OPTIMIZATION AND REAL LIFE APPLICATIONS - II

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SESSION ABSTRACT

Real life problems usually include multi criteria factors. These factors need to be analyzed by systematic and trustworthy methods. The parameters of multi criteria optimization problems also should be estimated carefully. Because their values directly affect the performance and the validity of the models and their outcome. This session invites presentations in this context.

Keywords: Optimization, AHP, ANP.

AN AHP MODEL BASED SUPPLY CHAIN NETWORK DESIGN

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ABSTRACT

In this study we consider multi objective supply chain network design problem for a real life case. In order to evaluate each candidate distribution center an AHP model is developed. By this model different tangible and intangible criteria can be incorporated. Then a mathematical model which uses selected candidate solutions according to a threshold value is developed and solved.

Keywords: AHP, supply chain network design.

1. Introduction

A firm's supply chain allows it to move product from the source to the final point of consumption. Leading firms around the world, from large retailers to high-tech electronics manufacturers, have learned to use their supply chain as a strategic weapon. The number and locations of these facilities is a critical factor in the success of any supply chain (Watson et al., 2012). Since network design problems involve strategic decisions, it is directly affects tactical and operational decisions of a firm. In this study we consider multi objective domestic distribution network design problem for a leading firm produces building products. An analytic hierarchy process (AHP) model is developed to take into account both qualitative and quantitative factors related to facilities on the distribution network.

2. Literature Review

Watson et al. (2012) is explained different aspects of supply chain network design in their recent book. This book is mainly focused on the practitioners with real life case studies and their applications on computer software it has very valuable information about the mathematical models for supply chain network design problems. Ambrosino, and Scutell, (2005) consider distribution network design problems which involve facility location, transportation and inventory decisions. Varthanan et al. (2012) proposed simulation based discrete particle swarm optimization algorithm production-distribution problems with stochastic demand. The authors also proposed an AHP based particle swarm optimization algorithm (Varthanan et al., 2013) for the same problem under the different assumptions. Sharma et al. (2008), solved network design problem with AHP methodology by considering a set of performance metrics and product characteristics. Ho and Emrouznejad (2009), taken into account the distribution network design using an integrated multiple criteria decision making approach. They combined AHP and goal programming methods.

3. Objectives

The aim of this study is to develop a solution methodology for supply chain network design problem by considering both qualitative and quantitative data about the facilities on the network.

4. Research Design/Methodology

We propose an AHP model to calculate the importance of the facilities on the network and select the locations of the facilities by using mathematical model with the weights getting from the outcome of this AHP model.

5. Data/Model Analysis

In order to evaluate the candidate locations of the facilities (warehouses or distribution centers) an AHP model is developed. Candidate locations are ranked with the resulting weights of AHP model. According to a threshold value and the preferences of the decision maker, mathematical model determines the location of the facilities by considering two objectives. First one of these objectives is about the service level and it is defined as maximization of demand within a distance band and the other objective is Minimization of total weighted distance. The mathematical model is taken from the study of Watson et al. (2013) with simple modifications and it is given as follows.

$$\min -w_1 \sum_{i\in I}\sum_{j\in J}\left(dist_{ij} > highServiceDist?\,0:1\right)d_j y_{ij} + w_2 \sum_{i\in I}\sum_{j\in J} dist_{ij} d_j y_{ij}$$

Subject to

$$y_{ij} \le \left(dist_{i,j} > MaximumDist?\,0:1\right); \forall i \in I, \forall j \in J$$

$$\sum_{i\in I} y_{ij} = 1; \forall j \in J$$

$$\sum_{i\in I} x_i = P$$

$$x_i = \begin{cases} 1 & \text{if } i\text{th location is used for warehouse} \\ 0 & \text{otherwise} \end{cases}$$

$$y_{ij} = \begin{cases} 1 & \text{if the } i\text{th facility will service } j\text{th customer} \\ 0 & \text{otherwise} \end{cases}$$

In this model two objectives are incorporated by using weighted sum scalarization. First objective is multiplied by minus to ensure that the objective is converted to the minimization one.

