處理家裡的一切事務，加上家母、岳父母們的協助照顧家庭，才能讓我無後顧之憂，專心的完成學業。最後，我也希望能將自己今天的一點歡愉，獻給先父，同時也給兩位可愛的女兒祐如、宴存一個榜樣，所有事情，只要努力不懈、堅持到底，終究會得到成功的果實。

僅此，再一次的向所有恩典於我的貴人，表達內心最誠摯的謝意！

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CHAPTER 1 INTRODUCTION

1.1 Overview

Service quality has been a frequently studied topic in the service marketing literature. In the last three decades, studies on service quality have been undertaken by researchers to be able to define and understand what service quality really is. Parasuraman et al. (2005) found from early researches that service quality stems from the comparison of what customers feel a company should offer and the company's actual service performance. However, even though there is an increasing number of companies which are realizing the importance of service quality and customer satisfaction, it is not always clear how to achieve these goals for these companies.

In today's competitive environment, especially, when the world economy has seen strong growth in the service sector, the pursuit of perceived services to meet customer's expectation is now considered be essential to get success. Unlike manufacturing sectors, service contains a common theme of intangibility and simultaneous consumption; service sectors typically do not apply rigorous process design standards prior to introducing the new services (Fisk et al., 1993). These characteristics collectively hindered service providing and make it more challenging than physical product manufacturing. Therefore, in order to remain competitive in the service market, a company should actively seek creative ways to generate differentiated services which can satisfy customer's expectation (Zhang et al., 2005).

From this respect, the main challenge facing companies is the need to continuously provide the service market with advanced services. How should companies go about creating new services? How can this process be made explicitly effective? Hence, the development of a valid methodology for the successful acquisition and provision of

innovative services is the pivotal concern of companies. With this, the dissertation focuses on proposing a systematic approach to effectively achieve the innovative services and to improve the service quality.

1.2 Motivations

The topic of new service development has for a long time been largely neglected, not just in practice but also in service research (Bullinger et al., 2003). In general, it is agreed by most of the service researchers that it is a poor strategy to develop new products only by luck (Zhang et al., 2005). Up to the present time, the practice of generating new products or services has mostly depended on the brainstorming, lateral thinking, or mind mapping methodology of the experienced practitioners; thus, in the starting state of new ideas generation, especially with unknown causes and unknown search directions, it is frequently limited to overcome the psychological inertia inherent in human thinking to strive for generating creative results.

In response, among the corporate structures and processes had been efficiently developed and implemented on the market in recent years, TRIZ researchers have utilized a number of successful process models to validate the method's effectiveness in creating and improving new services (Ishida, 2003). Although TRIZ was initially proposed for engineers and scientists as a systematic creativity and innovations methodology, recently, it has been applied in a wide range of fields from engineering to biomedicine, agriculture, social relations, business and management, etc.(Mann, 2000; Retseptor, 2003; Lau, 2004).

As a review of the existing literature, Domb and Mann (2001) pointed out that the strength of TRIZ as a method for developing creative solutions to problems is the removal of contradictions rather than the use of the conventional approach by means of compromises or tradeoffs. At this point, there are a number of ways forward, but within

the TRIZ tool set, contradiction analysis is the most frequently and widely used method for the elimination of contradictions which arise from the problem (Webb, 2002). The contradiction analysis process requires a matrix formed by 39 parameters or features of the technological systems and 40 types of inventive principles that originally invented by Altshuller who had investigated and classified over 400,000 patents worldwide (Liu and Chen, 2001). However, there are few researches found to provide a well-structured methodology in eliminating the contradictions of service quality when designed a new service, but TRIZ is unique in that it offers problem solvers a tangible tool to actually eliminate the compromises. From this, by way of developing a systematic approach with integrating TRIZ methodology is considered to be able to effectively enhance the service quality in service industries.

1.3 Objectives

When TRIZ is extended to a wider area of applications, Zhang et al. (2003) found that the 39 generic parameters and the 40 inventive principles are required to be modified in order to reflect their distinct characteristics for a growing diversity of technological areas. As compared to the extensive discussions on the 40 inventive principles of TRIZ, the modification of 39 engineering parameters pertaining to business-type problems is rarely mentioned in academic articles. Mann and Domb (1999) also observed that this modification is lengthy and time-consuming to update from the renewed patent database. Therefore, we are not going to modify the 39 TRIZ engineering parameters in this study, but instead, when developing a systematic process integrating with TRIZ methodology, we attempt to construct a parameter corresponding table to provide practitioners with an efficient way to extract the appropriate TRIZ parameters relating to the specified problem, and enable the indication of effective inventive principles. From this, the frequent discrepancy in mapping up the essentials of

the 39 TRIZ engineering parameters and the dominant determinants of the problem can be resolved.

In addition, Webb (2002) indicated that TRIZ process starts with stripping away the side issues and preconceptions to define the core problem which involves breaking the problem down into its most elementary components, understanding each one and expressing the components in the most elementary or fundamental way, and then, freeing oneself from the constraints of the language in which the problem is expressed. At this point, the TRIZ process relies on the problem solvers to actually look at the essential of the problem and conceptualize the critical characteristics of the problem. From the beginning of TRIZ process, the problem solvers need to clearly discuss and analyze the contradictory relationship within the specified problem. In practice, when the problem solvers focus on the process of formulating the problems, the uncertain and ambiguous expression of the opinions among them is usually occurred to impede the consensus of the discussion, and it will affect the invention levels of generated solutions consequently. Therefore, in this study, a systematic procedure is proposed to overcome this vagueness in problem formulating period by applying the relationship matrix of Fuzzy QFD to analyze the imprecise and subjective problem information (or it can refer to the customer requirements), and be able to clarify the dominant determinants within the essentials of the problem, and then by using the parameter corresponding table which we developed aforementioned, the appropriate 39 TRIZ engineering parameters can be effectively acquired. This consequently results to attaining the desired creative outcomes.

1.4 Organization and Research Framework

The remainder of this study is divided into four sections. The second chapter describes the related works in the development of service innovation, the TRIZ

methodology and the Fuzzy QFD methodology used in our research. The third chapter illustrates the proposed methodologies used in this study. In the chapter 4, as try to demonstrate the practicability of our proposed approach in service quality improvement, we illustrate a case study of an e-commerce company in Taiwan, and following the procedures of our proposed approach, firstly, through a qualitative literature survey in e-commerce, we collect the determinants of e-service quality (it refers to the service quality which is significantly concerned in e-commerce), and extract their characteristic meanings to analogically mapping with TRIZ 39 engineering parameters in interpretation. Then, according to the parameters mapping results, we verify the effectiveness of these results with the opinions from seven experts in the fields of e-commerce, service quality and TRIZ, and base on the experts' consensus in our parameters mapping results, a parameter mapping table which can be applied in e-commerce is constructed, and finally the creative solutions are acquired by following the TRIZ problem-solving process. The final chapter of this study discusses the managerial implications of our proposed methodology, and derives the conclusions and directions for future research from our study. The research framework is shown in Figure 1.1.

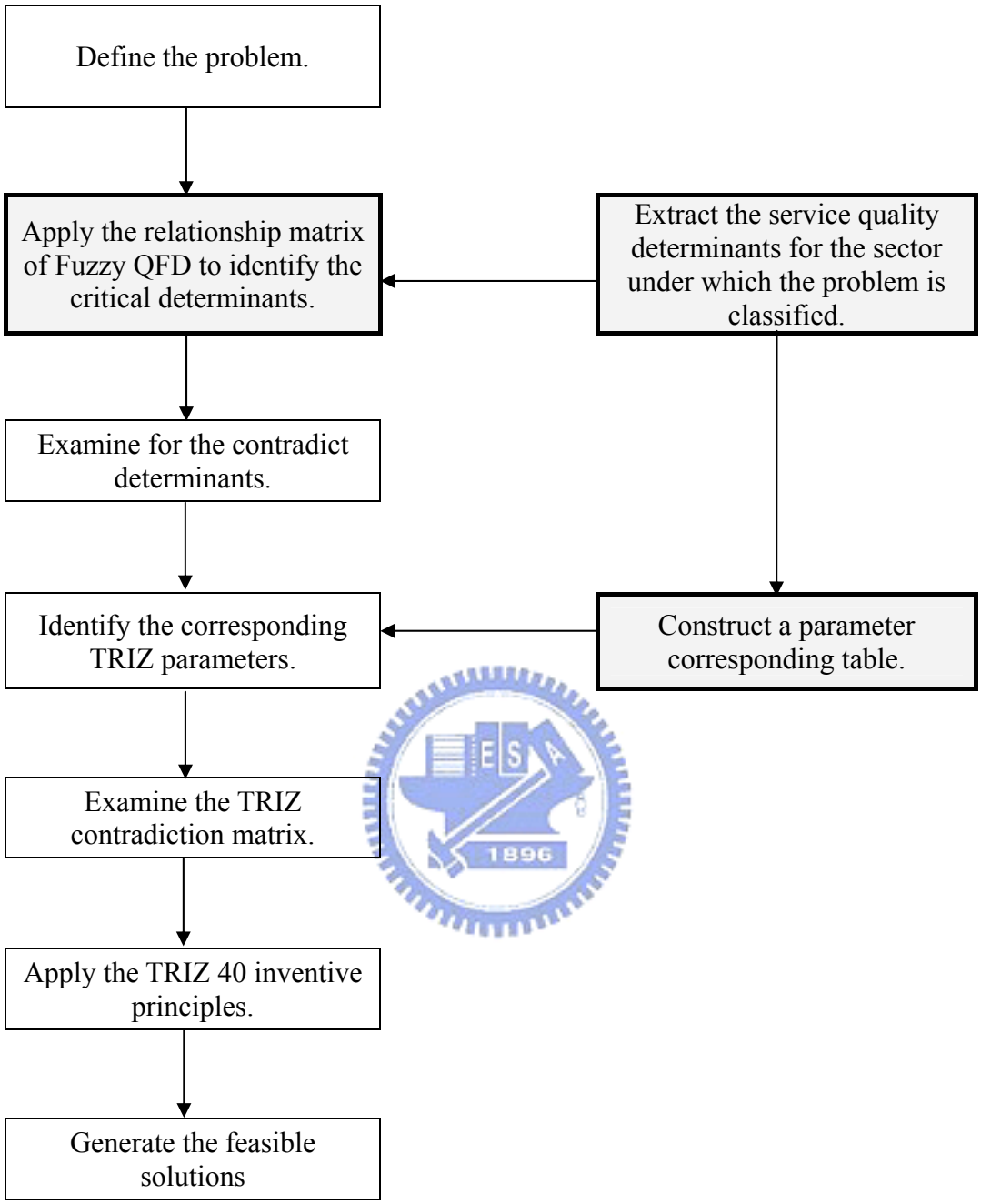

Fig.1.1 The Research Framework

CHAPTER 2 RELATED WORKS

2.1 The Development of Creating New Services

The importance of creating new services is well emphasized in today's market. However, many service providers are still limited by their present corporate structures and processes which are not designed to enable new services to be efficiently created and launched in the market in time (Bullinger et al., 2003). During the past few years, some researchers have paid attention to the area of New Service Development (NSD) (Kelly and Storey, 2000; Alam, 2000; Menor et al., 2002). In contrast to the development of tangible products, the literature on tangible product development is rich, but little is known about how new services are actually developed. Aranda and Molina-Fernández (2002) emphasized that the innovation patterns of service industries are different from those of manufacturing industries. Moreover, the critical success factors for the NSD process are explicitly different from those for the development of a new tangible product (Kwaku, 1996; Alam, 2000).

Due to the intangibility of services, it is difficult to verify the applicability of services before their launch. Therefore, when comparing the innovation activities of manufacturing and service firms, Kwaku (1996) found that the perception and evaluation of these activities are different, and that the critical success factors of these two types of firms greatly vary. Kelly and Storey (2000) also discovered in their survey on a group of service companies that only half of the sample has a formal NSD strategy, that generally, they do not have formal mechanisms with which to generate new ideas, and that prevalently, the idea screening process fails to support the NSD strategy. Even though little research is known about how new services are actually developed, Alam (2000) attempted to explore the stages in the NSD process of new business-to-business

service development in a specific service sector. He found that the service provider follows a 10-stage NSD process, and that the most important stages are idea generation and commercialization. Besides, parallel to the concept of NSD in America, Bullinger (2003) indicated that the term *service engineering* was coined in the mid-1990s in Germany and Israel, and in contrast with NSD, service engineering adopts a more technical-methodological approach, with an attempt made to systematize the development of services.

Recently, relating to the extant literature review on the topic of services and innovation, Zhang et al. (2003) considered service design to be one of the pivotal components of the NSD process, but there is a lack of a systematic and effective problem identification process which contains all service design activities. In their study, a systematic approach based on the TRIZ methodology is developed in order to design new services. With the integration of the TRIZ methodology in the service design, they tried to develop a formal approach which is helpful for service developers to plan and control design activities, and to systematically generate new services. Gao et al. (2005) compared the strengths and weaknesses between many common innovation methodologies and TRIZ, and it was found that TRIZ is the most powerful systematic innovation methodology among the methodologies compared. Furthermore, Zhang et al. (2005) argued that the limitations in existing service design tools in terms of overcoming the psychological inertia have severely affected both the amount and the quality of design solutions. Their approach integrating the TRIZ suggests that companies should seek creative ways to generate new service concepts that can meet customers' needs. Moreover, Zhang et al. (2005) believed that the effectiveness of using the TRIZ in the service domain can be further enhanced through the incorporation of knowledge on best practices in various fields. All in all, applying the TRIZ in the

service industry has emerged to have a great potential for further discussion and study.

2.2 The TRIZ Methodology

2.2.1 The Development of TRIZ

TRIZ (Teoriya Reshenuya Izobreatatelskikh Zadatch) is a Russian acronym that stands for the "Theory of Inventive Problem Solving" (also named TIPS): a systematic approach to finding innovative solutions to technical problems. The ideas were actually formulated way back in the 1940s, but remained firmly locked behind the Iron Curtain. With the progressive thawing of the old Cold War climate, TRIZ introduced to the West a little over a decade ago when a few American academics began studying its principles and applying them to real situations. Genrich Altshuller, the proponent of TRIZ, started his work in 1946 to develop a way to make significant technical breakthroughs without relying purely on creative processes, and he adopted the premise that most breakthroughs are not really breakthroughs at all, but simply the application of a well understood principle in a new way or in a new field. Altshuller worked in a patent office, so perhaps it was seeing so many inventions that led him to a systematic evaluation of hundreds of thousands of patents in order to uncover patterns of invention that might prove useful when it comes to looking at new problems. In time, this work would grow to an analysis of over 2.5 million patents (Alam, 2000).

Since its birth in Soviet Union and introduction to the world, TRIZ has developed successfully as a powerful problem solving tool, especially for product innovation design in conceptual design phase, to promise the engineers with breakthrough thinking. Before TRIZ, authorized thought about creative and human innovations was based on a paradigm that believed the creation as a unknown phenomena, but Altshuller believed that creation is not an unknown and unreachable function, but creation followed a special and achievable principles, and we can do the inventions with non-inventor

persons, if they learn the innovating principles and algorithms (Saliminamin and Nezafati, 2003). Altshuller analyzed thousands of worldwide patents from leading engineering fields, and he categorized these patents in a novel way by removing the subject matter to identify the problem-solving process rather than classifying the patents by industry. From this, he found that the same problems were often solved over and over again using one of only 40 fundamental inventive principles. With this view, Altshuller developed his algorithm for innovative problem solving.

2.2.2 The General Concept of TRIZ

The TRIZ methodology is a well-structured inventive problem-solving process. The application of TRIZ thinking tools in diverse industries successfully replaces the unsystematic trial-and-error method in the search for solutions in the everyday life of engineers and developers (Ruchti and Livotov, 2001). Thus, Altshuller analyzed a large number of patents, and he found that not every invention is equal in its inventive value, and there were five levels of innovation:

Level #1: A simple improvement of a technical system that requires knowledge available within a trade relevant to that system.

Level #2: An invention that includes the resolution of a technical contradiction that requires knowledge from different areas within an industry relevant to the system.

Level #3: An invention containing a resolution of a physical contradiction that requires knowledge from other industries.

Level #4: A new technology is developed containing a breakthrough solution that requires knowledge from different fields of science.

Level #5: Discovery of new phenomena.

Level #1 is not really innovative, and it provides only an improvement to an existing system without solving any technical problem. Levels #2 and #3 solve

contradictions, and therefore are innovative by definition. Level #4 also improves upon a technical system, but without solving an existing technical problem. Instead, it solves the problem by replacing the original technology with a new technology. Level #5 discovers a new phenomenon that always pushing the existing technology to a higher level. Altshuller concluded from his research that a large number of patents (77%) belong only to Levels #1 and #2. The practical utilization of TRIZ methodology can help inventors elevate their innovative solutions to Levels #3 and #4.

Concerning TRIZ methodology, Hasan et al. (2004) indicated that there are five basic notions of TRIZ, which are ideal final result, psychological inertia, inventive levels, evolution laws and eliminating contradictions. When the TRIZ thinking tools is used, basically, it does not provide the solutions but propose various resolution principles to solve the problem. But through the TRIZ paradigm is proceeded, TRIZ can be recognized as a process framework for problem solving. Besides, Lau (2004) showed that there are five underlying pillars which help to make the TRIZ method distinct from other problem solving strategies, they are: functionality, contradictions, ideality, resources, and shifting perspective. Chang and Chen (2003) also stated that the TRIZ method can be divided into four parts: the contradiction table, the substance-field analysis, the evolution detection, and the technique trend.

