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DEVELOPING A TOPSIS MODEL FOR PRIORITISING SUCCESS FACTORS IN HEALTHCARE CONSTRUCTION PROJECTS

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Abstract

Healthcare facilities play an important role in the welfare of countries while posing many challenges to health service providers. In addition to high cost and multi-specialization, design and execution complexities are a few challenges in building such facilities that often lead to delays, cost overruns, and off-specifications. The success of healthcare construction projects enhances the quality of services and entails the implementation of social justice. The existing literature on the success of construction projects shows that apart from cost, time, and quality, other factors, such as communication, access to resources, stable political and economic conditions, skilled workers, and management knowledge, play essential roles in the success of projects. In previous studies, success factors were generally identified for different sectors such as building, oil and gas, and road construction projects, and no study has identified specific success factors for healthcare construction projects that have unique attributes compared to regular building projects. Therefore, this study aims to determine the success factors by conducting open-ended interviews with experts and prioritizing the factors using the TOPSIS method to develop a tool for measuring the success of such facilities. The results revealed 56 success factors that were classified into eight groups. Correct estimation of project time, design accuracy, realistic budget estimates, sufficient feasibility studies, and compliance with the environment are the top factors that may increase the chance of success in healthcare projects. The outcomes of this research will be useful for stakeholders in healthcare construction projects to raise their awareness of how to execute successful projects in the future. Moreover, the developed TOPSIS model can be used to measure the success rate of facilities that are under construction or have been constructed recently, enabling stakeholders to learn from previous experiences.

Keywords: Healthcare construction projects, Healthcare facilities, Success factors, TOPSIS.

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1. Introduction

Improving health in society and achieving a high level of welfare can be achieved by constructing sufficient and appropriate healthcare facilities. In other words, enhancing the quality of health services depends on building successful healthcare facilities. The importance of healthcare facilities has been rising in Iran during the past decades because the population doubled in 40 years, the life expectancy rate has sharply increased and the need for specialized medical care in less developed regions of the country has increased [1]. Between 2009 and 2023 over 700 hospitals and health centres were constructed in Iran [1]. This illustrates the importance of investing in the construction of healthcare facilities by various governments. Three public organizations are responsible for building new healthcare facilities in the country: the Ministry of Road and Urban Development (MRUD), the Ministry of Health Treatment and Medical Training (MHTMT), and the Social Security Organization. MRUD has constructed the majority of facilities, whereas the MHTMT has been involved in small-scale health centres. To meet this huge public demand, more than 80,000 beds must be constructed [2]. Moreover, 60% of the facilities require retrofitting and refurbishment [2]. However, most of these projects were unsuccessful and suffered from delays, cost overruns, and low quality. As explained previously, enhancing the level of welfare requires the provision of quality healthcare services in each country, which means that much attention should be paid to how healthcare facilities are being constructed. The

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importance and sensitivity of this sector necessitate the involvement of authorities and managers of public and private organizations in healthcare projects to enhance productivity and consequently improve the success rate of projects. Therefore, it is necessary to evaluate the success of these projects.

Healthcare construction projects are fundamentally different from other building projects. The methods of both architectural and engineering design are different, as the focus of architectural design is on the functionality and relationship of spaces. In contrast, a structure should be designed in a manner that is resilient to natural disasters, such as earthquakes, and provide immediate occupancy after a disaster occurs. Furthermore, healthcare facilities require accurate and complicated calculation and design of M&Es, including medical gas piping and specialized power units for medical equipment, in addition to regular building services. In the execution phase, building healthcare facilities is more complicated than in typical projects because many trades and disciplines are involved. The range of materials required is vast, and many have an extended lead time and are produced by limited suppliers. High-tech medical equipment should be imported from other countries that have a long and complicated procurement process and require a highly specialized team for installation and testing. Moreover, the political sensibility of such projects, unreal expectations of stakeholders, and irregular budget injections make healthcare projects more challenging. Healthcare projects are generally more expensive than other building projects because of the high costs of special materials and various engineering and subcontracting services.