6. Limitations

To get the data about the whole candidate locations is not easy task. Precision of some data may not be sufficient analysis.

7. Conclusions

In this study, the supply chain network design problem is considered. A combined approach based on AHP and mathematical model with two objectives is proposed and implemented with GAMS program. Pareto optimal solutions getting from the mathematical model is reported.

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A TWO STEP MCDM METHODOLOGY TO MAKE EFFECTIVE SUPPLIER SELECTION AND AN EXAMPLE

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ABSTRACT

Choosing the best supplier is one of the most important subjects for a company to take care about and one of the most challenging decisions to make. In this study, the proposed methodology aims to make this important decision effectively. The methodology consists of two steps. Simply, it is possible to say that the first step is to determine criteria weights and the second step is to choose one of the suppliers according to criteria.
Buckley's Fuzzy AHP algorithm is a good candidate for the cases where the collected information is not certain but it is fuzzy. It is easier than other fuzzy AHP algorithms and it generally gives more accurate results than classical AHP model gives since its boundaries are more flexible. For all these reasons, in the first step, the criteria weights are determined by using Buckley's Fuzzy AHP algorithm. After determining the criteria weights the first step is concluded. In the second step, Promethee algorithm is used to choose the best supplier. All the suppliers are evaluated for each criterion and finally one or a few of them is chosen. The methodology is also supported with an example so as to explain the application process clearly.
This methodology provides the opportunity of objective and quantitative evaluation during all the process from the beginning (determining the criteria weights) to the end (choosing the best supplier). This important aspect makes this methodology differ from the other research in this subject.

Keywords: Promethee, Buckley's Fuzzy AHP, supplier selection.

9. Introduction

Choosing the right suppliers is not an easy problem for lots of company. In spite of the fact that they can achieve solving this problem by determining the suppliers according to their experiences and knowledge, a general rule and a quantitative method is not used widely. My study proposes a methodology which can be used by all the firms. It is easy to use and it provides objective results because it uses quantitative data from the beginning to the end.

10. Literature Review

We do not expect an exhaustive literature review here. However, the reader would like to know which are the 3 to 5 key articles that have informed your study and also your conclusion of what we know (or don't) about the topic and how this study will fill in that gap.

Especially in recent years, there are an increasing interest on this topic. Lots of researchers try to solve this problem by using various method including MCDM methods, optimization techniques, fuzzy approaches and mixed methods as well. Kilincci and Onal's study (2011) can be shown as an example to the fuzzy approaches. They used a Fuzzy AHP approach for supplier selection in a washing machine company. Bruno and his friends (2012) used AHP-based approaches for supplier evaluation. To give an example to the mixed techniques Shaw and his friends study (2012) can be shown. They used fuzzy AHP and fuzzy multi-objective linear programming for supplier selection.

All these studies (and even more) are used as a starting point for this study. By using them I determine the criteria and I have a general idea about the effectiveness of various methods. This study includes two step, and two different MCDM methods are used. The first method is used to determine the criteria weight and the second one is used to choose the suppliers. As a result, not any subjective evaluation is made during any phase. This is what makes this study different from the other and provide the maximum accuracy.

11. Hypotheses/Objectives

By using the proposed methodology it will become possible to choose the best supplier/suppliers according to quantitative data.

12. Research Design/Methodology

As I shortly mentioned in the abstract, during the first step I used Buckley's Fuzzy AHP algorithm. In order to determine the criteria and their weights I used two way. First, I reviewed the literature and in addition to that I have made interviews and applied surveys to 15 supply chain specialists. (7 of them were managers who have experience more than 15 years.) My procedure about consistency is that If there is a consistency problem in a survey I ask the person to take the survey again. During second try, if there is again an inconsistency, I will put that person's survey out of evaluation. However I did not see a consistency problem in a survey. I aggregated most of the surveys with same weights, however, I gave 1,5 weight to the survey of managers who has more than 15 years of experiences. During the second step I used the Promethee algorithm to choose the best supplier. Because, Promethee is an effecting algorithm for choosing one alternative.