Furthermore, Domb (1998) indicated that TRIZ researchers have encapsulated the principles of good inventive practice and set them onto a general problem-solving structure. The general model for TRIZ problem-solving is shown in Figure 2.1.

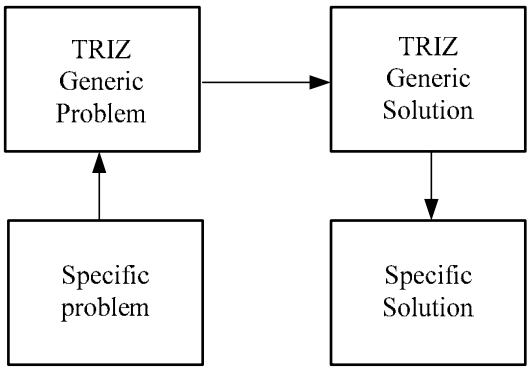

Figure 2.1 The General TRIZ Process (Domb, 1998)

Loebmann (2002) explained the general process by which the TRIZ method overcomes the psychological inertia barrier, and this is through the generalization of the specific problem to an analogous TRIZ generic problem. Then through the comparison of this generic TRIZ problem with the analogous generic TRIZ solution in the knowledge database obtained from scientific effects and patents research, one can generate the solutions for the specific problem. TRIZ helps avoid an inefficient route for problem solving, and instead provides a systematic and efficient way to solve the problem. Hence, it is a reliable process that results to systematic innovation.

Collectively, TRIZ was illustrated with a triangular pyramid in a hierarchical perspective by Mann (2002) who explored a different way of looking at TRIZ in his study. Figure 2.2 suggested that, at the top of the pyramid, TRIZ may be seen as the systematic study of excellence which was involved in the sciences, arts, business, social sciences and politics. Then, five key philosophical elements have emerged from this study of excellence. The concept of eliminating contradiction can be seen as the primary evolution driver in the systems, which are in terms of space/time/interface, and the functionality was analyzed and then evolved to increasing good and decreasing bad to maximize the effectiveness of resources in the system. At the bottom of the TRIZ hierarchy, there are series of tools and techniques for practically any problem may be encountered. In between the philosophy and this collection of tools is a method to string

the tools together in whatever process they think most appropriate. This hierarchical view of TRIZ depicts the essence of TRIZ technology.

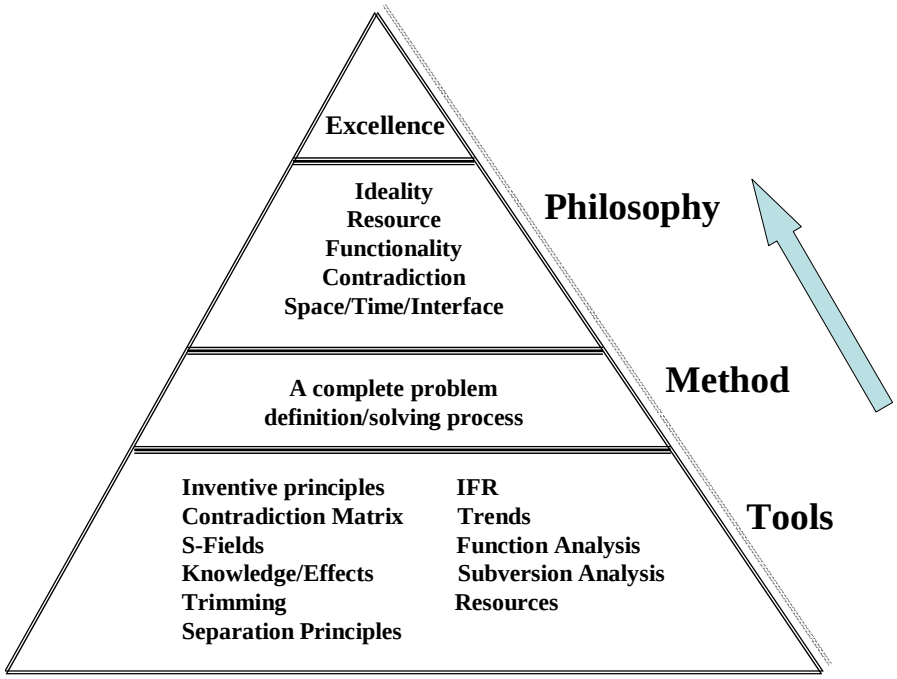

Figure 2.2 The Hierarchical View of TRIZ (Mann, 2002)

2.2.3 Resolving the Contradictions by TRIZ Contradiction Matrix

In the TRIZ methodology, the fundamental idea in the conceptual framework is the extraction of the essential conflicts from the problems and the eventual resolution of the conflicts. Altshuller asserted that an invention frequently appears when a contradiction between parameters is resolved. The contradictions can either be technical contradictions which are two mutually conflicting parameters within a system, or physical contradictions which are the direct opposite of two values for a parameter formulated by the same system. With regard to resolving contradictions within a system, one of the most popular tools of TRIZ is the contradiction matrix. This matrix is comprised of 39 engineering parameters and 40 types of inventive principles. The 39 engineering parameters are defined as the behavior or state of a technological system, and most of the engineering products are a compromise between competing features,

that is, trying to improve one feature often degrades another. The 40 inventive principles currently contained within the TRIZ methodology present complete descriptions of the detailed solution thinking contained in each principle, and a few samples of how other problem solvers have used a particular principle to resolve a given situation involving a contradiction. The names of the 39 engineering parameters and the 40 inventive principles are summarized in Table 2.1.

Table 2.1 TRIZ 39 Engineering Parameters and 40 Inventive Principles

Parameter Number	Parameter Name	Principle Number	Inventive Principle
1	Weight of moving object	1	Segmentation
2	Weight of stationary object	2	Taking out
3	Length of moving object	3	Local quality
4	Length of stationary object	4	Asymmetry
5	Area of moving object	5	Merging
6	Area of stationary object	6	Universality
7	Volume of moving object	7	Nested doll
8	Volume of stationary object	8	Anti-weight
9	Speed	9	Preliminary anti-action
10	Force	10	Preliminary action
11	Stress or pressure	11	Beforehand cushioning
12	Shape	12	Equipotentiality
13	Stability of the object's composition	13	The other way round
14	Strength	14	Spheroidality-Curvature
15	Duration of action by a moving object	15	Dynamics
16	Duration of action by a stationary object	16	Partial or excessive actions
17	Temperature	17	Another dimension
18	Illumination	18	Mechanical vibration

	intensity/brightness		
19	Use of energy by moving object	19	Periodic action
20	Use of energy by stationary object	20	Continuity of useful action
21	Power	21	Skipping
22	Loss of energy	22	“Blessing in disguise” or “Turn Lemons into Lemonade”
23	Loss of substance	23	Feedback
24	Loss of information	24	Intermediary
25	Loss of time	25	Self-service
26	Amount of substance	26	Copying
27	Reliability	27	Cheap short-living objects
28	Measurement accuracy	28	Mechanics substitution/another sense
29	Manufacturing precision	29	Pneumatics and hydraulics
30	Object affected harmful factors	30	Flexible shells and thin films
31	Object generated harmful factors	31	Porous materials
32	Ease of manufacture	32	Color changes
33	Ease of operation	33	Homogeneity
34	Ease of repair	34	Discarding and recovering
35	Adaptability or versatility	35	Parameter changes
36	Device complexity	36	Phase transitions
37	Difficulty of detecting and measuring	37	Thermal expansion
38	Extent of automation	38	Strong oxidants
39	Productivity	39	Inert atmosphere
		40	Composite material

Alshuller arranged these 39 features in each side of a two-dimensional matrix, and at each intersection, some inventive principles are indicated as a reference to resolve the contradictions between these denoted competing features. A sample selection from the TRIZ contradiction matrix is shown in Table 2.2. It can be seen that each of the parameters could either be an improving or a worsening feature. For instance, if one of the improving features of a specified system is strength (14), which is achieved at the expense of a worsening feature with regard to the weight of a moving object (1), then the inventive principles No. 1 ("segmentation"), No. 8 ("anti-weight"), No. 40 ("composite material"), and No. 15 ("dynamics") might be the applicable suggestions.

Table 2.2 A Partial Contradiction Matrix with Suggested Inventive Principles

Worsening feature → / Improving feature ↓		Weight of Moving Object	Weight of Stationary Object	Strength	Loss of Information	Ease of Repair
		1	2	14	24	34
1	Weight of Moving Object			28, 27, 18, 40	10, 24, 35	2, 27, 28, 11
2	Weight of Stationary Object			28, 2, 10, 27	10, 15, 35	2, 27, 28, 11
14	Strength	1, 8, 40, 15	40, 26, 27, 1			27, 11, 3
24	Loss of Information	10, 24, 35	10, 35, 5			
34	Ease of Repair	2, 27, 35, 11	2, 27, 35, 11	11, 1, 2, 9		

Besides, Domb et al. (1998) argued that one barrier in using the matrix is the very brief statement of the lists of improving and worsening features. Thus, in their study, they derived an expanded explanation of the 39 features of the contradiction matrix by comparing several different translations for convenience in using the matrix. Furthermore, in expanding the usage of the 39 engineering parameters of the contradiction matrix, Liu and Chen (2001) tried to develop a green innovation design method by using TRIZ inventive principles without contradiction information, and

examining the relationships between the 39 engineering parameters of TRIZ and each of the major elements of eco-efficiency in the development of non-impacted environmental products or processes for the company. Hasan et al. (2004) also showed considering the correspondence between safety standards and contradictions resolution by means of the TRIZ in order to come up with various resolution principles to assist the equipment or machines designer in his/her task and to take into account safety as soon as possible.

2.2.4 The Applications of the TRIZ Methodology

Recently, there are numerous articles discussing the 40 inventive principles which are examining connections between TRIZ and the frequently used solution of problems involving particular contradictions that are found in quite a few areas, such as business (Mann and Domb, 1999), social examples (Terninko, 2001), software (Rea, 2001), quality management (Retsptor, 2003), service operation management (Zhang et al., 2003), and in marketing, sales and advertising (Retsptor, 2005), etc. This researching results obviously reveal the feasibility of using TRIZ in more areas and a promising future of TRIZ development, but a more important uncovered meaning within TRIZ is the re-explanation of 40 inventive principles in the relating areas of the problems, which can be aiming at the connotation of problems to figure out a more practical solution for the practitioners, it should be more importantly to be further discussed.

However, there is limited literature discussing the 39 engineering parameters in the TRIZ contradiction matrix for distinct areas, and there is no systematic way to analyze the analogical relationship between the TRIZ 39 engineering parameters and the characteristic features of a specified sector. Besides, the present research on TRIZ focuses on extending TRIZ to a broader application, especially in non-technical areas, Zhang et al. (2003) proposed a modified TRIZ problem solving process to resolve the

problems of innovating new services, the process is shown in Figure 2.3.

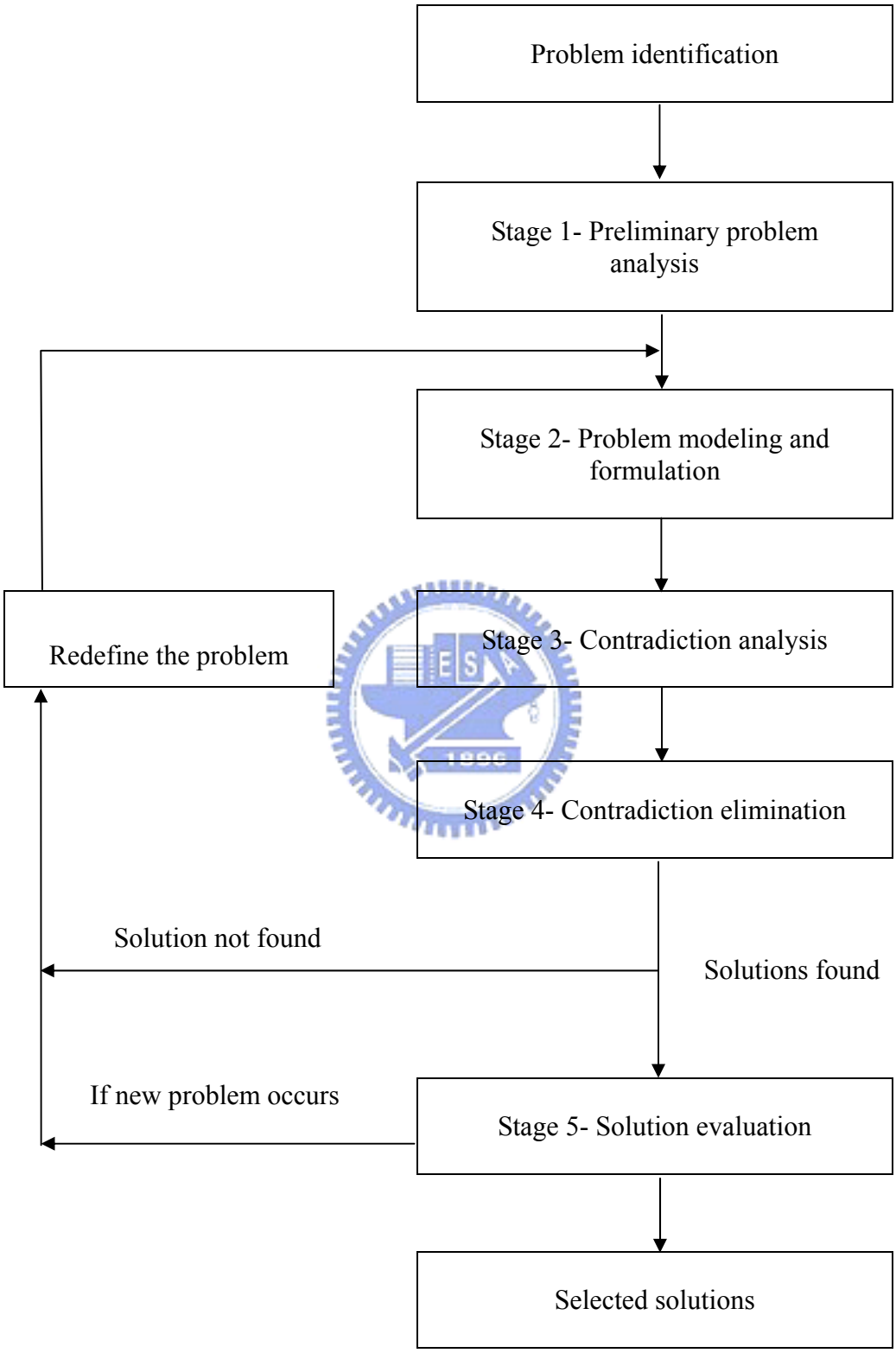

Figure 2.3 A Modified TRIZ Problem Solving Process (Zhang et al., 2003)

Therefore, the goal of this research is to present a systematic process to resolve the inventive problems in a specified sector and consequently acquire the inventive results. Besides, in the application of the TRIZ methodology, one of the recent trends is to integrate TRIZ with other methods in order to strengthen its strong points (Tan, 2002). Stratton and Warburton (2003) identified how the TRIZ separation principles and TOC (Theory of Constrain) tools may be combined in the integrated development of responsive and efficient supply chains. Petrali (2004) presented a structured workflow, intended mainly for cost reduction, and integrated with different methodologies along with the TRIZ. Most of the methodologies integrated with the TRIZ worked well and have been used by many practitioners. Yamashina et al. (2002) described a new method to systematically integrate QFD with TRIZ, and in the process, enabled the effective and systematic creation of new products.

In our study, we attempt to apply Fuzzy QFD matrix within our problem solving process to analyze the imprecise and subjective problem information in order to clarify the essences of the problem under a fuzzy environment.

2.3 The Fuzzy QFD

2.3.1 An Overview of QFD

Quality Function Development (QFD) is a planning methodology for translating customer needs into appropriate product features. The intents of applying QFD are to incorporate the voice of the customer into the various phases of the product development cycle for a new product or a new version of an existing product. QFD is a complex and very time consuming process, typically QFD consists hierarchically of four House of Quality (HOQ): the first HOQ represents the relationship between the end user's needs and product design variables; in the second HOQ, design variables of a product are related to those of components; in the third HOQ, design variables of

components are related to job attributes; finally, in the last HOQ, job attributes are related to personnel job assignment (Sohn and Choi, 2001).

QFD is not only a technical tool, but also a managerial philosophy that can help enhance the organizational and managing effects. However, it is difficult to manually record the QFD matrix in a paper form and especially in the qualitative and subjective decision-making process. From this, various quantitative methods, such as analytic hierarchy process, artificial neural networks, and fuzzy logic, are combined with QFD and proposed to provide a more objective and precise approach for its implementation (Yang et al., 2003).

2.3.2 The Concept of Fuzzy QFD

The fuzzy set theory, introduced by Zadeh (Klir and Yuan, 1995), is widely applied to resolve problems that are subjective, uncertain, and imprecise in nature. It provides a strict mathematical framework in which vague conceptual phenomena can be precisely and rigorously studied (Shen et al., 2001). Thus, the QFD method is often used to understand the voice of customers regarding products, and relate them with product design specifications or technical characteristics to be subsequently translated into production requirements. However, when capturing customer requirements from qualitative or linguistic data, for example, human perception, judgment, and evaluation on the importance of customer requirement or relationship strength which are often vague and imprecise in nature, these are difficult to estimate exactly such as numerical data. Thereby, the linguistic data that the conventional QFD process uses can be treated to approximate exactness with the help of the fuzzy set theory (Shen et al., 2001).

