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Conceptual Framework for a Decision-Making Model Based on the Analytic Hierarchy Process (AHP) to Select the Best Public Private Partnership (PPP) Model for Airports

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ABSTRACT

The adoption of public-private partnerships (PPPs) as a strategy for infrastructure projects, such as airports, highways, bridges, water supplies, and telecommunication, has been implemented in developed and developing countries with a number of obstacles. Based on this stance, critical success factors (CSFs) of public-private partnership projects and the selection of appropriate PPP models are critical issues that need to be analyzed. A multidisciplinary review of the literature on the critical success factors of public-private partnerships projects reveals the lack of a comprehensive decision-making model for selecting an appropriate PPP model. This paper presents a conceptual framework for a decision-making model to select the best PPP model considering CSFs for developing countries. The model is expected to be used for infrastructure projects, mostly for airports. The decision-making model is structured on the Analytic Hierarchy Process and sensitivity analysis. The decisionmaking model is expected to be adopted as a tool and contribute to decision makers for selecting the best fit PPP model for airports in order to enhance projects successfully.

Keywords: Public-Private Partnership (PPP); Critical Success Factors (CSF); Analytical Hierarchy Process (AHP); Sensitivity Analysis; Decision Making Model; Airport

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CONCEPTUAL FRAMEWORK FOR A DECISION-MAKING MODEL BASED ON THE ANALYTIC HIERARCHY PROCESS (AHP) TO SELECT THE BEST PUBLIC PRIVATE PARTNERSHIP (PPP) MODEL FOR AIRPORTS

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Abstract

The adoption of public-private partnerships (PPPs) as a strategy for infrastructure projects, such as airports, highways, bridges, water supplies, and telecommunication, has been implemented in developed and developing countries with a number of obstacles. Based on this stance, critical success factors (CSFs) of public-private partnership projects and the selection of appropriate PPP models are critical issues that need to be analyzed. A multidisciplinary review of the literature on the critical success factors of public-private partnerships projects reveals the lack of a comprehensive decision-making model for selecting an appropriate PPP model.

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1. Introduction

Measuring the success criteria of public-private partnership (PPP) procurement is a complex issue and depends highly on which stakeholders and experts have been asked. PPP refers to a specific strategic approach in which the projects are executed over the duration of contractual relationships between public and private entities to provide services and/or assets [1]. PPPs have become a popular way for governments to engage private actors in the delivery of government infrastructure and services with the aim of increasing quality and providing better implementations [2]. However, it is no surprise that researchers would continue to study this area of the PPP market [3], which will improve our understanding of the pros and cons of PPP. [4]. Critical Success Factors in PPP projects are the most important area of study related to the success of PPP procurement. According to the literature review on CSFs in PPPs, the attention given to further review and analysis is needed in this area of

study and area of success criteria of PPPs. However, the criteria for the success of public-private partnerships projects are a very important subject which has received little attention in the literature [5].

The conceptual framework and methods outlined in this paper have been developed as a part of a Ph.D. research project with a special focus on the success criteria of PPP projects for transportation sector “airports projects” in developing countries. A literature review for Critical Success Factors of Public-Private Partnership Projects covering the international point of view and comprehensive comparisons between different PPP models in transportations sectors have been done. The Analytical Hierarchy (AHP) Process method will be used to prioritize the success criteria (SC) from the perspective of Turkish experts, academics and decision makers. Based on the priorities gained, another AHP session will be structured to compromise the SC with the alternatives so

as to select the best fit. The outcomes of the literature review and AHP based surveys are expected to produce valuable ideas throughout the development of the interactive decision-making model in the final stage. This paper reviews PPP and its critical success factors followed by a brief description of the Multi-Criteria Decision-Making method and the methods based on the literature review covering AHP. The paper aims to reveal a conceptual framework for a novel approach to select the best fit PPP model based on AHP. In this paper, a proposed conceptual framework is presented and explained in detail.

