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EVALUATING HOSPITAL AND HEALTHCARE SERVICE QUALITY USING AN INTUITIONISTIC FUZZY MCDM FRAMEWORK: EVIDENCE FROM DISTRICT HOSPITALS IN PUNJAB

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Abstract

Healthcare service quality is multidimensional and difficult to evaluate because patients and healthcare managers assess different aspects of care using information that is frequently incomplete, subjective, and uncertain. This challenge is particularly relevant in Punjab, Pakistan, where empirical studies have identified gaps in responsiveness, reliability, communication, physical facilities, pharmacy and laboratory services, and waiting time. The present article develops an intuitionistic fuzzy multi-criteria decision-making (IF-MCDM) framework for evaluating district hospital service quality in Punjab. The proposed framework integrates established healthcare-quality dimensions with intuitionistic fuzzy Analytic Hierarchy Process (IF-AHP) for determining criterion importance and intuitionistic fuzzy Technique for Order Preference by Similarity to Ideal Solution (IF-TOPSIS) for comparing hospital alternatives. The framework is informed by published evidence from Pakistan and international applications of fuzzy and MCDM approaches to healthcare evaluation. Unlike conventional single-index or SERVQUAL-based assessments, the proposed approach can simultaneously represent membership, non-membership, and hesitation, thereby providing a more flexible representation of uncertain judgments. Published Pakistani evidence demonstrates substantial variation across service dimensions, while international studies show that fuzzy MCDM methods can support multidimensional hospital evaluation and managerial prioritization. Because no original district-hospital dataset was supplied for this manuscript, hospital-specific weights, rankings, scores, and statistical significance values are not presented as completed empirical findings. Instead, the article specifies the analytical structure and expected outputs of a future empirical application. The framework provides a systematic basis for identifying high-priority quality dimensions, comparing district hospitals, and supporting evidence-informed resource allocation and continuous quality improvement in Punjab.

1. Introduction

1.1 Background and Context

Quality is a central component of effective health-system performance. The World Health Organization (WHO) defines quality care in terms of the extent to which health services increase the likelihood of desired health outcomes and remain consistent with evidence-based professional knowledge. Contemporary quality frameworks emphasize effectiveness,

safety, people-centredness, timeliness, equity, integration, and efficiency. These dimensions demonstrate why hospital quality cannot be adequately represented by a single measure such as patient satisfaction, infrastructure, or clinical performance.

The measurement problem is especially important in low- and middle-income settings, where healthcare facilities frequently operate under resource constraints while simultaneously being expected to provide accessible, responsive, safe, and patient-centred care. In Punjab, empirical research has documented quality deficiencies across several levels of the health system. A study of 106 primary healthcare facilities in Punjab, comprising 92 basic health units and 14 rural health centres, reported deficiencies in medicine transportation and storage, limited availability of essential vaccines, and non-functional clinical equipment; approximately 14% of examined clinical equipment was reported to be non-functional.

Patient-based studies similarly demonstrate that quality is multidimensional. Fatima et al. (2017) analysed 817 completed questionnaires from tertiary-care hospitals in Pakistan and found statistically significant negative gaps between patient expectations and perceptions across tangibility, reliability, empathy, assurance, responsiveness, and communication. Shafiq et al. (2017), using data from nine hospitals, also found that the five SERVQUAL dimensions remained relevant in the Pakistani context, with reliability, tangibility, responsiveness, empathy, and assurance showing statistically significant quality gaps.

1.2 Problem Statement

Traditional healthcare-quality assessments often examine individual dimensions separately or calculate aggregate satisfaction scores. Such approaches can obscure trade-offs among competing criteria. For example, a hospital may have relatively strong clinical capability but poor responsiveness, inadequate facilities, long waiting times, or weaknesses in pharmacy and laboratory services. Decision-makers therefore require a method capable of integrating multiple criteria rather than treating service quality as a single undifferentiated construct.

This issue is particularly relevant to district hospitals because they occupy an important position between primary healthcare facilities and higher-level referral institutions. Their performance depends on interconnected resources, processes, professional capabilities, accessibility, and patient experiences. A decision-support framework must therefore accommodate multiple criteria and uncertainty in expert and patient judgments.

1.3 Research Gap and Rationale

Existing Pakistani studies provide valuable evidence about individual dimensions of healthcare quality, patient satisfaction, and service gaps. However, the literature remains relatively limited in integrating these dimensions into a single intuitionistic fuzzy MCDM framework specifically designed for comparative evaluation of district hospitals in Punjab. International studies demonstrate the feasibility of fuzzy AHP, fuzzy TOPSIS, intuitionistic fuzzy methods, and related MCDM approaches for hospital evaluation, but these methods have generally been applied outside the Punjab district-hospital context.

