Development and Application of a Network Service Quality Measurement Model：An Empirical Study of Chung Hwai University of Medical Technology

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Abstract

In recent years, research issues on network service quality calls attentions from the academics and practitioners due to the users on the Internet increase dramatically. To solve the issues mentioned above, this paper proposes a network service quality measurement model based on previous studies on network service quality. Three major dimensions of evaluating the network service quality are: (1) network performance, (2) stability of network-related equipments, and (3) information security. The weights of dimensions and evaluation indicators of proposed model are calculated using the AHP method by way of the data collected from the questionnaires. To examine the applicability and feasibility of proposed model, an empirical study is conducted in Chung Hwai University of medical technology in Tainan County. We developed a network service quality measurement model to compute the network service quality of two alternatives. Furthermore, a TQM improvement plan is proposed. According to the results of this research, the weights of dimensions of evaluating the network service quality are ranked as follows: information security, network-related equipments, and network performance. Improvement plans includes renewal of core switch, UPS devices and power generation equipments, firewall, etc. are suggested. Estimated improvements of proposed network architecture's network service quality comparing to the existing architecture amount to 48 %. Based on the result of this research, development and application of a network service quality measurement model is a powerful and useful tool for managing network management in a university. Findings of this research can provide useful references for the academics and the practitioners.

Keyword：Network Service Quality, Total Quality Management, Measurement Model

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I. INTRODUCTION

According to the survey conducted by the Institute for Information Industry of Executive Yuan, the total numbers of the users on Internet amounts to 25,140 thousands up to the end of December, 2010. Among of them, Internet users that use the services of mobile network and optical fiber consist of two major groups. Total numbers of ADSL attains to 5,050 thousands. Commercial internet users and TANet users continue to grow steadily. Therefore, research on network service quality calls attentions from the academics and the practitioners.

In previous years, a set of evaluation indicators for evaluating the service network quality had been proposed by some researchers (Conti et al., 2002; Roberts et al., 2003; Gozdecki eat al, 2003; Kumar et al., 2011). Sheth (2002) addressed that network service quality refers to network stability, execution times, reliability, availability, and trust are the major index for measuring the QoS (Zeng et al., 2003). Generally, QoS is defined as meeting or transcending the customer's expectation on products or services (Besterfield et al., 1999).

Recently with the rapid growth of users on the Internet in the universities of Taiwan areas , strong needs network service such as Voice on IP, e-learning, distant learning, Live video teaching, etc are increasing. Besides, PC in the computer classrooms and multimedia classrooms are connected to the computer centers of a university. Application systems are installed to the important locations of a university.

The advancements in information technologies improve the speeds of network traffic upgrades from 10/100 Mb to Gigabit. In this way, the stability and performance of network services are considered as the major concerns for a campus network administrator in a university. Meanwhile, network service quality is also the focus of network services in a university. As aforementioned, this paper proposes a network service quality measurement model that aims to monitor and diagnose the network service quality. Thus, it is hoped that network service quality of a campus network can be improved according to the results of network service quality measurement model.

In general, the complexities of a campus network of a university are computed based on the scales of total equipments in a university. In addition, different brands of equipments also related to the QoS of a campus network in a university. So, how to manage and improve the QoS of a campus network becomes a challenge for an administrator of a campus network in a university. Among of the tasks for network management, monitoring, diagnosis, troubleshooting of network failures are labor-intensive activities. Thus, monitoring of network flow, protections of network attacks, functional evaluations of network equipments and data collection and analysis become a hard work which can be resolved using a tool of network management. To attain the objectives of effective network management, it is necessary to formulate a network service quality measurement model to resolve problems mentioned above.

Therefore, the purposes of this paper are: (1) to investigate key issues on the factors affecting the network service quality, (2) to formulate a network service quality measurement model to support network management, and (3) to examine the feasibility and practicability of proposed model using a case study of Chung Hwai University of Medical Technology.

II. LITERATURE REVIEW

2.1 Definition of network service quality

The definition of quality of service (QoS) was proposed by ITU-T organization in the following: "A set of total abilities provided by the physical service". It refers the ability of meeting the user on the aspect of specified and implicit needs. Thus, network service quality refers to the extents of meeting the requirements of network users which is usually measured by times spent on the transmission on the network, reliability, delay, receive and transmission, loss rates of packages. Van Moorsel (2001) proposed the dimensions of evaluation indicator for evaluating the network service quality including system, execution time, user experiences, and business experiences. The quantitative evaluation indicators are successful possibility of meeting the service requests, response times, processing ability. Besides, evaluation indicators of service quality are information evaluation, information prices, information availability, information correctness, and information availability. Conti (2002) also proposed a revised method by adding expansion ability, processing ability, availability for network service quality. Sheth (2002) also proposed system reliability, availability, system ability, response times, and detection of network abnormal condition. Zeng et al. (2003) addressed that evaluation indicators of service quality need cover price, execution times, availability, degree of trust. Based on the above discussions, major dimensions of measuring the network service quality are contents of service, service availability, service performance, and service security. Table 1 shows types of evaluation indicators for evaluating the service network quality.

