

A hybrid Kano-fuzzy AHP method for measuring customer satisfaction: A case study of transportation system

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ABSTRACT

An increase competition on today's economy has created motivation for many organizations to look for different alternatives on better serving the customers. There are always some budget limitations on any customer relationship method, which leads us to prioritize different alternatives. In this paper, we present an empirical method based on an integrated Kano and fuzzy analytical hierarchy procedure to rank suitable alternatives. The proposed model of this paper uses a questionnaire survey to gather customer's opinions and implements the method for a real-world case study of transportation planning. The questionnaire includes 37 questions distributed among 976 passengers for two trips in Iran. The results indicate that driver's physical and mental health, buss equipments with GPS functionality and familiarity of drivers with road and road's conditions play important role on choosing a transportation company.

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1. Introduction

During the past few decades, there have been enormous number of works focused on service quality models (Teas, 1994; Ghobadian et al., 1994; Wassenaar, 2005; Xu, 2009). Grönroos (1984) presented a service quality model and its marketing implications based on examining a sample of business executives, which describes how customers perceive the quality of services. He explained that functional quality is a very important dimension of a perceived service and concluded that quality dimensions are interrelated. Lee et al. (2011) performed a study to examine the effects of consumers' service quality perceptions on satisfaction, revisit intention and the role of gender for high profile golf club business. They investigated the role of gender in forecasting their service quality perceptions and the relationship between quality perceptions and satisfaction and intention.

Xu et al. (2008) studied the inherent issues of traditional Kano method by proposing an analytical Kano technique based on focusing on customer need analysis. The Kano principles were originally proposed to incorporate quantitative measures into customer satisfaction where two methods were developed to provide decision support for product design. The first Kano classifiers are normally used as tangible criteria for categorizing customer needs, and the second configuration index is for product configuration design. They used A-Kano for a case study of dashboard in automotive design and

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demonstrated that the model can incorporate customer preferences in product design by a tradeoff between customer's satisfaction and producer's capacity. Kurniawan et al. (2009) showed that customer satisfaction in construction is a relatively complicated issue in which different factors have different impacts on the quality as perceived by the customer. Management and factors associated with skills have also different impacts on the factors describing the end result and methods of the project. Based on the results of Kurniawan et al., the contractor's ability to cooperate is divided into two directions of managing changes and communication. The results of their studies also emphasize the importance of communication in project production where it is recommended that the contractors must focus on developing and improving their central processes to increase the level of their services. Ha and Jang (2010) studied the impact of service quality and food quality using a comprehensive framework.

Li et al. (2008) presented an integrated method of rough set, Kano's model and analytical hierarchy procedure (AHP) for ranking customer requirements' final importance. Their proposed model ranks customer requirements in product planning house of quality. Chen (2008) investigated structural relationships between service quality, perceived value, satisfaction, and behavioral intentions for air passengers for a case study of a real-world in Taiwan. Caruana (2002) studied service loyalty using the effects of service quality and customer satisfaction. Dabholkar et al. (2000) presented a comprehensive framework for service quality using an integrated model. Lee et al. (2010) developed an econometrics analysis of the R&D performance in the national hydrogen energy technology development for measuring relative efficiency using an integrated fuzzy AHP (Saaty, 1992) and data envelopment analysis.

Analyzing customers' need is one of the most important duties of producers and interpret that the customers' beliefs and market situations can increase the success of businesses (Parassuraman et al., 1988). Since customer plays a vital role on the success of different businesses there are different methods to understand customers' needs. One of the most important methods called Kano is a qualitative instrument which is registered about customers' competitive analysis and help to understand voice of customers and their effectiveness on customers' satisfaction (Jamal & Naser, 2002). According to this concept, Kano model analyzes the customer's needs and study different parameters affecting customer's needs (Ting & Ping, 2009; Wang & Ji, 2010). However, this model does not have quantitative instruments and does not reflect differences among a group's needs. Li et al. (2009) presented an integrated method of rough set, Kano's model and AHP for rating customer requirements' final importance. Rivière et al. (2006) presented an adaptive preference target to measure the contribution of Kano's model of satisfaction for an optimized preference analysis using a sequential consumer test.

The present study of this paper uses an integrated Kano and AHP method to rank the most important issues that customers consider when they are travelling via buses between different cities. This paper is organized as follows. We first present the methodology of the proposed model in section 2. Section 3 demonstrates the implementation of the proposed model analyzes the results. Finally concluding remarks are given in section 4 to summarize the contribution of the paper.