Regarding the time and duration, healthcare projects take more time to build in comparison to other building projects and have a longer life-cycle to provide services to patients over 120 years. As is evident from the above points, healthcare construction projects are different from other building projects, and assessing their success requires more focus on understanding their attributes and configurations. The success factors identified in the reviewed literature were mainly derived from normal buildings, oil and gas, road construction projects, and non-healthcare. However, as previously stated, such projects are completely different and have attributes that are not similar to those of other projects. Hence, this study aimed to identify the factors pertinent to such projects in Iran and rank them based on their importance.

2. Literature review

In the context of project management, success factors are defined as the essential elements, conditions, or activities that significantly contribute to the successful outcome of a project. These may include aspects such as managerial competence, stakeholder engagement, effective communication, or adequate resource availability. In contrast, criteria refer to the specific, measurable indicators used to evaluate whether those success factors have been achieved. Common success criteria in construction projects include timely delivery, cost performance, quality compliance, and stakeholder satisfaction. While success factors are the drivers of success, success criteria serve as the benchmarks against which that success is assessed.

Project success is the most crucial goal in project management. Several studies were conducted on this subject from 1981 to 2012 [3,4,5,6,7,8,9,10,11]. The factors identified by these researchers are summarized in Table 1. [12] in 2013 using the technique for order of preference by similarity to ideal solutions (TOPSIS). They extracted the success factors from the literature and prioritized them using TOPSIS. This research provides new insights, but the outcomes cannot be generalized to other settings because the results were generated based on a single case study.

Gudiene et al.,[13] identified the success factors of Lithuanian projects and prioritized them using the Analytic Hierarchy Process (AHP). They identified 71 success factors and classified them into seven categories. They then prioritized and weighted the success factors using the AHP method. This valuable research did not focus on a specific project type and failed to observe the special attributes inherent to different sectors. A Case Studies [14] and [15] explores the multi-dimensional concept of project success and the complex interactions of success factors within construction projects. It highlights the importance of understanding the causal chains leading to success across different facets, including both measurable outcomes and psychosocial factors. The study uses a case study approach to analyze the performance of a company involved in major construction programs, identifying both generic and context-dependent success factors that contribute synergistically to project success. This research adds to the discourse on system city within project management by mapping and analysing the paths from root causes to success criteria, offering insights into the interconnectedness of success factors and their collective impact on project outcomes. Kuwaiti et al., [16] studied success factors of healthcare facility construction projects in Abu Dhabi. Using previous literature, they divided the success factors into 10 main categories with 36 subcategories. AHP questionnaires were distributed to public sector managers and private firm companies in the field of healthcare construction. The results show that managing the supply chain, financing, and availability of resources are the most important success factors in such projects. This research is the only one that focuses on the success of healthcare projects, but even in this study, the success factors extracted from previous research did not consider the uniqueness of healthcare facility construction. It can be realized that the success factors of healthcare construction projects have not been adequately and completely explored by previous researchers. This is the gap that this paper aims to cover. In another study [17] develops a comprehensive model for assessing construction contract administration (CCA) performance. The research combines qualitative and quantitative methods to establish a multidimensional Contract Administration Performance Model (CAPM) using fuzzy structural equation modelling. The model includes 93 CCA performance indicators grouped into 11 project management process groups. It aims to help industry stakeholders measure the CCA performance and identify strengths and weaknesses in the CCA system for ongoing or completed projects. This work contributes to the field by offering the first quantitative model that encapsulates contract administration performance into a structured and measurable framework. Project practitioners' perspectives" presents an extensive study on the perceptions of senior project managers regarding critical success factors (CSFs) and project success in large construction projects. It highlights the discrepancy between the exhaustive lists of CSFs found in literature and the few key factors identified by practitioners. The study [18] emphasizes that traditional measures of project success, like the Iron Triangle of cost, time, and quality, are considered insufficient by project professionals who rely on additional performance indicators. The research underscores the need for a comprehensive approach to understanding project success, factoring in the complexity of construction projects and the diverse viewpoints of stakeholders.

Table 1: Extracted Factors in the literature.