Table 1. Types of evaluation indicators for evaluating the service network quality.

Types of network service quality	Measures	References
Network information quality	l Information evaluation l Information price l Information availability l Information correctness l Information stability	Naumann et al. (1999)
Network response times	l QoS of system	Van Moorsel (2001)

	l QoS of task l QoOS of system	
Network operation service quality	l Extensibility l Process abilities l Reliability l Availability	Conti (2002)
Network service quality	l Reliability l Availability l System stability	Sheth (2002)
Network usage quality	l Price l Execution times l Reliability l Availability l Degree of trust	Zeng et al. (2003)
Network performance	l QoS of Times l Performance l Network sub-evaluation	Zhang et al. (2009)
Network information security	l Privacy l Integrity l Availability	Lai（2006）, Schneider and Therkalsen（1990）, ISO / IEC 27001 : 2005（2005）; Wu（1994）, Chen（1996）
	l Discriminative Attribution of responsibility l Undeniable l Reliability	ISO / IEC 27001 : 2005（2005）

Table 2 is a summary of evaluation indicators for network service quality. We review related previous research papers on network service quality. Three dimensions of evaluation indicators for evaluating the network service quality are network performance, stability of network-related equipments, and information security. Thus, network service quality is an aggregated indicator that collects related information about the network service quality in an objective and quantitative approach. To ensure the feasibility of calculating the network service quality in practices, it is necessary conducting an empirical study to examine the applicability of proposed method. Furthermore, correctness, computational efficiency and easy of use is a perquisite for developing a sound method of computing the network service quality.

Table 2.（A） A summary of evaluation indicators for evaluating the network service quality.

Dimension of evaluation	Item of evaluation	Descriptions of evaluation	Evaluation indicators	Sources data	References
Network performance（A）	Network speed（A1）	Measurements of network stability and system speed include: 1. connection speed 2. speed of terminal to terminals 3. indicators of service application	Download speed from the benchmark website (A1-1)	Collects data from manual testing	1. Van Moorsel (2001) QoS：Task 2. International Education Research Foundation (IERF) IP Performance Metric Working Group（IPPM WG） 3. ITU（SG 13） http://www.itu.int/ITU-T/studygroups/com13/index.asp 4. ITU-T Rec.E.800-1994, 5. ITU-T Rec.G.1000-2001
			Performance of the CPU's load ability of a core switch (A2-1)	Collects data from manual testing	
	Performance of network-related equipments（A2）	Evaluation of core switch and building core switch 1. core switch 2. backbone switch	Performance of the CPU's load ability of a core switch (A2-1)	Collects data from equipment management	1. Cisco,http://www.cisco.com 2. Extreme,http://www.extremenetworks.com 3. Alcatel,http://www.alcatel.com
			The useful life of a core switch (A2-2)	Collects data from useful life of equipment	
			Stability of user computers connected to the computer center's server (A3-2)	Collects data from system testing	
	Stability of network（A3）	Measurements of network stability and system speed include: 1. connection speed 2. Stability of connection 3. Stability of terminals to terminals 4. Indicators of service application	Stability of users' computers connected to the benchmark's website (A3-1)	Collects data from manual testing	1. Van Moorsel (2001) QoS：Task 2. IERF（IPPM WG） 3. ITU（SG 13） http://www.itu.int/ITU-T/studygroups/com13/index.asp 4. Naumann et al. (1999)
			Stability of user computers connected to the computer center's server (A3-2)	Collects data from manual testing	

Table 2.（B） A summary of evaluation indicators for evaluating the network service quality.

