Design And Validation Of A Quality Assessment Framework For Pre-Hospital Emergency Care In Iran

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ABSTRACT

Background and Objective:
Pre-hospital emergency services are a critical component of the healthcare system, playing a vital role in reducing mortality and improving patient outcomes. Evaluating the quality of these services in Iran faces challenges, including insufficient infrastructure and a lack of specialized human resources. This study aimed to design a comprehensive and localized model to evaluate the quality of prehospital emergency services in Iran.
Methods:
A systematic review was conducted to identify models, indicators, and dimensions related to service quality. Subsequently, individual and group interviews with experts and staff in the prehospital emergency field were conducted to identify local challenges and needs. Based on the collected data, a conceptual model was designed encompassing key dimensions such as accessibility, safety, patient satisfaction, and efficiency. Finally, the proposed model was validated using quantitative and qualitative methods.
Results: The systematic review revealed that existing global models were inadequate for Iran's structural and cultural context. The interviews highlighted challenges such as a shortage of skilled personnel, inadequate equipment, and weak coordination. The proposed model was developed considering these challenges and incorporating operational indicators. Validation processes confirmed the model's high accuracy and comprehensiveness.
Conclusion: The designed model provides a comprehensive tool for evaluating and improving the quality of prehospital emergency services in Iran. It offers policymakers an evidence-based framework to address challenges and enhance service quality. Implementing this model represents a significant step toward improving the healthcare system and increasing public trust in emergency services.

Keywords: Prehospital Emergency Services; Quality Evaluation; Healthcare System; Service Quality Model; Iran.

1. Introduction

Pre-hospital emergency care is a critical component of healthcare systems worldwide, providing immediate medical attention to patients experiencing acute illnesses or injuries before they reach definitive care facilities. This early intervention is pivotal in managing time-sensitive conditions such as trauma, myocardial infarctions, and strokes, which collectively account for a significant proportion of global morbidity and mortality (Mehmood et al., 2018). Notably, a substantial number of deaths from these conditions occur within the "golden hour," emphasizing the importance of prompt pre-hospital care in improving patient outcomes. The evolution of Emergency Medical Services (EMS) has transformed pre-hospital care into a sophisticated system capable of delivering advanced medical interventions route to healthcare facilities (Alotaibi et al., 2023). Historically, prior to the 1960s, emergency responses were often conducted by inadequately trained personnel, leading to inconsistent and inefficient care. The 1966 National Academy of Sciences report, "Accidental Death and Disability: The Neglected Disease of Modern Society," highlighted these deficiencies, prompting the establishment of standardized EMS training and protocols. Technological advancements, such as the invention of the

portable defibrillator in 1965, further enhanced pre-hospital care capabilities (Pierides et al., 2021).
Despite these advancements, EMS systems globally face numerous challenges, including variations in service quality, resource limitations, and the need for continuous training to keep pace with evolving medical standards (Khan et al., 2022). In low- and middle-income countries, for instance, there is a substantial need for evidence to improve understanding of EMS system capacities, strengths, Key interventions in pre-hospital care encompass airway management, non-invasive ventilation, circulatory support, and urgent surgical procedures, aiming to prevent further injury and stabilize patients (Delaney et al., 2025). Research indicates that efficient pre-hospital care can reduce trauma-related mortality by up to 32%. However, low- and middle-income countries (LMICs) bear a disproportionate burden of road traffic injuries due to socio-economic factors, inadequate road infrastructure, and limited access to healthcare services, exacerbating the severity of these injuries, weaknesses, and priority areas for improvement (Koome et al., 2020).
A significant challenge in pre-hospital care is decision-making based on patient symptoms rather than definitive diagnoses, necessitating specialized training for teams to operate effectively under high-pressure conditions. Response times and proper scene management are pivotal to service effectiveness. In urban areas, air transport can mitigate delays caused by traffic congestion, while accurate triage ensures patients are transported to appropriate facilities, reducing the need for secondary transfers (Torabi et al., 2020). Quality assessment of pre-hospital services involves evaluating structure, process, and outcomes, requiring adequate human and equipment resources, standardized procedures, and follow-up on patient outcomes (Azami-Aghdash et al., 2021).
In Iran, road traffic accidents are the second leading cause of death, with approximately 57% of victims dying before reaching medical facilities. These patients constitute 32% of those requiring EMS. The economic consequences of road accidents including medical expenses, productivity loss, and damage to equipment place a significant burden on the healthcare system and society. Key features of pre-hospital services include teamwork, effective communication between physicians and EMS teams, coordination with medical centers, essential equipment availability, and managing patient complexities (Azarbakhsh et al., 2023). Given the information gaps in this field, the present study aims to design a model for evaluating the quality of pre-hospital emergency services in Iran.