Factor	Factor
Project Team's Commitment.	Communication
Contractor Competencies	leadership
Risk Assessment	Management Competence
Client Competencies	Project Financing
Stakeholders' Needs	Subcontractor Control
Constraints Imposed by Stakeholders	Contractor's Competence
Integration	Senior Manager Support
Quality	Coordination
Commitment	Cost
Time	

3. Methodology

A qualitative methodology was used to identify the specific success factors of healthcare construction projects. This assists researchers in intensely focusing on the subject and identifying its hidden angles from experts in the field Open-ended interviews were selected to concentrate on the experiences and perceptions of experts working in the healthcare construction sector. This allowed interviewees to freely express their ideas about the subject to identify specific success factors for healthcare construction. In this study, the snowball sampling technique was utilized, which is a purposive sampling method to find knowledgeable and experienced participants for interviewing. Using this technique, the first identified interviewee introduced future interviewees to their acquaintances. This technique helps researchers reach a population of experts in the field of healthcare facility construction from both public and private organizations. Moreover, referrals made the interview process more reliable because the interviewees trusted the researchers as they were introduced by a friend, fellow, or colleague. A total number of 31 interviews were conducted with experts who held at least 15 years of experience in the healthcare construction sector. Because the average construction cycle time of healthcare projects in Iran is five years, experts should have been involved in three or more projects. The interviews were then recorded and transcribed. The theme analysis method was used to analyze the data gathered from the interviews. The qualitative data gathered were examined to identify success factors in the interview transcripts.

A repetitive process of coding and recording was conducted to highlight the sections of the text and create a code (success factor) associated with them. The codes were classified into eight categories and 29 subcategories. To rank the identified success factors, a method for weighting them according to their relative importance is required. For this purpose, the TOPSIS method was applied to quantify the importance of the factors with the help of a panel of highly experienced experts. The TOPSIS method was offered by Hwang and Yoon in 1981 [19] and quickly began to be used in the construction industry [20]. This method is a classic method for multi-criteria decision-making based on the distribution of individual alternatives according to the given criteria and factors [21].

The TOPSIS method evaluates a given set of alternative data without direct comparison between alternatives, and the result is expressed as a mark on a scale between the values of the ideal and negative solutions. The alternative closest to the ideal solution and farthest from the negative ideal solution is the best solution. A TOPSIS questionnaire was developed based on the results of the qualitative study and included all the factors identified in the literature and interviews. The questionnaire was validated by two highly experienced project managers and a few questions were merged or modified for clarity. The final questionnaire was distributed to seven experts in the field of healthcare construction projects. The basic algorithm of the TOPSIS method evaluates the decision matrix, which shows the alternatives evaluated by using n criteria. Since different criteria have different dimensions, the values in the decision matrix are first transformed into normalized, non-dimensional values, under the following equation [22]. To validate the results of the TOPSIS prioritization, the ranked list of success factors was shared with three experts from the client, consultant, and contractor organizations to review and provide feedback. They confirmed that the identified factors were representative of the current practice. They also agreed on the first factors that were sorted accordingly, although there was little disagreement among experts in terms of ranking.

Table 2: Demographic Information.

ROW	CODE	ROLE	EDUCATION	FIELD	EXPERIENCE(YEAR)	ORGANISATION TYPE
1	C1	Project Administrator	Bachelor	Civil Engineer	15	Client
2	C2	Physics	Specialist	Oncology	30	Client
3	C3	Project Manager	Bachelor	Civil Engineer	20	Client
4	C4	Project Manager	Bachelor	Civil Engineer	20	Client
5	C5	CEO	Master	Law	20	Client
6	C6	Project Manager	Master	Civil Engineer	20	Client
7	C7	Project Manager	Bachelor	Civil Engineer	17	Client
8	C8	Project Manager	Bachelor	Civil Engineer	25	Client
9	C9	Project Manager	Master	Civil Engineer	29	Client
10	C10	Physics	Specialist	Neurologist	26	Client
11	C11	Project Manager	Master	Civil Engineer	22	Client
12	N1	Project Administrator	Bachelor	Management	25	Consultant
13	N2	Project Administrator	Bachelor	Civil Engineer	18	Consultant
14	N3	Project Administrator	Bachelor	Civil Engineer	16	Consultant