2. Literature Review:

Although PPP is an important strategy in delivering public facilities and service in many developed and developing countries, the term PPP is still not clearly defined [5]. However, according to Canadian Council for PPP in 2007, PPP is defined as “a cooperative venture between the public and private sectors, built on the expertise of each partner that best meets clearly defined public needs through the appropriate allocation of resources, risks, and rewards” [6]. As shown by Zhang, et al. [7], in their critical review of PPP research, the popular research topics include PPP models and their applications as risk management, financing, and economic issues, legal and procurement issues, government regulations and guarantees. PPPs can perform in different models such as concessions, build-own-operate (BOO) build-operate-transfer (BOT), build-lease-transfer (BLT) and transfer of operation rights (TOOR) [8]. In the U.S. since 1991, the major types of PPP projects used are design-build (70%), concession (11%), design-build-finance-operate (5%) and design-build-finance (5%) [9]. Moreover, in Turkey, the popular PPP model which has been used is built-operate-transfer (BOT) [8]. Design Built Finance Operate (DBFO), Built Transfer Operate (BTO), Operate and Maintain (O&M), Design Construct Manage and Finance (DCMF) are

other PPP models which have been used widely in many developed countries [3]. In addition, these countries have performed this method for delivering infrastructure projects in many sectors: transportation, telecommunications, power, water, sanitation, health, education, and correctional facilities among others. Some developing countries have only implemented PPP as a delivery method for construction transportation, telecommunications and power infrastructure [10]. Many PPP models have been implemented in infrastructure development in both developed and developing countries, with diverse results [11]. However, it is very important that the role and performance of the public and private sectors be clearly identified and studied in order to achieve successful projects. [12]. Different reasons for failure of, and obstacles to, PPP projects have been studied and investigated by researchers during the previous year [12-14].

2.1 *PPP in the transportation sector*

Public-private partnerships (PPPs) are an effective way to build and implement new infrastructure and to solve critical transportation problems in many sectors such as airports, ports, railways and bridges. In addition to these, PPP is used for renovating, operating, maintaining and managing existing transport infrastructure facilities [15]. Therefore, the application of competitive tender procedures to award PPP contracts becomes even more important [8]. Many developed and developing countries are contending with two different policies, the first of which is that countries are faced with the necessity to improve competitiveness by investing in transport infrastructure and the second of which is that various member states are compelled to contain their public budgets [17]. Airports, as special and important infrastructure, constitute some of the most capital-demanding infrastructure and the level of risk to which these investments are subject is very significant, hardly

decreasing the ability of private investors and/or governments to undertake such bids [18]. On the other hand, there is not one single model for a PPP that can be used for any airport project. In a number of cases, the participation of the private sector needs to be limited due to regulatory or operational limitations. Moreover, financial and market limitations do not allow for private investment profitability. Nevertheless, there are also cases where general risks in a country, such as political instability and security risks, especially in the developing world, are perceived to be too high for major foreign private investment, and the domestic private sector does not have the necessary financial base for such business. Hence, the important question for any government considering an airport PPP is which PPP structure model is possible in the given situations, and which is able to achieve the best results for governments. Selecting the appropriate PPP structure model will always depend on a number of factors, including project objectives, financing requirements, market realities, the ability of the government to manage and supervise, the political and regulatory landscape and the risk factors. [16]

2.2 CSFs for PPP in the literature review

Critical success factors could be defined as the 'few key areas of activity where favorable results are absolutely necessary for a manager to reach his/her goals' [3, 16]. Numerous studies have been conducted to identify critical factors for PPP implementation, and a number of researchers have adopted the concept of CSFs to improve the understanding and the perfect way of implementing PPP policy to develop infrastructure in developed and developing countries [3, 17]. The concept of CSFs has been studied in different areas of PPP sectors, including the water sector [18, 19], telecommunications, housing [14], and the energy and transportation sector. [20] Moreover, researchers have investigated factors influencing the success of PPP in specific processes, such as the

tendering process [17], the feasibility phase [21], and the briefing stage [22]. Recently, attention has been given to studying CSFs for PPP projects in developing countries by many researchers in many countries such as the UAE, Nigeria, Ghana and China [18, 23-26].

Although there are many studies in the area of CSFs for PPP projects in the literature review in different sectors especially in the year 2016 [17, 18, 20, 23-27], it is clear that summaries, reviews and detailed analyses of these studies to identify the most important success factors for PPP implementation is critical. To deliver a PPP project in a better manner in developing and developed countries, a systematical review of the literature from 2000 to 2016 on CSFs for PPP was done in this paper to improve this objective. A list of the most important findings of PPP CSF studies in the last sixteen years and the details of the findings are shown below:

1. Risk allocation and sharing;
2. Strong private consortium;
3. Available financial market;
4. Commitment made by partners;
5. Transparent procurement;
6. Political support; and
7. Favorable legal framework.