Fuzzy QFD has been developed mainly in view of fuzzy relationship between the customers' needs and design specification. The methodologies using Fuzzy QFD to convert qualitative information into quantitative parameters have been explored in

various applications. Temponi et al. (1999) illustrated their approach, which is a fuzzy logic-based extension to HOQ for capturing imprecise requirements to facilitate communication of team members and the formal representation of requirements, using a textile mill supply business application. Meanwhile, Shen et al. (2001) developed a procedure to deal with the fuzzy data when implemented by the QFD under a fuzzy environment. Their approach allowed QFD users to avoid subjective and arbitrary quantification of linguistic data. Karsak (2004) presented a fuzzy multiple objective programming method which identifies imprecise and subjective information inherent in the QFD planning process to determine the level of fulfillment of design requirement. Finally, Sohn and Choi (2001) constructed a Fuzzy QFD model in order to convey the fuzzy relationship between customer needs and design specification for reliability in the context of Supply Chain Management (SCM). Nevertheless, the application of Fuzzy QFD in TRIZ methodology is rarely discussed; in our study, the relationship matrix of Fuzzy QFD will be applied in analyzing the essentials of the problems in the TRIZ problem solving process.

2.3.3 The Application of Fuzzy QFD Process

To implement the QFD process, the relationship matrix signifies the transition from the semantic of customer requirements or expectations to critical component characteristics. Since semantic data cannot be easily quantified, it is more appropriately to treat them as fuzzy rather than precise. The computational procedure for using relationship matrix of Fuzzy QFD includes the use of the concepts of linguistic variable, fuzzy number, fuzzy arithmetic, and defuzzification. The process introduced in the article of Shen et al. (2001) is summarized in the following:

Step 1: Identification of linguistic terms. The linguistic description of the customers or practitioners can be assigned such as “very important”, “important”, “not

important", instead of using the traditional numerical scale (e.g., 1-5 scale) for determining the degree of importance and strength of the customer requirements or imprecise problem information.

Step 2: Fuzzification of input data. Translate the linguistic data into fuzzy numbers based on the selected membership functions. Note that the choice of simple membership functions may not represent the exact functions used in the other situations. The triangular fuzzy number is easily illustrated and calculated, and it can be used to capture the vagueness of fuzzy linguistic terms and represents the subjective or uncertain expressions of evaluating results.

Step 3: Applying fuzzy arithmetic. Fuzzy arithmetic, which is a direct application of the extension principle developed by Zadeh, and by which operations on real numbers are extended to operations on fuzzy numbers (Klir and Yuan, 1995). For instance, let A_1 and A_2 denote fuzzy numbers and the symbol $\oplus$ denote the fuzzy addition. Then, $A_1 \oplus A_2$ can be operated with the following equation:

$$A_1=(c_1, a_1, b_1)$$

$$A_2=(c_2, a_2, b_2)$$

$$A_1 \oplus A_2=(c_1+c_2, a_1+a_2, b_1+b_2)$$

Step 4: Defuzzification of output data. Defuzzification is defined as the mapping of a fuzzy set A to elements of the universe considered significant with respect to A. The results of fuzzy arithmetic calculation, which is expressed in terms of a fuzzy set, will be defuzzified into crisp results which are easy to interpret. A number of defuzzification methods leading to distinct results were proposed in the literature. Each method is based on some rationale. There are three defuzzification methods have been predominant in the literature: center of area method, center of maxima method, and mean of maxima method (Klir and Yuan, 1995).

CHAPTER 3 METHODOLOGIES

3.1 The Systematic Problem-Solving Process

The existing literature on the application of the TRIZ methodology in creating new services is thus far limited. Since Zhang et al. (2003) indicated that TRIZ has already proven its effectiveness in resolving technical problems for tangible products, the present research in TRIZ has put much effort in extending it to a broader application, especially in non-technical areas. Furthermore, in Webb's (2002) practical experience, he stated that the most easily used method in the TRIZ toolset is the analysis of contradictions. Hence, in this study, we present a systematic process which applies the TRIZ contradiction matrix to identify the corresponding inventive principles. Together with the related standard solutions, the service problems could be more predictably resolved, and consequently, an innovative way to generate services is efficiently acquired.

Based on the literature review on service innovation, TRIZ and Fuzzy QFD, and with our main focus on service quality improvement, we follow the conventional way of thinking in TRIZ to be able to create a systematic framework of the problem-solving process for a specified sector. Figure 3.1 depicts the process flow of our proposed approach that comprises of eight main stages which conform to the TRIZ algorithm.

***Stage 1*:** Define the scope of the problem and identify the sector under which it is classified. It is essential to define the specified industry and preliminarily focus on resolving the problems in the same sector. For example, depending on the service that an ASP (Application Software Provider) company provides, the problems arising from this company can be classified under either the sector of electronic commerce (e-commerce) or electronic business (e-business).

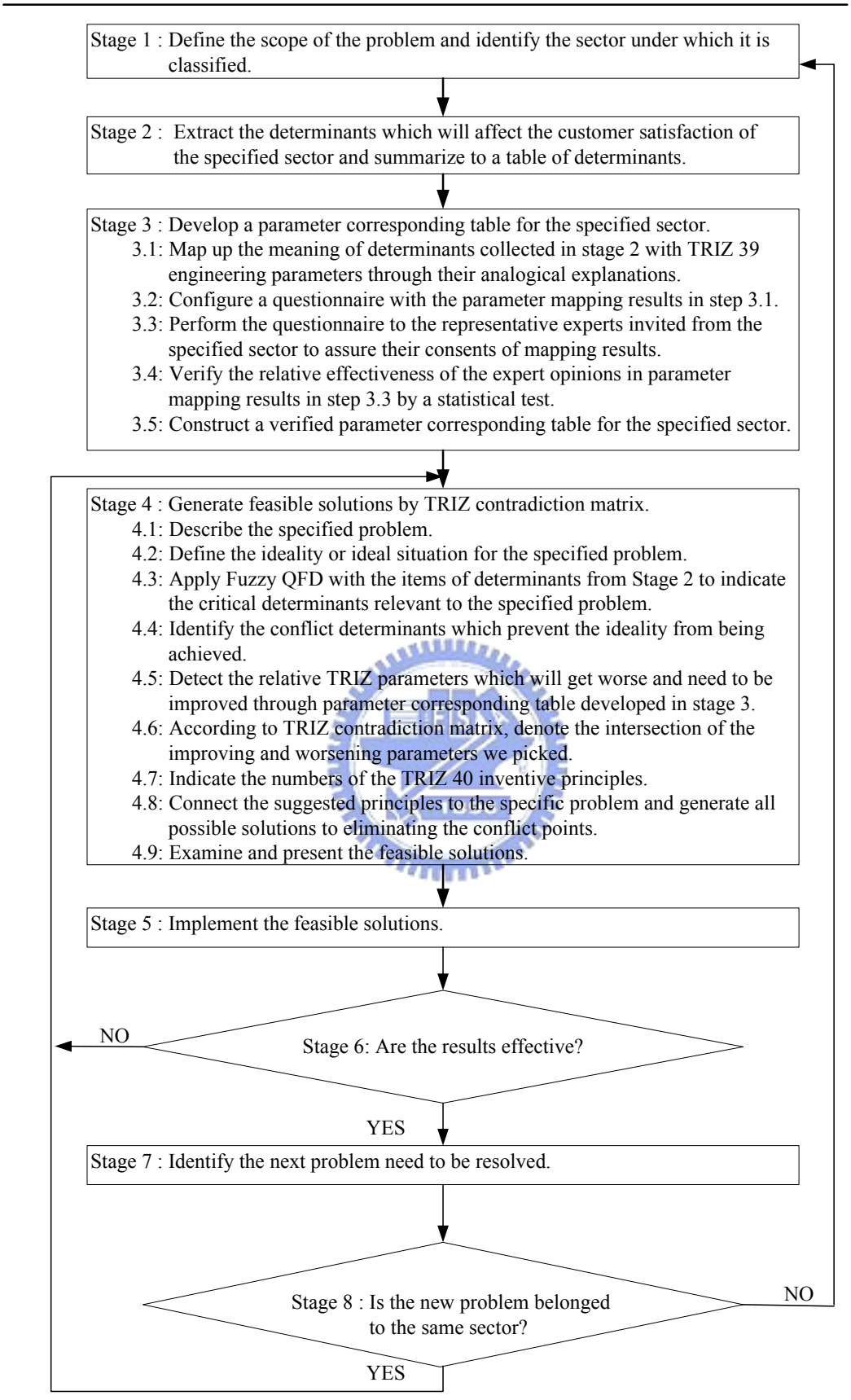

Fig. 3.1 The Systematic Problem-Solving Process for the Specified Sector

***Stage 2*:** Extract the determinants which will affect the customer satisfaction of the specified sector and summarize to a table of determinants. The determinants which affect the quality of service and customer satisfaction can be extracted from the review of various perspectives regarding the specified sector. When we focus on service quality improvement especially, the reference materials relating to this sector should be extensively analyzed to find out the dominant characteristics affecting the service quality in this sector.

***Stage 3*:** Develop a parameter corresponding table for the specified sector. There are five steps to develop a parameter corresponding table for the specified sector, and with this table, we can apply the TRIZ contradiction matrix more effectively. The first step is to map the determinants which are extracted from *stage 2* with the analogical explanations of the 39 TRIZ engineering parameters, and through the corresponding relationships, the essential properties of service quality in the specified field are made to reasonably relate to the definitions of the 39 TRIZ engineering parameters. When we apply the TRIZ contradiction matrix in problem solving, the assured TRIZ parameters can be effectively extracted and applied in the contradiction matrix. Furthermore, concerning the applicability and reliability of the parameter mapping results, they are evaluated by a group of experts in the sector from the second to the fourth steps, and then their relative effectiveness is further substantiated by means of a verified statistical test. Cochran' test which is suited for any dichotomization of the possible treatment results (Conover, 1980) is suggested to be used in this study. Consequently, the resulting parameter corresponding table is constructed to specifically suit the identified sector.

***Stage 4*:** Generate feasible solutions by TRIZ contradiction matrix. Apply the TRIZ contradiction matrix to resolve the problem step by step according to the TRIZ problem solving process.

Step 4.1 Describe the specified problem with all the customer's needs and expected requirements. Collect information on existing situations in the environment of the service operation, strip away the side issues and preconceptions, and analyze to identify the scope of the existing problem or the core requirements from the feedback of customers. Conducting a survey of a focus group is one of the more commonly used tools to accurately gather situation information. Another way to easily collect existing information from the possible problem is to consult the operators of the targeted service operation.

Step 4.2 Define an Ideality or Ideal Final Result (IFR) to achieve, with regard to the specified problem. First, break the problem down into its most elementary components and conceptualize the basic constituents of the specified problem. This involves expressing the components in their most fundamental state. Then identify the IFR as the ideal situation to achieve without using extra resources when the contradictions within the problem are resolved. There are seven questions which are very helpful in properly defining the IFR in this step. These are the following: what is the final goal of the system, what is the ideal final result, what will prevent us from achieving the ideal final result, why will it prevent us from achieving the ideal final result, how do we vanish those hindrances, what kinds of resources could be used to construct the ideal situation, and is there anyone who has been able to resolve the same problems.

Step 4.3 With the items of determinants developed from *stage 2*, we apply the relationship matrix of Fuzzy QFD to indicate the critical determinants relevant to the customer's requirements specified in *step 4.1*, and the computational procedures for the fuzzy numbers in the relationship matrix are shown in the following steps:

Step 4.3.1 Identification of linguistic terms: In order to identify the correlative relationships between the customer requirements and the service quality determinants of

the sector, we describe the importance of the relationship through linguistic terms with five distinct levels, which are EI (extremely important), VI (very important), I (important), LI (a little important), and NI (not important).

Step 4.3.2 Fuzzification of input data: The triangular fuzzy number which is easier to interpret is used in this study and all membership functions for the linguistic input data are standardized in the interval [0,1]. The figure of the triangular fuzzy numbers is shown in Figure 3.2, and the membership functions are shown in Figure 3.3.

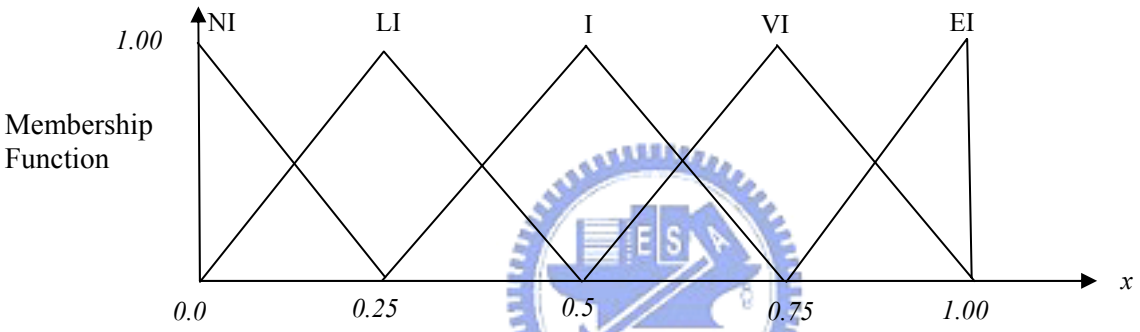

Figure 3.2 The Figure of the Triangular Fuzzy Numbers in the Interval [0,1]

$$\mu_{EI}(x) = \begin{cases} 4x - 3, & 0.75 < x < 1 \\ 1, & x = 1 \\ 0, & \text{others} \end{cases}$$

$$\mu_{VI}(x) = \begin{cases} 4x - 2, & 0.5 < x < 0.75 \\ 1, & x = 0.75 \\ -4x + 4, & 0.75 < x < 1 \\ 0, & \text{others} \end{cases}$$

$$\mu_{I}(x) = \begin{cases} 4x - 1, & 0.25 < x < 0.5 \\ 1, & x = 0.5 \\ -4x + 3, & 0.5 < x < 0.75 \\ 0, & \text{others} \end{cases}$$

$$\mu_{LI}(x) = \begin{cases} 4x, & 0 < x < 0.25 \\ 1, & x = 0.25 \\ -4x + 2, & 0.25 < x < 0.5 \\ 0, & \text{others} \end{cases}$$

$$\mu_{NI}(x) = \begin{cases} 1, & x = 0 \\ -4x + 1, & 0 < x < 0.25 \\ 0, & \text{others} \end{cases}$$

Figure 3.3 The Membership Functions of the Triangular Fuzzy Number

Step 4.3.3 Applying fuzzy arithmetic: The fuzzy arithmetic is applied to the calculation of the priorities of relevant service quality determinants, and the addition and multiplication of fuzzy numbers will be performed for the calculation. Suppose $S_{itj} = (q_{itj}, o_{itj}, p_{itj})$ is the triangular fuzzy number of the j^{th} team member assessing the correlative importance between the t^{th} customer requirement and the i^{th} category of service quality determinants. Then S_{it} is defined as the average fuzzy number of the i^{th}

category of the service quality determinant for the t^{th} customer requirement, where n is the number of the team members.

$$S_{it} = \frac{1}{n}\sum_{j=1}^{n} S_{itj} \tag{3.1}$$

We have $S_{it} = (q_{it}, o_{it}, p_{it})$ calculated by the following equations:

$$q_{it} = \frac{1}{n}\sum_{j=1}^{n} q_{itj} \tag{3.2}$$

$$o_{it} = \frac{1}{n}\sum_{j=1}^{n} o_{itj} \tag{3.3}$$

$$p_{it} = \frac{1}{n}\sum_{j=1}^{n} p_{itj} \tag{3.4}$$

Suppose there is no weighting difference considered among the determinants of service quality, and the integrated fuzzy number of each service quality determinant for k team members (Q_i, O_i, P_i) can be calculated by the following equations:

$$Q_i = \frac{1}{k}\sum_{t=1}^{k} q_{it} \tag{3.5}$$

$$O_i = \frac{1}{k}\sum_{t=1}^{k} o_{it} \tag{3.6}$$

$$P_i = \frac{1}{k}\sum_{t=1}^{k} p_{it} \tag{3.7}$$

Step 4.3.4 Defuzzification of output data: It is suggested that the output results be presented in crisp data as they are easier to interpret, and the defuzzification method used in Chen's research (1996) is applied in the current study. Let X denote the defuzzified value of the integrated fuzzy number for each service quality determinant (Q_i, O_i, P_i), and then the defuzzified values can be calculated with the following equation:

$$X = \frac{Q_i + O_i + O_i + P_i}{4} \tag{3.8}$$

Step 4.3.5 Rank the defuzzified values of service quality determinants: According to the crisp data calculated from the *step 4.3.4*, the prioritized importance of each relevant determinant can be sequentially ranked.

Step 4.4 From the most important determinants selected from the rankings, we discuss to identify all the conflicting determinants which will enhance and prevent the ideal solution to be acquired.

Step 4.5 Detect the relative TRIZ engineering parameters which get worse and need to be improved from the parameter corresponding table which was developed in *stage 3* based on the improving and worsening determinants which were identified from *step 4.4*.

Step 4.6 According to the TRIZ contradiction matrix, the denoted numbers of the 40 TRIZ inventive principles can be gathered from the intersection of the improving and worsening TRIZ parameters.

Step 4.7 When we indicate the 40 TRIZ inventive principles based on the content of the specified problem, we suggest that the appropriate reexplanations and examples of the 40 TRIZ inventive principles developed in distinct areas be examined and benchmarked. For instance, when the specified problem is relating to the service sector, the studies of Mann and Domb (1999), Rea (2001), Retseptor (2003), Zhang et al. (2003), and Retseptor (2005) are relevant to service quality in the non-technical field.

Step 4.8 Following the indicated principles and suggested ways, all possible solutions may be generated through various discussing meetings.