13. Data/Model Analysis

Here is a sample matrix.

Sample Matrix
Cost (C)
Product Quality (PQ)
Technical Capacity (TC)
Delivery Time (DT)
Geographic Location (GL)

	C	PQ	TC	DT	GL
C	0,34	0,32	0,38	0,34	0,33
PQ	0,34	0,32	0,29	0,34	0,27
TC	0,08	0,11	0,10	0,09	0,13
DT	0,17	0,16	0,19	0,17	0,20
GL	0,07	0,08	0,05	0,06	0,07

W	D	D/W	Lambda
0,34	1,738	5,051	5,032
0,31	1,573	5,045	CI
0,10	0,508	5,013	0,008
0,18	0,901	5,041	CR
0,06	0,32	5,008	0,007

As it seems from the last table, the CR (consistency rate) is 0,007 (<0,01) therefore it is possible to say that the matrix does not have any consistency problem.

This table shows us the criteria weights, as it seems cost is the most important factor, quality and delivery time is the second and third one. The least important factor here is geographic location.

14. Limitations

Of course this study has also some weaknesses. First of all, putting all the factors into account is impossible. I have made a wide research and I put all the important factors into account but it is certain that there are some other factors which effect this process. Maybe I could put all of them together and I could call them as ”other factors”. However this could cause lots of problems. For example it become much more complex for experts to compare the factors (like cost) with “other factors”. This could even affect the general accuracy of this model. In fact the “other factors” cannot have an important effect to the process, its effect cannot be more then %5. For this reason putting it out of consideration does not change the general accuracy of model, but if we want to have an exact model, it is necessary to put all the factors into account.

15. Conclusions

As a result of this study, we see that factors like cost, product quality, economic stability and sectorial knowledge are the most important factors. However if we want to make an effective selection we must use all the factors with their weights during the second step. According to the example in spite of the fact the cost of working with supplier A or supplier C is lesser than the cost of working with supplier B, supplier B is selected in the end. This means that the companies should not choose the supplier only according to low cost. Sometimes they must choose other suppliers even if the cost is more. It is actually about seeing the big picture. For most of the companies cost is even the only factor and this makes them unsuccessful. Beside the cost, there are a few important factors and by using this methodology they can easily be able to make quantitative and accurate decisions.

As I said in the beginning, it is possible to continue the analysis. Here, after choosing the supplier we have some new questions like what is the optimum lot size and/or what is the optimum inventory level. To answer this question, it is necessary to create a model by using the criteria weights as model parameters. Finally we have the opportunity to determine the optimum inventory level and lot sizes.

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A REAL LIFE MULTI OBJECTIVE COURSE TIMETABLING MODEL WITH ANP AND CONIC SCALARIZATIONPROCESS

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ABSTRACT

Course timetabling problem consists of assigning a number of courses to a certain number of rooms and timeslots with several constraints and objectives. Main objective of course timetabling problem consists of assigning the courses to the rooms and timeslots with hard constraints like capacity of rooms and non-allowed overlapping courses. Furthermore, avoiding in the timetable of a student not to have more than two consecutive courses and not to have only one course in a day are the soft constraints of the model. Soft constraints are added to model as objectives with minimizing the number of violation of these constraints. With this adaptation, the mathematical model changes as a multi objective structure.

Different weights of these objectives are defined with a developed ANP model. These weights are used in Conic Scalarization method to get scalarized problem. The scalarized problem is solved with an optimization tool and results are discussed. The ANP model developed here can also provide a general framework to investigate the course timetabling system in a systematic way.

Keywords: Conic scalarization, course timetabling, multiobjective decision making, ANP.