2.3 Analytical Hierarchy Process Method (AHP)

The AHP method was developed by Thomas Saaty in the 1970s. AHP is based on decomposing a complex MCDM problem into a system of hierarchies and then evaluating the components by a pairwise comparison. The pairwise comparison matrix is constructed using the relative importance of the alternatives in terms of each criterion [28]. The requirement for pairwise comparison in AHP is regarded as an advantage as it requires decision makers to think more deeply about the weights of different factors and to analyze all situations for deeper levels. Another advantage of AHP is its

ability to measure quality and quantity indicators by using mental preferences, expertise, and objective information [29]. According to Saaty, AHP is based on a two-stage process: first, “decomposing the complexity” and then “synthesizing the relations”

In the first step, AHP breaks down a complex decision making problem into a hierarchical structure (as shown in Figure 1), composed of decision-making components (criteria and alternatives) with at least three levels: (1) overall objective at the highest level; (2) multiple criteria which define alternatives at the intermediate level; and (3) alternatives at the lowest level. The second step involves comparisons of alternatives and criteria. Once a problem is analyzed and the hierarchical levels are formed, preferences are determined at each level based on the relative importance of each criterion. At each level, the pairwise comparison is made among the criteria to identify the impact of each criterion compared to certain criteria at the upper levels. Pairwise comparisons are carried out using a 9-point standard scale [29].

AHP is a reliable method for calculating the weight of each criterion since it is based on decision makers’ points of view rather than decision matrices. AHP also allows performing sensitivity analyses over criteria and sub-criteria. A unique feature of AHP is the possibility of calculating the compatibility/incompatibility of decisions made by the decision makers [29].

The advantages of using AHP include achieving a higher quality product and a shorter product development process. AHP helps capture both subjective and objective evaluation measures, providing a useful mechanism for checking the consistency of the evaluation measures and alternatives suggested by the team, thus reducing bias in decision-making. AHP allows organizations to minimize the common pitfalls of the decision-making process, such as lack of focus, planning, participation or ownership, which ultimately are costly distractions that can prevent teams from making correct choices [30]. The AHP structure comprises four levels, as shown in Figure (1): the goal, decision makers, criteria and the alternatives.

