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Article

Methodological approaches in prioritizing municipal projects: A case study of the municipality of the holy capital (Makkah)

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Abstract: This study aims to develop a robust prioritization model for municipal projects in the Holy Metropolitan Municipality (Makkah) to address the challenges of aligning short-term and long-term objectives. The research explores How multi-criteria decision-making (MCDM) techniques can prioritize municipal projects effectively while ensuring alignment with strategic goals and local needs. The methodology employs the analytic hierarchy process (AHP) and exploratory factor analysis (EFA) to ensure methodological rigor and data adequacy. Data were collected from key stakeholders, including municipal planners and community representatives, to enhance transparency and reliability. The model's validity was assessed through latent factor analysis, confirming the relevance of identified criteria and factors. Results indicate that flood prevention projects are the highest priority (0.4246), followed by road projects (0.3532), park construction (0.1026), utility projects (0.0776), and digital transformation (0.0416). The study highlights that certain factors are critical for evaluating and prioritizing municipal projects. "Capacity and Demand" emerged as the most influential factor (0.5643), followed by "Strategic Alignment" (0.2013), "Project Interdependence" (0.1088), "Increasing Investment" (0.0950), and "Risk" (0.0306). These findings are significant as they offer a structured, data-driven approach to decision-making aligned with Saudi Vision 2030. The proposed model optimizes resource allocation and project selection, representing a pioneering effort to develop the first prioritization framework specifically tailored to Makkah's unique municipal needs. Notably, this is the first study to establish a prioritization method specifically for Makkah's municipal projects, providing valuable contributions to the field.

Keywords: projects; project management; municipality; Makkah; project prioritization; EXPRO; AHP; EFA

1. Introduction

Municipalities are essential in achieving the objectives set at the local level, primarily through the development of urban planning and infrastructure. However, poor integration policies often lead to mergers, conflicts, layoffs, and service affordability. Selecting one or more projects from a list of options is among the most daunting decisions faced by performance-oriented businesses and organizations. To be successful and serve their resources well, Cities are committed to making informed decisions that align with their short-term and long-term goals. Cities are urban units within local government, representing subdivisions within a service area. In these municipalities, municipal departments were established to administer comprehensive local government tailored to the needs of specific populations within a defined geographical area. Project selection is based on various factors, including current conditions, long-term aspirations, and other important considerations. Role selection, a combination of planning and decision-making, is complex. One of the complicating factors of this process is the need to make decisions within a firm's strategic objectives and organizational planning framework, all while considering each project's financial and organizational benefits. There are many ways to evaluate and select projects, but no method is universally accepted, as each has pros and cons. Generally, the selection process is based on the characteristics of the managers and the issues and strategies that best suit the organization (Dutra et al., 2014; Iamratanakul et al., 2008).

Projects should be prioritized based on the benefits they bring to the organization, which can be quantified by metrics such as ROI, strategic planning, or other relevant metrics (Petro and Gardiner, 2015). This study aims to develop a model for prioritizing municipal projects in the Municipality of the Holy Capital (Makkah) City. This study does not include the prioritization of municipal projects, such as road maintenance, public facility maintenance, urban sanitation projects, etc., as they are inherently important projects to be undertaken and cannot be avoided. Multi-criteria decision-making (MCDM) methods are statistical tools that assist decision-makers (D.M.s) in analyzing and making policy decisions based on conflicting criteria in complex situations (Alipour Vaezi et al., 2020). Job availability includes selection and input methods; MCDM is one of the most influential and practical methods (Tavakkoli-Moghaddam et al., 2020). In MCDM methods, the main challenge for D.M.s is determining the path to the final decision (Alipour-Vaezi et al., 2022). Typically, this challenge is posed in reverse: assuming a decision has been made, the task becomes to identify a rational basis for that decision and assess the D.M.'s preference (Ehsanifar et al., 2013; Mohammad Nazari et al., 2018).

Our proposed model to enable the project to choose the best options will involve the community members' voices as one of the inputs in this model. Community involvement in policy and priority setting also encourages community leadership and gives a voice to the underserved. Their views on priorities may differ. Established by the government of Saudi Arabia (Government Expenditure & Projects Efficiency Authority (EXPRO)) to develop indicators and measurement standards, tools, processes, techniques, and procedures related to expenditure efficiency and projects that contribute to achieving its objectives and working with government agencies they jointly set up internal teams aimed at improving spending and increasing quality of services. EXPRO has criteria for evaluating all government projects based on specific criteria, and each criterion has sub-criteria, which have weights for each criterion and sub-criteria. In the current EXPRO approach, 15% percent has been allocated to evaluate each project for the project phase in line with the seven strategic objectives of the Municipality of Makkah.

However, only some of these strategic objectives include the municipal projects targeted in this study that achieve these objectives. For example, performance goals include attaining economic growth, improving self-efficacy, and improving organizational performance. When we look at the targeted industries to establish a way to compare them, we find that it has only a limited impact on these targeted targets. Similarly, the general objective of creating a healthy and socially responsible urban environment aims to improve the beneficiaries' sanitation in the city, and their satisfaction with public health regarding disease and food safety on the floor of restaurants has increased. This value is also consistent with what has been stated about the previous value. Therefore, the researchers had to improve the efficiency of the methods in evaluating and comparing the project by establishing new criteria for the category of the extent to which municipal projects contribute to achieving the objectives of the municipality of Makkah it is about direction. Despite these criteria, some may need to be more appropriate for municipal projects. Thus, it was necessary to have criteria for selecting and evaluating projects compatible with municipal projects to implement these criteria effectively. The urgency for a new strategy is underscored by the main reasons for the failure of various models in evaluation and application selection (Mohammadnazari et al., 2022).

However, only some of these strategic objectives include the municipal projects targeted in this study that achieve these objectives. For example, performance goals include attaining economic growth, improving self-efficacy, and improving organizational performance. When we look at the targeted industries to establish a way to compare them, we find that it has only a limited impact on these targeted targets. Similarly, the general objective of creating a healthy and socially responsible urban environment aims to improve the beneficiaries' sanitation in the city, and their satisfaction with public health regarding disease and food safety on the floor of restaurants has increased. This value is also consistent with what has been stated about the previous value. Therefore, the researchers had to improve the efficiency of the methods in evaluating and comparing the project by establishing new criteria for the category of the extent to which municipal projects contribute to achieving the objectives of the Municipality of Makkah. It is about direction. Despite these criteria, some may need to be more appropriate for municipal projects. Thus, it was necessary to have criteria for selecting and evaluating projects compatible with municipal projects to implement these criteria effectively. The main reasons for the failure of various models in evaluation and application selection are: (Mohammadnazari et al., 2022)

- D.M.'s judgment and experience are not considered; • Focusing on economic strategies and ignoring the need for integrated strategies; • Failing to choose values that fit the company's strategy; • Various weaknesses in handling non-financial factors. This research focuses on five types of municipal projects: flood protection, road infrastructure, park development, utilities, and digital transformation. These project categories were selected because they represent strategic priorities for Makkah's urban development and align with the broader objectives of Saudi Vision 2030. The projects are:
    1) Flood Protection Projects: These projects are essential for Makkah due to its vulnerability to flash floods during the rainy season. Protecting the city from flooding is crucial to safeguarding infrastructure and public safety.
    2) Road Infrastructure Projects: Road networks are critical for managing the city's growing population and the annual influx of millions of pilgrims. Prioritizing road development supports the efficient movement of people and goods, contributing to local and national economic growth.
    3) Park Development Projects: Green spaces and recreational areas are key to urban sustainability and public well-being. These projects were included to enhance Makkah's residents' and visitors' quality of life.