2. Materials and methods

The present study employed a mixed-methods approach and was conducted in four main phases. These included: (1) a comprehensive and conceptual literature review; (2) qualitative data collection through individual and focus group interviews; (3) model development using Grounded Theory; and (4) validation of the proposed model through the Delphi technique. Both qualitative and quantitative methods were utilized to ensure comprehensiveness in model development and to enhance its validity. In the first and third phase, due to the nature of the study, sampling did not take place. The study population included managers, deputies, and experts from governmental and non-governmental organizations, relevant professional associations, specialists and experts in the fields of policymaking, healthcare services management, and emergency medicine—particularly managers of the national emergency medical services organization, emergency medicine specialists, and heads of provincial pre-hospital emergency centers. Data collection continued until data saturation was achieved. Participants provided informed consent and were assured of data confidentiality.

Phase I- Systematic conceptual review

A systematic and integrative literature review was conducted to identify conceptual frameworks, models, and indicators relevant to EMS quality evaluation. Searches were performed in both international and national scientific databases (PubMed, Scopus, Web of Science, Embase, ScienceDirect, Google Scholar, Magiran, Iranmedex, Irandoc, Medlib, SID) using keywords such as: Prehospital, Emergency Medical Services (EMS), Ambulance, Quality, Service Evaluation, Models, Indicators, Iran.

2.1.1. Screening and inclusion

Studies were screened using the PRISMA guideline (Page et al., 2021). Articles were selected based on relevance, language (English/Persian), and content (EMS quality models). Duplicates were removed using EndNote X19, and two researchers independently reviewed the full texts.

2.1.2. Quality appraisal

Studies were assessed using the STROBE checklist (Ghaferi et al., 2021). Based on their scores, they were classified as low (0–7), moderate (8–17), or high (18–22) quality.

2.2 Phase II- Qualitative data collection through interviews

To explore expert insights regarding EMS service quality, semi-structured individual and focus group interviews were conducted. The purposive sampling approach was used.

2.2.1. Participants

A total of 26 personnel from the National Emergency Services Department, aged between 40 to 60 years, with work experience ranging from 10 to 30 years, participated in this phase of the study and completed the questionnaire form.

2.2.2 Data Collection

- Individual Interviews

One-on-one interviews were conducted with participants to explore their personal experiences and perspectives.

- Focus Groups

Small groups consisting of individuals with shared characteristics and experiences were formed. These groups participated in semi-structured interviews, guided by pre-designed prompts.

- Recording and Documentation

All interviews were audio-recorded with the participants' consent, and the conversations were transcribed verbatim. Each interview session lasted between 60 to 90 minutes, with the number of sessions varying depending on the depth of data required.

Following the initial round of individual interviews, semi-structured focus group discussions were conducted to enrich and complement the data. These sessions were facilitated using an interview guide, along with audio recordings and field notes for data triangulation. Each focus group session was managed by a team of three researchers: one moderator, one observer, and one note-taker.

2.2.3. Data Analysis

For qualitative data analysis, the Framework Analysis method was employed (Goldsmith, 2021). MAXQDA software (ver. 2020) was used to manage and analyze the qualitative data efficiently. Field notes were employed as supplementary sources to enrich the interview data. Initially, the interview transcripts and field notes were read repeatedly to achieve a comprehensive understanding of the content. Through this process, key themes and core concepts gradually emerged, forming the basis of a thematic framework. Statements that directly addressed the research questions were then identified and coded in the initial coding phase. Subsequently, central concepts were organized into coherent thematic categories, and similar themes were grouped together to facilitate more in-depth analysis and interpretation. To ensure the trustworthiness of the data, several strategies were employed. The researcher engaged in prolonged interaction with participants, fostering rapport and allowing for the collection of rich and reliable information. In addition, member checking was conducted, whereby participants reviewed and confirmed the accuracy of their interview data.

2.3 Phase III- model development using Grounded theory

In this phase, the data collected from the earlier stages served as the primary foundation for designing a model to assess the quality of pre-hospital emergency services. Grounded theory was employed as the methodological approach for model development (Wiesche et al., 2017). The model design process using grounded theory included several key steps. First was the stage of initial conceptualization, during which the interview data from the second phase were thoroughly reviewed, and core concepts related to the quality of pre-hospital emergency services were identified. These concepts were organized into broad and specific thematic categories. Next, open coding was conducted with the aim of identifying basic meaning units and assigning them initial codes. The data—interview transcripts and relevant documents—were broken down into smaller segments, each assigned a distinct code, resulting in an initial list of quality-related concepts and codes. This was followed by axial coding, which focused on creating relationships among the initial codes and grouping them into major categories. Similar codes were merged and organized into core categories, and the interconnections among these categories were also examined.

The selective coding phase aimed to identify and define the central or core category. Among the main categories, one was selected as the central axis based on its relevance and significance to the overall model. The other categories were integrated as subsets or related elements within the final framework. The outcome of this process was the development of a final model for assessing the quality of pre-hospital emergency services. This model included various dimensions, indicators, and items for evaluating service quality. A schematic representation of the model was also created to clearly illustrate the structural relationships among the categories and concepts. To ensure the credibility and reliability of the proposed model, several strategies were implemented. The final model was reviewed and approved by specialists and managers in the field of pre-hospital emergency services.