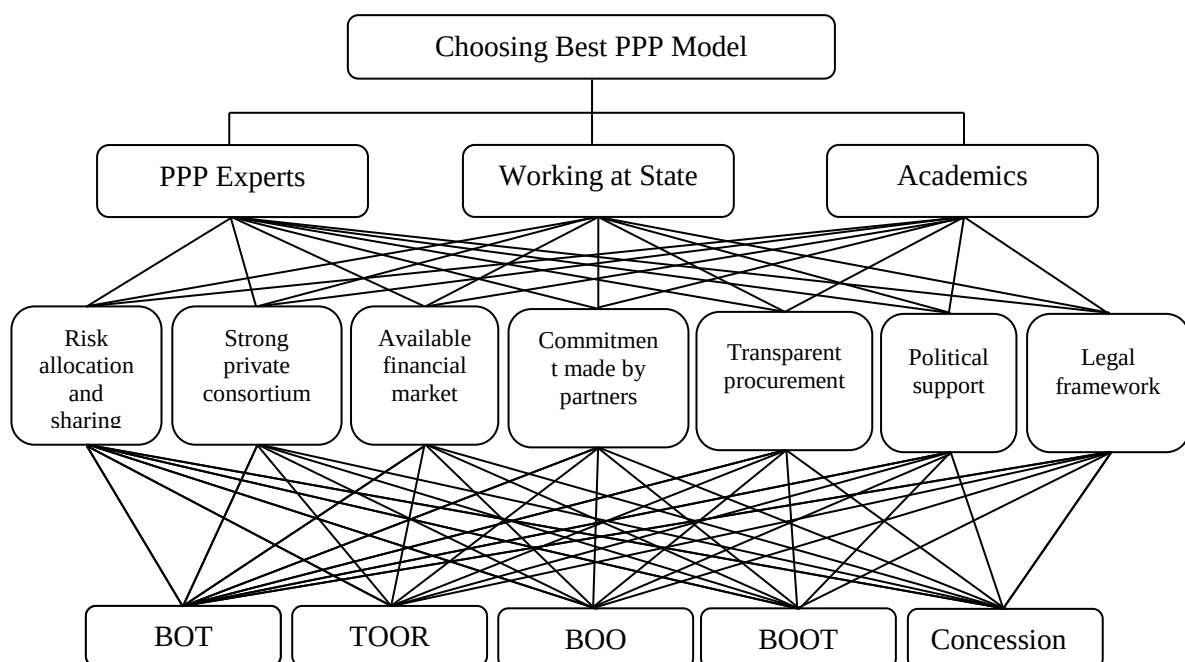


Figure 1. AHP Structure

3. Research Methods

The aims of this paper are to structure a conceptual framework so as to specify the effective success criteria that affect the selection of a best fit PPP model for airports project in developing countries. Using an inductive approach based on explorative analysis is the strategy of this research.

The research design is illustrated in Figure (2). The data which have been collected from the literature review are deconstructed, categorized and linked in order to use them as input data to the

Analytical Hierarchy Process method. The AHP method is used as the Multi-Criteria Decision Making (MCDM) method to evaluate the concepts (CSFs and PPP models) that have been selected from the literature review for a pairwise comparison. The decision-making model will be developed based on the sensitivity analysis to the result data from the AHP method. The criteria and the alternative from the final step will be sensitively analyzed to obtain the best fit result. Validation of the model will occur by applying it to a case study in future.

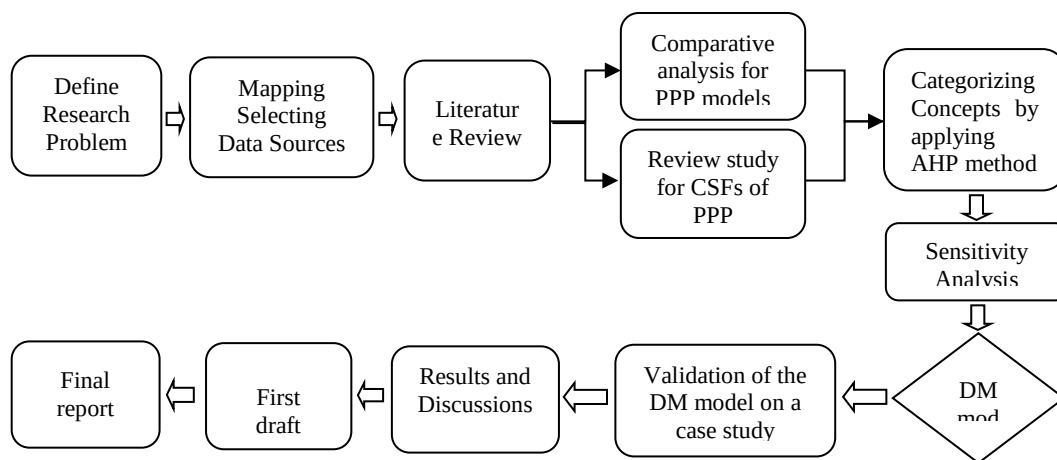


Figure 2. Research Design

4. Conceptual Framework for selecting a PPP Model.

The conceptual framework is defined, according to Jabareen [31], as “a network, or a plane of interlinked concepts that together provide a comprehensive understanding of a phenomenon or phenomena and are products of qualitative processes of theorization.” The proposed conceptual framework provides a step-by-step pattern to identify the research goal. The framework offers a process starting with identifying the research concepts that are collected from the literature review. The literature is reviewed to determine the most important critical success factors for public-private partnership projects through the articles published and indexed in search

engines such as Scopus and Web of Sciences. The next steps in the framework aim to explain how these concepts will be selected as well as the priorities by using pairwise comparisons with a suitable MCDM method (AHP). This Decision-Making Model will be used as a tool to select the best fit PPP model based on the success criteria for airports public-private partnership projects in developing countries. Finally, a real case study will be used to evaluate the model. The conceptual framework process contains five main steps: i) Identification, ii) Concept selection, iii) Evaluation and Implementation, v) Model development, and vi) Result improvement as shown in Figure (3).