Dimension of evaluation	Item of evaluation	Descriptions of evaluation	Evaluation indicators	Sources data	References
Stability of network-related equipments（B）	Backup mechanism（B1）	Regular backup of important data is carried out: 1. Different machine backup: builds a backup mechanism for	System response times (B1-1)	Collects data from observation	1. Lai （2006）,Schneider and Therkalsen（1990）: integrity, upgrade. 2.ISO/IEC 27001:2005（E）.

		major information systems and backup data are stored in tape media or other computer. 2. Remote backup ： Total distance with computer rooms is more than 30-50Km ， or places storage devices for computer rooms.	Ability of data recovery (B1-2)	Collects data from observation	
	Temperature and humanity of computer rooms （B2）	1. Temperature: Celsius: 20～25 degree. 2. The relative humanity: 40%-55%RH. 3. Maximum resistance to the degree: 21 Celsius degree. 4. Maximum temperature change rate: 5 Celsius degree per hour 5. ISMS：Physical security management procedure manual.	Stability of continuously keeping fixed temperature (B2-1)	Collects data from observation	1. Definition of temperature and humanity of computer rooms: TIA-942 2. ISMS ： Manual of physical safety management procedure.
			Stability of continuously keeping fixed humility (B2-2)	Collects data from observation	

Table 2.（C）A summary of evaluation indicators for evaluating the network service quality.

Dimension of evaluation	Item of evaluation	Descriptions of evaluation	Evaluation indicators	Sources data	References
Stability of network-related equipments （B）	Electrical power failures （B3）	Electrical power Planning：Taiwan electrical power company uses double lines as the backup mechanism to improve the stability of Power supply: 1. Electrical power has automatic switching system.	Numbers of Power failure in a month (B3-1)	Collects data from observation	Electrical power planning according to the manual of installation procedure of computer rooms (Tier 3) specified by American telecommunication association.

		2. Double lines can deal with the problem when one of them losses electrical power. UPS planning： 1. IDC second backup electrical power system: use 3 sets of diesel fuel generator with at least 1700KW (more than), and even can connect 4 sets of diesel fuel generator in parallel. The capacity of oil storage can maintain more than 10 hours. 2. UPS adopts N+1 double set backup mechanisms，build different types of UPS according to the needs of each floor in a building. 3. UPS backup times running more than 30 minutes. 4. Supplements of generators and backup genitors.	Percentages of Breakdown after power failure (B3-2)	Collects data from observation	
Information security (C)	Firewall (C1)	Protections of attacks from network using a firewall: 1. Performance of a firewall. 2. Adjustments of a firewall.	Percentages of intercepting attacks using the firewall (C1-1)	Collects data from the testing system	1.Conti (2002): system security. 2.Wu (1994), Chen (1996): privacy.
			Levels of parameters for firewall (C1-2)	Collects data from the testing system	
	User operation	Users in the campus network accept the training course on security and information security policy, and standard procedures.	Education and training on network courses (C2-1)	Collects data from the social engineering training platform	ISO/IEC 27001:2005 (E): personal security management and education training.
			Testing records of network courses (C2-2)	Collects data from the social engineering training platform	
	Hacker's attacks (C3)	Organization should carry out monitoring and controlling of computer antivirus and malicious software , and user cognition 1. computer virus 2. Repair the vulnerabilities of system	Numbers of infected by computer virus (C3-1)	Collects data from the repair information system	1.Conti (2002): system security. 2. ISO/IEC27001:2005 (E) 3. Lai (2006) Schneider and Therkalsen (1990), ISO/IEC 27001 : 2005 (2005) : privacy.
			Ability of bug fixes and automatic updating after infected by computer virus (C3-2)	Collects data from the practical repair records	

2.2 Total quality management and quality control tools

Total quality management (TQM) originates from America since from early 1960. Now, TQM is widely carried out in Europe and Japan areas. Persico (1989) addressed that TQM is a managerial philosophy and techniques of improving the performance of a company, thus, each member of the company should continuously improve the quality of work through teamwork to attain the objective of a company. Generally, implementations of a TQM project focuses on the improvements of business processes and integration of resources including manpower, equipments, and money, etc. Quality planning, quality improvement, and quality control are three major steps of implementing TQM. Deming (1986) proposed fourteen principles of effective quality management. So, the core concept of TQM are focused on continuously improve the business processes, delegation, satisfies the customers' requirements, reductions of wastes, total participations, teamwork, and problem-oriented approach (Ross, 1993; Mann and Keoe, 1995; Manni, 1994; Morgan and Murgatroyd, 1994; Juran, 1986_a, 1986_b).