Step 4.9 Examine to obtain the feasible solutions with concerned criteria such as cost, time, available human resources, technological level, etc.

***Stage 5*:** Implement the feasible solutions. After the feasible solutions have been

examined and presented, the confirmed feasible solutions can be implemented in this stage.

Stage 6: Are the results effective? This will be followed by the evaluation of the results with various specified performance criteria in this stage. If the conflicts of the problem are effectively resolved, we can proceed to the next stage; otherwise, we repeat the fourth stage to examine which step involved the problem.

***Stages 7 and 8*:** Identify the next problem need to be resolved and is the new problem belonged to the same sector? After resolving the problem, we can continue to identify the next problem, and identify if it belongs to the same sector or not. If it does, we can iterate the procedure back to *stage 4* and continue to generate the feasible solutions; otherwise, we can return to the first stage to redefine the scope of the new problem and identify the sector under which it is classified.

3.2 The Statistical Test

In order to verify the effectiveness of parameters corresponding results among the invited experts, it is necessary to perform a defensible validation test. Refer to the article of Saliminamin and Nezafati (2003), Cochran's test is selected by our study as a statistical hypothetic test which bases on experts' opinions in the specified sector, and test the consistent agreement of the parameter corresponding results which are developed in our research. Cochran's test is suitable because of conceptual adoption with our parameters mapping results which are testing reject or accept in expert's opinions and also are simplifying for answering (yes/no).

In some investigations that utilize the randomized complete block design, the response to a treatment may take on only one of two values. We may arbitrarily designate these two possible outcomes "agree" or "1", and "disagree" or "0" (Daniel, 1990). In the reference of Conover's (1980) description, the Cochran Test can be

illustrated in the following elaboration.

Data

Each of *c* treatment is applied independently to each of *r* blocks, and the result of each treatment application is recorded as either "1" or "0", to represent "success" or "failure" or any other dichotomization of the possible treatment results. The results are then given in the form of a table with *r* rows representing the blocks and *c* columns representing the *c* treatments, with entries that are either zeros or ones. Let R_i represent the row totals, i=1,2,….,r, and let C_j represent the column totals, j=1,2,….,c. Then the data appears as in the following table, where the X_{ij} are either 0 or 1, and N represents the total number of ones in the table.

	Treatments				
Blocks	1	2	…	c	Row Totals
1	X_{11}	X_{12}	…	X_{1c}	R_1
2	X_{21}	X_{22}	…	X_{2c}	R_2
…	…	…	…	…	…
r	X_{r1}	X_{r2}	…	X_{rc}	R_r
Column Totals	C_1	C_2		C_c	N=Grand Totals

Assumptions

1. The blocks were randomly selected from the population of all possible blocks.

2. The outcome of the treatments may be dichotomized in a manner common to all treatments within each block, so the outcomes are listed as either "0" or "1".

Hypotheses

H_0: The treatments are equally effective

H_1: There is a difference in effectiveness among treatments

Test Statistic

$$T = c(c-1)\frac{\sum_{j=1}^{c}(C_j - \frac{N}{c})^2}{\sum_{i=1}^{r} R_i(c-R_i)}$$

Decision Rule

The exact distribution of T is difficult to tabulate, so the large sample approximation is used instead. The number of blocks r is assumed to be large. Then the critical region of approximate size α corresponds to all values of T greater than $x_{1-\alpha}$, the (1-α) quantile of a chi-square random variable with (c-1) degrees of freedom. If T exceeds $x_{1-\alpha}$, reject H_0, otherwise accept the null hypothesis of no differences in the effectiveness of the various treatments.

CHAPTER 4 CASE STUDY

4.1 The Problem

The studied company, EC-SERVER.COM, is specializing in development of online database application, and has achieved the largest market share in Taiwan and the largest market share in online database software in Asia. The products of EC-SERVER.COM are designed to help enterprises solve data management problems. In addition, the incorporation of advanced database tools of SYBASE, with the specialty of EC-SERVER.COM in software development helps enterprises to effectively and systematically integrate their internal and external data. With absolute competitive advantages, EC-SERVER.COM's products have obtained a number of worldwide patents and won appraisal from customers. EC-SERVER.COM has cooperated with domestic and overseas institutions for technical advancement.

The case study focused on providing a systematic way of idea generation to solve EC-SERVER.COM's problems in service operations and to create valuable services in order to enhance the satisfaction of customers. Since 2002, the company rapidly expanded its versatile services by deploying management and remotely hosted software applications through centrally located services in a rental agreement with the Chinese Communication Corporation Company (Taiwan). However, since the delivery of new information technology services and business solutions to their clients, many of the client companies adopting their services experienced various problems in the areas of convenience and functionality. Hence, the company hoped that the true nature of the problems could be studied in depth, and they endeavored to generate solutions that will provide customers with overall value-added services.

4.2 Recognition

We started from organizing a problem-solving team in EC-SERVER.COM for the first step. Investigations were done on the business map, and interviews with relevant individuals in certain divisions of the company were likewise conducted. Finally, we found that there were various service contradictions contained within the services provided by the company, for instance, the contradiction of "Functionality *versus* Ease of use" remained unresolved among the division of software design for such a long time, and it might be possible to use TRIZ to resolve the service problems which have embedded contradictions. Therefore, we recognized that our proposed approach is suitable to resolve the problems, and we attempted to follow the steps in Figure 3.1 to generate the inventive solutions to resolve the company's problems.

In our studied case, the company delivers and manages computer applications and services from remote data centers to multiple users. Boyer *et al*. (2002) defined e-commerce to be "comprised of all interactive services that are delivered on the Internet using advanced telecommunications, information, and multimedia technologies." Thereby, depending on the type of services this company provides, the problem of this company can be classified under the scope of the e-commerce industry.

4.3 Extract the Major Determinants of Service Quality

Service quality is indicated as one of the best performance-based measured factors of success (Landrum and Prybutok, 2004). Hence, in stage 2, we studied various perspectives from the existing literature in order to extract the major determinants of service quality in e-commerce. Through categorizing the related academic papers within the scope of the case problem, we concluded that customer satisfaction is influenced by the following through the identification of the dominant characteristics of e-commerce: determinants of e-business operation, the measurement of the determinants of e-service

quality, and the determinants of e-service satisfaction.

Determinants of E-business Operation

Ruyter *et al*. (2001) proposed a conceptual framework for studying customer attitude and intentional behavior toward e-business. The paper dealt with the conceptualization of e-business, and on the basis of his proposed framework, a set of hypotheses which relates the determinants of service adoption to customer attitude and behavior was tested by means of an experimental study. The results showed that there are three factors that are equally important in relation to customer attitude and behavior toward e-business. They are organizational reputation, relative advantage, and perceived risk. Moreover, Cox and Dale (2001) discussed whether the dimensions and determinants of service quality in a physical services environment are applicable in assessing the services relating to e-business. Consequently, they identified six determinants which are equally applicable as physical services to e-business: accessibility, communication, credibility, understanding, appearance, and availability.

When the samples from subscribers of a regional Internet Service Provider (ISP) company were studied, Yang and Jun (2002) were able to investigate on the service quality dimensions in the context of internet commerce. From the differing perspectives of two groups, internet purchasers and internet non-purchasers, it was found that it was beneficial for internet companies to focus on the key dominants which the two groups perceive: reliability, personalization, ease of use, and access. Surjadjaja *et al.* (2003) viewed customer service as that encompassing all activities which focus on customers' requirements, including all pre-transaction, transaction, and post-transaction activities. The authors identified 20 possible determinants for an e-business operation in the literature review, and these 20 determinants were categorized into three groups: services marketing, service design, and service delivery. Madu and Madu (2002) noted that in

quality management, product and service are the two major dimensions divided traditionally, but with e-business, the authors identified a third dimension, virtual operations, which are online operations that often involve business transactions through the Internet. The goal of his research was to identify those attributes which are perceived by customers as a necessity in achieving customer satisfaction in virtual operations, and there were 16 identified attributes. Santos (2003) developed a conceptual model on e-service quality by studying 30 focus groups in a business school in United Kingdom, and the development of the model consisted of two groups of dimensions: an incubative dimension and an active dimension. Majority of the elements in the incubative dimension include ease of use, appearance, linkage, structure and layout, and content. The active dimension consists of reliability, efficiency, support, communications, security, and incentives. The summarized determinants of e-business operation and the referenced papers were shown in Table 4.1.

Table 4.1 The Summarized Determinants of E-Business Operation and the Referenced Papers

Determinants	Reference Papers
Organizational reputation, Relative advantage, Perceived risk	Ruyter et al. (2001)
Accessibility, Communication, Credibility, Understanding, Appearance, Availability	Cox and Dale (2001)
Reliability, Personalization, Ease of use, Access	Yang and Jun (2002)
Trusted service, Responsiveness, navigability, Up to date information, Site effectiveness and functionality, Availability/accessibility, Security, Fulfillment, Service recovery, Systems integration, Convenience, Real time assistance by a CSR, Personalization, Internal communication, External communication, Price, Return process, Supply chain integration, Customization, Interactivity	Surjadjaja et al. (2003)
Performance, Features, Structure, Aesthetics, Reliability, Storage capability, Serviceability, Security and system integrity, Trust, Responsiveness, Product/service differentiation and customization, Web store policies, Reputation, Assurance, Empathy	Madu and Madu (2002)
Ease of use, Appearance, Linkage, Structure and layout, Content, Reliability, Efficiency, Support, Communications, Security, Incentives	Santos (2003)

The Measurement of the Determinants of E-Service Quality

Zeithaml (2002) discussed the definition, conceptualization, and measurement of electronic service quality (e-service quality), and particularly focused on determining the dimensions of e-service quality. The researchers indicated that e-service quality has seven dimensions that form two scales: a core e-service quality scale and a recovery scale. The four dimensions of core e-service quality are efficiency, reliability, fulfillment, and privacy, and the three dimensions of recovery scale are responsiveness, compensation, and contact. Yoo and Donthu (2001) developed the scale "SITEQUAL" to measure Web site interface, and they found four dimensions: ease of use, aesthetic design, processing speed, and security of personal and financial information. Since 1998, WebQual has been under development and has been fully discussed in other studies (Barnes and Vidgen, 2003). Loiacono *et al*. (2000) identified 12 dimensions to measure Web site quality with the WebQual scale: informational fit to task, interactivity, trust, response time, ease of understanding, intuitive operations, visual appeal, innovativeness, flow/emotional appeal, consistent image, online completeness, and advantage over alternative channels.

When measuring the quality level of the service environment, the SERVQUAL scale developed by Parasuraman *et al*. (1988) is generally used in research applications. From analyzing the 293 questionnaire responses of Northeastern University students in a survey in U.S.A., Iwaarden *et al*. (2003) found that the quality dimensions applicable in the service sector are also applicable to Web sites. The items that were identified as most important to the quality of Web sites were tangibles, reliability, responsibility, assurance, and empathy. Rotondaro (2002) tried to redefine the quality dimensions of SERVQUAL and to conclude that these dimensions are also applicable in e-commerce. Li *et al*. (2003) explored the major differences between Web-based customer service

and traditional communication, and then conducted a survey on internet users to identify the service quality dimension shifts in the information age. In response to the challenges in assessing Web-based customer service, the authors proposed two additional new quality dimensions as compared to the dimensions of the SERVQUAL model. These two new quality dimensions are quality of information, and the dimension integration of traditional and Web-based communication. In addition, Parasuraman *et al*. (2005) used the means-end framework as a theoretical foundation, while this article conceptualized, constructed, refined, and tested a multiple-item scale (E-S-QUAL) for measuring the service quality delivered by Web sites from which customers do online shopping. Two stages of empirical data collection revealed that two different scales were necessary for capturing electronic service quality. The basic E-S-QUAL scale developed in the research was a 22-item scale with four dimensions: efficiency, fulfillment, system availability, and privacy. The summarized determinants of the measurement of e-service quality and the referenced papers were shown in Table 4.2.

Table 4.2 The Summarized Determinants of the Measurement of E-Service Quality and the Referenced Papers

Determinants	Reference Papers
Efficiency, Reliability, Fulfillment, Privacy, Responsiveness, Compensation, Content	Zeithaml (2002)
Ease of use, Aesthetic design, Processing speed, Security of personal and financial information	Yoo and Donthu (2001)
Informational fit to task, Interactivity, Trust, Response time, Ease of understanding, Intuitive operations, Visual appeal, Innovativeness, Flow/emotional appeal, Consistent image, Online completeness, Advantage over alternative channels	Loiacono et al. (2000)
Tangibles, Reliability, Responsibility, Assurance, Empathy	Iwaarden et al. (2003)
Quality of information, Integration of traditional and web-based communication	Li et al. (2003)
Efficiency, Fulfillment, System availability, Privacy	Parasuraman et al. (2005)

Determinants of E-Service Satisfaction

Szymanski and Hise (2000) used an online survey with a conceptual model to examine the factors that make consumers satisfied with their e-retailing experience. They found that online convenience, site design, and financial security are the dominant factors considered in consumers' assessment of e-satisfaction. In addition to this, Wolfinbarger and Gilly (2003) also developed a conceptual framework to define and measure online retail quality (eTailQ) that contributes to consumers' satisfaction and high-quality online shopping experience. The authors studied nine focus groups of online buyers, and the respondents answered a series of 40 statements regarding the desired and actual performance of their online purchasing experience. The paper concluded that either of the four-factor models could be used to model online quality. The four factors for the measurement of etail quality are: website design, fulfillment/reliability, privacy/security and customer service.

Stauss (2002) defined "complaint satisfaction" as "the satisfaction of a complainant with a company's response to his/her complaint." It is a necessary prerequisite for customer retention. According to Stauss's comprehensive review of complaint behavior literature, nine attributes of complaint satisfaction can be used to evaluate overall complaint satisfaction. These are adequacy, access, friendliness, empathy, individual handling, effort, active feedback, reliability, and speed of response.

Ribbink *et al*. (2004) constructed a conceptual model to validate the relationship among e-service quality, e-satisfaction, e-trust, and e-loyalty in an e-business context. The paper collected data from 350 university students in Europe, and the participants were asked to evaluate the Web site of book and CD store vendors which they were most familiar with. Except for the evaluation of electronic service and e-trust results in explaining customer loyalty to online retailers, assurance in e-service quality more

specifically showed a direct influence on e-satisfaction which resulted also to e-trust. Furthermore, the user interface must be characterized by ease of use, and the Web site's design should be attractive enough. The summarized determinants of e-service satisfaction and the referenced papers were shown in Table 4.3

Table 4.3 The Summarized Determinants of E-Service Satisfaction and the Referenced Papers

Determinants	Reference Papers
Online Convenience, Site design, Financial security	Szymanski and Hise (2000)
Website design, Fulfillment/reliability, Privacy/security, Customer service	Wolfinbarger and Gilly (2003)
Adequacy, Access, Friendliness, Empathy, Individual handling, Effort, Active feedback, Reliability, Speed of response	Stauss (2002)
Assurance, Ease of use, Web site design	Ribbink et al. (2004)

Summary of the Specified Determinants

After extensively discussing the papers relating to the determinants which affect service quality and customer satisfaction in e-commerce, the items which are similar in explanatory meanings are gathered in the same category after comparing the definitions of the extracted determinants. To compute for the total, there are 29 categories classified in our study for the dominant characteristics of e-service quality. We summarized and described all these categories of determinants in Table 4.4 and they are extracted mainly from the literature on e-service quality as shown in Table 4.5.

Table 4.4 The Summary of E-Service Quality Determinants

Category	Determinants of E-Service Quality	Interpretation
1	■ Active feedback	The activity to find out the best solution for the customer, notification about delays, feedback about procedures and decisions.
2	■ Adequacy	The adequacy of the problem's solution, fairness of the compensation, and fit-to-task information offered.
3	■ Aesthetic design	The appearance of the website including the clarity and readability of texts, and site creativity.
4	■ Assurance	The ability to convey trust and confidence in the organization with respect to security and privacy.
5	■ Communication	The integration of internal and external communication systems, and the ability of the website to tailor its products and services to meet customers' expectations.
6	■ Compensation	The degree to which the website compensates customers for problems.
7	■ Contact	The availability of assistance through telephone or online representatives.
8	■ Content	The presentation and layout of factual information and functions on the website.
9	■ Convenience	The trading hours, absence of queues, availability of more alternatives, and faster transactions.
10	■ Customer service	Responsive and helpful service that responds to customer inquiries quickly.
11	■ Customization	The degree of change according to customers' requirements and the ability to learn their needs in order to anticipate their future preferences.
12	■ Ease of use	Concise, orderly, easy-to-understand, and easy-to-navigate website contents.
13	■ Effort	The visible effort to resolve customers' problem.
14	■ Empathy	The willingness to take customers' perspective.
15	■ Incentives	The encouragement given by the website to consumers in consideration of the alternatives already available.
16	■ Interactivity	The services provided to enable interaction between a customer and a company representative or another customer of the website.
17	■ Perceived risk	The level of perceived risk with the activities provided by online service providers.
18	■ Performance	The ability of the website to store information and make it easily available to its customers when needed.
19	■ Price	The cost which customers are willing to spend in engaging in online activities.
20	■ Reliability	The ability to perform the promised service effectively, dependability, and consistency in performance.
21	■ Reputation	The perception which is affected by past experience, the site's performance, and other unexplainable intangibles that the customer may perceive.
22	■ Response time	The processing speed of a company to provide accurate and consistent response, promptness of response to customers' complaints, and speed of online processing.
23	■ Security	The degree to which the site is considered safe and protects customer information, including assurance of shopping behavior data and credit card information.
24	■ Serviceability	The quality of provision of various services, and the resolution of conflicts and complaints from customers.
25	■ Site effectiveness and functionality	How information is effectively presented including all elements affecting consumers' experience in the website.
26	■ System availability	Easy and convenient access to various sources in the website.
27	■ Systems integration	Internal integration of the company's system or external integration with its business partners.
28	■ Trust	Exact delivery of promised services and the willingness to help customers in providing prompt service.
29	■ Web store policies	Customer-oriented policies like the provision of effective warranty programs available in online purchases and the assurance of convenience for customers.