15	N4	Project Manager	PhD	Architecture	20	Consultant
16	N5	Project Manager	Bachelor	Civil Engineer	17	Consultant
17	N6	Project Manager	PhD	Civil Engineer	21	Consultant
18	N7	CEO	Master	Civil Engineer	30	Consultant
19	N8	CEO	Bachelor	Architecture	28	Consultant
20	N9	CEO	Master	Civil Engineer	34	Consultant
21	O1	Project Manager	Bachelor	Civil Engineer	25	Contractor
22	O2	CEO	Bachelor	Mechanics	35	Contractor
23	O3	CEO	Bachelor	Mechanics	36	Contractor
24	O4	Project Administrator	Bachelor	Civil Engineer	18	Contractor
25	O5	Project Manager	Bachelor	Management	17	Contractor
26	O6	CEO	PhD	Civil Engineer	35	Contractor
27	O7	Project Manager	PhD	Civil Engineer	16	Contractor
28	O8	Project Manager	Master	Civil Engineer	35	Contractor
29	O9	Project Manager	Master	Civil Engineer	40	Contractor
30	O10	CEO	Master	Management	36	Contractor
31	O11	Project Manager	Master	Civil Engineer	19	Contractor

4. Qualitative data analysis

The results of the data analysis indicated that there were 56 factors for the success of healthcare projects. The factors that were specific to healthcare projects or not identified in past research were ability providers, type of disease, regional diseases, cities needing hospitals, user-friendly equipment, and partnerships with each other. In the next step, the factors identified from the interviews and those extracted from the literature were integrated, similar factors were removed, and factors with the same definitions were merged. Finally, 29 success factors were classified into eight categories.

Table 3: Prioritizing Factors.

Rank	Factor	Score	Rank	Factor	Score
1	Estimating project's time	0.0484	16	Psychological and Emotional Factors	0.0366
2	Architecture Design	0.0470	17	Machinery	0.0364
3	Risk Assessment	0.0444	18	Personnel Experience	0.0353
4	Predetermined cost	0.0441	19	Complying with all Standards	0.0329
5	Feasibility	0.0429	20	Construction Materials	0.0311
6	Environment	0.0424	21	Managerial & Technical Knowledge	0.0306
7	Control and Supervision	0.0422	22	Budget Provision (Finance)	0.0266
8	Complying with the Schedule	0.0406	23	National Health Strategy	0.0257
9	Personal Competency	0.0405	24	Scope	0.0245
10	Quality Management	0.0395	25	Land Acquisition Issues	0.0231
11	Construction Method	0.0381	26	Economy	0.0225
12	Stakeholders	0.0379	27	Cultural and Social	0.0222
13	Repair and Maintenance	0.0378	28	Contract and Regulations	0.0183
14	Project Manager Role	0.0374	29	High-Level Policy	0.0137
15	Medical Equipment	0.0371			