2. Theoretical framework

2.1. Quality of services

According to the vast researches, one of the most important factors that affects on customers' satisfaction and their structure behaviors about services marketing, is quality of services. Quality of services on different areas could have different meaning. Quality of services includes understanding the customer from relative goodness of an institution or service provider. Quality can be defined also as customers' justice of total preference or relative preference of services (Zeithaml, 1988). Services include total characteristics of customer mentioned on institution (Kassim, 2010). Quality is the results of something that customer receive really and quality of process explains how the services imposed (Grönroos, 1984; 1990). There are four characteristics associated with service quality which are: un-touch, ability to disappear, un-homogeneity and synchronous. Those functions, which are

experienced by customers, are called un-touch ability. Disappearing emphasizes on the services, which would not be produced or reserved for future. Un- homogeneity reflects the services, which are different from one to another. The last one is synchronicity that refers to the services produced in present time and should be consumed. Therefore, a customer cannot judge about productions quality before consuming the service (Berry & oarasuraman, 1991).

2.2. Customers satisfactory

Customers satisfactory is one of the important theoretical and empirical objects for most market-finders and marketing researchers, that is mentioned as a necessary and important condition to compete on newly universal market (Jamal & Naser. 2002). Therefore, their satisfactory importance and customers' maintenance on strategy collection for customer-having companies are important issues. Therefore, the most accepted theory to explain customers' satisfaction is an unconfirmed theory, which sates satisfaction degrees by comparing the experiences or real function against their expectations. Universal satisfaction or un-satisfaction is called total satisfaction. Satisfactory reptition itself is a question with collection satisfaction, which is an indicator of past, present, and future of company.

2.3. Quality of services and customers satisfaction

Customer satisfaction is a total concept, which shows total result of reaction consumption and includes area of unsatisfactory toward satisfaction.

3. Research methodology

3.1. Kano model

Kano model is an economical method to access clients satisfaction on compete analysis and deep understanding about voice of customer. Kano model is used to grade products' characteristics according to customers' needs. In fact, Kano graph shows customers' satisfactory associated with production level and survey the quality of products. According to Kano, to provide customers' satisfaction, institutions must remove any obligations, which affect the customers. Satisfactory and products and services should provide all three kinds of needs.

3.1.1. Expectation (Fundamental) obligations

According to Kano's model, the fulfillment of the fundamental needs only prevents customers' unsatisfactory and does not have any influence on customers' unsatisfactory.

3.1.2. Functional obligations

The second group of quality characteristics is associated with functional needs about products. If functional needs are not met, customers may not be satisfied. It is always important to recognize this kind of needs which is the minimum effort which could be done.

3.1.3. Exciting obligations

It is normally difficult to discover and determine the obligations since these are not easy achieve.

3.1.4. The Kano structure

There is asimple and comprehensive method to present Kano's model which is shown in Table 1. As we can observe from Table 1, there are some questions associated with Kano's model to be analyzed.

Table 1

Assessment the results of customers needs

	Customers needs	very positive effect	positive effect	without effect	negative effect	very negative effect
Suitable	very positive effect	Q	A	A	A	Q
	positive effect	R	I	I	I	M
	without effect	R	I	I	I	M
	negative effect	R	I	I	I	M
	very negative effect	R	R	R	R	Q

(Unsuitable) R: Reversed Q: dubitable I: insignificance M: obligation A: Absorb O: one-dimentional

3.2. Fuzzy AHP

There are many cases where we have more than one qualitative criterion for decision-making. In such a case, we may use multiple criteria decision making (MCDM) methods such as AHP to reach a fair final decision. There are literally different versions of AHP methods and the one we use is based on fuzzy concept. In AHP, we perform pairwise comparison among different criteria and in fuzzy AHP we use linguistic verbs to perform the comparison. Although, Fuzzy AHP (FAHP) needs heavy computational process, but it is more systematic than other MCDM methods. FAHP handles paired compare of indicators and standards, vague and clearness of human's assessments. An ordinary AHP normally gathers pairwise comparison for different alternatives based on various criteria and based on two-stage normalization processes determines the ranking of the alternatives with respect to each criterion. Similar procedure is also repeated for all criteria in the second step and the overall ranking of different alternatives found in the first step is established based on the weights found from the second step. Lee et al. (2010) used triangular fuzzy numbers in forms of the linguistic numbers for ranking procedure. The details of the computations can be found in Lee et al. (2010) and is not repeated in this paper. Table 2 summarizes the triangular fuzzy numbers used for the proposed model of this paper (Lee et al., 2010).