2.3.1 Data analysis

Data analysis was conducted continuously throughout the model development process. The researcher maintained active engagement with both the data and participants to enhance the model's accuracy and credibility. Additionally, MAXQDA qualitative data analysis software was used to facilitate the coding

and analysis process. The final outcome was a comprehensive and coherent framework for evaluating the quality of pre-hospital emergency services. This model holds potential for use in policymaking, service quality improvement, and performance evaluation of related organizations.

2.4 Phase IV- Validation of the pre-hospital emergency services quality assessment model

In this stage, the Delphi technique was employed to validate the proposed model for evaluating the quality of pre-hospital emergency services. This method was utilized to achieve expert consensus regarding the model's structure, concepts, and processes.

2.4.1 Participants

The study population consisted of 30 individuals, including managers and experts from both governmental and non-governmental sectors, pre-hospital emergency specialists, university faculty members, and heads of pre-hospital emergency centers. Participants were selected using purposive sampling based on their expertise in the relevant field.

2.4.2 Data collection

A structured questionnaire was developed based on the indicators, components, concepts, and categories identified in the previous stages. The questionnaire was specifically designed for model validation and its items were formulated through consultations with the research team and several experts.

2.4.4 Data validation: Delphi method

The Delphi process consisted of multiple rounds of data collection, during which the researcher-developed questionnaire was distributed to the expert panel. Feedback from each round was systematically analyzed and used to revise and enhance the model. This iterative process continued until a final consensus was reached among the experts, confirming the model's validity and relevance.

2.4.5 Statistical analysis

The data collected at each stage were analyzed using SPSS software (Version 21.0), and the results were utilized to revise and refine the model accordingly.

3. Result

3.1 Comprehensive review of global data analysis and comparison with Iran

Using the PRISMA guidelines, the study selection and screening process was carried out in a precise and systematic manner (figure 1). This approach ensured the inclusion of high-quality and relevant studies for a comprehensive analysis and comparison between global data and the context of Iran.

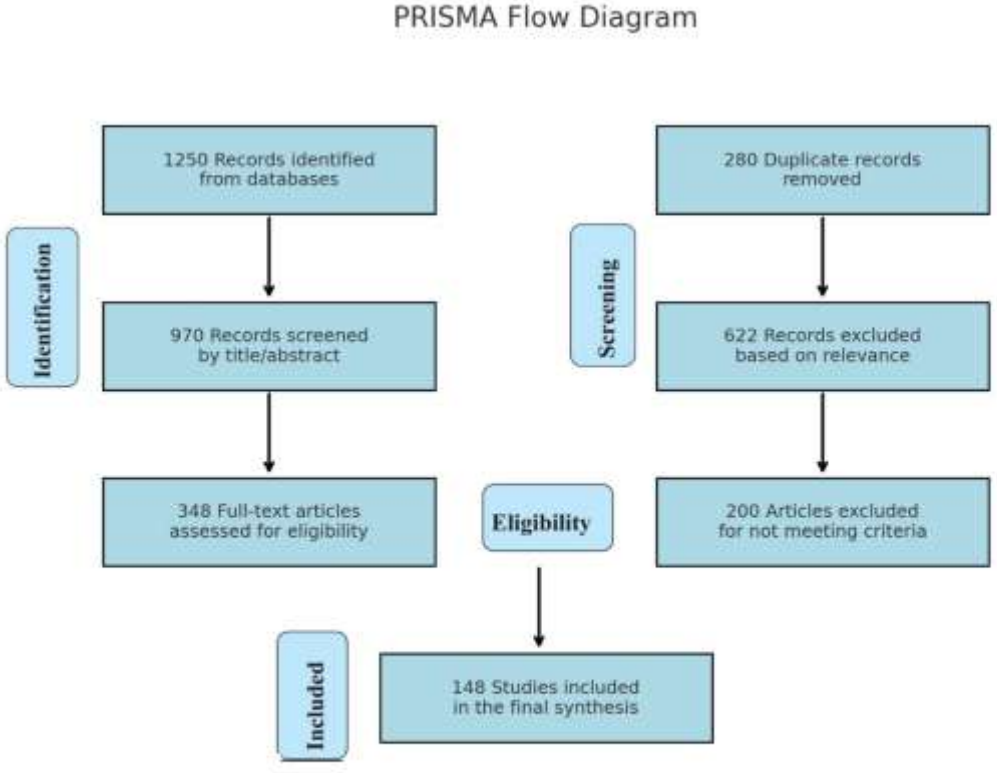

Figure 1. PRISMA flow diagram

3.1.1 Study quality assessment of phase I

To evaluate the quality of the selected studies, the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) checklist was used. The quality assessment results indicated that 45 studies, scoring between 18 and 22, were classified as high-quality. These studies demonstrated rigorous scientific design, comprehensive statistical analysis, and clear reporting. Many of them employed standard conceptual models such as SERVQUAL or Donabedian's framework to analyze service quality and provided strong evidence supporting the development of new quality assessment frameworks.