4) Utility Projects: Utilities such as water supply, electricity, and waste management are fundamental to any city's functioning. These projects were prioritized to ensure that essential services keep pace with urban expansion and the growing demands of Makkah's population.
5) Digital Transformation Projects: As part of Saudi Vision 2030, Makkah is expected to modernize its public services through digitalization. Digital transformation projects focus on integrating technology into municipal services, enhancing operational efficiency, and improving service delivery to residents and visitors.

These project categories were chosen based on their potential to address key infrastructure needs, improve public services, and align with Saudi Vision 2030's strategic goals for sustainable urban development. The study excludes routine maintenance projects as they are ongoing and do not require the strategic prioritization focus that the selected projects demand. By concentrating on these five types of projects, the study aims to provide a targeted framework for decision-makers in Makkah to optimize resource allocation and project selection. Thus, a balanced approach to municipal priorities in Makkah was needed. This approach emphasizes the participation of mainstream citizens in urban decision-making. This study's uniqueness is that, to the best of the researchers' knowledge, it is the first time a strategy has been developed to prioritize municipal projects in the Municipality of the Holy Capital (Makkah) and even Saudi Arabia.

2. Literature review

Many studies have explored this topic, and one of the critical studies from the researcher's perspective is (Baysal et al., 2015); in this study, a two-pronged Fuzzy Multiple Criteria Decision Making (MCDM) approach is proposed for municipal project evaluation and selection. This method has been used in the central provincial City of Konya, Turkey. (Mohammadnazari et al., 2022), presents an integrated approach based on four multi-criteria decision-making (MCDM) methods, namely, TOPSIS, ELECTRE III, VIKOR, and PROMETHEE, to assist builders' decisions in prioritizing post-disaster services.

Furthermore, an aggregation method (linear assignment) generates the final ranking vector since different methods can produce different results. An artificial neural network (ANN) algorithm was used to predict the efficiency. Due to the difficulty of prioritizing concrete bridge projects and parallel problem-solving using Multiple-Criteria Decision-Making (MCDM) methods, Gao et al. (2019) applied the VIKOR method to prioritize various bridge rehabilitation projects. The findings are summarized in **Table 1**.

Table 1. Summary of some of the literature.

Reference	Methodology	Criteria
(Baysal et al., 2015)	• fuzzy TOPSIS • fuzzy AHP	• Meeting societal needs • Resident's satisfaction • Staff satisfaction • Project completion times • Project Cost • Impact on area development • Maintenance cost per year
(Rasa, 2012)	• fuzzy AHP	• Technical/Engineering Parameters • Economic Parameters • Financial Parameters • Environmental Parameters • Social Parameters
(Mohammadnazari et al., 2022)	• VIKOR • TOPSIS • Artificial Neural Network • PROMETHEE	• Financial • Quality • Environmental • Social • customer satisfaction
(Marcelo et al., 2016)	• multi-criteria decision support tool	• social-environmental. • financial-economic
(Simplício et al., 2017)	• AHP. • cost analysis	• Gap value. • Degree of completion. • Level of political ambition. • Political priority
(Jalal et al., 2019)	• Delphi. • Analytic Network Process (ANP). • TOPSIS	• Social. • Environmental. • Financial. • Technical. • Economic
(Jalal et al., 2018)	• A snowball sampling technique was employed to select 30 municipal experts for the survey. • Data analyzed through coding, non-parametric statistics, and Cronbach's alpha for reliability	• Technical. • Risk. • Financial. • Economic. • Social-cultural. • Environmental. • Organizational-political. • Competitiveness. • Obligatory Indexes (support for plans, city policies, project checks, mega-project endorsements, and initial conditions like location and technical factors). • I am selecting Indexes (31 sub-indexes focusing on alignment with needs, environmental protection, project cost, financial facilitation, health impacts, spatial justice, expert experience, investment, and project scale).
(Pujadas et al., 2017)	• AHP • Multi-attribute utility theory (MAUT)	• Investment. • Cofinancing. • Environmental Contribution. • Service Change. • Surrounding Impacts
(Ziara et al., 2002)	• AHP	• Project Importance. • Sector Importance. • Finance Suitability. • Execution Suitability. • Operation Suitability. • Reliability.

Table 1. (*Continued*).

Reference	Methodology	Criteria
(da Silva et al., 2022)	• AHP • TOPSIS • 2-tuple linguistic model	• Social. • Environmental. • Economic. • Technical.
(Benjamin, 1985)	• Linear Goal-Programming	• Reducing investment risk. • We are increasing foreign exchange earning potential. • Political goals. • Social Goals (Employment). • Economic goals. • No multiple projects.

Pakdil (2021) conducted a systematic literature review, identifying 59 articles on project prioritization and selection in Six Sigma research using 111 methods. Analytic Hierarchy Process (AHP) was the most common method in 12 cases (20%). One-third of the methods involve multi-criteria decision-making processes. (Al-Sobai et al., 2024) propose a framework for comparing strategic performance across sectors using a multi-criteria decision evaluation model. The projects are weighted by inter-criteria correlation, compared to TOPSIS, and then vector-weighted. Qatar's real estate and transport sectors determine the strategy. Alpaugh (2008) describes selecting a project for economic development in urban areas. A ten-step process is used to select projects to achieve economic growth in small towns. The method combines a scoring method with the Analytical Hierarchy Process (AHP) for portfolio selection and uses the Benefit-to-Cost Ratio method to evaluate the feasibility of public projects.

Mohagheghi et al. (2019) examines project portfolio selection (PPS) by discussing various aspects, such as criteria used for selection, modeling uncertainty tools, selection and optimization methods, and application areas for such methods this application of Iamratanakul et al. (2008) provides various examples of business portfolio selection and emphasizes that this topic has been extensively studied in the last 40 years. The methods are divided into six categories: utility measurement methods, statistical design methods, simulation and heuristic models, mental analogy methods, real options, and ad hoc models. The most commonly used standards in the literature can be divided into policy, economic, and technical categories, as summarized in **Table 2** (Elbok and Berrado, 2020).

Table 2. Project evaluation and selection criteria (Elbok and Berrado, 2020).

Criteria type	Criteria name	Definition
Strategic criteria	Strategic alignment, Competitiveness improvement, social benefits Environmental benefits Meeting employee's needs Meeting customers' needs Meeting shareholder's vision Market potential/growth	Degree of project alignment with one or many strategic goals Ability of a project to improve competitive advantage Total benefits to society Total benefits to the environment Degree of fulfillment of employees' needs Impact on customer satisfaction Level of alignment with shareholders' vision and objectives Estimated increase/decrease of product sales in a given market

Table 2. (*Continued*).