The gap can therefore be expressed as:

What is known: Pakistani studies identify important patient-perceived and operational quality dimensions.

What remains insufficiently addressed: these dimensions are rarely integrated into an uncertainty-sensitive framework for systematic comparison of district hospitals.

Why the gap matters: hospital managers and health authorities need to know not only whether quality is inadequate, but also which criteria contribute most strongly to overall performance and where improvement resources should be concentrated.

How this article addresses the gap: it proposes an IF-AHP–IF-TOPSIS framework that converts qualitative assessments into intuitionistic fuzzy information, determines criterion weights, and generates comparative hospital performance profiles.

1.4 Study Objective and Contribution

The objective is to develop a structured IF-MCDM framework for evaluating district hospital service quality in Punjab. The contribution is methodological and contextual: the framework combines established Pakistani healthcare-quality evidence with an uncertainty-sensitive MCDM architecture capable of supporting multidimensional hospital comparison.

2. Literature Review

2.1 Healthcare Service Quality and Its Dimensions

Donabedian's classical quality framework established a distinction among healthcare structures, processes, and outcomes, providing a foundation for systematic assessment of medical care. Service-quality research subsequently expanded attention toward patients' expectations and perceptions. SERVQUAL, developed by Parasuraman et al. (1988), conceptualized service quality through dimensions including tangibles, reliability, responsiveness, assurance, and empathy.

Healthcare, however, differs from many conventional service industries because quality involves both technical and interpersonal components. Patients may evaluate communication and responsiveness while clinical quality also depends on professional competence, equipment, medicines, diagnostics, and care processes. Consequently, hospital quality assessment benefits from combining patient-oriented and system-oriented indicators.

2.2 Evidence from Pakistan

The Pakistani literature provides substantial evidence that patient experiences vary across service dimensions. Shafiq et al. (2017) validated five SERVQUAL dimensions using evidence from nine hospitals and reported significant gaps in all five dimensions.

Fatima et al. (2017) found significant negative expectation-perception gaps across six dimensions in tertiary-care hospitals. Their results are important for the present framework because they demonstrate that responsiveness, communication, reliability, empathy, assurance, and tangibility can be treated as distinct decision criteria rather than collapsed into a single satisfaction score.

Javed and Ilyas (2018) examined 456 patients from three public and three private hospitals in Lahore and assessed five service-quality constructs. Their findings showed that the relative importance of dimensions differed across sectors, illustrating the contextual nature of healthcare-quality assessment.

Javed et al. (2019) subsequently applied grey relational analysis to Pakistani public and private healthcare facilities. Reliability emerged as the strongest predictor of patient satisfaction in the public sector, whereas responsiveness was strongest in the private sector. The authors also noted that conventional SERVQUAL does not capture all context-specific factors, including cost.

Southern Punjab studies further demonstrate the importance of service-specific indicators. Hussain et al. (2019) analysed 850 responses from public hospitals and reported significant associations of doctor services ($\beta = 0.232$, $p = 0.01$), nursing services ($\beta = 0.256$, $p = 0.01$), and waiting time ($\beta = 0.091$, $p = 0.03$) with patient satisfaction, while registration services were not statistically significant ($\beta = 0.028$, $p = 0.390$). Another study based on 445 returned questionnaires from 554 distributed in public hospitals found significant relationships for laboratory and pharmacy services, while doctor-patient communication and physical facilities were not statistically significant in that particular model.

A district-level perspective is also provided by Al-Shifa and Sughra's study of 400 dental-service patients in two public hospitals in Rawalpindi. The study identified measurable gaps between expectations and perceptions, demonstrating the usefulness of service-gap assessment in public healthcare settings.