So far, causes & effects chart, pareto diagram, check list, stratification, scattered diagram, historgram, and statistical chart, named as QC seven tools, are widely applied into the process of implementing TQM. Among of them, causes and effect causes chart is a popular tool of quality management. The advantages of using the causes and effects chart are systematic ways of finding good ways to solve the problems. Brainstorming, fish-bone diagram, teamwork, and open discussions are major methods used to find the causes of problems. Five steps of using the causes and effect chart are described as follows: (1) decides a subject of problems solving, (2) illustrates main causes of problems, (3) derives secondary causes for each main cause, (4) finds out major cause of problems, and (5) completes the causes and effects chart.

2.3 Analytical Hierarchy Method

Analytic hierarchy process (AHP) was first proposed by Saaty (1980), and it is based on the analysis of expert surveys. AHP has been extensively used in research on the issues of business management in recent years. In strategy management, Sirikrai and Tang (2006) used AHP to develop a method for industry analysis and analyzed the Thailand automotive parts industry. Li et al. (2010) combined AHP with SWOT analysis to use in analyzing and selecting green manufacturing strategies. AHP can therefore effectively help business management with decision-making. Apart from strategy selection issues, it can also be used to solve other tangible selection problems. Lai et al. (2002) used AHP to solve the problem of group decision making in software selection by ways of composite measure for technology management knowledge included 11 items. Ngai (2003) used the AHP method to select the best website for placing online advertising. There are many similar applications where the AHP method is used and it is now quite a successful analytical method that helps research with solving tangible selection problems.

AHP has now developed into ANP or fuzzy AHP, and while they are applied in slightly different ways, they are still generally based on multi-attribute evaluation. Ding (2010) for example, used fuzzy AHP to understand the critical factors influencing customer value for global shipping carrier-based logistics service providers. As described by Saaty (1980, 2000), the basic concept of AHP is to first establish the problem or goal to be analyzed as part of Level 1. The problem is then broken down into several kinds of components/elements also referred to as the criteria. These criteria can be considered to be another level, referred to also as Level 2. From there, it can be broken down even further into other levels such as Level 3, Level 4 and so on. Each subcriterion within a level is independent and can be used to evaluate the criteria in the next upper level. Measurement is carried out using the ratio scale. A problem is therefore divided into two criteria for comparison (compare C_i and Cj). Nine ratio scales are laid out to evaluate their respective degree of importance to the evaluator and form a pairwise comparison matrix. To help the evaluator arrive at a consistent answer with the pairwise comparison matrix, the reliability must be verified. Usually, this is done by calculating the consistency index (C.I.) for the pairwise comparison matrix to avoid poor decision-making. If C.I. = 0, that means the decisions are completely consistent with each other. If C.I. > 0, that means the decisions are not consistent. C.I. ≤ 0.1 means an acceptable margin of error (Saaty, 1980). Saaty (2000) proposed the observation of the consistency ratio (C.R.). If C.R≤ 0.1, it means that the evaluation within the matrix is acceptable.

III. RESEARCH METHOD

In order to attain the objective of developing a network service quality measurement model, we have to derive the evaluation indicators which directly affect the quality of network services. A computational model of network service quality needs to be developed based on the evaluation indicators which are surveyed from the case company. In this study, AHP is used to measure the weight of evaluation indicators for calculating the network service quality. Our research process is shown as follows: (see Fig. 1)

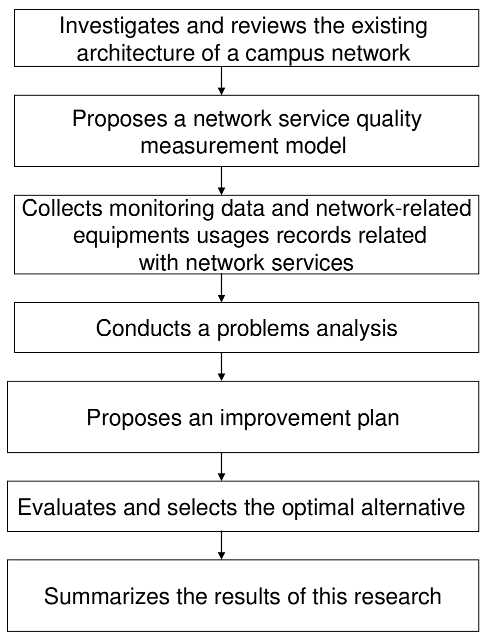

Fig. 1 Research process of developing a network service quality measurement model.

Step 1: Investigates and reviews the existing architecture of a campus network.

Step 2: Proposes a network service quality measurement model. The questionnaire is delivered to the respondents who are in charges of tasks on network services of a campus network. Then a computational method of network service quality is developed using AHP techniques.