Criteria type	Criteria name	Definition
Financial criteria	Total investment Uncertainties Total Cost Internal Return Rate (IRR) Net Present Value (NPV) Operating margin Pay-back period (PBP) Accounting rate of return (ARR) Return On Investment (ROI)	Capital expenditure-related amount Difficulty in predicting outcomes because of limited or inexact knowledge All operating costs Discount rate that makes the net present value (NPV) of all cash flows from a particular project equal to zero The difference between the present value of cash inflows and the present value of cash outflows A profitability measure that indicates how much revenues are left over after all the operating costs have been deducted The time required for benefits to match the total invested amount Ratio of average income expected on investment as compared to the initial investment amount Indicates the efficiency of an investment by measuring the amount of return on an investment relative to the invested amount
Technical criteria	Project complexity Time involved Degree of innovation Compliance with the regulatory aspects Resources availability Interrelations with other projects	Difficulty in executing the project scope Project timeframe Either incremental or radical. Incremental innovation describes the significant enhancement of an existing product or service. Radical or breakthroughs create a substantial impact on the concerned market Conformity to laws and regulations Availability of human, technical, or financial resources required by a project Degree of dependency on other projects in terms of resources, benefits, or outcomes

Integrating hybrid models with multi-criteria decision-making (MCDM) techniques has emerged as a robust approach to addressing complex decision-making scenarios by combining computational methods with systematic decision frameworks. Hybrid Monte Carlo Methods, Artificial Neural Networks (ANN), and integrated MCDM techniques offer enhanced precision and adaptability in project evaluation and prioritization. These methods address uncertainties, non-linear data relationships, and multi-faceted criteria, providing comprehensive insights for decision-makers.

Monte Carlo methods are particularly effective for handling uncertainty, enabling probabilistic modeling of decision outcomes. For example, Tuskan and Erzin (2024) demonstrated the effectiveness of Monte Carlo simulations in assessing slope stability under various scenarios. By simulating multiple conditions, this approach provided probabilistic insights, improving the reliability of risk assessments. When combined with MCDM, Monte Carlo methods enable decision-makers to prioritize projects with a deeper understanding of associated risks and potential outcomes.

Artificial Neural Networks (ANN) excel at predictive modeling, especially in scenarios involving non-linear data relationships. Studies like Erzin and Tuskan (2019) and Erzin and Tuskan (2017) highlighted ANN's ability to predict safety factors and geotechnical parameters with high precision. Similarly, Tuskan and Uncu (2024) showcased how ANN could predict the structural performance of heavily loaded infrastructures. Integrating ANN with MCDM enhances the accuracy of inputs and ensures data-driven decision-making when evaluating complex alternatives.

Hybrid MCDM techniques, such as integrating AHP and VIKOR, further strengthen decision-making by leveraging the strengths of both approaches. For instance, Tuskan and Basari (2023) demonstrated how combining AHP for criteria weighting and VIKOR for alternative ranking provided a balanced evaluation across technical, economic, and environmental factors. This approach highlights the efficiency of hybrid models in delivering comprehensive evaluations, particularly in projects requiring multi-faceted decision frameworks.

The paper addresses several critical gaps in the existing literature on project management, particularly in the context of municipal projects. It addresses the need for a tailored model for municipal project prioritization in the Holy Capital (Makkah) municipality, a context often overlooked in traditional management approaches. The study encourages a more participatory approach to city planning by incorporating community input into the project selection process. It addresses the use of broader stakeholder objectives of the project, which is often underutilized in the project management literature. Furthermore, the paper enhances the methodology by applying Multi-Criteria Decision-Making (MCDM) techniques such as Exploratory Factor Analysis (EFA) and Analytic Hierarchy Process (AHP) to prioritize projects across the snow. It critiques and enhances the assessment standards used by the Government's Economic and Development Commission (EXPRO), ensuring they are more relevant to urban infrastructure in Makkah. Furthermore, aligning municipal projects with Saudi Arabia's Vision 2030 provides a methodological approach that has been relatively unexplored in the current literature, thus providing theoretical advances and valuable tools for personnel management. By addressing this gap, the paper presents a comprehensive framework that advances the academic understanding of priorities in a municipal context and provides practical tools and techniques that practitioners can use directly.

3. Methodology

3.1. Research design

This study follows a quantitative research design to develop a robust model for prioritizing municipal projects in the Municipality of the Holy Capital (Makkah). The research design is grounded in the application of Multi-Criteria Decision-Making (MCDM) techniques, specifically the Analytic Hierarchy Process (AHP) and Exploratory Factor Analysis (EFA). These techniques were chosen due to their suitability in dealing with complex decision-making processes that involve multiple criteria. The AHP technique allows for comparing different municipal projects based on weighted criteria, while EFA is used to identify latent factors influencing project prioritization.

The study's design involves three key phases:

1) Data Collection: A structured survey was developed and administered to gather expert opinions.
2) Exploratory Factor Analysis (EFA): Used to identify and confirm the critical factors influencing project prioritization.
3) Analytic Hierarchy Process (AHP): Applied to weigh the factors and sub-factors derived from EFA and prioritize municipal projects based on these weighted criteria.

3.2. Sample and respondent details

The study's sample comprises experts and decision-makers from various departments in Makkah Municipality. These respondents were selected based on their involvement in municipal project planning, budgeting, and execution. The selection criteria for respondents ensured that participants had sufficient knowledge and experience in municipal project management, particularly in areas related to infrastructure development, urban planning, and budget allocation.

A purposive sampling method was used, targeting individuals holding senior positions such as:

- Directors of Infrastructure Planning
- Project Managers
- Budget Officers
- Urban Development Advisors

Purposive sampling was employed to ensure that only stakeholders with relevant expertise in municipal planning and project management were included, maximizing the relevance and accuracy of the input. The sample size of 56 was determined based on the availability of experts and the need for diverse representation across sectors. The study included 56 respondents, ensuring a broad representation of expertise from different municipal departments. This sample size was deemed adequate for conducting Exploratory Factor Analysis (EFA) and AHP, as it provided sufficient variance across responses to identify meaningful patterns.

3.3. Data collection and survey questionnaire

A structured survey questionnaire was developed to collect data on the factors influencing project prioritization. The survey was designed based on a comprehensive literature review and consultations with municipal project experts. The questionnaire consisted of two sections:

1) Demographic Information: This section collected data on the respondents' roles within the municipality, their years of experience, and the projects they typically manage.
2) Project Prioritization Criteria: Respondents were asked to rate a series of criteria related to project prioritization on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). The criteria were grouped into factors such as "Capacity and Demand," "Strategic Alignment," "Project Interdependency," "Risk," and "Increasing Investment."

   The survey included items like:

   - "This project fills a critical infrastructure gap."
   - "The project aligns with Saudi Vision 2030's strategic goals."
   - "The project is interdependent with other ongoing municipal projects."
   - "There is a significant risk associated with the project's completion."
   - "The project has the potential to attract external investment."

After collecting the completed questionnaires, data was entered into SPSS 26 for analysis. The questionnaire's reliability was tested using Cronbach's Alpha, and any items falling below the acceptable threshold (0.70) were revised or removed.

3.4. Exploratory factor analysis (EFA)

EFA was conducted to identify latent variables that influence municipal project prioritization. Principal component analysis with Varimax rotation was used to extract the factors. The Kaiser-Meyer-Olkin (KMO) test and Bartlett's Test of Sphericity were conducted to ensure the data was suitable for factor analysis. KMO values above 0.80 indicated the adequacy of the sample for factor analysis.

Factors were extracted based on an eigenvalue greater than 1, and items loading at least 0.40 on a factor were retained. The final factor structure revealed five primary latent factors: “Capacity and Demand,” “Strategic Alignment,” “Project Interdependency,” “Risks,” and “Increasing Investment.”

3.5. Analytic hierarchy process (AHP)

Following identifying factors through EFA, the AHP method was applied to prioritize the projects. The respondents were asked to perform pairwise comparisons between the identified factors, ranking them based on their relative importance. These comparisons created a weighted scoring system, where each factor’s weight contributed to the overall project prioritization score.

For example:

- Capacity and demand were the most critical factors, receiving a weight of 0.5643.
- Strategic Alignment received a weight of 0.2013.
- Project Interdependency was weighted at 0.1088, indicating moderate importance in project prioritization.
- Risks and Increasing Investment were the least influential, with weights of 0.0306 and 0.0950, respectively.