Table 2

Triangular fuzzy numbers

Linguistics variables	The same	Low	High	Very high	Completely higher
Triangular fuzzy number	(1,1,1)	(2.3, 1, 3.2)	(3.2, 2, 5.2)	(5.2, 3, 7.2)	(7.2, 4, 9.2)

3.3. Method of research

There are different stages for the proposed model of this paper. In the first stage, we interviewed some experts to find the most important issues affecting customer satisfaction. In this stage, we also interviewed passengers who filed complaint with different transportation organizations as a necessary feedback for preparing the necessary questions. The final questionnaire has included 37 questions about passenger's needs quality of services on road transportation. The questions of this questionnaire have been divided into three groups of necessary, attractive and functional using the Kano table. Next, we have used FAHP to prioritize different alternatives. The proposed model of this paper was applied for two paths located in east and north parts of the country. The first trip was between Tehran to Mashad and the second trip was from Tehran to Rasht. We distributed 377 questionnaire for the first trip and 599 questionnaire for the second trip. We have used the following sampling procedure to find out where the number of questionnaire is sufficient or not.

$$n = \frac{N \times z_{\alpha/2}^2 \times p \times q}{\varepsilon^2 \times (N - 1) + z_{\alpha/2}^2 \times p \times q}, \quad (1)$$

where N is the population size, $p = 1 - q$ represents the yes/no categories, $z_{\alpha/2}$ is CDF of normal distribution and finally ε is the error term. Since we have $p = 0.5$, $z_{\alpha/2} = 1.96$ and $\varepsilon = 0.004$. The results confirm that the number of questionnaire is sufficient for our survey.

Table 3

Personal characteristics of the people participating in the survey

	< 20	20-30	31-40	41-50	>50
Age(Years)	86	415	261	162	24
Educational background(Years)	<12	14	16	18	
	125	117	568	96	
Travel purpose	Pilgrim	Tour	Work	Study	
	293	175	44	412	
Occupation	Public sector	Private sector	University student	House keeper	Others
	198	161	397	91	77

In order to use the filled questionnaire we carefully check to see whether all questions have been responded, properly and eliminated the incomplete ones. Out of 926 questionnaire used for statistical analysis there were 513 men and 411 women. Table 3 demonstrates other characteristics of the people who participate in our survey. As we explained earlier, there three criteria of attractive, one-dimensional and obligation needs. We gathered various factors for each criteria and using a FAHP ranked these factors. Table 4 summarizes the results of the implementation of FAHP for three major criteria.

Table 4
FAHP results for major criteria

	Obligation needs	One – dimensional	attractive	W_{FAHP}
Obligation needs	(1,1,1)	(1.3 ,1.6,2)	(2.7 ,3.2 ,3.7)	0.543
One – dimensional	(0.62,0.77,1.02)	(1,1,1)	(2.1, 2.6, 3.1)	0.321
attractive	(0.3 ,0.33, 0.42)	(0.34, 0.4 ,0.52)	(1,1,1)	0.136

The consistency ratio for the information given in Table 4 is about 0.04, which confirms the results of our survey at this level. There are different factors for each criteria compared with FAHP method. Tables 5 to 7 summarize the results of our survey.

Table 6
The implementation of FAHP for obligation criterion

Rank	Index	W_{FAHP}
1	Physical and mental health of driver and driver-mate	0.16
2	Comfortable chairs in transportation busses	0.16
3	A good guidance from driver	0.143
4	Well equipped air-conditioned facilities	0.114
5	Best maintenance of instrument and things	0.101
6	Equipped with Immune facilities	0.092
7	Clean buss environment	0.087
8	Good information about the available space of movement	0.05
9	Having Hygienic places and clear lines of service places between ways	0.039
10	Cleanliness of hygiene services on passenger service terminal	0.023
11	Cleanliness of terminal place for passengers	0.023
12	Well equipped air-conditioned facilities inside the terminal busses	0.008

The consistency ration of the implementation of FAHP for obligation criterion is calculated to be 0.066, which is an acceptable number. As we can observe from Table 6, physical and mental health of driver and driver-mate along with comfortable chairs play the most important role on this criterion.

Table 7
The implementation of FAHP for one dimension criterion

Rank	One-dimension criterion	W_{FAHP}
1	The availability of GPS and other high tech facilities	0.16
2	Punctuality and on time schedule	0.129
3	Existence of cold and hot water in the bus	0.117
4	Behavior of ticket sellers and terminal workers	0.086
5	Suitable behavior of driver-mat	0.073
6	The availability of reception for passengers inside the buses	0.067
7	Giving newspaper and magazine inside the bus	0.065
8	Welfare facilities inside the terminal (Hand wheeled, public telephone, etc)	0.06
9	Well-dressed driver and driver-mate with good uniform and clean clothes	0.059
10	Collecting intermediates for sale ticket	0.055
11	Fixed price for bus ticket	0.044
12	The availability of show case movies inside the buses	0.044
13	Good quality of food services	0.041

The consistency ratio for the results of Table 7 is .09, which is on the acceptance level and the main feature, which is considered as the most important issue is the equipments of the buss such as GPS facilities. Finally, Table 8 shows the details of the FAHP implementation for attractive needs.