Step 3: Collects monitoring data and network-related equipments usages records related with network services. Data are collected from two sources including monitoring the abnormal packages and attacks from websites on the internet and measure the performance of core switch and computer center's servers. Next, we collect the usage records of network services. MTRG (Multi Router Traffic Grapher) is used a tool to monitor and collect the usages of network flow including network flow on Network server, utilization of CPU, NAT network flow, stabilities of connection between the servers in a campus network and websites outsides the campus network. Performance analysis, benefits and cost analysis are carried out. The CPU monitoring are focused on the attacks happened on the core switch or occurrences of abnormal network flows.

Step 4: Conducts a problem analysis. A project team is established to collect quantitative data related with the network service quality in a campus network. The ranges of discussions are focused on three subjects including network performance, stabilities of network-related equipments, and information security. Fig. 1 is the problem analysis-oriented causes of effects chart which can be used to identify the causes of poor network service quality in a campus network. Furthermore, problem solving-oriented causes of effects charts are also derived.

Step 5: Proposes an improvement plan to solve the problems according to the results of problem analysis. The key points of problem solving are focused on the network performance, information security, and system reliability. On the aspect of performance, we suggest that introduce new network-related equipments including core switch, optical switch, etc. On the aspect of security, we suggest that examine the function of firewall, the function of restricting P2P. Besides, on the aspect of security, we suggest that decide whether if backup mechanisms are required or not.

Step 6: Evaluates and selects the optimal alternative by ways of comparing the benefits and costs analysis for two alternatives.

Step 7: Summarizes the results of this research and completes the research paper.

IV. AN EMPIRICAL STUDY OF CHUNG HWAI UNIVERSITY OF MEDICAL TECHNOLOGY

Chung Hwai University of Medical Technology was established in 1968. The objectives of this university are placed on the training students on the medical affairs. So, far, total of students' numbers of Chung Hwai University amount to 9,000 and the numbers of employee is equal to 400. Fig. 2 is the Architecture of Campus Network of Chung Hwai University of Medical Technology. As shown in Fig. 2, TANet is connected with the Campus Network of Chung Hwai University through the routers with the speeds of 200 Mbps.

Under the existing the campus network's architecture of Chung Hwai University of Medical Technology, the challenges for the administrator of network management includes routine work related with network operation, upgrades of network equipments, and backup mechanism for network security. Thus, how to manage multiple brands network equipments using the techniques of network theory. A new architecture of a campus network is planned to developed to attain the objectives of optimal efficiency of network bandwidth, users of a campus network can employ network service more easier and safely in the Chung Hwai University of Medical Technology. A software project team is composed of nine participants including the section chief of network management and team members coming from the other department of computer center is organized to solve the problems mentioned above. Regular meetings of software project team were held in each week. Network performance, information security, and stabilities of network-related equipments are classified as three major dimensions of evaluating the network service quality. A survey questionnaire was delivered to the key users of a campus network aiming to collect the data on the service network quality. The AHP method is used to compute the weight of evaluating the network quality service. Thus, a comprehensive and objective result of measuring the network service quality was obtained.