Table 4.5 The Summary of the Referenced Papers for E-Service Quality Determinants

Category	Reference Papers															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	√	√				√	√									√
2		√														
3		√									√					
4			√			√		√			√				√	
5			√		√				√					√		
6		√				√	√	√			√			√		
7	√						√						√			
8	√												√			
9							√	√						√		
10							√									
11	√	√	√			√	√	√	√			√	√	√		√
12												√				
13			√				√									√
14					√			√			√				√	√
15	√		√	√			√	√			√		√			
16		√														
17		√	√			√			√		√			√		
18			√	√	√		√	√	√		√	√		√		
19	√		√	√			√	√				√	√		√	
20								√		√	√					
21		√	√													
22							√	√			√					
23			√							√	√					
24										√						
25							√									
26	√	√	√				√				√		√	√	√	
27			√				√		√		√					
28							√									
29			√													

Name of the papers:

1. Parasuraman et al. (2005)
2. Stauss (2002)
3. Madu and Madu (2002)
4. Szymanski and Hise (2000)
5. Ribbink et al. (2004)
6. Cox and Dale (2001)
7. Surjadjaja et al. (2003)
8. Santos (2003)
9. Iwaarden et al. (2003)
10. Ruyter et al. (2001)
11. Loiacono et al. (2002)
12. Wolfinbarger and Gilly (2003)
13. Zeithaml (2002)
14. Li et al. (2003)
15. Yoo and Donthu (2001)
16. Yang and Jun (2002)

4.4 Develop the Parameter Corresponding Table

The determinants of e-service quality were correlated with the 39 TRIZ engineering parameters, and the determinants of service quality in e-commerce are classified into 29 categories as shown in Table 4.4. Specifically, the study of Domb *et al*. (1998) which compared several different translations of the 39 features of Altshuller's contradiction matrix was also our reference when we reviewed the content of each parameter in this case example. The parameter corresponding table for e-commerce is shown in Table 4.6. In this table, there is one specific feature emphasized which is not just one property category of e-service quality corresponding to one TRIZ engineering parameter for some pairs of mapping relationship. If the analogical explanations for these categories of e-service quality are similar, we infer that these categories of e-service quality correspond to the same TRIZ engineering parameter. The reason for the parameter mapping results is shown as the following description.

Categories 18 and 22 correspond to TRIZ parameter No. 9

In e-business society, the efficiency of navigability of a Web site, including its online convenience, linkage, completeness, even the storage capability of the Web site, is concerned with the ease and speed of accessing the site. The interpretation of "speed" in TRIZ refers to the velocity of an object or the rate of a process, and it can be analogously recognized as the efficiency process to navigate the Web site. The response time or processing time of the site can be referred to as the velocity of a process. Therefore, categories 18 and 22 are corresponded to the same TRIZ parameter "speed".

Table 4.6 The Parameter Corresponding Table for E-Commerce

Category	Determinants of E-Service Quality	Parameter Number	Parameter Name in TRIZ
18	Performance	9	Speed
22	Response time		
8	Content	10	Force
13	Effort		
25	Site effectiveness and functionality	11	Stress or pressure
29	Web store policies		
3	Aesthetic design	12	Shape
4	Assurance	13	Stability of the object's composition
21	Reputation	14	Strength
14	Empathy	17	Temperature
6	Compensation	23	Loss of substance
19	Price	26	Amount of substance
2	Adequacy	27	Reliability
20	Reliability		
28	Trust		
5	Communication	28	Measurement accuracy
23	Security	30	Object affected harmful factors
17	Perceived risk	31	Object generated harmful factors
26	System availability	32	Ease of manufacture
9	Convenience	33	Ease of operation
12	Ease of use		
1	Active feedback	34	Ease of repair
7	Contact		
10	Customer service		
24	Serviceability		
11	Customization	35	Adaptability or versatility
16	Interactivity		
27	Systems integration	36	Device complexity
15	Incentives	39	Productivity

Categories 8 and 13 correspond to TRIZ parameter No. 10

In TRIZ, "force" is any interaction that is intended to change an object's condition. Referring to the contents of a Web site, items such as quality of information, up-to-date information, and even the visible effort to solve the customer's problem define the e-service provider, and all the addressed subjects will interact with the customer's

willingness to stay online. The efforts of the Web site to satisfy online customers are likened to the force intending to change an object's condition. Therefore, categories 8 and 13 might be ascribed to the TRIZ parameter "force."

Categories 25 and 29 correspond to TRIZ parameter No. 11

In TRIZ, "stress or pressure" is defined as the exercise of force on a unit, or the effect of forces on an object. Concerning Web site design or site effectiveness in terms of online service, a good Web site design is well organized and easily searchable, providing consumers with uncluttered screens, fast presentations, and all other elements which make a consumer's experience at the Web site meaningful. If we look at the consumer as the object, the functionality and effectiveness of the Web site's design, even the Web site's policies, will actively influence the consumer's intention to stay online. Hence, the functionality or effectiveness of a Web site design seems like a stress or pressure acting on the consumers. Therefore, the TRIZ parameter "stress or pressure" is possibly considered to be similarly explained by the site design.

Category 3 corresponds to TRIZ parameter No. 12

In TRIZ, "shape" is defined as the external contour or aesthetic appearance of a system. The attributes, for instance, the aesthetic design or appearance of a Web site, deal with the visual attractiveness, the sound effects, the clarity and readability of texts, and the site creativity with multimedia and color graphics are all the critical features of the external aesthetic appearance of a Web site. Therefore, we define the aesthetic design or appearance of a Web site as comparable with the TRIZ parameter "shape."

Category 4 corresponds to TRIZ parameter No. 13

In TRIZ, the "stability of the object's composition" is interpreted as the integrity and the relationship of a system's constituent elements. The assurance concerned in e-business service can be looked at as the ability of the Web site to ensure the trust and

confidence of customers. The company needs to ensure that their employees are very knowledgeable about their operations, courteous in their responses, and are able to convey trust and confidence to users. Therefore, the task of e-service providers is to ensure the willingness of a consumer to stay online, and to uphold their trust and confidence in the system. Therefore, the "stability of the object's composition" can be analogically explained by the assurance of the service system in e-business.

Category 21 corresponds to TRIZ parameter No. 14

In TRIZ, "strength" is defined as the extent to which the object is able to resist change in response to force. The organizational reputation of an e-service provider relies on its ability to maintain a customer's perceived satisfaction, as well as its good reputation or consistent image. This can be recognized as the particular strength of service providers to prevent probable changes in the customer's attitude or preference. Therefore, we assign organizational reputation to correspond to the TRIZ parameter "strength."

Category 14 corresponds to TRIZ parameter No. 17

In TRIZ, "temperature" is defined as the measured or perceived thermal condition of the object parameters. In Web site service, providing individualized attention to customer concerns and requests rather than issuing a generic auto reply shows empathy which communicates a message of willingness to take the customer's perspective, to understand his/her annoyance, and to handle the individual complaint. Even though there is no direct human interaction in virtual operations, certain elements of human contact are involved, say through the e-mail communication which is also critical in serving customers. The service provider should realize the diverse and changing needs of customers. Therefore, it can be seen as perceiving the thermal changes in the object's parameters, and thus corresponding to the parameter "temperature" in TRIZ.

Category 6 corresponds to TRIZ parameter No. 23

In TRIZ, the "loss of substance" is defined as the loss of some of a system's materials, substances, or subsystems. The compensation or service recovery for e-service providers is recognized as the degree to which the site compensates customers for problems, or it also refers to the process of redressing the loss of customers in the event of a failure within the service process. The process of regaining a customer's confidence is an incredibly difficult task because customers who are let down by a service failure can become more demanding when the company tries to resolve the problem. The service failure resulting in compensation is recognized as the loss of customer satisfactory elements of a service system. Therefore, the parameter "loss of substance" in TRIZ can be explained by compensation or service recovery in e-service operations.

Category 19 corresponds to TRIZ parameter No. 26

A competitive price is an essential determinant of an e-service operation. From customers' point of view, price is one of the most important motivations for engaging in online shopping, and it is concerned with the monetary value which the consumer is able to afford. In TRIZ, the definition of "amount of substance" is the quantity of a system's materials, substances, parts, fields, or subsystems. The quantity of a system's materials can be recognized as the amount of monetary value which exists in the e-service processes, and it is the price which a consumer is willing to pay. Therefore, price in e-service can be compared to the meaning of "amount of substance" in TRIZ.

Categories 2, 20, and 28 correspond to TRIZ parameter No. 27

In TRIZ, "reliability" is defined as the system's ability to perform its intended functions in predictable ways and conditions. In e-business, it refers to the ability to perform the promised service accurately and consistently, including frequency of

updating the Web site, prompt replies to customer inquiries, and accuracy of online purchasing and billing, which can all be referred to as part of the company's responsibility. Therefore, these three categories relating to the adequacy or fulfillment of a trusted service for online consumers can be compared to "reliability" in TRIZ.

Category 5 corresponds to TRIZ parameter No. 28

In TRIZ, "measurement accuracy" is defined as the closeness of a measured value to the actual value of a property of a system. Communication in Web site service intends to keep customers properly informed in a language they can understand. Although it is provided using text, color, graphics, and animation rather than contact through personnel, communication can also be used to describe services, feedback, and the linkage which enable the processes of informing and listening to customers, and which facilitates the service providers to tailor products and services to meet customers' expectations. When the communication process is well performed by service providers, customers' expectations can be met more easily. The objective of communication for a service provider is to target the level of customer satisfaction and to provide a closer perceived value to the actual satisfactory value. Therefore, we suggest the category of communication to correspond to the parameter "measurement accuracy" in TRIZ.

Category 23 corresponds to TRIZ parameter No. 30

In TRIZ, "object affected harmful factors" is defined as the susceptibility of a system to externally generated harmful effects. In online transactions, security is always a major consideration when deciding whether or not to buy items online. It is also concerned with the degree to which the site is safe or is able to protect customer information, even including assurance that shopping behavior data are not shared and that credit card information is secure. This means that online service providers must ensure that there is no harm which can result from the transaction process, and this

concept is possibly connected to the parameter "object affected harmful factors" in TRIZ.

Category 17 corresponds to TRIZ parameter No. 31

In TRIZ, "object generated harmful factors" is described as the aspects of an object or system that produce an adverse effect on external elements. The perceived risk is generally considered to be the potential advent of a problem in the online service system, and it might pose a possible detriment to products. Therefore, the perceived risk in the e-service process can be corresponded to the TRIZ parameter "object generated harmful factors."

Category 26 corresponds to TRIZ parameter No. 32

In TRIZ, "ease of manufacture" is defined as the degree of facility, comfort, or effortlessness in manufacturing the object. In terms of system availability, Internet users usually prefer to easily and conveniently access various services provided by Internet companies. Because most customers use the Internet for speed and convenience, they expect that access to the Web site will always be possible as a necessary determinant of the e-service environment. The availability of the system can be compared to the ease in manufacturing an object. Therefore, we related the availability of e-service to the parameter "ease of manufacture" in TRIZ.

Categories 9 and 12 correspond to TRIZ parameter No. 33

In TRIZ, "ease of operation" is defined as the simplicity of an operation by the intended user. In e-service processing, the system ensures convenience for users, in terms of unrestricted trading hours, absence of queues, availability of more alternatives, and faster transactions, and Web-based stores should also make it easy for customers to proceed through the whole purchasing process by minimizing technical difficulties. Most importantly, the contents of the Web site should be concise and easy to understand,

and should ensure functionality, accessibility of information, ease of ordering, and ease of navigation. All the features mentioned above relate to convenience in e-service operations, and they can be recognized as the explanatory meaning of the parameter "ease of operation" in TRIZ.

Categories 1, 7, 10, and 24 correspond to TRIZ parameter No. 34

In TRIZ, "ease of repair" refers to the convenience, comfort, simplicity, and time to repair faults, failures, or defects in a system. For e-service providers, feedback enables the identification of the best solution for a customer's concerns, notification about delays, feedback about procedures, and decisions. Furthermore, customer services or individual handling responses are intended to facilitate non-standardized operations which are customized to the problem and the requests of the complainants. It refers to completely addressing the issue in order to restore customer satisfaction after the complaint. From this point of view, we conclude categories 1, 7, 10, and 24 in Table 4.3 to be mapped up with the parameter "ease of repair" in TRIZ.

Categories 11 and 16 correspond to TRIZ parameter No. 35

In TRIZ, "adaptability or versatility" is defined as the extent to which a system positively responds to external changes and can be used in multiple ways in a variety of circumstances. In the customization of an e-service system, customers actively request the system to change according to their requirements, and this feeds information back to the service provider, allowing the provider to adjust the system interactively to accommodate customers' requirements. It is critical for businesses to engage customers in a personalized dialogue to learn more about their needs and to anticipate their future preferences. In personalization, service providers actively build personal profiles of customers and provide service offerings tailored to customers' individual needs. Therefore, in an e-service process with customization which positively responds to

external changes, processes can be used in multiple ways in a variety of circumstances. The TRIZ parameter "adaptability or versatility" is applicably matched with the properties of customization and interactivity of the e-service process.

Category 27 corresponds to TRIZ parameter No. 36

In TRIZ, "device complexity" is defined as the number and diversity of elements and element interrelationships within and across the boundaries of a system. In e-service operation, systems integration can be seen as the internal integration of the system across departments within the company or with its business partners, or the integration of supply chains or systems between various critical e-service providers. The integration of service systems results in the complexity of the service relationships, and it can be analogically compared to the complexity of a device. Therefore, system integration is made to correspond to the parameter "device complexity" in TRIZ.

Category 15 corresponds to TRIZ parameter No. 39

In TRIZ, "productivity" is defined as the number of useful functions or operations performed by a system per unit time. In e-service operation, we describe incentive is the encouragement given by Web providers to consumers in the form of rewards or benefits for browsing over or using the Web site, for instance. As compared to competitors, one who owns this relative advantage will be perceived to achieve more responses than other service providers with services already available. In other words, the e-service provider which provides incentives produces more useful functions or operations performed by the original system at that time period, and this can be related to the parameter "productivity" in TRIZ.

After the parameter corresponding table was developed, we designed a questionnaire based on the parameter corresponding table, and seven experts who have years of practical experience in the fields of TRIZ, service quality, and e-commerce

were invited to complete our questionnaires. Although these experts' help was not sufficient to cover all parts of the e-commerce sector; their professional opinions adequately indicated the reliable effect of our parameter mapping results. Before the experts started to fill out the questionnaires, we explained clearly the definitions of the 39 TRIZ engineering parameters and the reasons for mapping up the parameters in each pair. Each expert indicated his/her opinion by selecting either "Agree" or "Disagree" for each parameter mapping result in the blank provided for. The contents of designed questionnaire are displayed in the appendix. The result of the questionnaires is shown in Table 4.7.

Table 4.7 The Results of Questionnaires from Experts (A: agree, D: disagree)

The Determinants of E-Service Quality	No.	TRIZ Parameter	Expert 1		Expert 2		Expert 3		Expert 4		Expert 5		Expert 6		Expert 7		Final Results	
			A	D	A	D	A	D	A	D	A	D	A	D	A	D	A	D
Performance	9	Speed	■		■		■		■		■		■		■		■	
Response time																		
Content	10	Force		■	■			■		■	■		■		■		■	
Effort																		
Site effectiveness and functionality	11	Stress or pressure	■		■			■		■	■		■		■		■	
Web store policies																		
Aesthetic design	12	Shape	■			■	■		■			■	■		■		■	
Assurance	13	Stability of the object's composition	■			■	■			■	■			■	■		■	
Reputation	14	Strength	■		■		■			■	■			■		■	■	
Empathy	17	Temperature		■	■			■		■		■		■	■			■
Compensation	23	Loss of substance	■		■			■		■	■			■	■		■	
Price	26	Amount of substance		■	■			■	■		■		■		■		■	
Adequacy	27	Reliability	■		■		■			■	■		■		■		■	
Reliability																		
Trust																		
Communication	28	Measurement accuracy		■	■			■	■		■			■	■		■	
Security	30	Object affected harmful factors	■		■		■		■		■		■		■		■	
Perceived risk	31	Object generated harmful factors	■		■		■		■			■	■		■		■	
System availability	32	Ease of manufacture		■		■	■		■		■		■		■		■	
Convenience	33	Ease of operation	■		■		■		■		■		■			■	■	
Ease of use																		
Active feedback	34	Ease of repair		■	■			■	■		■			■	■		■	
Contact																		
Customer service																		
Serviceability																		
Customization	35	Adaptability or versatility	■		■		■		■		■		■			■	■	
Interactivity																		
Systems integration	36	Device complexity	■			■	■		■		■			■		■	■	
Incentives	39	Productivity	■		■			■	■			■	■		■		■	

After summing up 19 pairs of analogical mapping parameters, there is one mapping pair, “Empathy vs. Temperature”, to which only two experts agreed, while the rest of the pairs were approved by more than three experts. Therefore, we conclude that there are 18 pairs of parameter corresponding results which are analogically related. Furthermore, in order to confirm the consistency in experts’ opinions on the parameter corresponding results, we assumed that the results of the 18 mapping groups correspond at random with the e-commerce industry, and that the assumptions of the Cochran test are met. The Cochran test was used to test the null hypothesis, and the following statements were hypothesized:

H_0: There are no differences among experts’ opinions.