1. Introduction

Scheduling exams and courses are the main problems faced by academic institutions at least once in a semester. There has been a great attention on solving these educational timetabling problems since 1960's according to their complexities and different types. In the field of educational timetabling, the problem is classified into two main problems as course timetabling and exam timetabling. The problems in such systems may vary from assigning courses to instructors, time slots and/or rooms to assigning examinations to time slots, rooms and invigilators. When these problems are modeled by considering all their components, the size increases drastically. Besides, mostly conflicting constraints and objectives make the problem difficult to find even a feasible solution.

The course scheduling problem is a major administrative activity for all academic institutions that assigns courses to rooms and timeslots. The solution affects all students, faculties and administrators. The issue of taking preferences (like time and place) of these people transforms the problem to a multiobjective decision problem. To prioritize the preferences and transform the model to a single objective one we need a multicriteria technique. So, in this study we develop a mathematical model and take some of its parameters from an ANP model to obtain a feasible schedule. The outcome of the study can be used in different ways to facilitate the course scheduling process. As well as prioritizing the objectives we also obtain the priorities of all the factors defined for this problem.

17. Literature Review

The course scheduling problem is a complex combinatorial problem. In the literature there are so many researches related to educational timetabling. A review about automated timetabling problems is given by Burke and Petrovic (2002). This paper suggests a number of approaches and emphasizes three points: recent heuristics and evolutionary timetabling algorithms, multicriteria decision making, and cased-based reasoning approach. Sagir and Ozturk (2010) solve an invigilator-examination assignment problem by obtaining parameters from an ANP model. Ismayilova and etal. (2007) studied a faculty-course-time slot assignment problem. The multiobjective 0-1 linear programming model considering both the administration's and instructors' preferences is developed and a demonstrative example is included.

18. Objectives of the study

As Ismayilova and etal. (2007) show, both modeling and solving scheduling problems considering preferences are difficult tasks due to the size, the varied nature, and conflicting objectives of the problems. The difficulty increases because the individuals involved in the problem may have different preferences related to the instructors, courses and timeslots. It's important to obtain criteria weights of a course scheduling system in a more realistic way having considered all the dependencies and feedback among the criteria. By using the ANP we have a better way to represent the real dynamics of the problem. Also the decision model of the scheduling problem has a multi objective structure, we can weigh the objectives with ANP model and in the solution process we can scalarize the problem. Course scheduling problem is a problem that has to be solved in every educational term. In general the user preferences are not considered and it's solved by considering only the hard constraints.

19. Research Design/Methodology

In this study, an ANP model is developed to handle course scheduling system in a systematic way and also weigh defined criteria. The outcome of the study is going to be used as the input to the solution process of the multi objective course scheduling problem. Both the qualitative and quantitative parameters and the objectives of the problem are weighted by using the ANP. In the next step of the study, a multi objective linear decision model is developed by using weights gathered from the ANP model and we obtain optimal solution with this model.

20. Data/Model Analysis

In this study, we consider the course-room-time assignment problem studied within the Metaheuristics Network and the problem instances defined by Ben Paechter. In this problem two types of constraints as hard and soft are defined. Hard constraints are listed as follows:

1. No student should be assigned to more than one event at a timeslot.
2. The room assigned to an event should have sufficient capacity and all the features required by that event.
3. At most one event can be scheduled in one room at a timeslot.

Besides, to improve the solution quality and the overall performance of the educational system, three soft constraints are imposed as listed below. These constraints are preferred to be satisfied as much as possible.

1. A student is not preferred to have a class in the last time slot of a day.
2. A student is not preferred to have more than two consecutive classes in a day.
3. A student is not preferred to have only a single class on a day.

The quality of timetable is measured by penalizing each violation of the soft constraints where each violation will be penalized by '1' for each student who involves in this situation.