The AHP results were validated using the AHP-OS online system to ensure consistency in the judgments provided by respondents.

Their criticality guided the selection of projects to public safety, economic impact, and alignment with Vision 2030. Flood prevention ranked highest due to its direct influence on community safety and infrastructure resilience

4. Results and data analysis

4.1. Current methods used in Makkah municipality for identifying the municipal project needs of the city of Makkah

Makkah municipality and other municipalities follow fixed evaluation criteria set by EXPRO, shown in **Table 3**.

EXPRO evaluation criteria consider the following subjects in their criteria:

- Vision 2030 goals for the Kingdom of Saudi Arabia.
- Strategic objectives of the Ministry of Municipal and Rural Affairs and Population.
- Strategic objectives of the Holy Capital Municipality.
- The ministry’s strategic plan and its indicators contribute to achieving the Vision 2030 targets.
- Results of capacity and demand studies for projects supervised by the Holy Capital Municipality aimed at identifying priority sectors in the future developmental directions of Makkah.
- Targets of the strategic programs for the Kingdom, along with their indicators and executive plans.
- Targets of strategic initiatives and their indicators.

- National Urban Strategic Policies for 2030.

1	
Alignment of the economic objectives of the Municipality of the Holy Capital	**15%**
Initial Verification	20
Achieving sustainable urban development and improving the quality of life	8
Development and improvement of infrastructure and public facilities	12
Developing municipal services and providing them with high quality	8
Raising the efficiency of offering and implementing projects supporting municipal services	12
Providing an urban environment with healthy living and promoting social responsibility	9.6
Department of Land and Public Property Affairs	12
Achieving financial sustainability, self-sufficiency and developing institutional performance	18.4

2	
Aligning the strategic objectives of the Kingdom's Vision 2030	**15%**
Promoting Islamic values and national identity	
Enabling a full and healthy life	
Development and diversification of the economy	
Increase employment rates	
Enhancing Government Effectiveness	
Enabling Social Responsibility	

3	
Needs Assessment	**30%**
Needs assessment based on total projected needs in the service area	20
Project coherence, reliability and the need for a capital project	10

4	
Financial and economic criterion	**17.4%**
Enhancing financial sustainability	3
Improving the balance of current accounts (balance of payments) in the Kingdom	5.1
Increase non-oil GDP	3.9
Promoting Foreign Direct Investment	1.8
Increase local content	3.6

5	
Social and environmental impact	**12.6%**
Increasing the percentage of Saudis employed in the Saudi private sector	3.9
Addressing social inequality	3.3
Improving the quality of life	3
Building Competitive Cities	1.2
Environmental impact mitigation	1.2

6	
Risk assessment	**20%**
Construction-related hazards	5
Risks related to the type of project	5
Risks related to financing	5
Risks related to performance	5

Figure 1. Evaluation criteria set by EXPRO.

As shown in **Figure 1**. the EXPRO criteria are specifically designed to align with national economic objectives and broader policy objectives, such as those outlined in Saudi Arabia Vision 2030. While these criteria are appropriate for evaluating projects in a national or financial sector, if they are focused on that, they are only slightly more suitable for municipal projects, which generally require a local approach and more community management. Municipal projects typically focus on improving local services, improving the quality of life for residents, and meeting specific community needs. These projects usually require standards emphasizing local impact, community engagement, and environmental sustainability. However, the EXPRO standard provides a wide range of economic outcomes and processes, which may not adequately capture the nuances and priorities of urban infrastructure. Furthermore, the weights and classifications in the EXPRO standard may take time, but they can usefully reflect urban concerns, such as urban planning. As such, refined standards that address the unique challenges and goals of urban projects would be more relevant to ensure that these projects adequately meet the needs of their communities.

4.2. Proposed method for establishing criteria for prioritizing among these needs

4.2.1. Evaluating EXPRO criteria

In Saudi Arabia, any government agency that wants the Ministry of Finance to allocate funds to its projects must subject the project to the evaluation criteria specified in an Excel file prepared by the Expenditure Efficiency Authority. During this review, the Ministry of Finance will approve the project. Despite the quality of the standards set by the Efficient Spending Authority, most of these standards still need to be followed by municipal projects. This standard applies to all businesses in the Kingdom of Saudi Arabia. Furthermore, formatting the Excel file takes a long time because the total number of values exceeds one hundred and eighty values, and it is necessary to rethink the number and type of these values. From this perspective, the researcher has established this criterion as the basis for developing an appropriate criterion for municipal projects.

Since EXPRO has adopted standards of the industry and based on our findings while analyzing the standards set by EXPRO efficiency and how the decision-makers in the Municipality of Makkah expressed the inappropriateness of a standard for urban projects, we conducted a comprehensive review of all standards developed by EXPRO. In addition, we have requested that experts provide us with any additional criteria they consider necessary to include in evaluating the Municipality's project. The authors developed a 188-item questionnaire on the approval of urban projects. The questionnaire contained questions about project success, rated on a 5-point Likert scale (1—strongly disagree; 2—disagree; 3—neither agree nor disagree; 4—agree; 5—agree absolutely). The questionnaire was completed by employees closely linked to municipal projects. Fifty sex participants filled out this questionnaire.

The reviewers were assigned based on the criteria set by EXPRO to evaluate each project and subsequently approve it if the project achieves a certain percentage through this review. The researcher also referred to previous literature and case studies to find factors affecting project evaluation, especially municipal projects. In addition, the researcher consulted with experts in the field of municipal projects on the factors that influence the assessment of the comparative importance of municipal projects. The initial validation of the questionnaire required the expert judgment approach, with the participation of three experts. These experts examined the importance of each factor in assessing the factors affecting the approval of municipal projects. Experts also questioned the apparent validity and readability of the questionnaire. They were asked to qualitatively evaluate and comment on the adequacy of the information provided by the instrument on municipal services and the clarity and terminology of the items.

Considering the experts' feedback, several elements were modified minorly. Eventually, the final questionnaire was derived, showcasing its hierarchical structure through factor analysis.

For this purpose, the authors designed a questionnaire using a five-point Likert scale and distributed it to persons related to municipal projects in different departments inside Makkah Municipality.

4.2.2. Exploratory factor analysis (EFA)

Exploratory factor analysis measures the underlying factors that affect the variables in a data structure without defining a predefined outcome structure.

After collecting this questionnaire, the authors analyzed it using SPSS software to conduct an EFA. The researcher then determined the final factors and subfactors to evaluate the municipal projects.

We performed an exploratory factor analysis using the varimax method. The researcher implemented EFA on the data collected based on the following criteria:

- Principal component analysis as an extraction method.

- Varimax with Kaiser normalization as rotation method.
- The coefficient values should be more than 0.4

The researcher chose eigenvalues that were more significant than 1 for extraction.

Table 3. The total variance explained.

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	45.503	24.464	24.464	45.503	24.464	24.464
2	27.913	15.007	39.471	27.913	15.007	39.471
3	22.848	12.284	51.755	22.848	12.284	51.755
4	19.028	10.230	61.985	19.028	10.230	61.985
5	17.036	9.159	71.145	17.036	9.159	71.145
6	14.041	7.549	78.694	14.041	7.549	78.694
7	12.845	6.906	85.600	12.845	6.906	85.600
8	10.969	5.898	91.497	10.969	5.898	91.497
9	8.757	4.708	96.205	8.757	4.708	96.205
10	7.058	3.795	100.000	7.058	3.795	100.000

From **Table 3,** the authors considered the Kaiser criterion and examined the scree plot to determine the appropriate number of factors. Initially, the analysis was conducted without limiting the number of factors, resulting in ten with eigenvalues exceeding 1.0. Through a gradual refinement process and considering additional measures of model quality, the ultimate factor structure comprises eight factors and 188 variables. This refined model captures a substantial portion of the total Variance, amounting to 91.497%. Generally, the Variance explained value should be 50% or higher (Streiner, 1994).