A total of 73 studies, with scores ranging from 8 to 17, were categorized as moderate-quality. Although these studies met several scientific standards, they exhibited limitations such as weak sampling design, limited statistical analysis, or a lack of clarity in some sections of reporting. Most of these articles focused on general aspects of emergency service quality and addressed specific models or indicators less frequently. Finally, 30 studies, scoring between 0 and 7, were assessed as low-quality. These studies often lacked robust design, made insufficient use of data, or employed unscientific analytical methods, failing to provide reliable evidence. Some also lacked adequate explanations of methodology or statistical analysis.

3.1.2 Identification of indicators and models

From the comprehensive literature review, several key indicators for evaluating the quality of pre-hospital emergency services were identified (Table 1). Based on the comparative analysis of the studies, the strengths, gaps, and challenges in the quality of pre-hospital emergency services in Iran were identified that were documented as Table 2.

3.2 Data analysis of individual and group interviews

In this stage, the notes and transcripts of individual and group interviews were read multiple times to allow the researcher to gain a comprehensive understanding of the topics discussed. This process helped identify key and recurring points mentioned throughout the interviews (table 3). The qualitative analysis of the interviews revealed several key themes regarding the concept, dimensions, indicators, challenges, and potential solutions related to the quality of pre-hospital emergency services. The results of the interview analysis were organized into a structured framework comprising five main thematic areas and their corresponding subcategories (figure 2).

Table 1. Key indicators for evaluating the quality of pre-hospital emergency services

Indicator	Description	Reported Data (Iran)	Global Standard
Response Time	Average time for the emergency team to reach the incident location; a critical indicator of service quality.	12–15 minutes in urban areas; >20 minutes in rural areas	Less than 8 minutes
Success Rate of Initial Care	Percentage of successful cardiopulmonary resuscitation (CPR) cases.	34%	Up to 60% in developed countries
Patient Safety	Adherence to protocols and availability of equipment; lack of either increases patient risk.	Equipment shortages and protocol violations reported in some areas	High adherence expected
Patient Satisfaction	Level of patient satisfaction with emergency services.	62% satisfied; 38% dissatisfied due to delays or staff behavior	Higher satisfaction expected

Table 2. Strengths, gaps, and challenges in the quality of pre-hospital emergency services in Iran

Category	Details
Strengths	1. Extensive network of emergency bases across the country. 2. Use of air ambulance services for remote areas. 3. Specialized training programs for emergency personnel.
Challenges	1. Shortage of qualified personnel in certain regions. 2. Inadequate equipment and uneven distribution of resources among different bases. 3. Weak coordination between relevant institutions and healthcare centers.
Identified Gaps	1. Significant gap between standard response times and actual performance. 2. Lack of specific evaluation models tailored to Iran's context. 3. Limited financial resources and insufficient infrastructure for service development.

Table 3. Analysis of participants' responses to the questionnaire

Question topic	Key responses from interviewees	Analysis and categorization of responses
Definition of service quality in pre-hospital emergency care	- Scientific, appropriate, and timely services - Delivery of services with sufficient accuracy and patient satisfaction - Rapid service delivery and gaining public trust	Service quality is defined based on: accuracy, timeliness, knowledge-based practice, patient satisfaction, and public trust.
Dimensions of service quality	- Scientific and practical aspects - Human resources, equipment, and training - Effectiveness, safety, patient-centeredness, service continuity, and timeliness	Main identified dimensions: human, equipment-related, educational, effectiveness, safety, and service continuity.
Quality assessment indicators	- Response time - Patient satisfaction - Modern equipment - Staff skills - Evaluation checklists for each dimension	Key indicators: timely response, up-to-date equipment, staff training and competency evaluation, and patient satisfaction.
Challenges to improving service quality	- Lack of sufficient emergency bases - Outdated equipment - Organizational and human resource issues - Cultural and social barriers	Challenges include: shortages in human resources and equipment, inefficient organizational structure, and socio-cultural obstacles.
Strategies to address challenges	- Standardization of procedures - Continuous staff training - Recruitment of new personnel - Upgrading equipment and administrative policies - Inter-organizational collaboration	Suggested strategies: standardization, ongoing education and retraining, equipment upgrades, workforce expansion, and enhanced inter-agency cooperation.

3.3 Analysis of key themes and codes

Results of analysis with grounded theory method presents the coding results. These themes were directly derived from initial coding using MAXQDA software displaying the frequencies of various codes associated with each thematic axis identified during the interviews (figure 3). The analysis of the frequencies reveals key themes related to the quality of pre-hospital emergency services, as well as organizational challenges. 24-hour service (18 occurrences) had the most frequency and underscores the demand for round-the-clock availability of emergency services, which was identified as a primary quality indicator in the interviews.