Table 8

The implementation of FAHP for attractive needs criterion

Rank	One-dimension criterion	W_{FAHP}
1	Basic knowledge with first aid assistance and medical care	0.14
2	The availability of internet or phone service to purchase ticket	0.12
3	Using Headphone to hearing film and music sound	0.11
4	Increase the number of services and welfare building between ways	0.098
5	The availability of a bus to physician, nurse or medical cares	0.097
6	The availability of a place for injured people	0.09
7	Having a hostess in bus	0.084
8	The availability of a SMS service to make complaints on the bus services	0.08
9	Good quality of sitting chairs inside the terminals	0.073
10	The possibility of increasing capacity of Tehran trip	0.049
11	The availability of special services on terminal and inside the terminal	0.034
12	Equipped buses with communicational facilities (card phone, fax, etc ...)	0.025

Note that the consistency ratio for the implementation of FAHP is calculated as 0.09, which indicates that the results are acceptable. As we can observe from the table customers prefer to go to trip with those drivers with some basic knowledge of first aid assistance. The relative importance of each criterion given in Table 6, 7 and 8 are combined using the relative importance of each major criterion given in Table 5 and they are summarized in Table 9.

Table 9

The overall priorities for sub- indicators of road transportation services among special buses based on (FAHP)

Rank	Title	W_{FAHP}
1	Physical and mental health of driver and driver-mate	0.087
2	A good guidance from driver	0.078
3	Comfortable chairs in transportation busses	0.087
4	Well equipped air-conditioned facilities	0.062
5	Equipped with Immune facilities	0.05
6	Best maintenance of instrument and things	0.051
7	Clean buss environment	0.047
8	The availability of GPS and other high tech facilities	0.055
9	Punctuality on time schedule	0.042
10	Existence of cold and hot water in the bus	0.038
11	Good information about the available space of movement	0.027
12	Behavior of ticket sellers and terminal workers.	0.028
13	Having Hygienic places and clear lines of service places between ways	0.021
14	The availability of reception for passengers inside the buses	0.022
15	Giving newspaper and magazine inside the bus	0.021
16	Suitable behavior of driver-mat	0.023
17	Well-dressed driver and driver-mate with good uniform and clean clothes	0.019
18	Cleanliness of terminal place for passengers	0.0125
19	Welfare facilities inside the terminal (Hand wheeled public telephone and ...)	0.019
20	Cleanliness of hygiene services on passenger service terminal	0.0125
21	exclusion intermediates for sale ticket	0.018
22	Familiarity with assistance periods and first aids among drivers and drivers-mat	0.019
23	The availability of show case movies inside the busses	0.014
24	Fixed price for bus ticket	0.014
25	Good quality of food services	0.013
26	The availability of internet or phone service to purchase ticket	0.016
27	Increase the number of services and welfare building between ways	0.013
28	The availability of a bus to physician, nurse or medical cares	0.013
29	Using Headphone to hearing film and music sound	0.015
30	Collecting intermediates for sale ticket	0.004
31	The availability of a place for injured people	0.012
32	The availability of a SMS service to make complaints on the bus services	0.011
33	Having a hostess in bus	0.011
34	Good quality of sitting chairs inside the terminals	0.01
35	The possibility of increasing capacity of Tehran trip	0.007
36	The possibility of increasing capacity of Tehran trip	0.005
37	Equipped buses with communicational facilities (card phone, fax and ...)	0.003
Total		1

As we can observe from Table 9, six factors play important roles on customer satisfaction. The first and the most important factor is physical and mental health of driver and driver-mate followed by a good guidance from driver and comfortable chairs in transportation busses. In addition, the availability of a well equipped air-conditioned facilities and the immune facilities as well as good maintenance of the equipment and clean buss facilities are important factors for customer satisfaction. The customers tend to believe that drivers could use high technology facilities such as GPS to reach their destinations.

There are some evidences that many bus or truck drivers used to be addicted to drugs. On the other hand, there are many incidents in Iran that bus driver faced with fatal accidents solely because the bus driver was suffering from drug usage side effects. Therefore, the customers who participated in our survey were very much concerned on having a trip with drivers with good health condition and no history of drug usage. The people who took part in our survey were willing to have a comfortable trip and a good sitting chair with good air-condition facilities could help, significantly having a pleasant trip.

The other important factor in recent bus accidents is violating transportation laws and feeling sleepy. Although the results of this survey do not explicitly show this fact but there are many statistics to confirm that government's officials must provide restaurants and other places such that drivers would be able to rest.

4. Conclusion

In this paper, we have presented an empirical survey to study the most important issues affecting customer satisfaction. The proposed model of this paper used a combination of Kano method and fuzzy analytical hierarchy process. In our survey, Kano method was used to find the most important criteria for customer satisfaction and fuzzy AHP was implemented to rank the criteria. The results of our survey indicated that customers were very much concerned for drivers with good health conditions. The customers who participated in our survey preferred to use the buses with good quality facilities such as flexible sitting chair, air-conditioned equipments, etc.

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