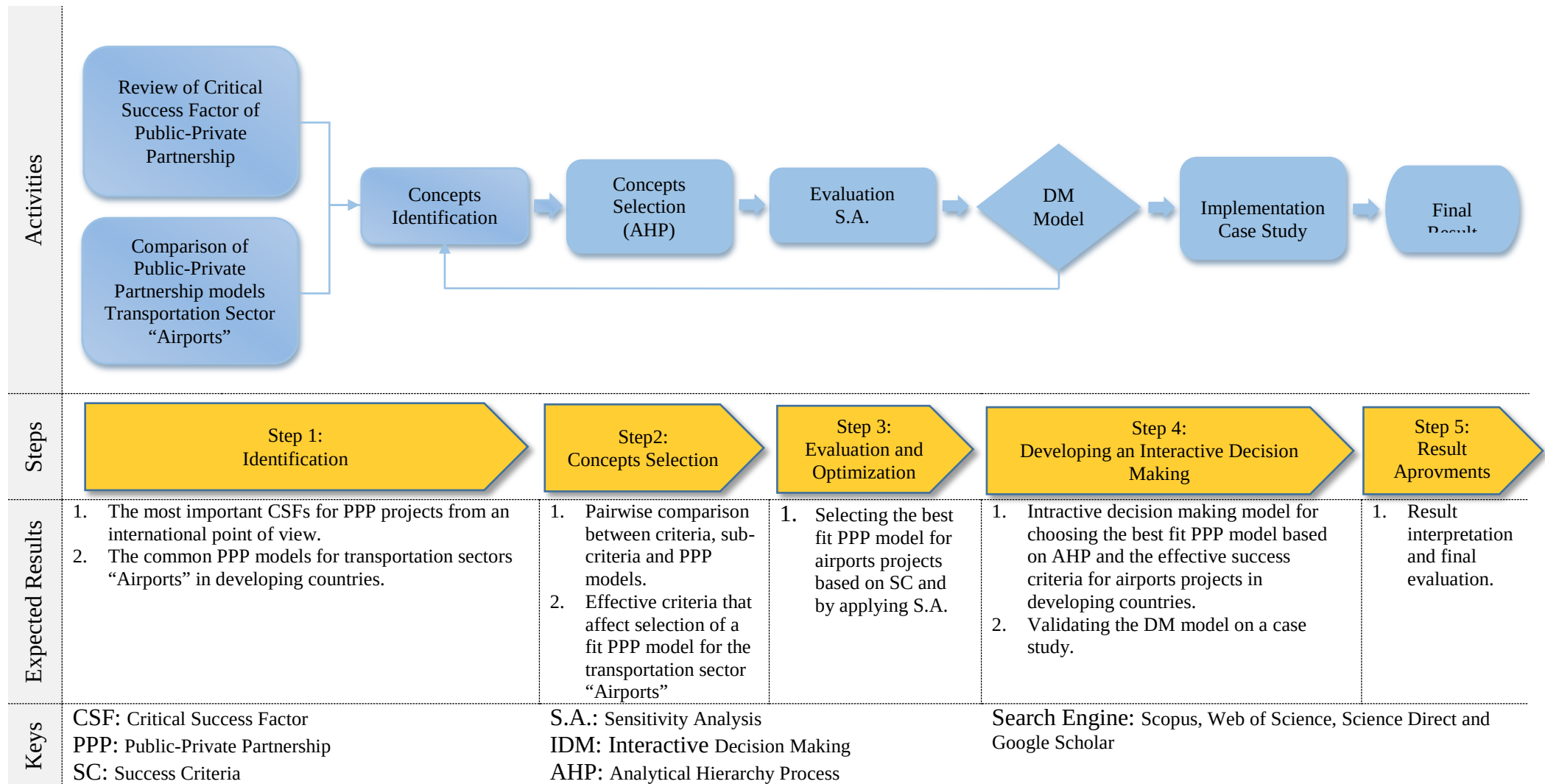


Figure 3. Conceptual Framework to select a PPP model

5. Discussion & Conclusion

Public-Private Partnership projects are increasingly being used in the rapid development of both developed and developing infrastructure projects. The aim of this paper is to reveal a conceptual framework for a novel approach to selecting the best fit PPP model based on AHP. In the paper, a proposed conceptual framework is presented and explained in detail. The finding from the literature review has revealed that there are seven important critical success factors for PPP projects including risk allocations and sharing, a strong private consortium, an available financial market, commitments made by partners, transparent procurement, political support and favorable legal frameworks. These CSFs will be pairwise compared with the selected PPP models, which are BOT; TOOR; BOO; BOOT and the Concession by the AHP method. The results will be used as input data to the interactive decision-making model. The framework presents a method that enables the decision makers to select the best fit PPP model for airport projects. The framework should be tested in a case study. Furthermore, the decision-making model revealed based on the research is expected to be adapted as a tool and expected to contribute to the decision makers for selecting the best fit PPP model for airports in order to enhance the projects successfully.