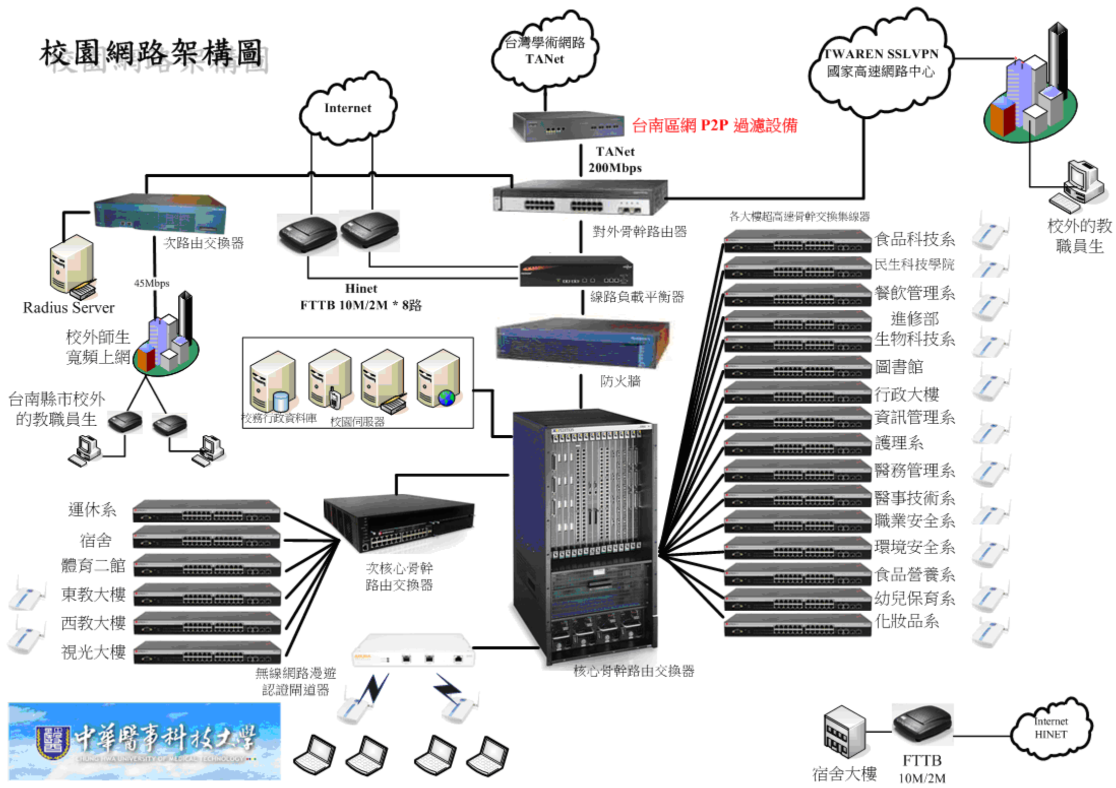

Fig. 2. The Architecture of a Campus Network of Chung Hwai University of Medical Technology.

As shown in Fig.3, network performance, network-related equipments, and information security are three main causes of poor network service quality. Next, we further investigate each main cause in more detail by ways of brainstorming and group discussions. Factual data are collected to examine whether the cause exist or not. Until the major causes of poor network service quality are found, the above step is executed continuously. Finally, we use the problem solving-oriented causes and effects chart to find the optimal method to solve the problem mentioned above (See Fig. 4).

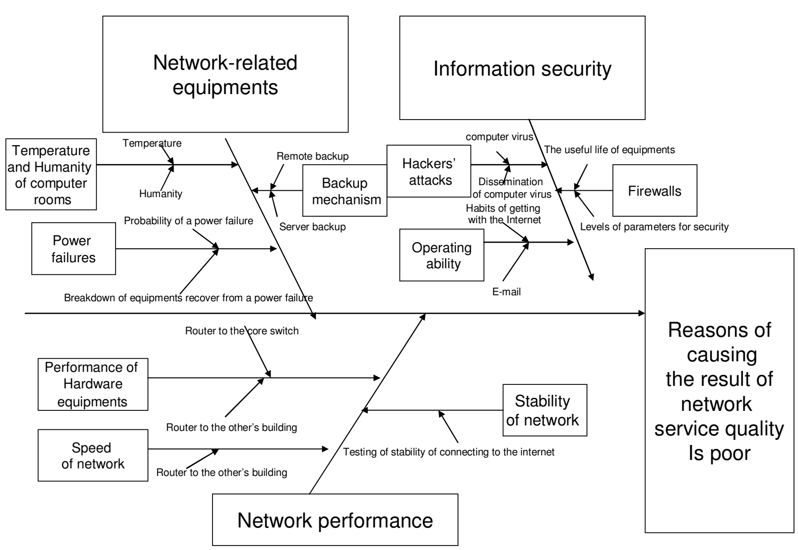

Fig. 3. Problem analysis-oriented causes and effects chart.

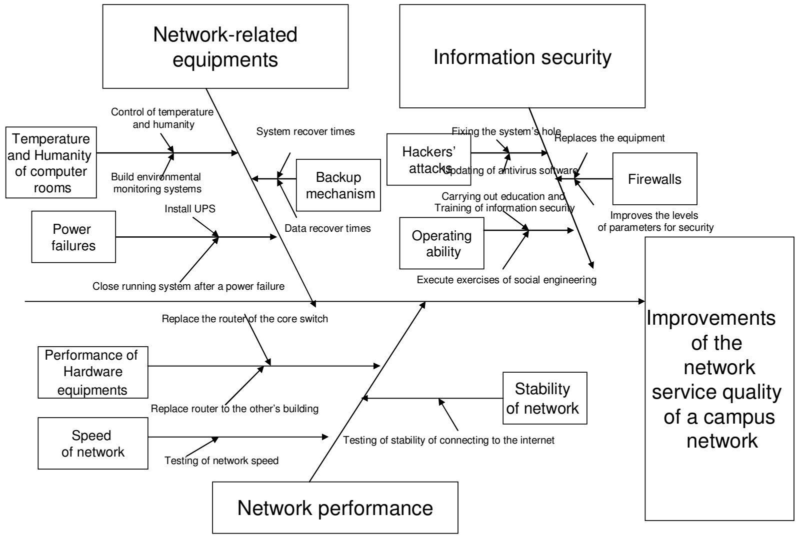

Fig. 4. Problem solving-oriented causes and effects chart.