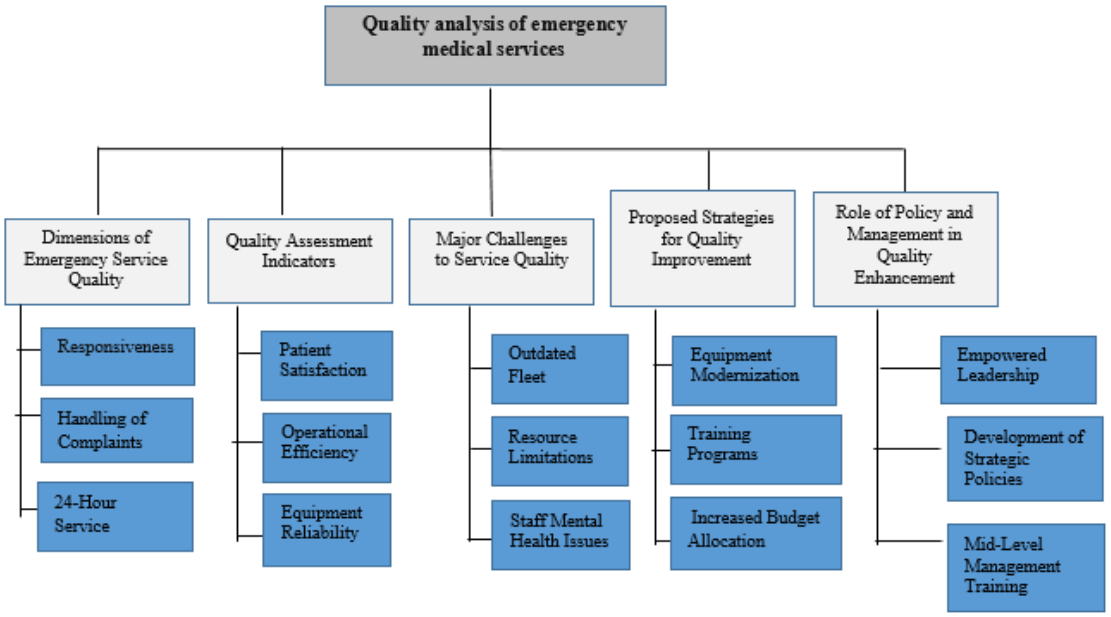

Figure 2. The thematic framework for analyzing the quality of emergency medical services consists of five main domains and their corresponding subcategories.

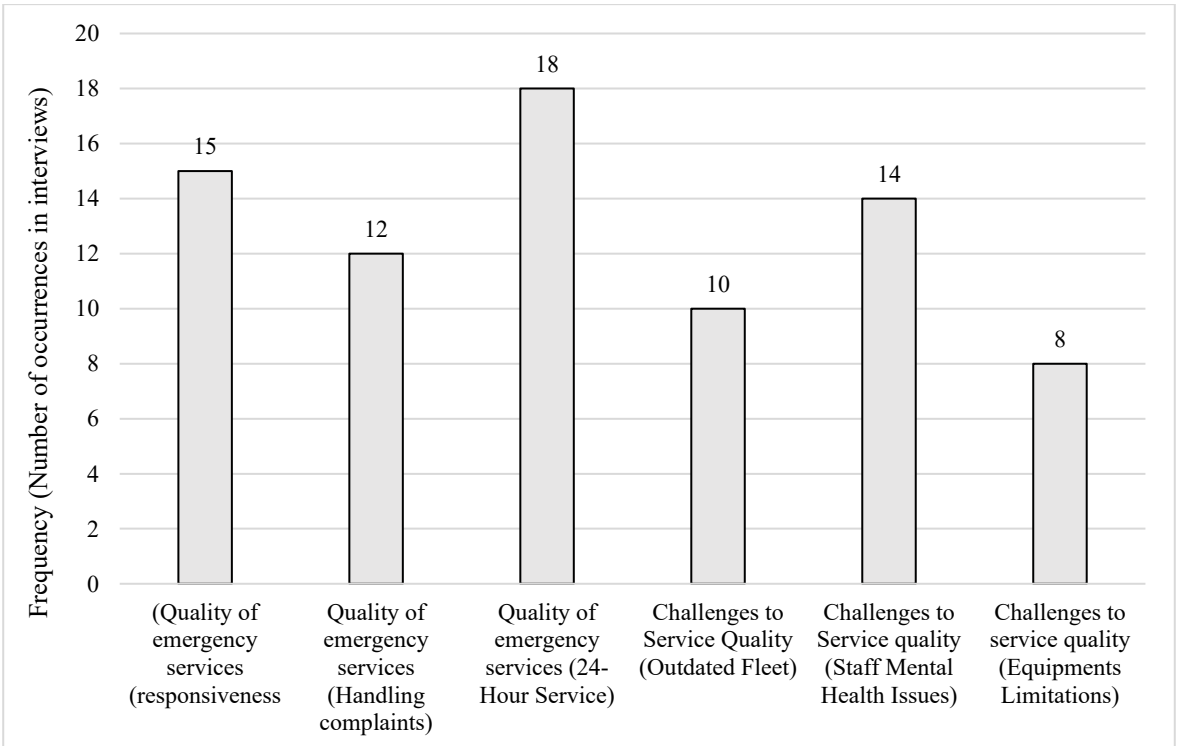

Figure 3. Code frequency distribution chart

These findings underscore the need for strategic interventions aimed at improving both the operational efficiency of emergency services and the support systems for staff members. The results emphasize the

importance of addressing infrastructural weaknesses, mental health concerns, and ensuring continuous service availability to enhance overall service quality.