Table 1. Evidence supporting the proposed healthcare-quality criteria in Pakistan

Evidence source	Context	Sample/evidence	Key quality dimensions or findings	Relevance to proposed framework
Shafiq et al. (2017)	9 Pakistani hospitals	Inpatients/outpatients	Reliability, tangibility, responsiveness, empathy, assurance	Core patient-perceived criteria
Fatima et al. (2017)	Tertiary hospitals	817 questionnaires	Significant gaps in six dimensions including communication	Adds communication and responsiveness
Javed & Ilyas (2018)	Lahore public/private hospitals	456 patients	Five SERVQUAL dimensions	Sector-sensitive weighting
Hussain et al. (2019)	Southern Punjab public hospitals	850 responses	Doctor, nursing and waiting-time effects	Adds clinical interaction and timeliness
Hussain et al. (2019)	Public hospitals in Southern Punjab	445 responses	Laboratory and pharmacy significant	Adds diagnostic and pharmaceutical services
Al-Shifa & Sughra (2021)	Rawalpindi public dental hospitals	400 patients	Expectation-perception quality gaps	Supports district/public-sector application
Tahir et al. (2024)	Punjab primary healthcare	106 facilities	Equipment and medicine-system deficiencies	Supports infrastructure and resource criteria

The evidence indicates that no single dimension consistently captures healthcare quality across settings. Differences in facility level, public/private ownership, patient population, service type, and analytical method partly explain variation across studies. An MCDM framework can accommodate such multidimensionality by treating individual indicators as criteria with explicit relative weights.

2.3 Fuzzy and MCDM Approaches in Hospital Evaluation

MCDM methods have been increasingly applied to healthcare evaluation because hospital performance involves multiple, sometimes conflicting, criteria. Akdağ et al. (2014) used AHP and TOPSIS alongside other aggregation approaches to evaluate hospital service quality in Turkey. Torkzad and Beheshtinia (2019) evaluated four Iranian public hospitals using multiple MCDM techniques and identified environment, responsiveness, equipment and facilities, and professional capability as major evaluation criteria.

Fuzzy approaches are particularly useful when decision-makers cannot provide precise numerical judgments. Lupo (2016), for example, combined SERVQUAL, AHP, and triangular fuzzy numbers to evaluate public hospital service quality in Sicily. Büyüközkan and Çifçi (2012) similarly combined fuzzy AHP and fuzzy TOPSIS to assess healthcare e-service quality.

Intuitionistic fuzzy sets extend conventional fuzzy representation by incorporating membership, non-membership, and hesitation information. Atanassov (1986) formally introduced intuitionistic fuzzy sets as a generalization of fuzzy sets. This characteristic is

particularly relevant to healthcare because patients and experts may simultaneously recognize evidence supporting and opposing a quality judgment while remaining uncertain about the appropriate assessment.

Otay et al. (2017) demonstrated the feasibility of integrating intuitionistic fuzzy AHP and intuitionistic fuzzy DEA for healthcare institutions using 16 hospitals in Istanbul, with seven inputs and six outputs. Tuzkaya et al. (2019) used interval-valued intuitionistic fuzzy PROMETHEE and compared its results with IVIF-TOPSIS in a public hospital, explicitly emphasizing the complexity and vagueness of patient evaluations. Yucesan and Gül (2020) further developed a hospital service-quality model combining Pythagorean fuzzy AHP and fuzzy TOPSIS.

These studies establish a methodological basis for applying intuitionistic fuzzy MCDM to district hospital evaluation in Punjab. Nevertheless, methodological transfer requires contextual adaptation because Pakistani hospitals operate under different institutional, resource, and patient-service conditions.

3. Conceptual and Theoretical Framework

3.1 Conceptualization of Hospital Service Quality

The proposed framework conceptualizes hospital quality as a multidimensional construct consisting of patient-perceived service characteristics, operational performance, and selected structural and clinical capabilities. The principal criteria are tangibility, reliability, responsiveness, assurance, empathy, communication, waiting time, pharmacy services, laboratory services, accessibility, patient-centredness, clinical capability, equipment availability, and staffing.

This conceptualization combines the patient-oriented logic of SERVQUAL with the broader health-system perspective emphasized by WHO and Donabedian.

3.2 Intuitionistic Fuzzy Representation of Uncertainty

An intuitionistic fuzzy number can be represented as:

$$A = (\mu A, \nu A),$$

where μA represents the degree of membership and νA represents the degree of non-membership, subject to:

$$0 \leq \mu A + \nu A \leq 1.$$

The remaining quantity,

$$\pi A = 1 - \mu A - \nu A,$$

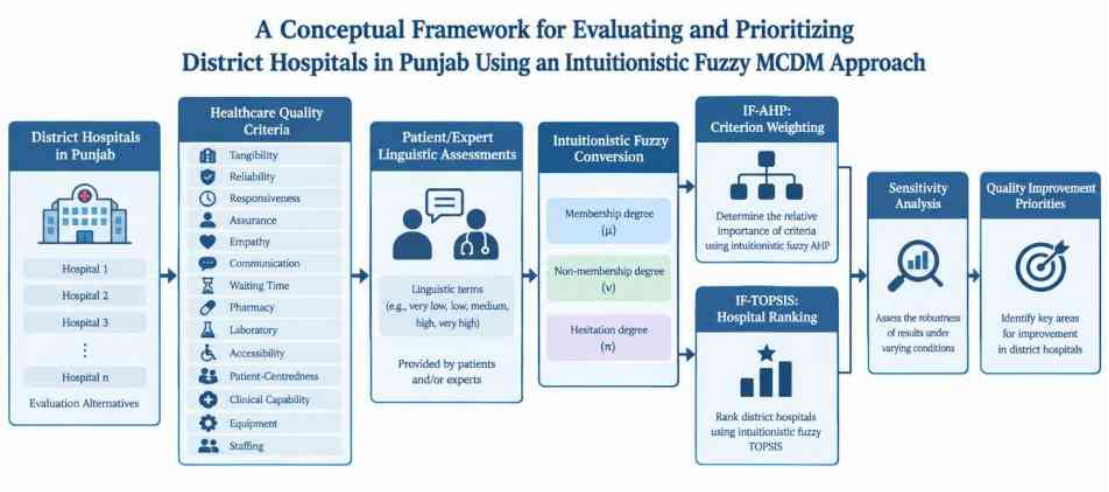
represents the hesitation degree.

The inclusion of hesitation is valuable in hospital-quality evaluation because respondents or experts may not have sufficiently precise information to assign a conventional numerical score.

3.3 Integration of IF-AHP and IF-TOPSIS

The framework uses IF-AHP to derive relative criterion weights and IF-TOPSIS to compare district hospitals with positive and negative ideal solutions. AHP provides a structured mechanism for pairwise prioritization, while TOPSIS ranks alternatives according to their relative closeness to the ideal solution. The methodological foundations of AHP and TOPSIS are established in the MCDM literature.

Figure 1. Conceptual framework for evaluating district hospital service quality using an intuitionistic fuzzy MCDM approach



4. Methodology

4.1 Research Design and Study Alternatives

The proposed study follows a quantitative multi-criteria decision-analysis design. The decision alternatives are district hospitals in Punjab selected according to a defined sampling frame. Because an original hospital-level dataset has not been supplied for the present manuscript, the methodology is presented as a reproducible empirical framework rather than as a report of completed hospital rankings.

A future empirical implementation should collect assessments from relevant healthcare users and/or qualified experts using a structured instrument. The instrument should operationalize the quality criteria identified from the Pakistani and international literature.

4.2 Healthcare Quality Evaluation Criteria

Table 2. Proposed criteria and indicators for evaluating district hospital service quality

Criterion	Illustrative indicators	Evaluation orientation
Tangibility	Cleanliness, physical environment, equipment appearance	Benefit
Reliability	Accurate and dependable service	Benefit
Responsiveness	Prompt attention and staff willingness	Benefit
Assurance	Professional confidence and competence	Benefit
Empathy	Respect, individual attention and understanding	Benefit
Communication	Clarity and information provided to patients	Benefit
Waiting time	Registration, consultation and diagnostic delays	Cost
Pharmacy	Availability and accessibility of medicines	Benefit
Laboratory	Availability and reliability of diagnostic services	Benefit
Accessibility	Geographic and service accessibility	Benefit
Patient-centredness	Respect for preferences and needs	Benefit
Clinical capability	Professional and technical capability	Benefit
Equipment	Availability and functionality	Benefit
Staffing	Adequacy and availability of personnel	Benefit

The selection deliberately extends beyond the conventional five SERVQUAL dimensions. This is justified because Pakistani studies have demonstrated the relevance of waiting time, pharmacy, laboratory services, doctor services,

nursing services, and equipment alongside conventional service-quality dimensions.

4.3 Linguistic Evaluation and Intuitionistic Fuzzy Numbers

Respondents or experts can evaluate each criterion using linguistic categories such as **Very Poor, Poor, Fair, Good, and Very Good**. Each linguistic category is converted into an intuitionistic fuzzy representation consisting of membership and non-membership degrees. The associated hesitation degree is then retained rather than discarded.

This procedure is appropriate because healthcare evaluations frequently involve subjective judgments and incomplete information. International hospital-quality studies have demonstrated the usefulness of fuzzy and intuitionistic fuzzy approaches in dealing with these characteristics.