6. References

- [1] Shang Zhang, Albert P.C. Chan, Yingbin Feng, Hongxia Duan, and Y. Ke, "Critical review of PPP Research – A search from the Chinese and International Journals," *International Journal of Project Management*, vol. 34, pp. 597-612, 2016.
- [2] Tang LiYaning, Shen Qiping, and C. E. W. L., "A review of studies on Public-Private Partnership projects in the construction industry," *International Journal of Project Management*, vol. 28, pp. 683-694, 2010.
- [3] Osei-Kyei Robert and A. Chan., "Review of studies on the Critical Success Factors for Public-Private Partnership (PPP) projects from 1990 to 2013," *International Journal of Project Management*, vol. 33, pp. 1335-1346, 2015.
- [4] LiYaning Tang, Qiping Shen, and E. W. L. Cheng, "A review of studies on Public-Private Partnership projects in the construction industry," *International Journal of Project Management*, vol. 28, pp. 683-694, 2010.
- [5] Osei-Kyei Robert, Albert P. C. Chan, Arshad A. Javed, and E. E. Ameyaw, "Critical Success Criteria of Public-Private Partnership Projects: International Expert's Opinion," *International Journal of Strategic Property Management*, vol. 21, 2017.
- [6] Kwak Young Hoon, Chih YingYi, and I. C. William., "Towards a Comprehensive Understanding of Public-Private Partnerships for Infrastructure Development," *California Management Review*, vol. 51, pp. 51-78, 2009.
- [7] C. C. f. P.-P. Partnership, "Canadian Council for Public-Private Partnership "About PPP: Definitions." ", http://www.pppcouncil.ca/aboutPPP_definition.asp2007.
- [8] Zhang Shang, Chan Albert P. C., Feng Yingbin, Duan Hongxia, and K. Yongjian., "Critical review of PPP Research – A search from the Chinese and International Journals," *International Journal of Project Management*, vol. 34, pp. 597-612, 2016.
- [9] Emek Uğur, "Turkish experience with public-private partnerships in infrastructure: Opportunities and challenges," *Utilities Policy*, vol. 37, pp. 120-129, 2015.
- [10] Gurgun Asli Pelin and T. Ali., "Public-Private Partnership Experience in

the International Arena: Case of Turkey," *Journal of Management in Engineering*, vol. 30, p. 04014029, 2014.

[11] Sastoque Lina María, Arboleda Carlos Alejandro, and P. J. Luis., "A Proposal for Risk Allocation in Social Infrastructure Projects Applying PPP in Colombia," *Procedia Engineering*, vol. 145, pp. 1354-1361, 2016.

[12] Heravi Gholamreza and H. Zeinab., "Risk Allocation in Public-Private Partnership Infrastructure Projects in Developing Countries: Case Study of the Tehran-Chalus Toll Road," *Journal of Infrastructure Systems*, vol. 18, pp. 210-217, 2012.

[13] Ismail Abdul Rahman, Aftab Hameed Memon, and N. S. M. Zulkiffli., "Failure Reasons of PPP Infrastructure Projects Case Study of Kuala Lumpur LRT Project " *Life Science Journal* vol. 11, pp. 238-246, 2014.

[14] Mohamed Alhashemi, Voisin Alexandre, Florence Ling, and M. Kumaraswamy., "Critical Success and Failure Factors for Public-Private Partnership Projects in The UAE" presented at the CIB W065/055 Commissions: Transformation through Construction 2008.

[15] A. R. Abdul-Aziz and Jahn Kassim P. S., "Objectives, success and failure factors of housing public-private partnerships in Malaysia," *Habitat International*, vol. 35, pp. 150-157, 2011.

[16] W. B. Group. (2016). Public-Private-Partnership in Infrastructure Resource Center, Public-Private Partnerships for Transport.