H_1: There is a difference among experts’ opinions on the effectiveness of the parameter mapping results.

We used “1” to express agreement with the mapping result (“agrees with the mapping result”) and “0” to express disagreement with the mapping result (“disagrees with the mapping result”). The results were then tabulated with r rows representing the mapped numbers of TRIZ 39 parameters and c columns representing the c experts, with entries that are either zeros or ones. Let R_i represent the row totals, i=1,2,….,r, and let C_j represent the column totals, j=1,2,….,c, with N representing the total number of ones in the table. The result of questionnaires from seven experts is tabulated in Table 4.8.

Table 4.8 The Computing Data of Questionnaires

TRIZ No.	Experts							Row Totals (R_i)
	1	2	3	4	5	6	7	
9	1	1	1	1	1	1	1	7
10	0	1	0	0	1	1	1	4
11	1	1	0	0	1	1	1	5
12	1	0	1	1	0	1	1	5
13	1	0	1	0	1	0	1	4
14	1	1	1	0	1	0	0	4
23	1	1	0	0	1	0	1	4
26	0	1	0	1	1	1	1	5
27	1	1	1	0	1	1	1	6
28	0	1	0	1	1	0	1	4
30	1	1	1	1	1	1	1	7
31	1	1	1	1	0	1	1	6
32	0	0	1	1	1	1	1	5
33	1	1	1	1	1	1	0	6
34	0	1	0	1	1	0	1	4
35	1	1	1	1	1	1	0	6
36	1	0	1	1	1	0	0	4
39	1	1	0	1	0	1	1	5
Column totals (C_j)	13	14	11	12	15	12	14	91

The test statistic is computed using the following equation:

$$T = c(c-1)\frac{\sum_{j=1}^{c}(C_j - \frac{N}{c})^2}{\sum_{i=1}^{r} R_i(c-R_i)} = 7(7-1)\frac{\sum_{j=1}^{7}(C_j - \frac{91}{7})^2}{\sum_{i=1}^{18} R_i(7-R_i)} = 7\times 6\times \frac{18}{158} = 4.785$$

The exact distribution of T is difficult to tabulate, so a large sample approximation is used instead. The number of blocks r is assumed to be large. Then the critical region of an approximate size 0.05 (α) corresponds to all values of T greater than 12.592, which is the 0.95 (1-α) quantile of a chi-square random variable with 6 degrees of freedom. The calculated statistic value of T which is 4.785 is smaller than the critical value 12.592. Therefore, the null hypothesis H_0 cannot be rejected. We conclude that no significant difference among the experts' opinions is detected, and that these 18 pairs of mapped parameters are formulated as the content of the parameter corresponding table which will be used in the following problem-solving process.

4.5 Generate Feasible Solutions

In stage 4, the feasible solutions are generated by TRIZ contradiction matrix. We analyzed the detailed operation process in the business and software development division by following the steps of this stage.

Step 4.1: Describe the specified problem.

The function and attribute analysis (FAA) is used to define our problem in this sample case. Mann (2002) described that the FAA process allows users to analyze the functional relationships of a physical object between components and the component feature attributes. It results to the functional description of the attributes of the relevant components to better access the problem's root causes. From our preliminary analysis, a FAA diagram of a major problem in customer satisfaction is developed in Figure 4.1.

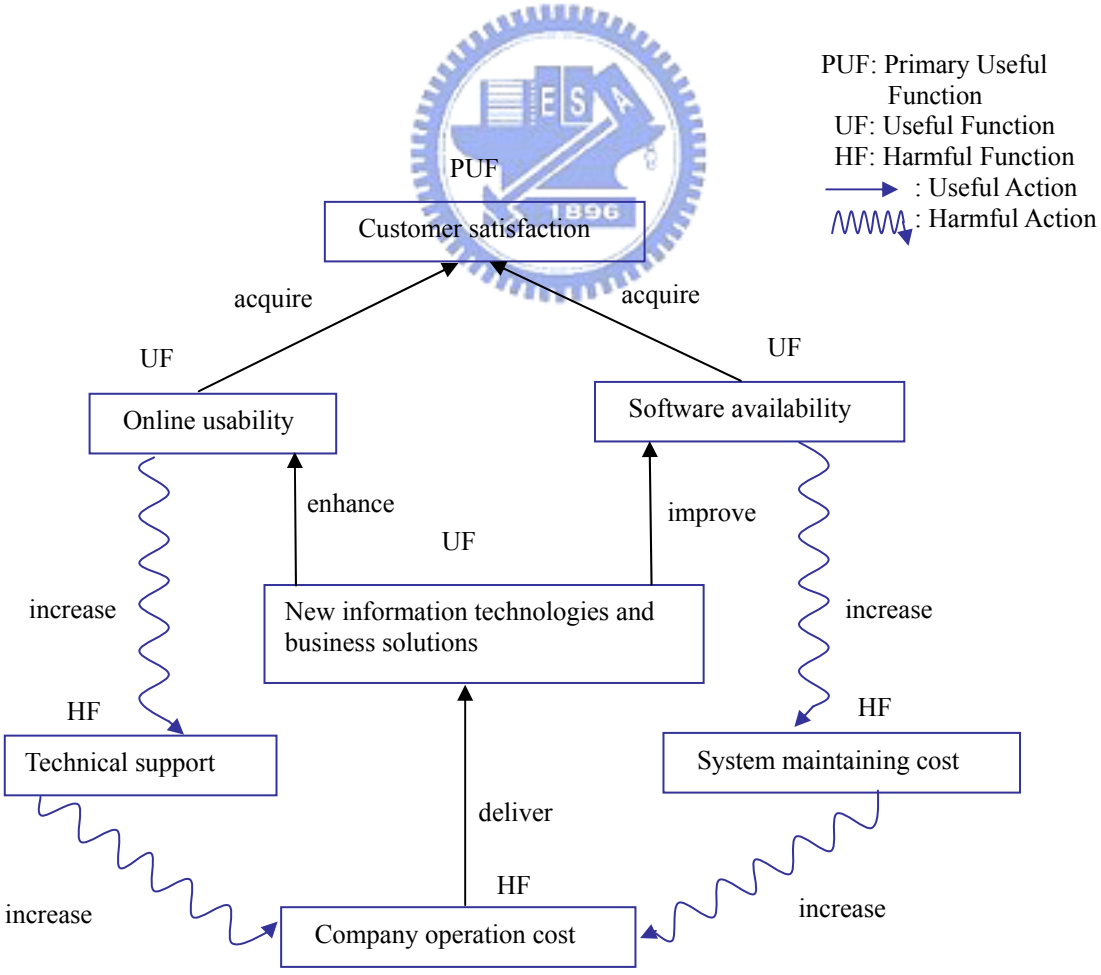

Figure 4.1 The Function and Attribute Analysis Diagram for the Case Example

Based on the formulated relationships, it could be observed that customer satisfaction is the primary useful function (PUF), which becomes the goal of the company as it tries to gain a competitive advantage in the operation of its business. For this purpose, the company delivered new information technologies and business solutions to its clients. From this, customer satisfaction is acquired through the useful functions (UF) of improving software availability and enhancing the software's online usability. However, the harmful functions (HF) of an increased system maintaining cost and an increased quantity of technical support are accompanied by a corresponding increase in the company's total operation cost. Since there are inherent contradicting relationships existing in this situation, we could thus define the scope of the problem to be within the various areas of software availability, online usability, cost of system maintenance, and cost of technical support.

Step 4.2: Define the ideal situation for the specified problem.

Following the principle of ideality in the TRIZ definition and the focused areas of the problems formulated in *step 4.1*, we define the ideal situation as the "provision of an easily operated environment for users without any effort."

Step 4.3: Apply Fuzzy QFD process to indicate the critical service quality determinants.

We followed the steps of proposed problem solving process from *steps 4.3.1* to *4.3.5* of Figure 3.1 to indicate the critical service quality determinants. First, the correlative importance between the specified customer requirements of the problem in *step 4.1* and the determinants of service quality in Table 4.4 was collected in linguistic terms from the opinions of three managers in EC-SERVER.COM, and the results are shown in Table 4.9. Then the linguistic variables were translated into triangular fuzzy numbers from Figure 3.2 and Figure 3.3; that is, the triangular fuzzy numbers {(0.75,1,1),

(0.5,0.75,1), (0.25,0.5,0.75), (0,0.25,0.5), (0,0,0.25)} were made to correspond with linguistic variables {“EI”, “VI”, “I”, “LI”, “NI”}, respectively. Computing from Equations (3.1) to (3.4), the average fuzzy numbers of the translating results for the determinants of service quality are shown in Table 4.10. The integrated triangular fuzzy numbers for the determinants of service quality were computed by Equations (3.5) to (3.7), and the defuzzied values of integrated fuzzy numbers for each service quality determinant were calculated by Equation (3.8). Consequently, the prioritized importance of each determinant was ranked by the defuzzied values. The results are shown in Table 4.11.

Table 4.9 The Results of the Opinions from Three Managers in Linguistic Terms

Manager 1:

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
(1)	EI	VI	EI	VI	EI	I	VI	VI	EI	VI	VI	EI	VI	I	I	EI	I	VI	LI	EI	LI	VI	VI	VI	EI	EI	LI	I	I
(2)	VI	I	VI	EI	VI	LI	I	LI	I	I	I	EI	LI	NI	NI	EI	VI	I	NI	EI	I	I	EI	VI	VI	EI	LI	I	I
(3)	LI	VI	EI	I	I	VI	I	I	I	VI	I	VI	LI	LI	LI	VI	VI	VI	EI	VI	VI	LI	I	VI	VI	VI	VI	VI	I
(4)	EI	VI	EI	VI	I	LI	VI	I	VI	EI	I	EI	I	LI	LI	EI	I	I	I	EI	I	EI	I	VI	I	EI	LI	I	I

Manager 2:

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
(1)	VI	VI	EI	I	VI	VI	VI	I	EI	VI	VI	EI	I	VI	NI	EI	LI	EI	LI	EI	VI	VI	I	VI	VI	EI	VI	VI	VI
(2)	VI	I	EI	LI	LI	LI	VI	LI	I	VI	VI	VI	VI	VI	NI	EI	VI	VI	I	EI	VI	EI	EI	VI	I	VI	I	EI	EI
(3)	I	I	VI	I	I	I	VI	I	I	VI	I	EI	I	I	I	VI	I	I	EI	VI	I	LI	I	I	VI	EI	I	I	I
(4)	LI	I	EI	I	VI	NI	VI	VI	VI	VI	I	EI	I	LI	LI	EI	LI	I	I	EI	I	I	I	VI	I	EI	I	I	I

Manager 3:

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
(1)	I	I	VI	VI	I	I	VI	LI	I	I	I	EI	I	LI	LI	EI	LI	I	LI	EI	LI	VI	VI	VI	VI	EI	I	VI	I
(2)	I	VI	EI	VI	I	LI	VI	LI	VI	VI	VI	EI	LI	LI	LI	EI	VI	I	I	VI	I	I	EI	VI	I	VI	I	I	I
(3)	LI	LI	EI	I	I	I	LI	LI	I	I	I	EI	I	LI	LI	EI	LI	I	VI	EI	LI	LI	I	VI	I	EI	LI	LI	LI
(4)	I	VI	EI	I	VI	I	I	I	VI	VI	I	EI	I	I	I	EI	I	I	I	EI	I	I	I	VI	I	EI	I	I	I

Notes:

1. There are four assessed customer requirements on the first columns of the table: (1) Software availability; (2) On line usability; (3) Maintaining cost; (4) Technical support.

2. The 29 categories of e-service quality determinants from Table 4.4 are showed on the first row of the table, and they are denoted as the numeric number from 1 to 29.

Table 4.10 The Average Fuzzy Numbers of the Service Quality Determinants

	Category 1			Category 2			Category 3			Category 4			Category 5			Category 6			Category 7			Category 8			Category 9			Category 10		
	q_{it}	o_{it}	p_{it}	q_{it}	o_{it}	p_{it}	q_{it}	o_{it}	p_{it}	q_{it}	o_{it}	p_{it}	q_{it}	o_{it}	p_{it}	q_{it}	o_{it}	p_{it}	q_{it}	o_{it}	p_{it}	q_{it}	o_{it}	p_{it}	q_{it}	o_{it}	p_{it}	q_{it}	o_{it}	p_{it}
(1)	0.5	0.833	0.916	0.416	0.666	0.916	0.666	0.916	1	0.416	0.666	0.916	0.5	0.75	0.916	0.333	0.583	0.833	0.5	0.75	1	0.25	0.5	0.75	0.583	0.833	0.916	0.416	0.666	0.916
(2)	0.416	0.666	0.916	0.333	0.583	0.833	0.666	0.916	1	0.416	0.666	0.833	0.25	0.5	0.75	0	0.25	0.5	0.416	0.666	0.916	0	0.25	0.5	0.333	0.583	0.833	0.416	0.666	0.916
(3)	0.083	0.333	0.583	0.25	0.5	0.75	0.666	0.916	1	0.25	0.5	0.75	0.25	0.5	0.75	0.333	0.583	0.833	0.25	0.5	0.75	0.166	0.416	0.666	0.25	0.5	0.75	0.416	0.666	0.916
(4)	0.333	0.583	0.75	0.416	0.666	0.916	0.75	1	1	0.333	0.583	0.833	0.416	0.666	0.916	0.083	0.25	0.5	0.416	0.666	0.916	0.333	0.583	0.833	0.5	0.75	1	0.583	0.833	1

	Category 11			Category 12			Category 13			Category 14			Category 15			Category 16			Category 17			Category 18			Category 19			Category 20		
	q_{it}	o_{it}	p_{it}	q_{it}	o_{it}	p_{it}	q_{it}	o_{it}	p_{it}	q_{it}	o_{it}	p_{it}	q_{it}	o_{it}	p_{it}	q_{it}	o_{it}	p_{it}	q_{it}	o_{it}	p_{it}	q_{it}	o_{it}	p_{it}	q_{it}	o_{it}	p_{it}	q_{it}	o_{it}	p_{it}
(1)	0.416	0.666	0.916	0.75	1	1	0.333	0.583	0.833	0.25	0.5	0.75	0.083	0.25	0.5	0.75	1	1	0.083	0.333	0.583	0.5	0.75	0.916	0	0.25	0.5	0.75	1	1
(2)	0.416	0.666	0.916	0.666	0.916	1	0.166	0.416	0.666	0.166	0.333	0.583	0	0.083	0.333	0.75	1	1	0.5	0.75	1	0.333	0.583	0.833	0.166	0.333	0.583	0.666	0.916	1
(3)	0.25	0.5	0.75	0.666	0.916	1	0.166	0.416	0.666	0.083	0.333	0.583	0.083	0.333	0.583	0.583	0.833	1	0.25	0.5	0.75	0.333	0.583	0.833	0.666	0.916	1	0.666	0.916	1
(4)	0.25	0.5	0.75	0.75	1	1	0.25	0.5	0.75	0.083	0.333	0.583	0.083	0.333	0.583	0.583	1	1	0.166	0.416	0.666	0.25	0.5	0.75	0.25	0.5	0.75	0.75	1	1

	Category 21			Category 22			Category 23			Category 24			Category 25			Category 26			Category 27			Category 28			Category 29		
	q_{it}	o_{it}	p_{it}	q_{it}	o_{it}	p_{it}	q_{it}	o_{it}	p_{it}	q_{it}	o_{it}	p_{it}	q_{it}	o_{it}	p_{it}	q_{it}	o_{it}	p_{it}	q_{it}	o_{it}	p_{it}	q_{it}	o_{it}	p_{it}	q_{it}	o_{it}	p_{it}
(1)	0.166	0.416	0.666	0.5	0.75	1	0.416	0.666	0.916	0.5	0.75	1	0.583	0.833	1	0.75	1	1	0.25	0.5	0.75	0.416	0.666	0.916	0.333	0.583	0.833
(2)	0.333	0.583	0.833	0.416	0.666	0.833	0.75	1	1	0.5	0.75	1	0.333	0.583	0.833	0.583	0.833	1	0.166	0.333	0.666	0.416	0.666	0.833	0.416	0.666	0.833
(3)	0.25	0.5	0.75	0	0.25	0.5	0.25	0.5	0.75	0.416	0.666	0.916	0.416	0.666	0.916	0.583	0.833	1	0.25	0.5	0.75	0.25	0.5	0.75	0.166	0.416	0.666
(4)	0.25	0.5	0.75	0.416	0.666	0.833	0.25	0.5	0.75	0.5	0.75	1	0.25	0.5	0.75	0.75	1	1	0.166	0.416	0.666	0.25	0.5	0.75	0.25	0.5	0.75

Table 4.11 The Integrated Triangular Fuzzy Numbers and the Rankings of their Importance.