The findings were evaluated, and it was determined that this ten-factor structure, comprising 188 items, met the cutoff values established in the literature.

Table 4. Results of the KMO.

Test	Value
Kaiser-Meyer-Olkin Measure of Sampling Adequacy	0.926
Bartlett's Test of Sphericity: Approx. Chi-Square	110427.853
df	16110
Sig.	< 0.001

The Kaiser–Meyer–Olkin (KMO) test assesses the suitability of data for factor analysis, examining how well the indicators of a construct are related. Ideally, the KMO value should exceed 0.80, though a value above 0.60 is generally acceptable (Elsaman et al., 2022). When variables within a relatively homogeneous set show high correlations, it indicates that they can be consistently categorized. Bartlett's sphericity test evaluates the correlation matrix's factorability, which can then be assessed using statistical methods. In **Table 4**, the KMO test yielded a value of 0.926, indicating vital significance. The KMO value of 0.926 confirms the dataset's high sampling adequacy, suggesting that variables are significantly correlated and suitable for exploratory factor analysis. Bartlett's test further supports this with a significant *p*-value (< 0.05), confirming that the correlation matrix is not an identity matrix and, thus, appropriate for factor extraction. This combination validates the factor structure and ensures the robustness of the results. This result affirms the adequacy of the sample for the KMO test. The Kaiser–Meyer–Olkin and Bartlett sphericity test results indicated that the EFA method was appropriate for this study.

After that, the researcher performed a reliability test and conducted an exploratory factor analysis for all factors; all the results for the reliability test were above 0.70, which is acceptable. Many sources suggest that a value above 0.70 is adequate, with 0.80 or higher preferred. (Cortina, 1993).

4.2.3. Descriptive analysis findings

Statistical computations were performed using the Statistical Package for Social Science (SPSS) version 26. The research design used a descriptive method.

Descriptive analysis comprised several components, including frequency distribution and percentage calculations. Additionally, measures of central tendency such as mean and standard deviation were computed, along with skewness and kurtosis values for the dataset.

The mean scores for variables, measured on a five-point Likert scale, ranged from 1.5 to 4.7. Skewness parameters varied between −3.464 and 1.733, while kurtoses ranged from −2.263 to 12. Notably, some of these values fall above the threshold proposed by Lei and Lomax (Lei et al., 2005), which suggests that, in absolute terms, they should be at most 2.3.

Table 5 summarizes the scoring range of the Likert scale used in this study (Sözen et al., 2019).

Table 5. Scoring range of the Likert scale of the survey

From	**To**	
Mean		**Interpretation**
1	1.8	Strongly Disagree
1.81	2.6	Disagree
2.61	3.4	Neutral
3.41	4.2	Agree
4.21	5	Strongly Agree

To filter the variables, we first eliminated those with a mean ranging from 1 to 2.6, as this suggested that the survey participants did not agree with these variables. Only variables with a mean of 2.61 or higher were retained. Additionally, the variables that were removed were reviewed by five experts from the Holy Capital Municipality in Makkah to confirm that their exclusion was logical and that they were not relevant to the municipal projects targeted in this study. The experts validated the removal of these variables. From this first filtration step, we eliminate 40 variables.

Secondly, we presented the variables with a mean ranging from 2.61 to 3.4 (neutral) to the experts for their opinion on removing or retaining them. Most variables within this range were removed, while a few were retained based on the experts' recommendations.

Thirdly, we looked at the variables whose skewness and kurtosis values were not within the range ±2 and showed them to the experts to decide whether to eliminate or keep the variable. Some of the variables were removed, and the other was kept. (Hair et al., 2010) recommends that, for univariate normality, skewness and kurtosis values should ideally lie within the range of ±2 to prove normal univariate distribution. After conducting elimination in steps 2 and 3, we reached thirty-nine variables divided into five factors. Once again, we asked the experts to distribute the variables across the five factors based on the relationship between the variables according to their nature. For example, variables related to capacity and demand were grouped under one factor, and variables related to risks were also placed under a single factor. Afterward, it was observed that many variables could be combined into a single variable. For instance, variables from 99 to 105 could be merged into just one variable, with the rest eliminated. Ultimately, we reached two twenty-two variables that disturbed it in all five factors.

Table 6. Final factors name.

Factor No.	**Factor Name**	**No. of variables**
F1	Capacity and Demand	3
F2	Project interdependency with other projects	4
F3	Strategic Alignment	9
F4	Risks	3
F5	Increasing investment	3

Table 7. Factors and subfactors names.

No.	Factor Name	Variables
1	Capacity and Demand	Amount of the asset gap
		Contribution to covering the asset gap
		Citizen's voice
2	Project interdependency with other projects	Connection of the project with other "completed" projects
		Connection of the project with other "ongoing" projects
		Dependence of the project on other "ongoing or completed" projects
		Availability of an approved feasibility study for the project
3	Strategic Alignment	Contributing to the development of e-government
		Contributing to the development and diversification of entertainment opportunities to meet the needs of the population
		Contributing to the protection of the environment from natural hazards
		Contributing to the provision of high-quality services to pilgrims and Umrah performers
		Contributing to enhancing the quality of services provided in Saudi cities (public facilities, public transport, etc.)
		Contributing to the improvement of the urban landscape in Saudi cities
		Contributing to the enhancement of traffic safety
		Contributing to public health by eliminating pests
		Contributing to the promotion of sports activities in the community

Table 7. (*Continued*).

No.	Factor Name	Variables
4	Risks	Presence of services that need to be relocated. Presence of sites that require expropriation. Lack of approval from the Project Coordination Office.
5	Increasing investment	Maximizing Revenue from Services The municipality's projects contribute to maximizing government revenue Alternative financing opportunities are available to implement the project.

Consequently, all factors were ultimately categorized into five factors; the researcher requested experts to name each latent variable for all five latent variables based on the elements of each latent variable. The agreed names are listed in **Table 6**, and the subfactors are listed in **Table 7**.

These factors are critical for evaluating and prioritizing municipal projects. Here is a detailed explanation of each factor:

1) Capacity and Demand (F1):

This refers to the scarcity or depletion of all critical assets (such as roads, parks, etc.) needed to meet current and future demands. The property gap highlights the need for more existing properties to meet the City's needs. For example, suppose Makkah has 100 kilometers of roads (capacity) but needs 300 kilometers (demand) to serve its population efficiently. In that case, the asset gap becomes a 200-kilometer capital budget specific to the difference between capacity and demand in position-specific internal identification of asset class, such as the development of parks. If there is a gap (indicating that demand exceeds capacity), there is an apparent reason to increase capacity through additional capital projects (i.e., specific budgets). On the other hand, if there is a surplus (meaning demand is less than capacity), no additional capital is needed.

- The amount of the Asset Gap refers to the difference between the current infrastructure or service capacity and the demand. Projects addressing significant gaps are prioritized as they respond directly to pressing needs.
- Contribution to Covering the Asset Gap: Evaluate how much the project reduces the identified asset gap. Projects that substantially close the gap are more valuable.
- Citizen's Voice: Measures the Degree to which the project aligns with public demands or addresses concerns voiced by citizens, reflecting community needs and preferences.