[17] Francesca Romana Medda, Gianni Carbonaro, and S. L. Davis, "Public-private partnerships in transportation: Some insights from the European experience," *IATSS Research*, vol. 36, pp. 83-87, 2013.

[18] W. B. Group, "2105 Transport Sector Global PPI Update," World Bank Group, <https://ppi.worldbank.org/2015>.

[19] A. F. Pena, "Public-Private Partnerships in the Airport Sector," Master of Science Complex Transport Infrastructure Systems, Technical University of Lisbon, Portugal, 2012.

[20] P. K. Lab. (2017). The knowledge to innovate for smarter public-private partnerships.

[21] J. F. Rockart and W. Sloan, "Information Systems Executive: A Critical Success Factors Perspective," 1982.

[22] Liu Tingting, Wang Yan, and W. Suzanne., "Identifying critical factors affecting the effectiveness and efficiency of tendering processes in Public-Private Partnerships (PPPs): A comparative analysis of Australia and China," *International Journal of Project Management*, vol. 34, pp. 701-716, 2016.

[23] Ernest Effah Ameyaw and A. Chan., "Critical success factors for public-private partnership in water supply projects," *Facilities*, vol. 34, pp. 124-160, 2016.

[24] Xianhai Meng, Qi Zhao, and Q. Shen., "Critical Success Factors for Transfer-Operate-Transfer Urban Water Supply Projects in China," *Journal of Management In Engineering*, vol. 27, pp. 243-251, 2011.

[25] Hemantkumar P. Bulsara, Alok Kumar, Rakesh Kumar, and K. A. Chauhan., "Principal Factors for Success of Traditional vs. PPP Road Projects in India," *I J A B E R*, vol. 14, pp. 3575-3590, 2016.

[26] Ng S. Thomas, Wong Yoki M. W., and W. J. M. W., "Factors influencing the success of PPP at feasibility stage – A tripartite comparison study in Hong Kong,"

Habitat International, vol. 36, pp. 423-432, 2012.

[27] L. Tang and Q. Shen, "Factors affecting effectiveness and efficiency of analyzing stakeholders' needs at the briefing stage of public-private partnership projects," *International Journal of Project Management*, vol. 31, pp. 513-521, 2013.

[28] Rauda Al-Saadi and A. Abdou., "Factors critical to the success of public-private partnerships in UAE infrastructure projects: experts' perception," *International Journal of Construction Management*, 2016.

[29] Robert Osei-Kyei and A. Chan., "Implementing Public-Private Partnership (PPP) Policy for Public Construction Projects in Ghana: Critical Success Factors and Policy Implications," *International Journal of Construction Management*, 2016.

[30] A. O. Sanni., "Factors determining the success of public-private partnership projects in Nigeria," *Construction Economics and Building*, vol. 16, pp. 42-55, 2016.

[31] Solomon Olusola Babatunde, Srinath Perera, Lei Zhou, and C. Udeaja., "Stakeholder Perceptions of Critical Success Factors for Public-Private Partnership Projects in Nigeria," *Built Environment Project and Asset Management*, vol. 6, pp. 74-91, 2016.

[32] A. Mudi., "Quantity Surveyor's Impact: A Panacea to achieving Critical Success Factors in PPP Implementation," *International Journal of Engineering Science Invention*, vol. 5, pp. 01-09, 2016.

[33] Timuçın Harputlugl, Matthijs Prins, A.Tanju Gültekin, and Y. I. Topçu, "Conceptual Framework for Potential Implementations of Multi-Criteria Decision Making (MCDM) Methods for Design

Quality Assessment," presented at the Management and Innovation for a Sustainable Built Environment, Amsterdam, The Netherlands, 2011.

[34] Balali Vahid, Zahraie Banafsheh, and R. Abbas., "A Comparison of AHP and PROMETHEE Family Decision Making Methods for Selection of Building Structural System," *American Journal of Civil Engineering and Architecture*, vol. 2, pp. 149-159, 2014.

[35] Hambali Ariff, Mohd Sapuan Salit, Napsiah Ismail, and Y. Nukman., "Use of Analytical Hierarchy Process (AHP) for Selecting the Best Design Concept," *Jurnal Teknologi*, vol. 49, pp. 1-8, 2008.

[36] Y. Jabareen, "Building a Conceptual Framework Philosophy Definitions and Procedure.," *International Journal Qualitative Methods*, vol. 8, pp. 49-60, 2009.