If d_1 is the number of occurrences students has a course in the last time slot of days; d_2 is the number of occurrences students has more than two consecutive courses for all days and d_3 is the number of occurrences students has only a single course on a day than the objective function of the course scheduling (course-room-timeslot assignment) problem can be given as follows:

$$\text{Minimize } z = d_1 + d_2 + d_3$$

The ANP model given in Figure 1 is developed to weigh the three objectives (d_1, d_2 and d_3) of the course scheduling problem. The objectives are the three alternatives of the model. The main criteria are defined as course, course duration, course time, course day, faculty, administration and students.

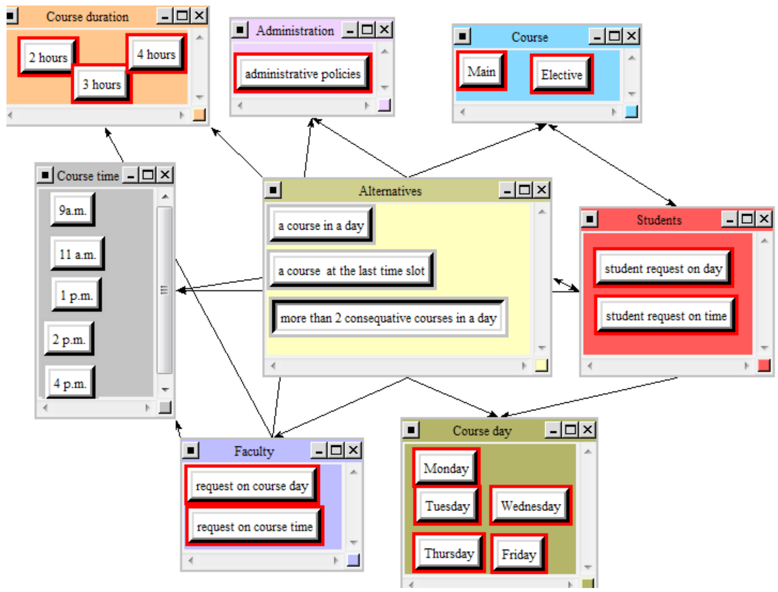

Figure 1 The ANP Model

Scalarization means combining different objectives into a single objective in such a way that repeatedly solving the single objective optimization problem with varying parameters allows us to find all efficient (or properly efficient) solutions of the initial multiobjective problem.

In this study, conic scalarization approach proposed by Gasimov (2001) is used for scalarization. . Gasimov introduced a class of increasing convex functions to scalarize the multiobjective problem without any assumptions on objectives and constraints of the problem under consideration. This approach is based on supporting the image set of the problem by using cones instead of hyperplanes used in the weighted scalarization. Another advantage of this approach is that it preserves convexity, if the objective functions and constraints of the initial problem are linear or convex.

21. Limitations

The paired comparisons of ANP model are performed by administrators, faculties and students of Industrial Engineering Department of Anadolu University. The problem instances considered here are classified in three groups as small, medium and large. We obtain optimum solution for the small type problems. However, when the problem dimension gets bigger the optimal solution can not be reached. For further studies heuristic/metaheuristic approaches can be used for large type problems and the diversity of users can be expanded.

22. Conclusions

In this study, the multiobjective course scheduling problem is solved by scalarizing the objective function of the problem model. To scalarize the function we need weighs of the individual objectives. In that point, the ANP model gives that weights. The ANP model also gives a chance to investigate a course scheduling system in a systematic way and helps administrators to determine new policies for scheduling.

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24. Appendices

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MULTICRITERIA DECISION MAKING FOR CUSTOMER SATISFACTION IN WAREHOUSE MANAGEMENT

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ABSTRACT

In the rapid changing and developing market, the aim of the service systems is improving the customer satisfaction by offering the best service. Thus, to reach this aim, the consumer services that supply replacement part support of the production companies must attach importance to the warehouse management. In this study, four objectives are determined to improve warehouse management performance as maximization of satisfying ratio, maximization of circulation ratio, maximization of efficiency ratio and minimization of satisfying duration.
Under these objectives a multiobjective linear mathematical model is developed. In the second part of the study, a warehouse management system for replacement parts is systematically investigated by an AHP model that considering both tangible and intangible criteria. There are lots of criteria that effect the replacement part management in the warehouse. With the AHP model all the relative weights of the criteria are obtained and also some of these weights are used to prioritize the objectives of the warehouse inventory model. By using these weights of the determined objectives, the multiobjective function is transformed to a scalar function. Then the previously developed optimization model is solved with several constraints using these weights.