The results of the MAXQDA software analysis indicated that "organizational challenges" and "infrastructure improvement" had the highest frequency among the responses. This suggests that the majority of participants identified structural issues and limitations related to equipment and financial resources as the primary barriers to delivering high-quality services. Other themes such as "mental health of personnel" and "improving responsiveness" also had high frequencies, but they were prioritized lower.

One of the most significant findings of the analysis was the identification of differences in perspectives between senior managers and operational staff. Senior managers primarily focused on policy-making and strategic planning issues, particularly emphasizing the role of effective leadership and the development of formal policies as key factors in improving service quality. In contrast, operational staff focused mainly on everyday challenges, such as resource shortages, an outdated fleet, and the psychological pressure resulting from mandatory overtime. This difference highlights the need for policies that address both the overarching goals of management and the daily operational needs.

These differences underscore the importance of designing models that can adapt to the multifaceted needs of the organization. The findings suggest that managers must align strategic policies with the day-to-day issues faced by personnel to enhance service quality. Moreover, the results of the analysis align with similar studies conducted in Iran and other countries, which emphasized the role of policy-making and resource management.

3.4 Designing the pre-hospital emergency service quality evaluation model

The design of the pre-hospital emergency service quality evaluation model was based on grounded theory and data gathered from the conceptual review (Phase 1) and individual and group interviews (Phase 2). The final model provided a comprehensive and actionable framework for evaluating service quality in this field, which is detailed in Table 4.

Table 4. Stages of Designing the Pre-Hospital Emergency Service Quality Evaluation Model

Phase	Activity Description	Results
1. Initial Conceptualization	Reviewing interview data and documents to identify fundamental concepts related to emergency service quality.	Concepts such as "Responsiveness", "Response Time", "Improvement of Equipment", "Personnel Mental Health", and "Effective Leadership" were identified and initially categorized.
2. Open Coding	Extracting basic semantic units from the gathered data and defining initial codes.	Over 65 initial codes were identified; the most frequent codes included "Responsiveness to Patients", "Outdated Fleet", "Equipment Renovation", and "Increasing Personnel Motivation".
3. Axial Coding	Combining similar codes and organizing them into main and subcategories.	Main categories: "Service Quality", "Organizational and Operational Challenges", "Infrastructure and Equipment", and "Management and Policy-making" along with related subcategories were identified.
4. Selective Coding	Choosing the central category and determining its relationships with other categories.	Central category: "Effective Leadership and Strategic Policy-making". Relationships: Developing standard procedures for "Service Quality" and securing resources for "Organizational Challenges".
5. Final Model Development	Designing a schematic framework including dimensions, indicators, and sub-indicators for service quality evaluation.	The model included 4 main dimensions, 12 indicators, and 36 sub-indicators: "Service Quality", "Organizational Challenges", "Infrastructure Improvement", and "Management and Policy-making".

6. Model Validation	Conducting multiple reviews by experts and researchers, and analyzing data using MAXQDA 2020 software.	The model was validated by 10 experts. Data analysis and conceptual relationships indicated the comprehensiveness and accuracy of the designed model.
7. Final Model	A comprehensive and actionable framework for evaluating pre-hospital emergency service quality.	The model was introduced as a policy-making tool and performance improvement for emergency organizations, including indicators such as patient satisfaction, response time, and equipment renovation.

3.5 Final Model

The final model was designed as a schematic framework, including dimensions, indicators, and sub-indicators related to the quality of pre-hospital emergency services. This model consists of four main dimensions, 12 indicators, and 36 sub-indicators, covering detailed topics such as service quality, infrastructure, organizational challenges, and management (Table 5).

Table 5. Final Model for Evaluating Pre-Hospital Emergency Service Quality After Validation in the Current Study

Main Dimension	Indicators	Sub-indicators
Emergency Service Quality	Responsiveness	- Response time to calls - Patient satisfaction with responsiveness - Transparency in communication
	Accessibility	- 24-hour service provision - Full geographic coverage - Reduced time to reach the incident site
	Effectiveness	- Positive outcomes of services provided - Satisfaction with on-site treatment - Reduced unnecessary transfers
Organizational Challenges	Human Resources	- Mental health of personnel - Reducing work pressure - Organizing motivational programs
	Financial Resources	- Securing sustainable funding - Equitable allocation of resources - Cost management
	Operational Challenge Management	- Addressing internal complaints - Crisis management during large-scale incidents - Optimal use of available resources
Infrastructure and Equipment	Equipment and Facilities	- Renovation of emergency equipment - Access to advanced medical equipment - Regular maintenance of equipment
	Fleet	- Renovation of ambulances - Provision of ambulances equipped with new technologies - Reduced fleet downtime
	Information Technology	- Development of contact management systems - Implementation of GPS systems - Analysis of performance data to improve processes

Management and Policy-making	Effective Leadership	- Transparency in managerial decision-making - Development of strategic policies - Increased involvement of managers in decision-making
	Training and Development	- Conducting training courses for personnel - Crisis management training - Developing standard operating procedures
	Evaluation and Monitoring	- Ongoing performance monitoring - Analysis of quality indicators - Annual review of policies and processes