Category of Determinants	Integrated Triangular Fuzzy Number (Q_i, O_i, P_i)			Defuzzied Fuzzy Number	Rankings of Importance
	Q_i	O_i	P_i		
1	0.333	0.603	0.791	0.582	17
2	0.353	0.603	0.853	0.603	12
3	0.687	0.937	1	0.89	4
4	0.353	0.603	0.833	0.598	14
5	0.354	0.604	0.833	0.599	13
6	0.187	0.416	0.666	0.421	27
7	0.395	0.645	0.895	0.645	10
8	0.187	0.437	0.687	0.437	26
9	0.416	0.666	0.874	0.656	8
10	0.457	0.707	0.937	0.702	7
11	0.333	0.583	0.833	0.583	16
12	0.708	0.958	1	0.906	2
13	0.228	0.478	0.728	0.478	24
14	0.145	0.374	0.624	0.379	28
15	0.062	0.249	0.499	0.265	29
16	0.708	0.958	1	0.906	1
17	0.249	0.499	0.749	0.499	21
18	0.351	0.602	0.833	0.597	15
19	0.27	0.499	0.708	0.494	23
20	0.708	0.958	1	0.906	3
21	0.249	0.499	0.749	0.498	22
22	0.333	0.583	0.791	0.573	19
23	0.416	0.666	0.854	0.651	9
24	0.479	0.729	0.979	0.729	6
25	0.395	0.645	0.874	0.639	11
26	0.666	0.916	1	0.875	5
27	0.208	0.437	0.708	0.447	25
28	0.333	0.583	0.812	0.578	18
29	0.291	0.541	0.77	0.535	20

We identified the first five ranked categories of determinants from Table 4.11 as the major characteristics which influenced the client's inconvenience when it comes to manipulation and application of the software. The primary determinants selected from each of the five categories were the following:

- Interactivity
- Ease of use

- Reliability
- Aesthetic design
- System availability

Step 4.4: Identify the conflict determinants which enhance and prevent the ideality from being achieved.

In order to achieve the ideal situation, the "provision of an easily operated environment for users without any effort", with the exclusion of the five important determinants identified in *step 4.3* to achieve the ideality, there were relatively two main issues which called our attention:

(1) The design complexity in software and application environment will be increased.

(2) The training cost that EC-SERVER.COM provides to clients will be increased.

Refer to Table 4.4 with their intent, and these two conflict points were made to correspond to the determinants of "site effectiveness and functionality" and "price" in e-service quality, respectively.

Step 4.5: Detect the relative TRIZ parameters which get worse and parameters to be improved from the parameter corresponding table that was developed in *stage 3*.

From Table 4.6 and the five characteristic properties pointed out in *step 4.3*, we

identified the corresponded TRIZ parameters to be improved were:

- 12 Shape (from “aesthetic design”)
- 27 Reliability (from “reliability”)
- 32 Ease of manufacture (from “system availability”)
- 33 Ease of operation (from “ease of use”)
- 35 Adaptability or versatility (from “interactivity”)

The corresponded TRIZ parameters which get worse were:

- 11 Stress or pressure (from “site effectiveness and functionality”)
- 26 Amount of substance (from “price”)

Step 4.6: According to the TRIZ contradiction matrix, we denoted the numbers of TRIZ inventive principles in the intersection of the improving and worsening TRIZ parameters which were identified in *step 4.5*.

Step 4.7: Indicate the relative 40 TRIZ inventive principles.

We ranked the orders of the denoted numbers of inventive principles by their frequencies: No.35 (occurred six times), No.1 (occurred two times), No.3 (occurred two times), No.10 (occurred two times), No.12 (occurred two times), No.15 (occurred two times), No.19 (occurred two times), No.24 (occurred two times), and the rest occurred only once. We suggested using those inventive principles occurring at least twice as our targeted reference principles to start with, and they were the following:

- Inventive principle 35: Parameter changes
- Inventive principle 1: Segmentation
- Inventive principle 3: Local quality
- Inventive principle 10: Preliminary action
- Inventive principle 12: Equipotentiality
- Inventive principle 15: Dynamics
- Inventive principle 19: Periodic action
- Inventive principle 24: Intermediary

Step 4.8: Connect the principles to the specified problem and generate all possible solutions to eliminate the conflict points.

We iteratively analyzed each of the inventive principles and examples from the related researches, and conducted discussions with the managers of the business development and customer service divisions to generate the following ideas for solutions:

- From the inventive principle 35: Parameter changes.

Idea 1: Referring to the subprinciple "change an object's physical state" of the inventive principle 35, there was an example which suggested "virtual shopping" in the study of Mann and Domb (1999), and this hint gave us an idea to provide an "online training program" to a client company instead of sending people to train

on-site. This suggestion reduced the cost of EC-SERVER.COM in sending engineers to train the client on how to use the software. The proposed online training service could also be accessed easily at any time and place for the client's convenience.

■ From the inventive principle 1: Segmentation.

Idea 2: As to the subprinciple "dividing an object into independent parts" of the inventive principle 1, there was an example from the work of Rea (2001) which stated the "division of a system into autonomous components". The customer service division of EC-SERVER.COM proposed an idea called "Web 080", and this aimed to provide clients with direct online communication through a virtual service representative rather than communicating with the service provider on the telephone only. With a live representative to talk to online, the interface between the service representatives and clients become friendlier.

■ From the inventive principle 3: Local quality.

Idea 3: Referring to the example of the subprinciple "make each part of an object or system fulfill a different and useful function" of the inventive principle 3 from Zhang et al.'s work (2003), it is stated that "in most service industries, service package is a mix of tangible and intangible goods". From this example, we appended one more suggestion to idea 1. Besides the "online training program" provided on the website which targets the general customers, and it was also helpful to provide an

on-site training program to the primary client companies in order to extend stronger relations with them.

- From the inventive principle 10: Preliminary action.

Idea 4: From the subprinciple "perform, before it is needed, the required change of an object or system (either fully or partially)" of the inventive principle 10, we suggested that EC-SERVER.COM provide an online chatting session on its website for customers. The new policies or products of EC-SERVER.COM can be published in advance, though not formally, enabling the company to get opinions from chatting with clients. Through this, the company can realize the needs of customers, and the customers' response can in turn provide valuable information to amend policies or products.

- From the inventive principle 12: Equipotentiality

Idea 5: None from this principle.

- From the inventive principle 15: Dynamics

Idea 6: From the example of the subprinciple "allow the characteristics of an object, external environment, or process to change to be optimal or to find an optimal operating condition" of the inventive principle 15 from the study of Mann and Domb (1999), it is suggested that a "customer response team" be organized. Likewise, we suggested that EC-SERVER.COM organize this team which should consist of

members from various divisions, including all the divisions relating to customer services.

■ From the inventive principle 19: Periodic action

Idea 7: The example of the subprinciple "if an action is already periodic, change the periodic magnitude or frequency" of the inventive principle 19 from Retseptor's study (2003) stated that "monthly and weekly feedback reporting should be done instead of annual reviews". We suggested that the managers of each division in EC-SERVER.COM should shorten the customer response time period, especially focus on the direct customer service divisions from one day to four hours. It was really challenging for these divisions to do so because this practice differed from their current one, but for the sake of obtaining a competitive advantage in this market, it was worthwhile for EC-SERVER.COM to work out this policy.

■ From the inventive principle 24: Intermediary

Idea 8: None from this principle.

Step 4.9: Examine the feasible solutions and present the results.

To examine the ideas generated from *step 4.8* and prioritize them by the grading of five managers based on the criteria from the President of the company, five various ideas were suggested to EC-SERVER.COM, and the evaluation result is shown in Table 4.12.

Table 4.12 The Evaluating Results of the Proposed Ideas

Ideas / Criteria	Idea 1	Idea 2	Idea 4	Idea 6	Idea 7
Expenses	39	43	42	30	45
Time	36	37	41	36	39
Manpower	43	40	41	35	31
Total	118	120	124	101	115
Priority	3	2	1	5	4

4.6 Realization

Following stage 5 of the problem-solving process in Figure 3.1, these solutions were suggested to the company for implementation. Stages 6 to 8 are the processes to be iterated for the evaluation of the results and for the resolution of new problems which are not further described in this case study.

However, the proposed solutions can be implemented from the prioritized list on Table 4.12 until apparent satisfaction is manifested in providing new services according to the needs of the customers. When this was compared to the previous inefficient new services-generating process utilized by the company, most of the new ideas were frequently limited by the experience and knowledge of the managers. Nevertheless, our proposed approach provides a systematic way of thinking and uses the inventive guidelines of TRIZ to inspire the creation of new services. Collectively, for the studied company, the online application software users are mostly small and medium enterprises (SME) in Taiwan. Furthermore, the number of users is estimated

to increase by 5% as compared to 6000 users in the next year after the new services are applied. In addition, the expected number of 200-250 on-site service stations will be reduced to 150 locations once the online training program is announced. This new method of service creation will become one of the several approaches toward enhancing the competitiveness of the company in the service market.

CHAPTER 5 CONCLUSIONS

Prior to the structuring of TRIZ by Altshuller and his associates, most of the improved creativity and inventive processes were merely based on psychological stimulation to change the thinking patterns and attitudes already existing within the problem solving group, in an attempt to generate ideas that were not seen earlier by these same individuals. These idea-stimulating techniques bring no additional knowledge into the innovation session, but only attempt to stimulate the knowledge already present within the problem-solving group. Thus, when some aspects of the TRIZ methodology have been successfully applied to challenge the human psychological inertia that aims to break the conventional mindset, the emergence of the TRIZ methodology has therefore been an attempt to stimulate a creative way of thinking and developing various new solutions. Specifically, as compared to other problem-solving methodologies, TRIZ provides a powerfully systematic and knowledge-based procedure to generate quality and innovative solutions without compromise.

In the problem-solving process proposed in this study, idea generation from the contradiction analysis process requires the contradiction matrix formed by 39 parameters of technological systems and 40 types of inventive principles which were

originally formed by Altshuller. When TRIZ is extended to a wider area of application, Zhang et al. (2003) emphasized that the 39 generic parameters and the 40 inventive principles are required to be modified in order to reflect their distinct characteristics for a growing diversity of areas. In this study, we did not focus on modifying the 39 TRIZ engineering parameters, but instead, developed a parameter corresponding table to provide practitioners with an effective way to extract the appropriate TRIZ parameters relating to the specified problem and to enable the efficient identification of effective inventive principles. Therefore, the frequent discrepancy in mapping up the essentials of the 39 TRIZ engineering parameters and the dominant determinants of the problem can be resolved.

This study particularly focused on proposing a systematic way of building a parameter corresponding table as a means to effectively extract TRIZ parameters from the contradiction matrix for the specified problem. The parameter mapping results deduced from 29 categories of e-service quality were comparatively related to the 18 items of 39 TRIZ engineering parameters, and the essentials of the specific problem in the identified sector could be effectively generalized to the TRIZ generic problem. There was an argument in ascertaining the adequacy of the parameter mapping results of our study, but through a consensus confirmed by the experts' opinions, the parameter corresponding table can be recognized as a reliable and efficient support in

applying the TRIZ contradiction matrix in the process of problem solving.

Additionally, an extensive literature analysis on e-commerce was used to extract the 29 significant determinants of e-service quality which are closely related to customer satisfaction. We tried to narrow down a specific scope of work to service quality relating to the e-commerce sector in order to identify the specific vital elements that are valued by e-service providers. Thus, it may be necessary to further discuss more various facets and characteristics of e-commerce and then precisely define the determinants which can be completely acquired. Collectively, from the rich results of the demonstrated case study, the proposed approach can be used to help companies get rid of previous non-systematic practices in developing new services, and as shown, the methodology is feasible and can be efficiently implemented.

The other main point emphasized in this study is that when applying the TRIZ method in practice, especially in the primary stage of formulating a problem, the subjective and ambiguous expression of opinions among the problem solvers frequently impedes consensus in the achievement of results. However, the influence of this circumstance is rarely discussed by TRIZ practitioners. As a matter of fact, thereafter, the level of inventive solutions generated from the TRIZ process will be affected by the vague and inappropriate identification of TRIZ engineering parameters. In this regard, the application of the TRIZ method in our study is focused on applying

the Fuzzy QFD method to analyze the correlation between the imprecise requirements from customers and the determinants of service quality in order to identify the critical determinants which pertain to customer satisfaction. Consequently, the corresponding TRIZ engineering parameters from the specified problem can be efficiently and precisely extracted.

This study proposes a systematic framework to structure an inventive problem-solving procedure basing on classical TRIZ methodology to resolve the problems in e-commerce sector. This approach demonstrates the practicability for the practitioners to own a systematic supporting tool to develop new services beyond the insufficiency of traditional problem solving tools in service industries. Since the fundamental of the classical TRIZ is based on the extracting knowledge of technological inventions, it may not be able to comprise all the distinct patterns of service quality problems. The extended explanation of TRIZ 39 engineering parameters in interested industries can be further analyzed to enhance the applicability of TRIZ contradiction matrix to a broader arena.

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APPENDIX

Questionnaire of Research in TRIZ Attributes Mapping Results for E-Commerce

1. There are 39 parameters for TRIZ used in the contradiction matrix.
2. The attributes of service quality for E-commerce are abstracted mainly from the literatures reviews relating in the field of e-service quality.
3. The principle for mapping the attributes of service quality in E-commerce with 39 TRIZ parameters is based on their analogies in explanatory meanings done by this research.
4. Please fill in the blanks by '√' to express your personal viewpoints to show agree/disagree with researcher's mapping results.
5. Please leave your personal information for further contacts and thank you for your kindly cooperation.

Name:_____, Company/University:_____,
Position:_____, Email Address:_____.
Date:_____

Professor: Su, Chao-Ton
Student: Lin, Chin-Sen

Attributes of E-service quality	Descriptions	No.	Name of TRIZ Parameter	Interpretation	Agree	Disagree
Performance/ Efficiency/ Navigability/ Online convenience/ Linkage/ Online completeness/ Storage capability	Refer the speed of downloading, search, navigation. (Santos, 2003)	9	Speed	The velocity of an object or the rate of any kind of process or action. Relative or absolute speed; linear or rotational.	☐	☐
	The ability of the customers to get to the Web site, find their desired product and information associated with it and check out with minimal effort. (Zeithaml, 2002)					
	The ease and speed of accessing and using the site. (A.Parasuraman, Valarie A, Zeithaml, Arvind Malhotra , 2005)					
	Navigability is a process of customers finding what they want, rather than their getting what they want. (Surjadjaja et al. 2003)					
	Shopping online can economize on time and effort by making it easy to locate merchants, find items, and procure offerings.(Szymanski and Hise, 2000)					
	The performance of a virtual operation is based on its ability to offer two key features. These key features as identified by Abels et al. (1997) are use and content. These key feature deals with ease of use the Web site, ability to get an overview of the structure, and ease of navigation. Online users can easily be turned off when the Web site is not easy to navigate, difficult, and thereby time consuming. Further, it is important that the site is rich in content. Content deals with a variety of factors including the accuracy of information presented, concise nature of the information, and the timeliness of the information. When the Web site is not frequently updated, the information becomes outdated and therefore cannot deliver the expected performance. The information provided has to also have some uniqueness and be presented in a form that is readable and not ambiguous. One thing online users are conscious of is time. It is therefore important to ensure that information is presented in a concise and timely manner.(Madu, 2002)					
	Refer to the number and quality of links that a Web site offers. (Santos, 2003)					
	(Loiacono et al., 2002)					
	Another major issue in using online services is the storage capability of the site. How easy is it for users to retrieve information when needed? For example, online bank users may want access to download their transaction information for a period of a year. Does the site have the capability to store the information and make it easily available to its customers? (Madu, 2002)					
Responsiveness/ Response time/ Speed of response/	(Loiacono et al., 2002)					
	Refer to lead-time, accuracy and consistency of response. (Surjadjaja et al. 2003)					
	Speed of reaction to the complaint, speed at which complaints are resolved. (Stauss,					

processing speed	2002)					
	Measure the ability of a company to provide appropriate information to customers when a problem occurs, have mechanisms for handling returns and providing online guarantees. (Zeithaml, 2002)					
	Online stores also have to worry about the courtesy of its customer services. How courteous is the customer service in responding to customer needs through e-mail? And how flexible is it about its policies? Even when usage agreements may be appended in the Web sites, the customers are not often privileged by time to go through all the fine prints. How will the store respond to the concern of the customer in terms of order cancellations, refunds, etc? (Madu, 2002)					
	The ability of WIS to perform the online service consistently and accurately. (Li et al., 2003)					
	Effective handling of problems and returns through the site. (A.Parasuraman, Valarie A, Zeithaml, Arvind Malhotra , 2005)					
Content/ Quality of information/ Up to date information	Refer to the presentation and layout of factual information and functions on a Web site. Provide lots of detailed information and that they should be easy to understand. (Santos, 2003)	10	Force	Any interaction that is intended to change an object's condition. Can be linear or rotational; the term applies equally well to torque. Applies to static and dynamic forces.	☐	☐
	Such as accurate, relevant, up-to-date, timely, and easy to locate. (Li et al., 2003)					
	A good example of up-to-date information is a tracking facility giving information about the status of an order so that a customer can monitor and track the order. And up-to-date information also includes updated content of Web pages. (Surjadjaja et al. 2003)					
Effort	Visible effort to solve the customer's problem. (Stauss, 2002)					
Features/ Site design/ Site effectiveness and functionality/ Structure and layout/ Tangibles/ Web site design/ innovativeness	What other features are available through the site? Dose the site anticipate and provide enough access to the questions that the user may have? Does the site provide the user with links to other sites that may deal better with some issues of interest to the user? These are things that customers may often want to know and seek in order to be satisfied with a virtual service operation. Other important features include the search capability of the site and being able to get a link to the Web site from any search engine. It is also important to design with user control in mind. For example, the use of flash to control users may often be abused and lead to dissatisfied users. Users want to have control and this may be a key issue in establishing their trust of the Web site. (Madu, 2002)	11	Stress or pressure	Force exercise on a unit. Stress is the effect of forces on an object. Also, tension, compression. Includes static and dynamic effects, fatigue, creep. Also strain – provided length is not the main issue.	☐	☐
	Good web-site design is about good organization and easy search, it includes offering consumers uncluttered screens, simple search paths, and fast presentations. (Szymanski and Hise, 2000)					