As shown in Table 3, the weight of information security for evaluating the network service quality ranked as first priority was equal to 55.7%. Next, the weight of stability of network-related equipments was equal to 28.5%, and lastly the weight of network performance was equal to 15.8%. Two alternatives were proposed to improve the network service quality of a campus network. The first alternative was introducing a multiple-function firewall and establishing a protection system of network services, and installing information security analysis system. The second alternative was installing a core switch, UPS, and a firewall. For the comparison of benefit and cost of two alternatives, a network service quality measurement model was applied to the process of the evaluation and selection of the optimal alternative (Table 4).

Table 3. Results of the weight for evaluating the network service quality.

Dimension	Weight of dimension	Rank	Evaluation indicators	Weight of evaluation indicator	Rank
Network performance （A）	15.8%	3	Network speed （A1）	14.20%	3
			Performance of hardware equipments（A2）	27.30%	2
			Stability of network-related (A3）	58.50%	1
Stability of network-related equipments （B）	28.5%	2	Backup mechanism（B1）	56.10%	1
			Temperature and humility of computer rooms （B2）	15.00%	3
			Electrical power failure （B3）	28.80%	2
Information security （C）	55.7%	1	Protection by firewalls （C1）	39.20%	1
			User operations（C2）	26.90%	3
			Attacks by hackers （C3）	33.90%	2

Two alternatives were proposed to improve the network service quality using the proposed network service quality measurement model (see Table 6). Apparently, Alternative 2 is superior to alternative 1 according to the score of the network service quality. Alternative 2 is better than the score of the existing architecture 39.4.

Table 4. The comparisons of two alternatives.

Types of alternative / Item of comparison	Alternative 1	Alternative 2
	Replacement of a firewall	Installing a core switch, UPS, and a firewall
Score of network QoS	56.9	81.8
Cost	1200,000 NT dollar	7,000,000 NT dollar
Descriptions	The focus of this alternative is to improve the information security of a campus network	The focus of this alternative is to improve the performance of network and information security. Comparing to the Alternative 1, network service quality of Alternative 2 is grater than alternative 1 with 24.9%.
Suggestion		( )

Results of evaluating the network service quality alternative 1 and alternativ2 are shown in Table 5 and Table 6.

Table 5. Results of evaluating the network service quality: Alternative 1.

Dimension	weight	rank	Value of weight (average score*weight)	Score of each item						Averag score
Network performance(A)	15.80%	3	52.9	**Evaluation indicators**	**score**	**Evaluation indicators**	**score**	**Evaluation indicators**	**score**	
Network speed(A1)	14.20%	3	7.1	Download speed from the benchmark website (A1-1)	40	Download speed from the computer center’s server(A1-2)	60			50
Performance of hardware equipments (A2)	27.30%	2	13.6	Performance of the CPU’s load ability of a core switch (A2-1)	40	The useful life of a core switch (A2-2)	40	Stability of data transfer from optical fiber exchanger to the core switch (A2-3)	70	50
Stability of network(A3)	58.50%	1	32.2	Stability of users’ computers connected to the benchmark’s website (A3-1)	40	Stability of user computers connected to the computer center’s server (A3-2)	70			55
Stability of network-related equipments (B)	28.50%	2	17.4							
Backup mechanism (B1)	56.10%	1	5.6	System response times (B1-1)	10	Ability of data recovery (B1-2)	10			10
Humanity of the computer room (B2)	15.00%	3	7.5	Stability of continuously keeping fixed temperature (B2-1)	50	Stability of continuously keeping fixed humility (B2-2)	50			50
Power failure (B3)	28.80%	2	4.3	Numbers of Power failure in a month (B3-1)	0	Percentages of Breakdown after power failure (B3-2)	30			15
Information security (C)	55.70%	1	78.3							
Firewall (C1)	39.20%	1	37.2	Percentages of intercepting attacks using the firewall (C1-1)	90	Levels of parameters for firewall (C1-2)	100			95
Ability of user operation (C2)	26.90%	3	24.2	Education and training on network courses (C2-1)	100	Testing records of network courses (C2-2)	80			90
Hacker’s attacks (C3)	33.90%	2	16.9	Numbers of infected by computer virus (C3-1)	90	Ability of bug fixes and automatic updating after infected by computer virus (C3-2)	10			50
Total score of network service quality	56.9									

Table 6. Results of evaluating the network service quality: Alternative 2.

