EVALUATION METHODOLOGY IN TEMS OF QUALITY

Min-Suk YOON
Session Organizer
Electronic Commerce
Chonnam National University
Yeosu, S. Korea
E-mail: msyoon@chonnam.ac.kr

SESSION ABSTRACT

In this session of ISAHP 2014, three papers are presented about evaluation model in terms of quality. The first paper presents a power quality evaluation model for electric power customer. The second paper presents a nursing evaluation methodology using the AHP for undergraduate students. The third one is for the software quality evaluation using the AHP and ANP.

Key Words: quality evaluation, AHP/ANP, electric power, nursing education, software product

POWER QUALITY EVALUATION MODEL FOR ELECTRIC CUSTOMER BASED ON ANALYTIC HIERARCHY PROCESS

Buhm Lee
Dept. of Electrical and Semiconductor Engineering
Chonnam National University
Yeosu, South Korea
E-mail: buhmlee@chonnam.ac.kr

Kyoung Min Kim
Dept. of Electrical and Semiconductor Engineering
Chonnam National University
Yeosu, South Korea
E-mail: kkm@chonnam.ac.kr

ABSTRACT

This paper presents a power quality evaluation model for electric power customer. Because every electric power customer needs high quality power, in the viewpoint of Stable Voltage, Stable Frequency, Low Harmonics, and High Reliability, they do effort to upgrade power quality. To maintain high-quality power with less-effort, this paper focuses on evaluation methodology for power quality and develops a power quality index which reflects these power quality factors by using Analytic Hierarchy Process.

Keywords: Power Quality Evaluation, Electric Customer, Reliability, Power Quality

1. Introduction

Power companies expend significant capital and effort to increase reliability and power quality (PQ). For quantitative assessment of PQ, indices for reliability, indices for voltage sags, and indices for harmonics, have been developed. Because these indices require all related quantities to be measured at every load point of a distribution system, measurements are not possible for non-existing systems, i.e. systems in the planning stage. Another problem of using these individual indices is ensuing limited information from individual indices and conflict between reliability and PQ indices. Accordingly, planners have employed tradeoff analysis of individual indices when making decisions.

This paper presents a new methodology to obtain a power quality evaluation index that can assess the performance of a customer system. First, this paper classifies events into three classes: (a) Inconvenience (Power Supply), (b) Inconvenience (Clear Sinusoidal), and (c) Cost. Second, this paper proposes the use of three states to measure PQ level, such as [Ideal], [Actual], and [Possible]. Third, this paper proposes a methodology to rescale [Actual] states instead of employing one-to-one matrices. This methodology can rescale them to fit human judgment. Finally, this paper presents an Analytic Hierarchy

Process(AHP) model to obtain a unified index from various indices and cost using eigenvalue analysis. By using the proposed methodology, we can obtain a unified power quality index that can show the power quality of the system, whether existing or non-existing. This method is especially effective for planning. For example, a decision-maker can build expansion plan alternatives, and can choose the best plan among power quality alternatives. We applied the proposed method to real system planning, and demonstrate the effectiveness.

2. Review of Power Quality Evaluation

PQ of a system is quantified by following attributes: sustained reliability, momentary reliability, voltage sags, harmonics, and voltage drops. To evaluate a system, we calculate every item at each load point, and calculate system-wide indices and cost. Here, overvoltage and undervoltage which exceed 20% of nominal values and harmonics which exceed 20% of THD are considered as sustained interruptions.

We classify PQ into Inconvenience (Power Supply), Inconvenience (Clear Sinusoidal), and Cost. In Inconvenience (Power Supply) related to interruptions of power, we consider SAIFI and SAIDI as a sustained reliability, MAIFI as a momentary reliability, and $SARFI_{70}$ as voltage sags. In Inconvenience (Clear Sinusoidal) related to the negative effects of the system without interruptions of power, we consider harmonics and voltage deviations. Finally, we consider costs, which can evoke system operation cost, such as harmonic aging cost, system loss cost, harmonic loss cost, and annual operation cost.