	Include the provision of facilities for online catalogues, status checking, shopping carts or baskets, checkouts, call-back buttons, frequently asked questions (FAQs), helpdesks, search engines, technical support, discussion forums and chat rooms. (Surjadjaja et al. 2003)					
	This deals with how information is presented on the Web site. Is the information organized with the appropriate keywords or sub-headings that the user can identify with? The structure will also deal with how hyperlinks are used within the pages and whether such links lead to sources of information or to dead ends. This, in fact, requires a special skill on presentations and organizations, if the site is not well organized, it becomes difficult to find information that may actually be contained in the site. There will be no repeat users if the user is not able to locate key information. An overview of the entire Web site should also be presented in a page so that from the onset, the user knows where to find information. (Madu, 2002)					
	Refer to the organization and presentation of a Web site's content and information. (Santos, 2003)					
	The appearance of the Web site, navigation, search options, and structure.(Iwaarden et al., 2003)					
	Suitable infrastructure including software and hardware.(Li et al., 2003)					
	Include all elements of the consumer's experience at the Web site (except for customer service), including navigation, information search, order processing, personalization and product selection.(Wolfinbarger et al., 2003)					
	Because of the lack of a human touch, the web site can be personalized to the user's needs. (Ribbink et al., 2004)					
Web store policies	How customer-oriented are the Web store policies? Are users given comparable policies that are available in major department stores? For example, charging excessive restocking fees for returned items, not providing effective warranty programs available in local areas could dissuade users from online purchases since the cost becomes excessive and may outweigh the value of convenience. (Madu, 2002)					
Aesthetics/ Appearance/ Visual appeal/ Aesthetic design	This attribute deals with the appearance of the Web site namely its visual attractiveness. It has to do with the color combinations that are used, the type and size of fonts, the animation, the sound effects, the clarity and readability of texts. (Madu, 2002)	12	Shape	The external contour, and/or aesthetic appearance of a component or system.	☐	☐
	Color is considered as an important factor of quality in that it serves to reflect the corporate image of the web site. (Cox and Dale, 2001)					

	The proper use of colors, graphics& image, animation, the appropriate size of the Web pages. (Santos, 2003) (Loiacono et al., 2002) Site creativity with multimedia and color graphics. (Yoo and Donthu's, 2001)					
Assurance	Virtual operations need to ensure that their employees are very knowledgeable about their operation, courteous in their responses, and able to convey trust and confidence to users. Since many virtual operations rarely encourage any direct communication except through e-mail services, they need to provide impeccable service to avoid creating a mass of disenchanted users who have failed to get adequate responses from the online service. (Madu, 2002) The ability of the Web site to convey trust and confidence in the organization behind it with respect to security and privacy. (Iwaarden et al., 2003) The ability of WIS to convey trust and confidence. (Li et al., 2003) The customer's perceived security and privacy when using the e-tailer's services.(Ribbink et al., 2004)	13	Stability of the object's composition	The integrity of a system; the relationship of a system's constituent elements. Wear, chemical decomposition. Dissociation, and increasing entropy should all be interpreted as issues concerning 'stability'.	☐	☐
Reputation/ Organizational reputation/ consistent image	With a good reputation, and that is perceived as placing great importance on maintaining it, will be preferred over the organization that has a bad reputation and does not really care about it.(Ruyter et al. 2001) The perception of quality will be affected by past experience, perception of the site's performance, and other unexplainable intangibles that the customer may perceive. The goal of virtual operations should be exceed the performance expectations of users and thereby develop satisfied customers that will repeat their visits to the site and enable the site to survive and continue to provide valuable services to its customer base. (Madu, 2002) (Loiacono et al., 2002)	14	Strength	The extent to which an object is able to resist changing in response to force. Resistance to breaking. Can mean elastic limit, plastic, limit, or ultimate strength; tensile or compressive; linear or rotational. Also includes toughness and hardness.	☐	☐
Empathy / Understanding/ flow or emotional appeal	Even though there is no direct human interaction in virtual operations, certain elements of human contact are involved, say through the e-mail communications. Providing individualized attention to customer concerns and requests rather than a generic auto reply shows empathy. Responses must be cognizant of the needs of the user and show concern and understanding of their needs. (Madu, 2002) The provision of caring, individualized attention to customers, including user recognition and customization. (Iwaarden et al., 2003) The ability of WIS to provide caring and individual attention. (Li et al., 2003) Willingness to take the customer's perspective, understanding the customer's annoyance,	17	Temperature	Measured or perceived thermal condition of the object parameters, such as heat capacity, conductivity, radiation, and convection parameters.	☐	☐

	individual complaint handling. (Stauss, 2002) Knowing the customer. (Cox and Dale, 2001)					
Compensation/ Return process/ Service recovery	Involve receiving money back, return shipping and handling. (Zeithaml, 2002) The degree to which the site compensates customers for problems. (A.Parasuraman, Valarie A, Zeithaml, Arvind Malhotra , 2005) If a Web site fails to state a clear policy on returns and refunds, a customer's perception of risk increases. (Surjadjaja et al. 2003) Service recovery is a process of redressing loss to customers in the event of a failure in the service process. The process of regaining a customer's confidence is an incredibly difficult task because customers who are let down by a service failure can become more demanding when the company tries to resolve the problem. (Surjadjaja et al. 2003)	23	Loss of substance	Loss of elements of a system – substances, materials, sub-systems, product, etc. can be partial or complete, permanent or temporary.	☐	☐
Price	A competitive price is an essential determinant of an e-service operation. From the customers' point of view, price is one of the most important motivations for engaging in online shopping. (Surjadjaja et al. 2003)	26	Amount of substance	The quantity or number of a system's materials, substances, parts, fields or sub-systems.	☐	☐
Adequacy/fairness of the outcome/information fit-to-task	Adequacy of the problem solution; fairness of the compensation offered.(Stauss, 2002) (Loiacono et al., 2002)	27	Reliability	A system's ability to perform its intended functions in predictable ways and conditions. Also includes durability and issues related generally to the ability to use of an object or system over prolonged periods.	☐	☐
Credibility / Reliability./ Fulfillment	Usually refers to such factors as security, privacy, company details, and quality certification. Reliability is determined as consistency of performance and dependability, and security is one of the barriers to customers making purchases online and can be seen as a part of reliability. (Cox and Dale, 2001) Require the online companies having the ability to perform the promised service accurately and in a timely manner. In reality, product and service fulfillment still remains a big challenge for online suppliers and most online consumers feel frustrated with the poor service reliability provided by virtual stores.(Yang and Jun, 2002) How consistent is the performance over time? For example, is the Web site able to keep up with changes by updating material promptly and providing accurate information to the customer? Another issue is the availability of the Web site. How often is the Web site available for usage? The issues of accessibility, speed and ability to quickly download information come into play when measuring the reliability of the Web site. Also, how reliable is the site in recording information and customer transactions? (Madu, 2002)					

	Refer to the ability to perform the promised service accurately and consistently, including frequency of updating the Web site, prompt reply to customer enquiries, and accuracy of on-line purchasing and billing. (Santos, 2003)					
	The ability to judge the trustworthiness of the offered service and the organization performing the service. (Iwaarden et al., 2003)					
	Associate with the technical functioning of the site, particularly the extent to which it is available and functioning properly. (Zeithaml, 2002)					
	The ability of WIS to provide accurate information and perform the promised service. (Li et al., 2003)					
	Keeping of promises. (Stauss, 2002)					
	Refer to the delivery of products and services within a service level agreement (on time and as specified). (Surjadjaja et al. 2003)					
	Incorporates accuracy of service promises, having products in stock and delivering the products in the promised time. (Zeithaml, 2002)					
	The extent to which the site's promises about order delivery and item availability are fulfilled. (A.Parasuraman, Valarie A, Zeithaml, Arvind Malhotra , 2005)					
	It is the accurate display and description of a product so that what customers receive is what they ordered, and delivery of the right product within the time frame promised. (Wolfinbarger et al., 2003)					
Responsibility/ Trusted service/ Trust	The willingness to help customers and provide prompt service. (Iwaarden et al., 2003)					
	Can be defined as exact delivery of promised services.(Surjadjaja et al. 2003)					
	Trust is closely associated with security and system integrity. Trust affects the willingness of users to disclose personal information or to make purchases online. Users are often concerned about dealing with virtual organizations that may not have a physical location where they could be tracked. It is therefore imperative that a virtual operation must build trust by being highly reliable and dependable in the manner it responds to customer inquires and complaints. (Madu, 2002)					
	(Loiacono et al., 2002)					
Communication/ External communication/ Internal communication/	Although it is provided using text, color, graphics and animation rather than personnel, communication can also be used to describe service, feedback and customer confidence because of the link with informing and listening to the customer. (Cox and Dale, 2001)	28	Measurement accuracy	Degree of precision. The closeness of a measured value to an actual value of a property of a system. Measurement error.	☐	☐
	Keeping customers properly informed and communicating with them in language they can understand. (Santos, 2003)					

Ease of understanding/ Friendliness/ Integration of traditional and Web-based communication	Such as that involved in image-building is vital in e-service operations. (Surjadjaja et al. 2003) Integrated internal communication systems also improve relationships between employees across levels and departments. Internal communication is critical to e-service operation, enabling firms to tailor products and services to meet customers' expectations. (Surjadjaja et al. 2003) (Loiacono et al., 2002) Politeness, courtesy, communication. (Stauss, 2002) For example, a customer may start to evaluate a product/service through traditional media such as a newspaper or TV advertising. The person may then switch to an online evaluation on a company Web site, prompted by the inclusion of a URL in the traditional media. (Li et al., 2003)					
Financial security/ Security /Privacy/ Security and system integrity / security of personal and financial information	The security of online transactions is a major consideration when deciding whether or not to buy items online. (Szymanski and Hise, 2000) Include assurance that shopping behavior data are not shared and that credit card information is secure. (Zeithaml, 2002) The degree to which the site is safe and protects customer information. (A.Parasuraman, Valarie A, Zeithaml, Arvind Malhotra , 2005) It is security of credit card payments and privacy of shared information. (Wolfinbarger et al., 2003) Refer to the technical safety of the network against fraud or hackers. (Surjadjaja et al. 2003) Refer to freedom from danger, risk, or doubt during the service process. (Santos, 2003) Price waterhouse coopers reports that credit card security is a major barrier to online purchasing with 79 percent of their respondents citing it. Likewise, users are worried about providing personal information online since it could potentially get into the wrong hands or be abused. The quality of an online site is intertwined with the site's ability to safeguard and protect information that is provided to it. (Madu, 2002) (Yoo and Donthu's, 2001)	30	Object affected harmful factors	Susceptibility of a system to externally generated harmful effects. Includes safety related issues.	☐	☐
Perceived risk	The level of perceived risk is generally considered to be higher than for products. The problem of risk has increased considerably with the advent of on-line service providers. Not only are customers unable to derive quality cues from tangible aspects and have to release personal or financial information, they often do not know whether the service provider is "big or small, new or established, legitimate or illegitimate". The increase in	31	Object generated harmful factors	Aspects of an object or system that produce an adverse effect on external elements. Includes environmental issues like contamination, emissions, noise as well as things like vibration.	☐	☐

	information asymmetry in e-business leads to include perceived risk as a possible determinant of e-service adoption. (Ruyter et al. 2001)					
Availability / System availability/ Accessibility /Access	For Internet purchasers and non-purchasers, they may have a desire to access various sources provided by Internet companies for help. Consumers expect that a site will have a street and an e-mail address, plus a toll free phone and fax numbers available for them to contact customer representatives easily. (Yang and Jun, 2002)	32	Ease of manufacture	Issues related to manufacture, fabrication and assembly issues associated with an object or system. Also includes ease of inspection.	☐	☐
	Ease of finding a competent contact person. (Stauss, 2002)					
	Customers can browse the medium of the Internet on a continuous basis. If a web site is too slow to download or unavailable for a significant amount of time, customers will probably not attempt to use that site again but click to a competitor. Because most customers use web site for speed and convenience. (Cox and Dale, 2001)					
	It considers the ability of the web site to inform the customer of stock information for products offered in real time. It is important for the customers to know whether the product they are ordering is available now or out of stock. (Cox and Dale, 2001)					
	Access to the Web site 24 hours a day, seven days a week is a necessary determinant in e-service operations. (Surjadjaja et al. 2003)					
	The correct technical functioning of the site. (A.Parasuraman, Valarie A, Zeithaml, Arvind Malhotra , 2005)					
Convenience	Including unrestricted trading hours, no queues, availability of more alternatives, and faster transactions. (Surjadjaja et al. 2003)	33	Ease of operation	Simplicity of operation by the intended user.	☐	☐
Ease of use/ intuitive operation	Web-based stores should make it easy for customers to proceed through the whole purchasing process by minimizing technical difficulties. Most importantly, contents of the Web-site should be concise and easy to understand. (Yang and Jun, 2002)					
	How easy the Web site is for customers to conduct external search in cyberspace and internal navigation and search with the Web site.(Santos, 2003)					
	Include aspects such as functionality, accessibility of information, ease of ordering and navigation. (Ribbink et al., 2004)					
	(Yoo and Donthu's, 2001)					
Active feedback	Activity to find out the best solution for the customer, notification about delays, feedback about procedures and decisions. (Stauss, 2002)	34	Ease of repair	Quality characteristics such as convenience, comfort, simplicity, and time to repair faults, failures, or defects in a system. Includes issues associated with need for special	☐	☐

Contact	Point to the need of customers to be able to speak to a live customer service agent online or through the phone- requiring seamless multiple channel capabilities on the part of e-tailers. (Zeithaml, 2002)			tooling or equipment required to achieve repair. Also think about conditions associated with in situ repair.		
	The availability of assistance through telephone or online representatives. (A.Parasuraman, Valarie A, Zeithaml, Arvind Malhotra , 2005)					
Customer service	It is responsive, helpful, willing service that responds to customer inquiries quickly. (Wolfinbarger et al., 2003)					
Individual handling/ Serviceability	Non-standardized response that is customized to the problem and the wishes of the complainant. (Stauss, 2002)					
	This deals with how well conflicts and complaints from customers are resolved. The effectiveness of online usage also depends on the user's knowledge and ability to click the right responses. There is bound to be some mistakes with amateur uses and that may trigger complaints that may have to be resolved to make them satisfied. How able the Web site is in resolving complaints and creating a happy customer will influence customer perception of the site. (Madu, 2002)					
Customization/ Personalization/ Product or service differentiation and customization	In customization, customers actively tell the system to change according to their requirements. This feeds information to the service provider, allowing the provider to adjust the system to accommodate customer requirement. (Surjadjaja et al. 2003)	35	Adaptability or versatility	The extent to which a system/object is able to respond to external changes. Also, relates to a system capable of being used in multiple ways or under a variety of circumstances. Flexibility of operation, use. Customizability.	☐	☐
	Consumers long for personalized or individualized attention and expect to receive a personal 'thank you' note as confirmation after they place an order. It is critical for businesses to engage customers in personalized dialogue and to learn more about their needs for better anticipate their future preferences. (Yang and Jun, 2002)					
	In personalization, service providers actively build personal profiles of customers and provide service offerings tailored to customers' individual needs. (Surjadjaja et al. 2003)					
	What is unique about the services provided by the online Web site? Online users are primarily looking for convenience. How does the store offer "maximum" convenience to its customers? That may include offering customized products or services, i.e. electronic books or publishing. How timely is the delivery of products and services to the user? And what features in this Web site are not attainable from competitors whether in physical or virtual operations? These are the unique qualities that make the online service standout as a leader to be benchmarked by others. (Madu, 2002)					
Interactivity/ Real time assistance by a CSR/ Support	Discussion forums and chat rooms enable interaction between a customer and a company representative or another customer. Discussion forums also enable customers to solve problems by sharing information among themselves. (Surjadjaja et al. 2003)					

	(Loiacono et al., 2002) Due to information overload on the Net (much of it irrelevant to customers' needs), a "live" CSR can alleviate performance risks by giving informed advice regarding purchasing decisions. (Surjadjaja et al. 2003) Technical help, user-friendly guideline, personal advise available to customers from a Web site. (Santos, 2003)					
Systems integration/ Supply chain integration/	Due the complexity of handling inquiries, several companies have outsourced the process to call centers or e-mail router facilities. This can cause problems with date security and privacy, and integration of supply chains and systems are necessary in such information sharing. (Surjadjaja et al. 2003) Systems integration can be seen as internal integration of the system across departments within a company or with its business partners. (Surjadjaja et al. 2003)	36	Device complexity	The number and diversity of elements and element interrelationships within and across the boundaries of a system. The user may be an element of the system that increases the complexity. Includes issues like use-ability, train-ability, number of functions, excessive number of components.	☐	☐
Incentives/ Relative advantage/ better than alternative channels	Incentive is the encouragement given by Web providers to consumers to browse and use the Web site, including rewards for doing so. (Santos, 2003) Denotes the extent to which the innovation is perceived to be superior to alternatives already available. The alternatives includes the product/service classes, forms and brands over the ones existed, such as "ease of use", "time saving", and "range of options". (Ruyter et al. 2001) (Loiacono et al., 2002)	39	Productivity	The number of useful (value-adding) functions or operations performed by a system per unit time. The inverse of the time per unit function or operation. Useful output per unit time. The inverse of cost per unit output, or amount of useful output.	☐	☐

Notes:

From Table shown above, there is one specific feature we have to emphasize is that there is not only one category of the e-service quality properties to match with each of the TRIZ engineering parameter for some mapping up relationships. That is because of the reason when there are similar analogical explanations between these categories of e-service quality and one specific TRIZ engineering parameter, then we conclude these categories of e-service quality be mapped with the same TRIZ engineering parameter.