2) Project Interdependency with Other Projects (F2):

It refers to the interrelationships among multiple projects in a portfolio in which one or more other projects directly or indirectly influence a project's results, growth, or success. This interaction can manifest in many ways, such as shared resources, sequencing, shared goals, or influence among the same stakeholders.

- Connection of the Project with Other "Completed" Projects: Assesses whether the project builds on or enhances previously completed projects. Synergies between projects can lead to more significant overall benefits.

- Connection of the Project with Other "Ongoing" Projects: Evaluate how the project integrates with ongoing projects. Projects that align with or complement ongoing efforts are often more strategically important.
- Dependence of the Project on Other "Ongoing or Completed" Projects: Considers whether the project's success depends on the completion of other projects. High dependency can introduce risks or delays.
- Availability of an Approved Feasibility Study for the Project: This check ensures that a feasibility study has been conducted and approved, making the project practical, cost-effective, and likely to succeed.

3) Strategic Alignment (F3):

Planning ensures that projects support broader objectives that align with Saudi Vision 2030 and the City's vision. For example, one of the objectives of Vision 2030 is to increase the number of pilgrims per year from 2 million to 5 million and to increase the number of Umrahs from the current 8 million to 30 million per year; this ambitious plan makes it necessary for the Municipality of Makkah to examine the infrastructure of the city. This analysis includes determining the appropriateness of this high pass rate. Based on the differences in capacity and requirements, the relevant authorities in the Municipality of Makkah have proposed necessary initiatives.

- Contributing to the Development of E-Government: Projects that support the transition to digital government services are aligned with modernization goals.
- Contributing to the Development and Diversification of Entertainment Opportunities to Meet the Population's Needs: Assesses how the project enhances entertainment and recreational facilities to serve a growing and diverse population.
- Contributing to the Protection of the Environment from Natural Hazards: Evaluate the project's role in safeguarding the environment against risks like floods, landslides, or other natural disasters.
- Contributing to the Provision of High-Quality Services to Pilgrims and Umrah Performers: Measures the project's impact on improving pilgrim services and facilities, a key objective for Saudi cities like Makkah and Madinah.
- Contributing to the Enhancement of the Quality of Services Provided in Saudi Cities (Public Facilities, Public Transport, etc.): Look at how the project improves essential services like public transport, utilities, and public spaces.
- Contributing to the Improvement of the Urban Landscape in Saudi Cities: Considers whether the project enhances the visual and functional appeal of urban areas, such as parks, streetscapes, and public areas.
- Contributing to Enhancing Traffic Safety: Evaluate the project's potential to reduce accidents and improve road safety.
- Contributing to Public Health by Eliminating Pests: This assessment assesses whether the project addresses public health concerns by controlling or eliminating pests.

- Contributing to the Promotion of Sports Activities in the Community: This section examines the project's impact on encouraging sports and physical activities within the community.

4) Risks (F4):

This includes risks that could affect the project's development if approved and included in the list of approved projects in the Holy Capital Municipality. These hazards include things that need to be relocated, such as underground or aboveground power or water lines. Other dangers and areas requiring expropriation exist for the benefit of the city. Finally, there are other opportunities for the business; this means having different options or financing options and services that can be used if traditional methods are not possible, such as being able to implement the project through the private sector, where some private entities will bid for the project themselves and then benefited from it.

- Presence of Services that Need to Be Relocated: This determines whether critical services (e.g., utilities, roads) must be relocated to accommodate the project, which could increase costs and complexity.
- Presence of Sites that Require Expropriation: Evaluate whether the project requires acquiring private land, which can lead to legal challenges and delays.
- Lack of Approval from the Project Coordination Office: Considers the risk of proceeding without necessary approvals, which could cause delays or project failure.

5) Increasing Investment (F5):

This refers to strategic efforts to enhance financial resources for municipal projects by maximizing revenue from services, ensuring that the Municipality's projects significantly contribute to government revenue, and identifying and utilizing alternative financing opportunities to implement projects effectively.

- Maximizing Revenue from Services: Assesses whether the project generates income, making it financially sustainable and beneficial for the Municipality.
- The Municipality's Projects Contribute to Maximizing Government Revenue: Evaluate how the project supports broader government revenue goals, such as increased tax income or economic growth.
- Alternative Financing Opportunities Available to Implement the Project: This section examines the availability of external funding sources, such as grants, partnerships, or private investments, that can reduce the Municipality's financial burden.

4.2.4. AHP Prioritization for five types of projects included in this study

The researcher conducted pairwise comparison and column-normalized matrixes for all latent variables and subfactors in this study using Excel software and verified the results with the AHP Online System (AHP-OS; https://bpmsg.com/ahp/index.php?logout). The results for the pairwise comparison matrix and column-normalized matrix for all the primary factors are listed in **Table 6**.

To do that, we must first categorize the projects. The proposed categorization is based on the five target projects in this study's scope: roads, parks, utilities, flood protection, and digital transformation.

These types of projects represent critical areas in urban development and infrastructure. Here is an explanation of each:

1) Roads:

Road projects involve planning, construction, and maintenance of roadways. This includes building new roads, expanding existing ones, and improving road quality through repairs and upgrades. Such projects are essential for enhancing transportation networks, reducing traffic congestion, and improving connectivity within and between cities.

2) Parks:

Park projects focus on creating, renovating, or enhancing public green spaces. This includes designing and building parks, recreational areas, and community gardens. Parks contribute to the quality of life by providing spaces for leisure, promoting environmental sustainability, and enhancing urban aesthetics.

3) Utilities:

Utility projects involve developing and maintaining essential public services like water supply, sewage systems, electricity, gas, and waste management. These projects are critical for ensuring communities' access to vital services for daily living and economic activity.

4) Flood Protection:

Flood protection projects aim to safeguard communities from flooding risks by constructing dams, levees, drainage systems, and floodwalls. These projects also include river bank reinforcement and the development of flood management plans. Flood protection is vital for reducing damage to property and infrastructure and protecting lives during extreme weather events.

5) Digital Transformation:

Digital transformation projects involve integrating digital technologies into municipal services and infrastructure to improve efficiency and accessibility. This can include implementing innovative city technologies, automating public services, and enhancing data management systems. Such projects aim to modernize operations, improve service delivery, and create a more connected and responsive urban environment.

The five experts were asked to weigh these five project categories. **Table 8** shows a pairwise comparison and column-normalized matrix for all five types of projects included in this study.

Table 8. Pairwise comparison and column-normalized matrix for all five types of projects included in this study.

PAIR-WISE COMPARISON MATRIX					
F5	**F4**	**F3**	**F2**	**F1**	**Type of Project**
9.00	0.33	7.00	5.00	1.00	Roads
3.00	0.33	1.00	1.00	0.20	Parks
2.00	0.20	1.00	1.00	0.14	Utilities
7.00	1.00	5.00	3.00	3.00	Floods protection
1.00	0.14	0.50	0.33	0.11	Digital transformation
22.00	2.01	14.50	10.33	4.45	TOTAL

Table 8. (*Continued*).