4.4 IF-AHP for Criterion Weighting

The first analytical stage applies IF-AHP to determine the relative importance of the criteria. Pairwise comparisons are obtained from decision-makers, converted into intuitionistic fuzzy values, aggregated where multiple experts are involved, and processed to obtain normalized criterion weights.

The resulting weights represent the relative contribution of each criterion to the overall evaluation. Importantly, these weights should be calculated from the actual study data and should not be assumed from previous studies.

4.5 IF-TOPSIS for Hospital Ranking

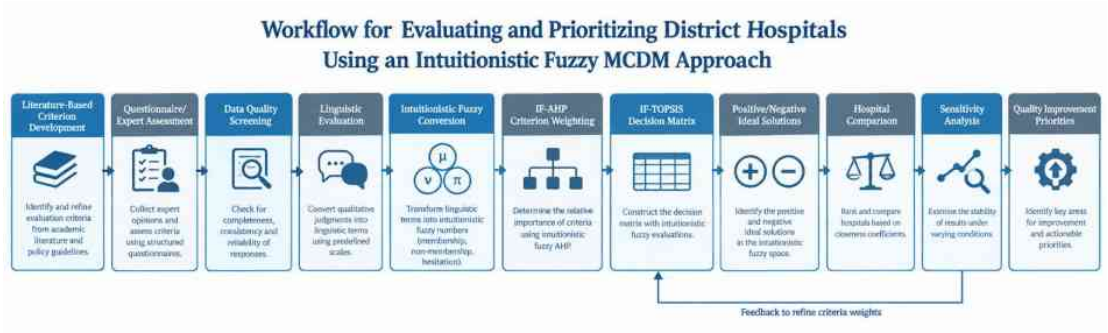
In the second stage, each district hospital is represented as an alternative in an intuitionistic fuzzy decision matrix. The matrix is normalized according to the benefit or cost nature of each criterion. Weighted evaluations are then used to determine positive and negative ideal solutions.

For each hospital, the relative closeness to the positive ideal solution is calculated. Higher closeness indicates stronger overall performance under the specified criteria and weights. TOPSIS is appropriate for this purpose because its logic compares alternatives with both ideal and anti-ideal reference points.

4.6 Sensitivity and Robustness Analysis

Sensitivity analysis should vary the criterion weights and, where appropriate, the linguistic-to-fuzzy parameterization to determine whether hospital rankings remain stable. This is important because MCDM results may change when decision-maker preferences change. Recent intuitionistic fuzzy MCDM research has similarly used sensitivity and comparative analyses to evaluate robustness.

Figure 2. Analytical workflow of the proposed intuitionistic fuzzy MCDM framework.



5. Results and Evidence-Based Analytical Expectations

5.1 Published Evidence Relevant to the Proposed Analysis

The evidence base indicates that several dimensions are likely to require explicit examination in a district-hospital model. Pakistani research has repeatedly identified reliability, responsiveness, communication, physical facilities, waiting time, laboratory services, pharmacy services, and professional interactions as relevant components of patient experience.

For example, Hussain et al. (2019) found significant associations between patient satisfaction and doctor services, nursing services,

and waiting time in Southern Punjab. Similarly, the Punjab primary-care assessment identified deficiencies in equipment functionality and medicine systems. These findings justify incorporating both service-process and structural criteria into the proposed model.

5.2 Proposed Analytical Outcomes

An empirical implementation is expected to generate four principal outputs. First, IF-AHP would produce normalized weights for each quality criterion. Second, IF-TOPSIS would generate a relative performance score for every district hospital. Third, criterion-level analysis would identify the specific strengths and weaknesses of each hospital. Fourth, sensitivity analysis would indicate whether the resulting comparisons are robust to reasonable changes in criterion importance.

No hospital-specific ranking or numerical weight is reported here because doing so without the underlying primary dataset would constitute fabricated empirical evidence.

Table 3. Proposed IF-MCDM analytical outputs

Analytical stage	Output	Management use
IF-AHP	Criterion weights	Identify high-priority quality dimensions
IF decision matrix	Hospital-by-criterion assessments	Identify performance differences
IF-TOPSIS	Relative closeness coefficients	Compare hospital performance
Criterion-level analysis	Strength/weakness profile	Identify targeted interventions
Sensitivity analysis	Ranking stability	Test robustness of decisions
Integrated interpretation	Improvement priorities	Support resource allocation

6. Discussion

6.1 Interpretation of the Multidimensional Framework

The central implication of the proposed framework is that hospital quality should be treated as a multidimensional decision problem. Pakistani studies do not identify a single universally dominant quality dimension. Instead, the importance of criteria changes according to setting, service type, hospital ownership, and analytical method. Javed et al. (2019), for example, reported differences between public and private healthcare sectors in the relationship between service-quality dimensions and satisfaction.

