The role of the analytic hierarchy process (AHP) algorithm in health care services

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Abstract. Improvement in quality health care has now become a must that both developed and developing countries work on improving their health care system, especially in midwifery emergencies, using information systems. UNICEF has developed a midwifery referral system with its program known as Expanding Maternal and Newborn Survival to speed up the referring process. AHP is one of the information system procedures that support decision making to speed up the determination of health care facilities. This research discusses some journal articles by conducting a detailed analysis of their preliminary studies, research objectives, achievement indicators, variables, and methods used. It is expected that readers can briefly learn some benefits of AHP in health care. This research employed the PRISMA protocol guidelines. Chosen journal articles are full papers published in reputable journals. Inclusion and exclusion criteria were also implemented in choosing proper journal articles for this systematic literature review. It is found that the implementation of AHP in any type of health care service has proven to be very effective. It is expected that this literature review can serve as a reference for the implementation of AHP in health care based on practice evidence.

1. Introduction

Nowadays, patients expect easier access to be able to choose health care facilities in which they wish to have health care services. Many advanced countries have employed information systems to provide early screening services and suggestions for proper health care facilities that patients need according to their health conditions [1]. This policy certainly has a reciprocal effect as a nation’s wealth is also defined by the health of its population. It is only true as one of the indicators of community health is low maternal and infant mortality rate. In line with this, the World Health Organization (WHO) has set achievement targets for 2016-2020 to be higher than the 2011-2015 standard [2, 3]. Most countries welcome this measure by implementing strategies and efforts to lower maternal and infant mortality rates. This research studies one of the strategies to lower maternal and infant mortality rates by using information systems in health care services [4].

Each unit of health care services has to be very competitive. The 4.0 era demands proper use of information technology to health easy, speed up, and extend the coverage areas of health care services [5]. The information system has not only been implemented in health care services, especially in midwifery care, by developed countries. Developing nations like China, Thailand and some other Asian
countries have also made use of this system [3, 6, 7]. The are many machine learning systems that can be employed in midwifery care, and one of them is an Artificial Intelligence System using the method of Analytical Hierarchy Process (AHP) [8]. The AHP method is often used by health care professionals in providing easier health care for their patients [9, 10]. Some research conducted in 2018 found that AHP can help make effective decision making in health care services [11].

2. Method
This research analyzes some research on health care services and how issues are solved using Artificial Intelligence with the AHP method. The journal articles selected for systematic analysis are shown in Figure 1. The methods employed in line with the purpose and specific questions to be answered in this systematic literature review are as follows:

2.1. Research method
This is research reviewing theories on AHP in health care services using the PRISMA Protocol Guidelines. Journal articles included in this review are those issued over the past 10 years. Earlier in the research, 1194 journal articles were found using AHP as a keyword. They were then further screened using both inclusion and exclusion criteria and 10 journal articles were found to be of the perfect match for analysis of AHP in health care services.

2.2. Operational definition
This research studies AHP implementation in health care services to figure out what health care services can AHP help to improve.

2.3. Research question
Specific questions set for this systematic literature review of the use of artificial intelligence using AHP method in health care services are:

1) What AHP Artificial Intelligence information systems are used in health care services?
2) What AHP Artificial Intelligence information systems can be the solution for issues in health care services?
3) What do AHP Artificial Intelligence information systems serve as an aid in decision making in health care services?

2.4. Criteria
AHP is the variable of this systematic literature review. The inclusion criterion is the implementation of the AHP information system in making decisions in health care services. Journals published over the past ten years. The exclusion criteria are the implementation of the AHP information system outside health care services and non-full paper journals.

2.5. Results
Results reveal all kinds of AHP implementations to improve health care services. Initially, there were 1250 journal articles found from all sources using the keywords of the information systems and health care services. They were then further refined using more specific keywords and further categorization of full paper non-duplicative journal articles. The results are ten journals for this systematic literature review consisting of three journals on AHP in health care services, three journal articles on the use of AHP health care services mapping, and four journals on the use of AHP in health care decision making.
3. Results and discussion

This research is aimed at gathering information on relevant research that proves the efficacy of the Analytic Hierarchy Process (AHP) in health care services. Results from this may serve as a reference for further research on the use of AHP in improving health care services and/or solving issues related to it. There are 10 journal articles that are found to have proven the efficacy of AHP in solving issues in health care services and helping with decision making. Classifications of efficacy in implementing AHP in detail are as follows:

3.1 Application of Analytic Hierarchy Process (AHP) to help ease health care services

The research entitled Use of the Analytic Hierarchy Process for Medication Decision-Making in Type 2 Diabetes uses AHP to analyze and help decision making for medication to be performed on patients. This research, which is conducted in the US, employed AHP to help ease health care services for diabetic patients both for medication and everyday treatment. This research analyzes early basic requirements for diagnosis establishment and suggested medication from experts that have been recorded using a custom artificial intelligence. Implementation for patients was then made and effectiveness comparison from both manual and application-based assessment was also conducted. Intervention in this research was performed for 9 participants using in-depth interviews to seek suggestions that may improve the application. Results from this research show that AHP is worthy and beneficial to make a decision on the proper diabetic medication to prescribe for patients. This research also suggests a combination of other methods in further researches. It is also suggested that stakeholders in health care services evaluate their decision and purpose of health care services and put them into a set of regulations [12].