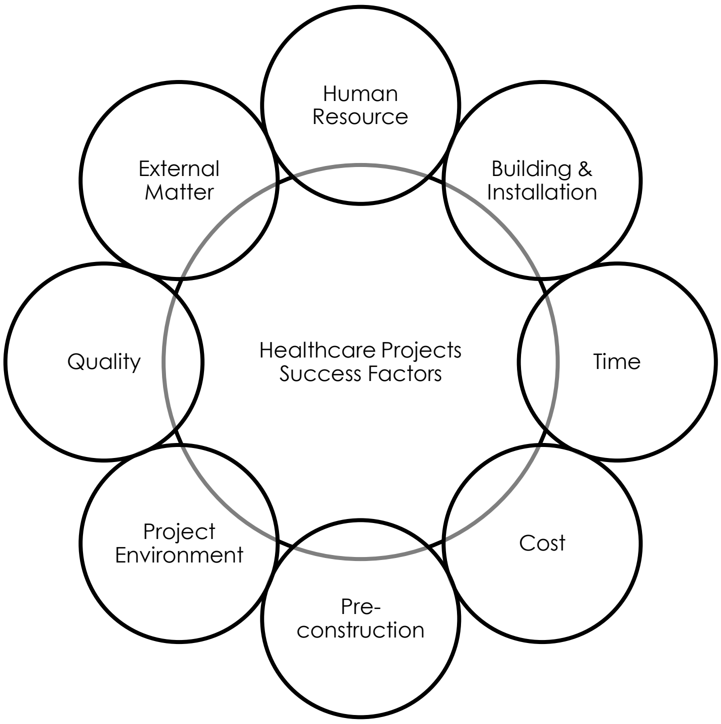

Fig 1: Categories of Success Factor.

5. Discussion

The results confirm the importance of the traditional success factors of time and cost emphasized by the interviewees and the prioritization process. The most critical success factors for healthcare projects due to this research are time estimation, predetermined cost, and architectural designs that cause frequent project changes and stops, as well as project time and cost overruns. Conducting an appropriate feasibility study, considering the environmental impact that could be caused by incomplete architectural design using typical drawings for different projects with variable geographical locations, and effective control and supervision are other highly weighted factors that may lead to future obstacles and are emphasized repeatedly by experts. It must also be mentioned that the destruction of the environment around the projects is the result of ignoring the harmful effects of hospitals and inattention to climatic factors when designing the facility. The use of competent staff and labor for both the design and construction of healthcare projects is essential because of technical complexities owing to the complicated architecture, sophisticated structural calculations, and installation of sensitive medical equipment. Another problem is the selection of senior staff and project managers based on neo-potism. Many interviewees believed that financing was an important factor; however, other factors challenged the success of the project, even when finance was available. Although it seems unimportant, emotional decisions, lack of managerial and technical knowledge among practitioners, and unfamiliarity with the local culture also lead to failure. Legal and contractual matters and high-level political issues are still important subjects but with lower weights at the bottom of the table. Given these points, to succeed in healthcare projects, projects must first be defined according to the needs of a region, which requires precise qualitative and quantitative studies. Through preliminary studies, the area should be examined for disease type, culture, climate type, beds per capita, and demographics. Thus, each project should be designed individually and regionally with a different funding plan. By selecting experienced and knowledgeable managers and people and using the identified success factors, a big step can be taken toward achieving successful healthcare projects. One thing that must be kept in mind is the chain-like relationship between the success and failure of construction projects. Factors such as stakeholders need wise material selection, and post-occupation considerations are usually missed but are highlighted by experts in this study. Moreover, psychological and emotional issues, resolving land acquisition problems, and cultural and social matters are new factors identified in this research and are ranked relatively important. Legal and contractual matters and high-level political issues are still important subjects but with lower weights at the bottom of Table 3.

To succeed in healthcare facility construction, projects must first be defined according to the needs of a region and not according to political priorities. Precise qualitative and quantitative feasibility studies are required. The area should be examined for type of disease, culture, climate, required beds per capita, and demography. Subsequently, designs should be carried out for each project individually and based on regional needs. Innovative financing projects using the private sector and minimizing political pressure increase the chance of success. Selecting experienced and knowledgeable managers and human resources based on competency will help projects address challenges and achieve successful healthcare projects. Accurate estimation of the time and cost of projects is crucial. Furthermore, considering the whole life-cycle of the projects and taking maintenance into account is a big step towards achieving success in healthcare projects.

6. Conclusion

A review of the literature revealed that although success factors have been explored by several researchers in different construction sectors, there is a lack of focus on healthcare construction projects. Thus, this study, by taking a qualitative approach, identified success factors that are specific to healthcare projects considering their unique attributes. The factors were then ranked based on their importance using the TOPSIS technique. The results of this research help practitioners to consider success factors before starting projects and enhance the chance of success by focusing on factors with higher importance. The outcome can be used as a success measurement tool, specially developed for assessing the success of healthcare facilities. This enables stakeholders to evaluate existing facilities to understand their level of success and compare them with each other. The TOPSIS model developed in this study can be used by practitioners to determine the success rates of under construction and completed projects. The lessons learned can be used to improve the performance of future projects.

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