This variation supports a data-driven weighting mechanism rather than imposing identical weights across all hospitals. IF-AHP allows the relative importance of criteria to be derived systematically from stakeholder judgments.

6.2 Role of Uncertainty

Healthcare-quality judgments contain uncertainty because patients may lack complete information about technical quality, while managers and experts may have incomplete knowledge of patient experience. Conventional crisp scoring can conceal this uncertainty. Intuitionistic fuzzy sets provide an explicit representation of membership, non-membership, and hesitation, making them particularly suitable when respondents are uncertain about their evaluations.

The international literature supports this methodological direction. Otay et al. (2017) demonstrated the application of IF-AHP and IF-DEA to 16 hospitals, while Tuzkaya et al. (2019) used interval-valued intuitionistic fuzzy PROMETHEE in a public hospital and compared its results with IVIF-TOPSIS.

6.3 Implications for District Hospitals

The proposed framework can shift quality assessment from descriptive identification of weaknesses toward structured prioritization. If, for example, waiting time receives a high weight and a hospital performs poorly on that criterion, management could prioritize patient-flow redesign. If pharmacy or laboratory services receive high weights but poor performance scores, resource allocation could be directed toward medicine availability, diagnostic capacity, equipment maintenance, or staffing.

Such decisions should nevertheless remain context-sensitive. A criterion that receives a

high weight in one district or hospital may receive a lower weight elsewhere. The value of the framework therefore lies not in prescribing universal priorities but in making local priorities transparent and analytically comparable.

7. Implications

7.1 Managerial Implications

Hospital administrators can use the proposed model to identify criteria that combine high importance with relatively weak performance. This can support targeted quality-improvement plans rather than generalized interventions. Because the model produces criterion-specific information, managers can distinguish infrastructure problems from process problems and patient-interaction problems.

7.2 Policy and Health-System Implications

At the provincial level, aggregated IF-MCDM results could provide a structured evidence base for comparing district hospitals and identifying areas requiring additional support. This is consistent with WHO's emphasis on continuous measurement, monitoring, and improvement of quality at facility and health-system levels.

7.3 Patient-Centred Implications

Incorporating communication, empathy, responsiveness, waiting time, accessibility, and patient-centredness alongside technical and structural criteria ensures that quality assessment does not reduce healthcare quality to infrastructure alone. WHO similarly emphasizes people-centred, timely, equitable, and integrated services as components of quality care.

8. Limitations and Future Research

The primary limitation of the present article is that no original district-hospital dataset was supplied. Consequently, the manuscript does not report original hospital rankings, criterion weights, questionnaire responses, p-values, regression coefficients, or other empirical statistics. Published statistics are used solely as contextual evidence and are not presented as findings of the proposed IF-MCDM analysis.

Future research should implement the framework using primary data from a clearly defined sample of district hospitals in Punjab. The empirical study should establish sampling procedures, instrument validity and reliability, respondent characteristics, ethical approval where required, and inter-rater procedures for expert judgments. Comparative analysis could subsequently examine differences among districts, hospital types, or geographical regions. Further research could also compare IF-TOPSIS with other MCDM methods such as PROMETHEE, VIKOR, Pythagorean fuzzy TOPSIS, or DEA-based approaches.

9. Conclusion

Healthcare service quality in Punjab is a multidimensional problem involving patient experience, service processes, professional capability, infrastructure, equipment, medicines, diagnostics, accessibility, and timeliness. Existing Pakistani studies provide evidence of gaps across these dimensions, but conventional approaches do not always provide a unified mechanism for weighting and comparing multiple criteria under uncertainty.

This article proposes an intuitionistic fuzzy MCDM framework combining IF-AHP and IF-TOPSIS for district hospital evaluation. The approach is theoretically grounded in established healthcare-quality models and supported by international applications of fuzzy MCDM in hospital evaluation. Its principal methodological advantage is the explicit treatment of membership, non-membership, and hesitation in stakeholder judgments.

The proposed framework should be regarded as a structured analytical model rather than as a completed empirical ranking study. Its final value will depend on application to validated district-hospital data. Once implemented, it can provide criterion weights, hospital-level comparisons, sensitivity estimates, and targeted improvement priorities that may support evidence-informed hospital management and provincial healthcare planning.

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