3.6 Validation of the pre-hospital emergency service quality evaluation model

In this phase of the research, the validation of the pre-hospital emergency service quality evaluation model was conducted using the Delphi technique. This method was employed to achieve expert consensus on the structure, concepts, and processes of the designed model. The statistical population consisted of 30 individuals, including managers and experts from governmental and non-governmental sectors, pre-hospital emergency specialists, university professors, and heads of pre-hospital emergency centers, who were selected through purposive sampling based on their expertise. The validation process was carried out in three stages. In each stage, a researcher-developed questionnaire was designed to collect opinions, and the feedback obtained was analyzed. The results of each stage were used to refine and complete the model in subsequent stages, ultimately leading to a final consensus among the experts. The data collected in each stage were analyzed using SPSS software. In the first stage, feedback focused primarily on the clarity of the indicators and the relationships between the categories. In the second stage, 85% of participants confirmed the model's structure and provided suggestions for minor adjustments to the details of the indicators. In the third stage, final agreement was reached, with more than 95% of the experts approving the revised model. The analyses indicated that the main categories, such as "service quality," "organizational challenges," and "infrastructure improvement," were fully aligned with the operational priorities of emergency organizations.

Based on the feedback from the experts, revisions were made to the model. These revisions included adding sub-indicators to the "mental health of personnel" dimension, such as support and motivational programs, as well as adjusting the structure of the "organizational challenges" dimension with an emphasis on resource and equipment management. Furthermore, the relationship between the central category of "effective leadership" and other categories was more clearly defined to ensure the model's structure was more cohesive. The final model, developed after the validation process, was introduced as a comprehensive and reliable tool for evaluating the quality of pre-hospital emergency services.

4. Discussion

Evaluating the quality of prehospital EMS is a fundamental element in improving the responsiveness, safety, and overall effectiveness of national health systems. In particular, EMS systems serve a critical role during acute emergencies and disasters, where timely and coordinated care can significantly reduce morbidity and mortality (Neira-Rodado et al., 2025, Böbel et al., 2025). The current study aimed to design a comprehensive, evidence-based model for evaluating the quality of prehospital emergency care in Iran, tailored to local structural, operational, and cultural contexts. The proposed model, developed through a systematic literature review and expert consultations, incorporates five core dimensions: accessibility, safety, patient satisfaction, efficiency, and process quality. Each dimension was operationalized through measurable indicators, allowing for practical application and performance benchmarking.

The systematic review conducted as part of this research revealed a diverse array of existing frameworks within the global literature, including prominent models such as SERVQUAL and HEALTHQUAL. These models have been widely utilized in the evaluation of healthcare services, offering valuable insights into customer satisfaction, service quality, and the perceived performance of healthcare providers. However, while these frameworks have proven effective in many contexts, their application to resource-limited settings, such as Iran, is problematic. Both SERVQUAL and HEALTHQUAL primarily emphasize consumer perceptions and service experiences, which are undoubtedly important for gauging satisfaction. Yet, they fall short in capturing the operational and systemic challenges inherent in environments where resources are constrained. These models often assume that healthcare systems operate efficiently, with well-trained personnel, sufficient medical supplies, and seamless coordination

across departments and institutions.

In the context of Iran, the situation is starkly different. The country faces significant challenges that hinder the effective delivery of EMS. These include severe shortages in specialized human resources, such as emergency physicians, paramedics, and other trained professionals, making it difficult to maintain high-quality care (Naboureh et al., 2024, Jadidi et al., 2024). Furthermore, there are frequent issues with the availability of essential medical equipment, which not only impacts the quality of care but also delays critical medical interventions. Delayed response times, particularly in rural and underserved areas, exacerbate the problem, as EMS teams struggle to reach patients in a timely manner due to infrastructural limitations and geographical barriers (Zamzam et al., 2021). Moreover, the fragmented nature of inter-organizational coordination further complicates the delivery of EMS in Iran. The lack of streamlined communication and cooperation between hospitals, ambulance services, and other healthcare entities results in disjointed care, with patients often experiencing delays in receiving appropriate treatment. These systemic constraints are not adequately addressed by traditional models, which tend to focus solely on the service experience from the perspective of the consumer (Sadat et al., 2021, Aldilami et al., 2024).