3. Development of Ideal Analytic Hierarchy Process Model

3.1 3-state model

We propose the use of three states, defined as [Ideal], [Actual], and [Possible] states in the AHP model. [Ideal] are the ideal values that customers feel as ideal, [Possible] are the possible values that customers feel as extremely challenging because of PQ, and [Actual] are calculated values that reflect current states. As an example of voltage deviation, guess the voltage of a load point is 0 to infinitive. Even though, voltage of load point can vary 0 to infinitive, we can only load at this load point under -20 to 20[%] of voltage deviation. Accordingly, 20[%] of voltage deviation is [Possible], 0[%] of is [Ideal], and 3[%] is [Actual] if voltage deviation of the current state is 3[%].Your study may be trying to prove something or at the very least will have a specific objective (e.g. development of a decision model for a particular problem). Make sure to list them here. The reader must be clear about the specific objectives or hypotheses in your study.

3.2 Scaling for human sense

In spite of the above, [Actual] state of 3-State model can reflect the current state between [Ideal] and [Possible] states, but it does not reveal the proper scale of PQ to fit human judgment. We propose a methodology that rescales [Actual] states, instead of employing one-to-one matrices. As a methodology, we normalize [Actual] state between

[Ideal] and [Possible] states to overcome different standards, and apply a new non-linear scale.

3.3 Build Ideal AHP model

The AHP model which inherently quantifies the system performance indices is presented in a unified manner. We calculate indices and costs for 3 states, and rescale them. From rescaled values, we calculate an eigenvalue using a one-to-one matrix. This eigenvalue is a unified PQ index, because it can reveal the competitiveness between ideal and possible states. The smaller value indicates a better system.

4. Application of Electric Customer

We applied developed model for electric customer, and its procedure is as follows:

(1) PQ and its indices
We introduce system-wide indices of power quality for Alternatives.

(2) Define of States, Rescale, and one-to-one matrix
This paper introduce 3-states to apply the proposed AHP model consisting of [Ideal] - [Actual] - [Possible] states. Here, Ideal states are all zero, because ideal power supply indicates no interruptions, no voltage sags, no harmonics, and no voltage fluctuation without additional operating cost. We set possible states of PQ indices considering their characteristics and arbitrarily cost. All possible states can be changed by customers and decision maker's opinion.

(3) Unified PQ index
This paper obtain eigenvalues, which are power quality evaluation index for each alternatives

5. Conclusions

This paper presents a customer power quality evaluation index. The contributions of the paper are:
(1) This paper proposes a new AHP model which can evaluate PQ for an electric customer system. First, authors classify three states, such as [Ideal], [Actual], and [Possible] states. Second, authors propose a rescaling methodology to fit the [Actual] state for human interpretation, rather than one-to-one matrices in AHP. Third, authors present an AHP model to obtain unified index using eigenvalue analysis from various indices and cost. By using this model, obtained Power Quality evaluation index can show the PQ of the electric customer system, regardless of whether it exists.
(2) By using a customer power quality index that includes cost, the decision maker can select the most effective alternative without a pareto-optimal solution.
(3) This paper applies this methodology to a relatively large distribution system under expansion, and show the usefulness in planning is confirmed. The study case demonstrates the process of selecting the best system in terms of improving power quality at low cost.

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EVALUATION OF NURSING EDUCATION FOR STUDENTS BASED ON ANALYTIC HIERARCHY PROCESS

Sang Suk Kim
Red Cross College of Nursing
Chung-Ang University
Seoul, South Korea
E-mail: kss0530@cau.ac.kr

ABSTRACT

This paper presents a nursing evaluation methodology for undergraduate students. To enhance educational effect for training nursing students, faculties of college of nursing develop number of methodology such as Simulation, Standard patient, and Virtual patient etc.. Even though each methodology can obtain good results in a certain viewpoint, but obtain side effects also. So this paper focused on the basic model which can evaluate a methodology for its results. Because this study is a start of nursing education evaluation, this paper presents a methodology only.

Keywords: Evaluation, Nursing Education, Student Training, Simulation

1. Introduction

Many nursing school in Korea do evaluate effects of nursing education. As a methodology, researchers obtain answers of question from students who finished education, and analyze by using quantitative and qualitative methodology. This methodology has merit to obtain analyzing result for specified field only, but has limitations for overall evaluation.

This paper employed Analytic Hierarchy Process methodology and build a model which can evaluate overall fields of nursing education. First, author proposes the use of three states to measure effects of nursing education, such as [Ideal Achievement], [Actual Achievement], and [No Achievement]. Second, this paper proposes a methodology to rescale [Actual] states instead of employing one-to-one matrices. This methodology can rescale them to fit human judgment. Finally, this paper presents an Analytic Hierarchy Process(AHP) model to obtain an absolute achievement using eigenvalue analysis. By using the proposed methodology, author can specialize for evaluation of nursing education.