COLUMN-NORMALIZED MATRIX								
Consistency Measure	**Weight**	**Total**	**F5**	**F4**	**F3**	**F2**	**F1**	
5.45	0.3532	1.77	0.41	0.17	0.48	0.48	0.22	**F1**
5.04	0.1026	0.51	0.14	0.17	0.07	0.10	0.04	**F2**
5.14	0.0776	0.39	0.09	0.10	0.07	0.10	0.03	**F3**
5.82	0.4249	2.12	0.32	0.50	0.34	0.29	0.67	**F4**
5.15	0.0416	0.21	0.05	0.07	0.03	0.03	0.02	**F5**
	1.00	5.00	1.00	1.00	1.00	1.00	1.00	
							0.08	**CI**
							0.07	**CR**

Because (n) is significant for most factors, the following R.I. values are used in **Table 9**.

Table 9. R.I. values based on N numbers (Golden and Wang, 1990).

Dimension (*N*)	**RI**
1	0.00
2	0.00
3	0.5799
4	0.0892
5	1.1159
6	1.2358
7	1.3220
8	1.3952
9	1.4537
10	1.4882

Table 10 shows all five types of projects included in this study and their weight.

Table 10. Five types of projects and their weights were included in this study.

Project type	**Weight**	**%**
Roads construction	0.3532	35.32
Parks	0.1026	10.26
Utilities	0.0776	7.76
Floods protection	0.4249	42.49
Digital transformation	0.0416	4.16

From **Table 10**, it is clear that flood protection projects hold the highest importance among the five types of projects related to this study, with a weight of 0.4246. Road projects rank second in importance, with a weight of 0.3532, while park construction projects come in third, with a weight of 0.1026. Utility and digital transforming projects came in fourth and fifth place, respectively, with weights of 0.0776 and 0.0416.

4.2.5. AHP prioritization for main factors and subfactors

The researcher used Excel software to conduct pair comparison and column-normalized matrixes for all five latent variables and subfactors in this study and verified the results with the AHP Online System (AHP-OS; https://bpmsg.com/ahp/index.php?logout). The five experts were asked to weigh the main five factors we get from EFA. The results for the pairwise comparison matrix and column-normalized matrix for the five latent factors (F1, F2, F3, F4, F5) are listed in **Table 11**.

Table 11. Pairwise comparison and column-normalized matrix for five latent factors (F1, F2, F3, F4, F5).

PAIR-WISE COMPARISON MATRIX					
F5	**F4**	**F3**	**F2**	**F1**	
7.00	9.00	5.00	7.00	1.00	Capacity and Demand
1.00	7.00	0.33	1.00	0.14	Project interdependency with other projects
3.00	7.00	1.00	3.00	0.20	Strategic Alignment
0.20	1.00	0.14	0.14	0.11	Risks
1.00	5.00	0.33	1.00	0.14	Increasing investment
12.20	29.00	6.81	12.14	1.60	TOTAL

COLUMN-NORMALIZED MATRIX								
Consistency Measure	**Weight**	**Total**	**F5**	**F4**	**F3**	**F2**	**F1**	
5.80	0.56	2.82	0.57	0.31	0.73	0.58	0.63	**F1**
5.20	0.11	0.54	0.08	0.24	0.05	0.08	0.09	**F2**
5.66	0.20	1.01	0.25	0.24	0.15	0.25	0.13	**F3**
5.11	0.03	0.15	0.02	0.03	0.02	0.01	0.07	**F4**
5.31	0.10	0.48	0.08	0.17	0.05	0.08	0.09	**F5**
	1.00	5.00	1.00	1.00	1.00	1.00	1.00	
							0.10	**CI**
							0.09	**CR**

Table 12 shows the weights of five latent factors after conducting AHP on it.

Table 12. Weights for All five Latent factors.

	Factor Name	**Weight**
F1	Capacity and Demand	0.5643
F2	Project interdependency with other projects	0.1088
F3	Strategic Alignment	0.2013
F4	Risks	0.0306
F5	Increasing investment	0.0950

The results and discussion reveal the application of a Multi-Criteria Decision-Making (MCDM) model, primarily integrating Exploratory Factor Analysis (EFA) and Analytic Hierarchy Process (AHP), to optimize project prioritization in the Municipality of Makkah. The research identified five primary types of municipal projects: flood protection, road construction, park development, utilities, and digital transformation. According to **Table 13**, Capacity and Demand emerged as the most critical, weighing 0.5643, followed by the risks factor at 0.3060, then the Strategic Alignment factor at 0.2013. The analysis highlighted "Capacity and Demand" as the most significant latent factor influencing project success, emphasizing the strategic importance of ensuring alignment with local needs. This model offers a refined approach to decision-making, ensuring alignment with Saudi Vision 2030 and addressing regional and national priorities.

This study aimed to develop a prioritization model for municipal projects in the Municipality of the Holy Capital (Makkah) using Multi-Criteria Decision-Making (MCDM) techniques, particularly the Analytic Hierarchy Process (AHP) and Exploratory Factor Analysis (EFA). The findings indicate that flood protection projects were prioritized, followed by road projects, park development, utilities, and digital transformation. This section will discuss these results in the context of previous research and highlight the significance of "Capacity and Demand" as the most influential factor in the model, alongside its alignment with Saudi Vision 2030.

4.3. Comparison with previous research

The prioritization of flood protection projects in this study aligns with previous studies that emphasize the critical role of infrastructure resilience in urban planning. For instance, Gao et al. (2019) applied the VIKOR method to rank bridge rehabilitation projects. They found that projects focused on mitigating natural disasters, like flood protection, were often deemed most critical due to their direct impact on public safety and long-term sustainability. Similarly, Baysal et al. (2015) utilized a fuzzy MCDM approach for municipal project evaluation in Konya, Turkey, where societal needs and infrastructure protection were prioritized over other developmental projects.

However, our study's second-highest prioritization of road projects diverges slightly from other studies that often place utilities and public health infrastructure ahead of transportation projects. For instance, Pujadas et al. (2017) used AHP and found that public health and utilities often rank higher due to their immediate and measurable impact on population well-being. This study's relatively lower prioritization of utilities and digital transformation projects may be attributed to Makkah's specific socio-economic and environmental context, where road infrastructure and flood protection are of more immediate concern.

4.4. Relevance to Vision 2030

The study's findings also align with the broader objectives of Saudi Vision 2030, particularly in its emphasis on sustainable urban development and infrastructure improvement. The prioritization of flood protection and road projects resonates with Vision 2030's goals of enhancing the Kingdom's infrastructure to accommodate economic growth and improving public services to boost the quality of life. Road and flood protection projects directly contribute to the Vision's focus on infrastructure resilience and sustainability.

Furthermore, the "Strategic Alignment" factor, ranked second in the model, reflects the necessity of aligning municipal projects with national strategic goals. Projects that enhance the urban environment, such as road networks and flood control, address immediate public safety and mobility concerns and contribute to the broader objectives of diversifying the economy and increasing the capacity to host more pilgrims in the future. This strategic alignment ensures that municipal priorities contribute to national development goals, thus reinforcing the interdependence between local and national planning efforts under Vision 2030.

On the other hand, the lower prioritization of digital transformation projects, while surprising given Vision 2030's strong focus on digital economy development, may indicate that such projects, while crucial, are seen as less urgent compared to Makkah's immediate physical infrastructure needs. This suggests that future iterations of the model could incorporate additional criteria that give greater weight to long-term digital transformation goals in line with Vision 2030's aspirations.

4.5. Implications for municipal planning

The results of this study provide a clear framework for municipal decision-makers in Makkah to prioritize projects that fill critical capacity gaps and align with national strategic goals. By focusing on projects with the highest demand and capacity gaps, such as flood protection and road infrastructure, the municipality can ensure that resources are directed toward areas with the most immediate impact on public safety and mobility. Additionally, the model's emphasis on strategic alignment ensures that local projects contribute to national goals, fostering a more cohesive approach to urban development.