Recognizing these limitations, the current study seeks to bridge this gap by proposing a novel model that integrates both the perceptual and operational dimensions of service quality. This proposed framework acknowledges the critical role of consumer experiences such as patient satisfaction, trust, and perceived service quality in assessing the overall performance of healthcare services. However, it goes a step further by considering the real-world challenges faced by healthcare systems, particularly in resource-limited settings. In countries like Iran, where there are significant constraints in terms of human, material, and financial resources, it is essential to examine both the perceptual factors and the operational realities that directly impact the delivery of services (Haghighi et al., 2019). The model emphasizes that service quality cannot solely be evaluated from the perspective of consumer experience but must also account for the operational issues that hinder effective service delivery. By incorporating a broad range of operational factors including human resource availability, the readiness of medical equipment, response times, and inter-organizational coordination alongside perceptual factors, the model provides a more holistic and contextually relevant approach to evaluating EMS delivery. This integrated approach ensures that the complexities of operating in resource-constrained environments are addressed, offering a more accurate representation of service quality (Mirza et al., 2024). To further validate the relevance of these dimensions, the qualitative findings gathered through semi-structured interviews with frontline technicians, EMS managers, and policy stakeholders highlighted the persistent challenges that EMS personnel face on a daily basis. Interviewees consistently emphasized that staffing shortages, inadequate or outdated medical supplies, and delayed arrival times to emergency scenes were significant barriers to delivering high-quality care. These issues not only compromise the effectiveness of EMS interventions but also directly impact patient outcomes and overall satisfaction with the service (Wilson et al., 2022, Safarabadi et al., 2024). By considering these operational challenges within the framework, the study ensures that the model is grounded in the realities of EMS systems in Iran, offering valuable insights for both policymakers and healthcare practitioners.

These observations are consistent with findings from national studies, including Bahadori et al. (2012), which highlighted similar deficiencies across Iranian EMS systems (Bahadori et al., 2012). Likewise, Toushmal et al. (2015) employed the SERVQUAL model and found substantial quality gaps in dimensions such as empathy and trust, which were echoed in this study's interview data (Toushmal et al., 2015). Importantly, participants also identified certain systemic strengths, such as existing communication infrastructure and region-specific initiatives aimed at improving dispatch efficiency, which served to inform the model's structure and practical relevance. While, when compared with international research, the findings of this study reveal both convergences and contextual distinctions. For example, studies conducted in high-income countries, such as Pap et al. (2018), also prioritize service timeliness, safety, and clinical effectiveness indicators similarly emphasized in the present model (Pap et al., 2018). However, while international models often assume the availability of advanced infrastructure and well-distributed resources, the Iranian context is marked by fundamental operational deficits. Strauss et al. (2021), in a German case study, demonstrated how investment in continuous training and modern equipment leads to significant quality improvement (Strauss et al., 2021). While such strategies are endorsed by our findings, the implementation pathways must differ in Iran due to resource limitations. Hence, the proposed model contributes uniquely by offering context-appropriate metrics and interventions suitable for developing EMS systems.

The model underwent rigorous validation using both qualitative content analysis and quantitative reliability testing. The results confirmed the model's internal consistency, construct validity, and

practical applicability. It offers a scientifically grounded and context-sensitive framework for evaluating and improving prehospital emergency care in Iran. Beyond assessment, the model can serve as a strategic tool for identifying performance gaps, informing evidence-based decision-making, and optimizing the allocation of resources across EMS units.

Despite its strengths, this study has several limitations. First, its geographic scope was confined to Iran, which may restrict the generalizability of the model to other regions with different health system architectures. Second, the qualitative component, while rich in operational insights, involved a limited number of stakeholders, which may introduce response bias. Third, although the model has been statistically validated, it has not yet been piloted in live EMS environments, which limits our ability to assess its real-world functionality and implementation feasibility. Future research should focus on field-testing the proposed model across various regions within Iran, particularly rural and underserved areas, to examine its practical impact on service quality and patient outcomes. Additionally, multi-country comparative studies could provide valuable insights into the model's adaptability and scalability in other low- and middle-income countries. Incorporating patient-reported experience measures (PREMs) and outcome data would further enhance the model's robustness. Moreover, integration of digital health solutions—such as mobile triage platforms, real-time monitoring systems, and AI-driven dispatch optimization—could be explored as part of a broader strategy to modernize and streamline prehospital emergency services in constrained environments.

In total, this study presents a novel and context-specific framework for evaluating the quality of prehospital emergency services in Iran. Drawing from both global evidence and local expertise, the model bridges the gap between theory and practice, offering actionable pathways for system-wide improvement. By aligning evaluation criteria with real-world conditions and service delivery challenges, this framework not only enhances our understanding of EMS performance but also supports strategic planning, policy development, and capacity building in a critical area of public health.

5. Conclusion

In conclusion the results of this study highlight the importance of designing and implementing a comprehensive model for evaluating the quality of pre-hospital emergency services in Iran. The proposed model, which is based on international frameworks adapted to Iran's specific conditions, integrates key dimensions such as accessibility, safety, patient satisfaction, efficiency, and process quality. Validation of the model confirmed its accuracy and comprehensiveness, making it a valuable tool for policymaking, planning, and improving emergency services. The study also emphasizes the need to address structural and managerial challenges, such as the shortage of specialized personnel, equipment deficiencies, and delayed response times, to enhance service delivery. By identifying operational weaknesses and providing practical indicators for improvement, the model offers a framework for increasing service quality and patient satisfaction. Ultimately, the use of this model could reduce mortality rates, boost public trust in the healthcare system, and enhance the efficiency of pre-hospital emergency services in Iran, contributing to a significant improvement in this vital sector of the healthcare system.

Competing of Interest

The authors declare that they have no conflict of interest

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Author contributions

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by [HR], [MS] and [BI], the first draft of the manuscript was written [BI] and [HR] commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Consent for publication

Manuscript has been read and approved by all the authors for submission.

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