2. Review of Korean Nursing Education Evaluation

Nowadays, Korean nursing school do education as follows:

(1) Problem-based Learning(PBL)
(2) Team-based Learning(TBL)
(3) Simulation
(4) Standard Patient(SP)
(5) Micro Simulation

Because each education methodology has good point and weak point, evaluator has difficulties to evaluate the overall effect of nursing education.

3. Evaluation of Nursing Education by using AHP

3.1 Ideal Analytic Hierarchy Process

To overall evaluate for a system, Ideal AHP was developed, and authors employed it. Ideal AHP has [Ideal] – [Actual] – [Possible] States, and showed as follows:

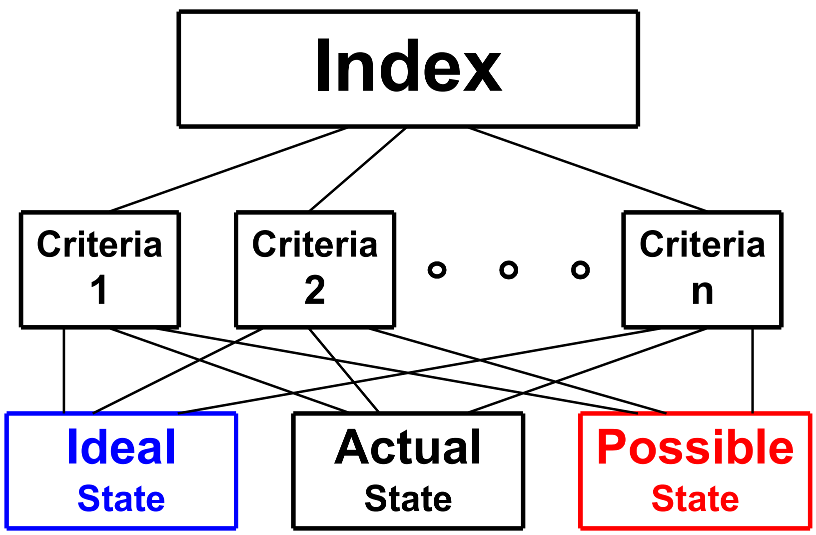

Fig. 1. Ideal AHP

3.2 Application of Nursing Education

This paper propose an application model for nursing education which has [Ideal Achievement], [Actual Achievement], and [No Achievement] for Alternatives, and Student achievements and understandings for Criteria. Concept of the model as follows:

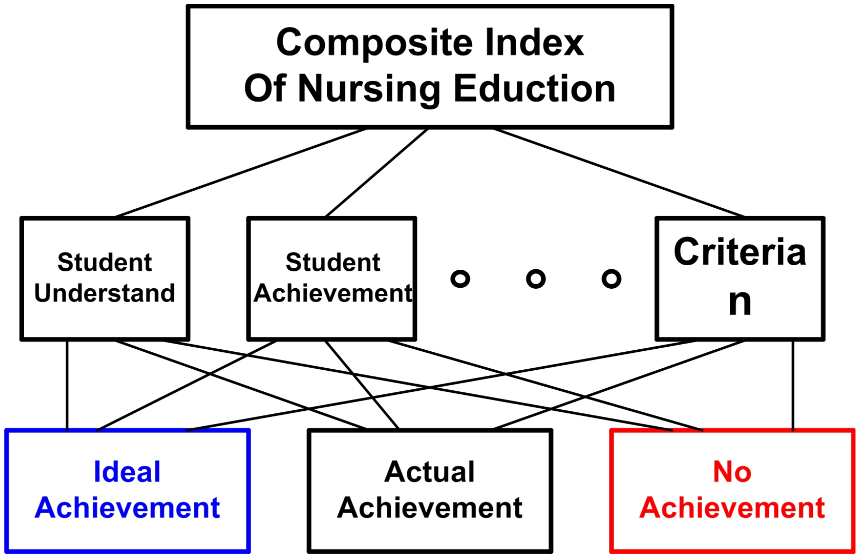

Fig. 2. Developed AHP Model

4. Conclusions

This paper employed Ideal Analytic Hierarchy Process, and applied it to the evaluation of nursing education of nursing school of Korea. By this methodology, authors can obtain overall evaluation index for achievement of nursing education.