Keywords: Warehouse management, scalarization, AHP.

1. Introduction

An effective inventory management is very crucial for consumer services to increase their customer satisfaction. So, spare parts management becomes an important area of inventory management. Mathematical models are usually aimed at optimizing the problem of inventory investment and service levels. However, as in many real-life problems, spare parts management has a multi objective structure. In this study, first of all, an AHP model is developed to prioritize the parameters of a multi objective spare parts inventory problem. Then, relative weights are obtained for the elements in the AHP model. Finally, we solve a multi objective optimization model using these weights.

1. Literature Review

Mathematical models are important tools for optimization problems. The quality of the solution of such a model depends strongly on the estimated values of the parameters of the problem. There are some AHP and optimization integrated inventory optimization studies in the literature. Ramanathan (2006) propose a weighted linear optimization model and illustrate in this study for classifying inventory items in the presence of multiple criteria by using AHP. Cakir and Canbolat (2008) propose an inventory classification system based on the fuzzy analytic hierarchy process (AHP), a commonly used tool for multicriteria decision making problems. They integrate fuzzy concepts with real inventory data and design a decision support system assisting a sensible multi-criteria inventory classification. Besides these studies, Sagir and Ozturk (2010) gives an example about how to solve a scheduling problem after estimating its parameters by using an ANP model.

2. Objectives of the Study

The main objective of this study is to develop a multi objective decision model for spare part inventory management. All of the objectives of the model do not have the same priorities. We need weights of the objectives to obtain a scalar objective function of the mathematical model. According to this necessity and also to investigate a real spare part inventory management system in a systematic way we developed an AHP model.

3. Research Design/Methodology

In this study, the AHP model is developed based on the spare part inventory literature and a group of experts from a consumer service department. The AHP model is presented for estimation of the parameters of spare part inventory problem. For this purpose, the judgments of five experts are synthesized by using geometric mean approach. The outcome of the study is going to be used as the input to the solution process of the multi objective decision problem. Both the qualitative and quantitative parameters and the objectives of the problem are weighted by using the AHP. After gathering the parameters from AHP model, a multi objective linear decision model is developed and we obtain optimal solution with this model.

4. Data/Model Analysis

The decision model developed for the inventory problem is given below, where the positive decision variable x_j is the number of spare parts coming from production to inventory and y_j is the number of spare parts send to customers.

$$\max z = 0{,}521 \sum_{j}^{765} y_i + 0{,}479 \sum_{j=1}^{765} y_j - 0{,}15x_j - k_j - x_j$$

s.t

$$\left((0{,}15)x_j + k_j + x_j\right) - a_j \geq 0, \qquad \forall j \qquad (2)$$

$$\sum_{j=1}^{765} d_j \left(x_j + (0{,}15)x_j + k_j - xy_j\right) \leq \sum_{j=1}^{765} b_j, \qquad \forall j \qquad (3)$$

$$0 \leq y_j \leq a_j, \qquad \forall j \qquad (4)$$

$$\sum_{j=1}^{n} \sum_{i=1}^{m} c_i y_j \leq N \qquad (5)$$

$$x_j, y_j > 0 \quad \text{and integer} \qquad \forall j \qquad (6)$$

With constraint (2) it's provided that parts coming from production, inventory from last term and buffer stock meet the demand for each part. It's provided that the cost of inventory after sending the demand is less than for the inventory holding cost by constraint (3). With constraint (4), the demand of each part cannot be less than number of send parts. And the shipping cost cannot be more than the money determined for shipping with constraint (5). The parameters of the decision model like 0.521, 0.479 and 0.12 are obtained from the AHP model.