This model could also be used in other municipalities facing similar challenges, particularly those with rapid urbanization and significant infrastructure demands. By integrating local priorities with national strategies, municipalities can optimize their project selection processes and ensure that infrastructure development supports both short-term needs and long-term growth.

5. Conclusions and recommendations

This study addresses the gaps in existing municipal project prioritization methods by developing a tailored model that integrates Multi-Criteria Decision-Making (MCDM) techniques, particularly the Analytic Hierarchy Process (AHP) and Exploratory Factor Analysis (EFA). The model is specifically designed for the Municipality of the Holy Capital (Makkah), considering the unique demands of the region and aligning with Saudi Vision 2030. To the researcher's knowledge, this study is the first to develop a method for prioritizing municipal projects in the Municipality of the Holy Capital (Makkah).

This study bridges a critical gap in prioritizing municipal projects by introducing a hybrid model combining AHP and EFA tailored for Makkah's unique urban and strategic context, aligned with Vision 2030 objectives. Unlike previous research, this model integrates latent factors and stakeholder-driven criteria to ensure strategic alignment and practical implementation.

Local needs can be addressed by incorporating more relevant criteria to municipal projects, such as community engagement, environmental sustainability, and localized service improvements.

The study demonstrated that flood protection projects hold the highest importance among the five project types evaluated, with a weight of 0.4246. Road projects ranked second with a weight of 0.3532, followed by park construction projects at 0.1026, while utilities and digital transformation projects ranked fourth and fifth with weights of 0.0776 and 0.0416, respectively.

Table 13. Weights for all latent factors and subfactors.

Factor No.	Factor Name	Sub factor Weight	Sub Factors	Total Factor weight
F1	Capacity and Demand	0.00490	Amount of the asset gap	0.5643
		0.00451	Contribution to covering the asset gap	
		0.00059	Citizen's voice	
F2	Project interdependency with other projects	0.00154	Connection of the project with other "completed" projects	0.1088
		0.00069	Connection of the project with other "ongoing" projects	
		0.00389	Dependence of the project on other "ongoing or completed" projects	
		0.00389	Availability of an approved feasibility study for the project	
F3	Strategic Alignment	0.00025	Contributing to the development of e-government	0.2013
		0.00049	Contributing to the development and diversification of entertainment opportunities to meet the needs of the population	
		0.00277	Contributing to the protection of the environment from natural hazards	
		0.00177	Contributing to the provision of high-quality services to pilgrims and Umrah performers	
		0.00109	Contributing to enhancing the quality of services provided in Saudi cities (public facilities, public transport, etc.)	
		0.00029	Contributing to the improvement of the urban landscape in Saudi cities	
		0.00173	Contributing to the enhancement of traffic safety	
		0.00126	Contributing t o public health by eliminating pests	
		0.00036	Contributing to the promotion of sports activities in the community	
F4	Risks	0.00633	Presence of services that need to be relocated.	0.0306
		0.00261	Presence of sites that require expropriation.	
		0.00106	Lack of approval from the Project Coordination Office.	
F5	Increasing investment	0.00143	Maximizing Revenue from Services	0.0950
		0.00429	The municipality's projects contribute to maximizing government revenue	
		0.00429	Alternative financing opportunities are available to implement the project.	

As described in **Table 13**, the analysis of the latent factors and subfactors further revealed that "Capacity and Demand" is the most critical factor, with a weight of 0.5643, followed by "Strategic Alignment" at 0.2013 and "Project Interdependency" at 0.1088 "Increasing Investment" and "Risks" were weighted at 0.0950 and 0.0306, respectively. The model provides a structured and effective decision-making tool that aligns with the strategic goals of Saudi Vision 2030, ensuring that project selection and resource allocation are optimized to meet local needs and national objectives.

The proposed prioritization model has been implemented in Makkah Municipality through an initial Excel-based system, where all factors, such as capacity and demand, strategic alignment, and risk, are included as evaluation criteria. The responsible evaluators assess each municipal project based on these criteria, inputting scores into the Excel file. The system is pre-programmed to calculate weighted scores for each project and rank them automatically. This streamlined process ensures quick, transparent, and consistent evaluation, providing decision-makers with actionable rankings for resource allocation and strategic planning.

The model is transitioning into a digital decision-support system to enhance efficiency and scalability. The digital platform will enable evaluators to input data remotely, automatically validate the inputs, and generate real-time rankings and visualizations. This centralized system minimizes human error, facilitates collaboration, and stores data for historical analysis. By digitizing the model, Makkah Municipality is moving toward a robust and scalable solution that aligns project prioritization with Vision 2030, ensuring sustainable development and optimized resource management.

5.1. Research limitations

Although this study provides a valuable prioritization model, it has limitations. First, the research is limited to the Makkah Municipality. The findings may not directly apply to other municipalities with different economic and social contexts or infrastructure. Although this approach can be used in other cities, the specific priorities of flood prevention and road infrastructure modeling reflect Makkah's uniqueness. Second, the study focuses on a limited type of project: flood protection. Road infrastructure, parks, utilities, and digital transformation Although these categories were chosen because of Makkah's strategic importance, future studies could include other types of projects, such as public health or education infrastructure. which play an important role in the city's development. Additionally, the sample size for data collection is sufficient for the method used, but this may limit the generalizability of the results. This study surveyed 56 municipal experts, which is an appropriate sample size. However, it may not cover stakeholders' views, such as those of residents or businesses.

While robust, the proposed approach in this study has inherent limitations that should be acknowledged to ensure transparency and guide future improvements. First, reliance on stakeholder input and pairwise comparisons in AHP introduces subjectivity, which could bias the prioritization process. Variability in stakeholder priorities or inconsistent judgments may affect the reliability and repeatability of results. Additionally, the methodology assumes linear relationships between criteria, which may oversimplify complex decision-making scenarios. Including non-linear models or hybrid techniques could capture more nuanced relationships.

Another limitation is the exclusion of potentially critical factors, such as public satisfaction, broader sustainability metrics, and social equity, which may affect the comprehensiveness of the framework. The computational complexity of combining

AHP with exploratory factor analysis (EFA) also presents challenges, particularly for municipalities with limited technical expertise or resources. Moreover, the static nature of the model does not account for dynamic changes in project priorities due to evolving socio-economic or environmental factors. Incorporating mechanisms for periodic updates to criteria weights and rankings could enhance the framework's long-term relevance. By addressing these limitations, the study can demonstrate a deeper understanding of its methodology and inspire further research to refine and expand the proposed model.

5.2. Future research directions

Future research could extend this study in several ways. First, applying this prioritization model to other cities or regions in different demographic, economic, and environmental contexts can help validate the model's generalizability. Comparative study in different municipalities It allows tuning of the parameters used in the model. Especially when adapted to cities with Different infrastructure challenges, such as coastal cities or deserts at particular environmental risk. Second, future studies could expand the model to include project types other than those examined in this study. For example, prioritizing public health, education, or housing projects could provide a more comprehensive framework for decision-making in municipalities facing broader urban development challenges. Additionally, future research could include stakeholder participation and public participation in the prioritization process, including the views of residents, local businesses, and other key stakeholders. It can increase the robustness and transparency of the model. This ensures that the selected projects reflect the needs and preferences of the community. Finally, a long-term study can assess the long-term impact of such prioritization models in municipal decision-making. Evaluating the model's effectiveness in practice, especially regarding resource optimization and project success rates. It provides valuable insights into its practical benefits and areas for improvement.

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