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A STUDY ON THE PRIORITY CHANGEOVER AND INTERACTION OF SOFTWARE QUALITY FACTORS USING THE AHP/ANP

Min-Suk YOON
Department of Electronic Commerce
Chonnam National University, S. Korea
E-mail: msyoon@chonnam.ac.kr

Lingyu HAO
Electronic Commerce in Graduate School
Chonnam National University, S. Korea
E-mail: hly0413@naver.com

ABSTRACT

This paper purposes to identify the priorities changeover of software quality factors according to the development of software product corresponding to information technology and digital contents, judging by user perceived satisfaction in terms of quality. The quality model has changed from ISO 9126 to ISO 25000, and the difference is measured by the Analytic Hierarchy Process (AHP). This paper also analyzes the interaction between quality characteristics and factors in software use using the Analytic Network Process (ANP). AHP and ANP have been usefully accepted when the evaluation depends on subjective judgment and/or expert knowledge. The study is empirically exemplified with popular software products. Only reliable data, identified by screening with the consistency ratio of the AHP, are analyzed. This paper discusses the meaning of priorities changeover

Keywords: Software Quality Evaluation, Analytical Hierarchy Process, Analytical Network Process, Compatibility Index

1. Introduction

In this study, the AHP (Analytical Hierarchy Process; Saaty 1980) and ANP (Analytical Network Process; Saaty 1996) is applied to identifying the change of priorities over software quality characteristics between the past and the prsent. The usefulness of the AHP (Analytic Hierarchy Process) has been verified by its rich applications in almost all industries (Saaty 1980; Yoon and Kinoshita 2010). The context of the AHP application has been extended by the ANP (Analytic Network Process) as the generalized form of the AHP (Saaty and Vargas 2013).

For the past decades, the degree of software competition has increased with more and more software developed while information technology and associated digital contents have evolved. Software is defined as programs, procedures, rules and any associated documentation pertaining to the operation of a data processing system [ISO 8402], and software product is a software entity designated for delivery to a user [ISO 9126 series]. Quality is defined as the totality of characteristics of an entity that bears on its ability to satisfy stated and implied needs [ISO 8402] and it is a driver for user satisfaction. As a result, the definition of quality to satisfy user needs is transferred to software product according to ISO/IEC 9126 which is being superseded by ISO/IEC 25000 series [2005]: Software engineering - Software product Quality Requirements and Evaluation

The objective of this study is to find the priorities changeover of software quality factors/criteria, judging by user perceived satisfaction in terms of quality according to the quality model in the past and present. The difference is measured by the Analytic Hierarchy Process (AHP). This paper also analyzes the interaction between quality characteristics in software use using the Analytic Network Process (ANP). Additionally, this model shall not only identify the dominant criteria as key drivers of user-perceived software quality but also extract weak and strong points contributing to quality preference in the competitive market.

The study is empirically exemplified with popular software products. Only reliable data, identified by screening with the consistency ratio of the AHP, are analyzed. This paper discusses the meaning of priorities changeover using compatibility index of the AHP.

2. Literature Review

Multiple Criteria Decision Making (MCDM) techniques have been applied to the evaluation of information systems [Chandler, 1982; Klein and Beck, 1987] and software products [Anderson, 1990; Fritz and Carter, 1994]. Among MCDM methods, weighted sum is general out of many aggregation methods. In order to get priorities or weights of quality, this study adopts the ISO 9126 quality model as evaluation criteria, and the AHP as an evaluation method.

The AHP and its general form, ANP are the measurement methods for dealing with quantifiable and/or intangible criteria that has found rich application in decision theory, conflict resolution, and models of the brain because of its easy-going applicability and its ability of judgmental consistency check [Kim and Whang, 1993]. Now the AHP/ANP are usefully accepted when the evaluation depends on subjective judgment and/or expert knowledge. The AHP is for hierarchical decomposition with independence and the ANP is for feedback or dependent relation among criteria and/or alternatives. A characteristic advantage of the AHP/ANP is pairwise comparisons, which covers subjective and fuzzy evaluation [Saaty and Tran 2007].

Quality in information systems is a multi-dimensional concept [Curtis, 1980; Cusumano and Kermerer, 1990]. Likewise is quality in software products. Understanding or measuring software quality has been discussed through the hierarchical quality model. A quality model is defined as the set of characteristics and the relations between them which provide the basis for specifying quality requirements and evaluating quality [ISO 9126]. More precisely, quality evaluation is the systematic examination of the extent to which an entity is capable of fulfilling specified requirements. A quality characteristic is a set of attributes of a product by which its quality is described and evaluated. An attribute is a measurable physical or abstract property of an entity [Fenton, 1994]. The quality attributes may be conflicting or cooperative among themselves [ISO 14598-1].