Dimension	weight	rank	Value of weight (average score*weight)	Score of each item						Averag score
Network performance(A)	15.80%	3	84.3	**Evaluation indicators**	**score**	**Evaluation indicators**	**score**	**Evaluation indicators**	**score**	
Network speed(A1)	14.20%	3	9.23	Download speed from the benchmark website (A1-1)	60	Download speed from the computer center's server(A1-2)	70			65
Performance of hardware equipments (A2)	27.30%	2	25.4	performance of the CPU's load ability of a core switch (A2-1)	90	The useful life of a core switch (A2-2)	100	Stability of data transfer from optical fiber exchanger to the core switch (A2-3)	70	93.3
Stability of network(A3)	58.50%	1	49.7	Stability of users' computers connected to the benchmark's website (A3-1)	80	Stability of user computers connected to the computer center's server (A3-2)	90			85
Stability of network-related equipments (B)	28.50%	2	87.4							
Backup mechanism (B1)	56.10%	1	56.1	System response times (B1-1)	10	Ability of data recovery (B1-2)	100			10
Humanity of the computer room (B2)	15.00%	3	7.5	Stability of continuously keeping fixed temperature (B2-1)	50	Stability of continuously keeping fixed humility (B2-2)	50			50
Power failure (B3)	28.80%	2	23.8	Numbers of Power failure in a month (B3-1)	0	Percentages of Breakdown after power failure (B3-2)	100			15
Information security (C)	55.70%	1	78.3							
Firewall (C1)	39.20%	1	37.2	Percentages of intercepting attacks using the firewall (C1-1)	50	Levels of parameters for firewall (C1-2)	50			50
Ability of user operation (C2)	26.90%	3	24.2	Education and training on network courses (C2-1)	100	Testing records of network courses (C2-2)	80			90
Hacker's attacks (C3)	33.90%	2	16.9	Numbers of infected by computer virus (C3-1)	10	Ability of bug fixes and automatic updating after infected by computer virus (C3-2)	10			10
Total score of network service quality	81.8									

V. CONCLUSIONS AND FUTURE RESEARCH

In conclusion, the focuses of this paper are summarized as follows: (1) proposes a network service quality measurement model for evaluating the network service quality in a campus network, (2) AHP is used to compute the weight of evaluation indicators for evaluating the network service quality, and (3) applicability and practicability of the proposed model is conducted in an empirical study of a university of medical technology. The advantages of the proposed model are summarized as follows: (1) systematically and objectively evaluating the network service quality of a campus network, (2) easy of use and data transparency during the process of computation of the network service quality, and (3) integration of quantitative and qualitative approach to evaluating the network service quality. Future research directions are suggested in the following: (1) this model can be extended to the application in different industries, developing suitable evaluation indicators for different industries, (2) fuzzy AHP is adopted as a method of evaluating network service quality, results of evaluating the network service quality is more accurate, and (3) multiple cases studies are conducted to examine the applicability and practicability.

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網路服務品質度量模型之建立與應用
-以中華醫事科技大學為實證分析對象

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摘要

近年來，網際網路的人口急遽增加，網路服務品質的研究議題受到學術界與產業界的共同關注。有鑑於此，本研究根據網路服務品質度量的相關文獻，發展出一個網路服務品質度量模型，主要評估構面包含：(1) 網路效能指標，(2) 網路相關設備之穩定度，與 (3) 資訊安全指標三大類，本研究是採用 AHP 問卷計算上述三大類的權重值。為了驗證本研究網路服務品質在實務應用之可行性與實用性，個案實證分析對象為中華醫事科技大學，運用網路服務品質度量模型測量校園網路的服務品質，同時，採用全面品質管理手法提出一些改善對策。根據本研究的實證分析結果，評估構面之排序為資訊安全指標、網路相關設備之穩定度、網路效能指標，至於提出的改善方案為購置核心骨幹交換器、斷電系統與發電設備、防火牆等，改善後之網路服務品質水準提升比率為 48%。因此，網路服務品質模型之建立與應用是從事於校園網路管理一項重要事項，本研究成果可以提供學術界與實務界之參考。

關鍵詞：網路服務品質、全面品質管理、度量模型