Another research entitled Facility Layout Planning with SHELL and Fuzzy AHP Method Based on Human Reliability for Operating Theatre reveals solutions and answers in dealing with the management of operation ward that helps ease everyday procedures there. It employed AHP to analyze the efficient layout of instruments in the operation ward and determine proper layout using further fuzzy analysis by
taking four aspects of environment, activity, software, and hardware into account. It is prototype research performed in 10 trials to assess its implementation and efficacy. Intervention in this research was an analysis of proper layout by paying attention to human resources, work efficiency, as well as patient safety and security. The results of this research reveal the layout of facilities in the hospital operation ward that must be in line with system strategy and purpose, and also stipulation on patient safety, work security, and treatment effectiveness [13].

3.2 Application of Analytic Hierarchy Process (AHP) to help solve issues in health care services
One of the researches belonging to this category is entitled A Model for the Development of Hospital Beds Using Fuzzy Analytical Hierarchy Process (Fuzzy AHP). It employed both interviews with chosen respondents and fuzzy analysis involving 30 participants of military officers with 5-10 years of managerial experience and who are still learning health care management. The average age of participants was 44 years (± 1.7 years). Intervention is this research was the observation in stages. This intervention made use of calculation analysis using fuzzy AHP. Once finished, the step was an explanation of the fuzzy AHP concept based on the Extent Analysis (EA) method. This research, which was conducted in a conflict zone, shows that providing direct health care to patients of military personnel is not only aimed at maintaining their dignity but also taking the effects of war into account. It is also aimed at keeping military personnel and improving the number of beds per capita, in line with regulations of laws in place [14].

Some other similar researchers also found that this type of multi-criteria analysis instrument help to provide ease of access, shorten bureaucracy in health care services and deal with other health issues. It is expected that the ease of use of such instruments helps to solve health care issues. This type of instrument should also involve stakeholders in its analysis, development, and implementation. Some instruments analyzed do not involve financial methods in their operation. However, it is true that most paid software available on the internet can operate better compared to the free ones, in terms of features and ease of use and access. This finding certainly points to the need for free software that comes with more complete features and is easier to use, just as the paid ones [15].

Another research analyzed solutions to reduce financial loss suffered by hospitals. AHP was used to figure out the major cause of financial losses in the work system of hospitals. Results show that the central operation unit is the one using most of the hospitals’ business processes, especially when there is cancellation or rescheduling of surgeries. Detailed analysis of surgery cancellation for 6 scheduled operations, for instance, would have cost a hospital approximately IRR 1,165,653,450 per year [16].

3.3 Application of Analytic Hierarchy Process (AHP) to help make decisions in health care services
The research entitled Decision Support System (DSS) for Recipients of Family Hope Program (Program Keluarga Harapan/PKH) Aid in Bangun Rejo Village, Panduh Pidada Sub-district, Pesawaran District using Analytical Hierarchy Process (AHP) Method has some interesting findings. This research employed a random sampling method to find respondents. It made use of questionnaires to gather data. Intervention in this research was by providing a list of questions based on a set of criteria for aid recipients. Results show proper match between consideration for names to receive aid and the proper health aids are given. This means that the system built using AHP is capable of helping to make decisions as to which people should be given aids effectively. This certainly helps with the work of PKH personnel based on the custom assessment system. This assessment system can be improved further by setting up a Geographical Information System to map people who deserve to receive aids [17].

Research using AHP in Korea is entitled Strategies for Promoting the Medical Device Industry in Korea: An Analytical Hierarchy Process Analysis. It reveals that the implementation of the AHP program has become the answer to a strategy for advancing the medical instrument industry there. This research used discussion with experts such as physicians, professors, health care providers, the Ministry of Health, and Office of Industrial Policy in Health care Services to make application design that will be implemented, as well as setting modification principles that will serve as a consideration in making
decisions concerning the application of AHP. There was a total of 18 participants involved in this research.

Intervention in this research is the determination of priority elements that will serve as points of consideration in introducing Korean health care products via the mass media, as to reach for a wider audience. It discovered that some aspects to consider are regulation on the development of health care support instrument that is precise and firm. This will help the implementation of key strategies to promote the medical instrument industry with the help of AHP analysis. In turn, it will contribute to the growth and development of the medical instrument industry in this country. AHP analysis comes up with some strategies after surveying the medical instrument industry. The main strategy found is regulation that boosts product sales (access strategy), improved investment in research and development of medical instruments (expansion strategy), and increasing support for global market expansion (infrastructure expansion). All of these three strategies are aimed at promoting the medical instrument industry [18].

Another research highlighting the success of AHP use in decision making comes from Colombia. The use of AHP is combined with the Naive Bayes method in making a decision tree in health care services with a successful and accurate suggestion level of 94.7034% [19]. And another research of the same nature entitled Presenting A Model to Evaluate Factors Affecting Outsourcing of Health Information Technology Services came up with similar conclusions. This is analytical research employing a descriptive method involving 30 participants. It made use of in-depth interviews to figure out the causes and factors affecting decision making. Intervention in this research was applying certain principles to all parties within the IT and Finance Departments of the Faculty of Medicine at Shiraz University. This research made use of a model of decision making and came up with seven factors affecting the success of that method. These include: application quality, implementation motivation, risk management, decision making strategy to help patients, fewer risks associated with jobs, an increase in income, and work efficiency [5].

4. Conclusion

Results show that implementation of Artificial Intelligence using the AHP method does help ease health care services. This is also evident with many countries found to have been able to improve and ease health care services for patients. AHP can serve to help find a solution to health issues by identifying causing factors and suggesting probable solutions to certain health issues. This is certainly beneficial as different health issues may require a significant amount of time to solve due to many complexities involved, both in terms of the causes and the alternative solutions. Therefore, AHP can serve as one of the modalities to help find proper solutions in health issues. It is possible that this system is implemented along with other methods such as Naive Bayes and Extent Analysis. Either way, AHP has proven to be a versatile method in helping provide better health care services even as a standalone

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