Up to present, research on software quality has developed such quality models that are intended to be comprehensive and applicable to any context of software. In order to evaluate software quality, it is necessary to use a quality model which breaks software down into its different characteristics. Software engineering researchers have suggested such a various number of quality characteristics and/or criteria that they may cause confusion and not be empirically useful. Thus the ISO 9126 and are provided as a standard model for software quality and ISO 12119 is for software package. ISO 9126-1 (2001) defines 6 characteristics;

- functionality, reliability, usability, efficiency, maintainability, portability
- total 27 sub-characteristics under 6 characteristics hierarchically

Since 2005 the quality model has changed as ISO 25000 series with 8 characteristics. The quality model is externally identified with quality in use – Effectiveness, Efficiency, Safety and Satisfaction.

3. Research Design/Methodology

ISO 9126 quality model is given as in Figure 1 with 6 characteristics and sub-characteristics for each. The software evaluation model of this study shall be intended to make subjective judgment into objective priorities and to become a scoring model rather than a simple choice model with matching the AHP with ISO 9126 requirements.

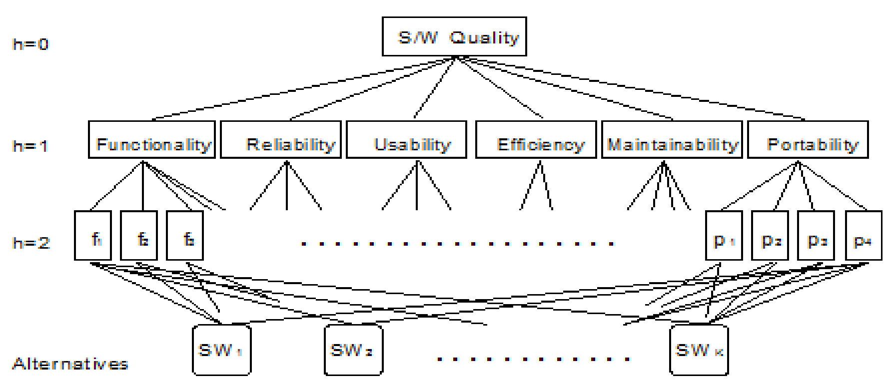

Figure 1. Quality Model

In order to evaluate quality in use, we have to measure the interaction between objectives in use and characteristics in external quality. We use the ANP to measure it. The ANP provides a way to input judgments and measurements to derive priorities of ratio scale for the distribution of influence among the factors and groups of factors in the decision. Ratio scales make possible proportionate allocation of resources according to derived priorities. The well-known decision theory, the Analytic Hierarchy Process (AHP) is a special case of the ANP. Both the AHP and the ANP derive priorities by making pairwise comparisons of elements on a common property or criterion. Although many decision problems are best studied through the ANP, one may wish to compare the results obtained with it to those obtained using the AHP or any other decision approach with respect to the time it took to obtain the results, the effort involved in making the judgments, and the relevance and accuracy of the results (www.SuperDecisions.com).

4. Data/Model Analysis

In order to get priorities, we perform pairwise comparison survey to pool of the software users including experts. In order that end-users may evaluate software quality, two preliminary steps are required: identifying characteristics applicable to the designated software product and re-describing the characteristics in user's language. In addition, the definition of characteristics containing a pure terminology may not sufficiently support users to assess software quality.

The analyzed data is not all responded, but only reliable data that is regarded as consistent data. The consistency is checked by the consistency ratio of hierarchy (CRH) of the AHP (See [Saaty, 1980] p. 84). Only data that satisfy the condition of $CRH<0.2$ are selected, because $CRH<0.1$ would be desirable but $CRH<0.2$ would be tolerable [Saaty, 1980]. The following results are obtained from the analyses.

5. Conclusions and Limitation

This paper analyzed the priorities of software quality factors using the AHP and ANP, and this paper will help software competition in the market.

The analyzed data shows that software quality is composed of some concepts and the priorities of quality characteristics change according to time flow. This study also shows in real condition that it is necessary to connect quality in development with quality in use. As a result of the combination, the priorities of software quality factors in use are analyzed in this paper.

Consecutively, this paper compares the results of the two matrices using the Compatibility index in the AHP, empirically. This study may become the basis for the empirical research to clarify the relation between perceived quality and objective indicators of external quality.

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