The main criteria are *duration*, *ratio*, *cost*, *criticality*, *differences* and *unmeasured* as given in Figure 1. The objective function of the model tries to maximize *satisfying ratio*, *circulation ratio*, *efficiency ratio* and minimize *satisfying duration*. To handle all of these performance measurements in a scalar function the weights are obtained from the AHP model. All the pairwise comparisons are consistent.

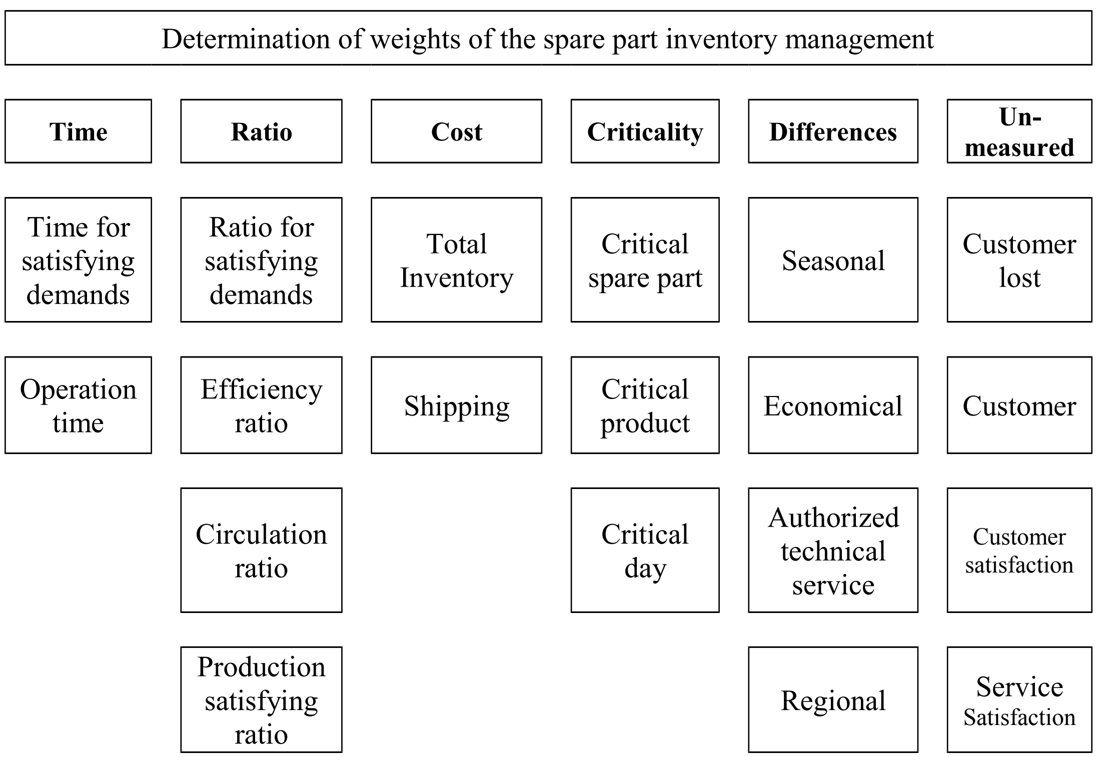

Fig. 1. The AHP model

To obtain the scalar objective function, the weights of the related criteria obtained from AHP are used. According to the mathematical model's solution, the ratio for satisfying demands is obtained as 100% and the circulation ratio becomes 97.7%.

5. Limitations

In this study, a real life consumer service inventory problem is considered. It's a hard work to determine the objectives and also their priorities. To handle this, different opinions and judgments are taken from a group of experts.

6. Conclusions

As a conclusion, in this study a mixed method integrating optimization and AHP is proposed. Real life problems generally have multi objective/criteria structure. By using AHP, the proposed decision model has a more realistic structure. With the application in a real firm, optimum solution is obtained.

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9. Appendices

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