

# Rapid Assessment of Hospital Emergency Department Performance from the Perspectives of Sustainability, Resilience, and Lean Management

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## ABSTRACT

The hospital emergency department, as one of the most critical units within the healthcare system, plays a vital role in saving patients' lives, improving the quality of medical services, and increasing public trust. However, challenges such as patient congestion, limited resources, high workloads, and exposure to unforeseen crises have made evaluating and enhancing the department's performance a significant challenge. Therefore, this study aimed to comprehensively and rapidly assess the hospital emergency department's performance based on the Goodson model, utilizing three complementary approaches: lean management, resilience, and sustainability. This applied, descriptive-analytical study was conducted cross-sectionally at a healthcare center in Iran. Data were collected through standardized questionnaires on lean management, resilience engineering, and organizational sustainability, and analyzed using the Goodson rapid assessment model. Experts confirmed the validity of the instruments, and their reliability was verified using Cronbach's alpha. The findings revealed that the emergency department's performance in the sustainability dimension was at an excellent level, surpassing the criteria of the assessment model, indicating a strong focus on social, economic, and environmental factors. The resilience dimension was rated as demonstrating relative readiness to handle critical situations. However, the lean management dimension showed incomplete implementation of lean principles and the presence of waste in some operational processes. These results highlight the importance of improving lean management practices while maintaining and strengthening resilience and sustainability to enhance the overall performance of the hospital emergency department.

## 1. Introduction

Evaluating and improving the performance of systems and organizations is a challenge that has been considered in many studies today. One of these systems of interest in this field is the health and healthcare system [1]. Today, increasing the level of public health and well-being in human societies is considered, and efforts have always been made to improve the performance of health

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and healthcare service providers and to meet the increasing demand in this field. The health services and health system of each country affect different sectors, including the social, economic, and political sectors of that country, and a large part of the gross domestic product of countries is always allocated to the health system [2]. For this reason, researchers in various fields are taking steps to improve the quality of health services in order to meet the needs of all stakeholders in the health system of countries. One of the important sectors in the field of health and medical services is the hospital sector, especially the hospital emergency services sector. Although historically, the health and treatment system has entered the topic of lean management a little later than other industries and sectors, in recent years, lean management thinking has been prevalent in many medical and treatment centers and has been able to make great improvements in providing very appropriate and desirable services to patients, along with reducing costs and injuries [3]. Lean management in health is a management approach that can lead to continuous improvement in efficiency. LaGanga [4] indicated that a 27% growth in the capacity of services to new patients is the result of improving lean management. There are many definitions for the concept of resilience engineering, and in essence, the concept of resilience is a multidimensional concept. The ability of a system to adjust its operations, before or at the same time as changes, is called resilience. Resilience is the ability to bounce back in the face of sudden or abrupt demands. Resilience engineering has the ability to develop new methods that can control events and incidents and limit the consequences arising from them, in other words, resilience engineering is the essential ability of a company to face complexities and sudden events [5]. Therefore, it can be concluded that by conducting this research and implementing sustainability, lean management and resilience, it is expected to increase job satisfaction, reduce medical costs, and increase patient safety and satisfaction [6]. Therefore, considering the above, it is better to conduct a study to clarify the comprehensive evaluation of the performance of the hospital emergency department from the perspective of sustainability, resilience and lean management.

## **2. Literature review**

Putra & Yusof [7] studied lean management tools to identify effective factors in prescription errors, high workload, staff shortages, and inappropriate user attitudes, and made suggestions for improving the work process. Hospital emergency departments are of particular importance due to their significant impact on the health system. The use of efficient human resources in this sector can lead to an improvement in the quality of services provided and patient satisfaction. The results showed that lean management tools are effective in identifying factors affecting errors related to prescription writing, high workload, staff shortages, and inappropriate user attitudes. Poksinska et al., [8] studied how to implement the lean approach in health centers and identified the obstacles to implementing the lean approach in health centers and also stated the results obtained from it. The health care system has become one of the largest and most costly industries in the world. These factors have caused hospital management to require fundamental changes, including organizations measuring performance to achieve organizational goals. Evaluating and monitoring the performance of the emergency department is considered one of the most important processes in health centers. Al-Balushi et al., [9] conducted a study to examine the readiness indicators of medical centers for using lean management in medical centers. Their results showed that the top ten indicators were identified among the readiness indicators of medical centers for using lean management in medical centers. Managers and decision-makers are always faced with the problem of choosing the best indicator from a diverse set of indicators, and often, due to the accumulation of data, it is not possible to use all of them. For this reason, managers and employees have a negative view of performance evaluation systems, and it is necessary to determine and identify a limited number of basic indicators

that can meet the management goals of the organization. Bayat et al., [10] studied the factors affecting the performance evaluation of hospital emergency departments using a multi-criteria decision-making approach. Hospitals, as the most important element of the health system, play a key role in providing health services and have an impact on the efficiency of the health system. Given that every hospital has an emergency department with a high referral rate, it can be said that evaluating indicators in this department is inevitable in order to achieve organizational goals. In this study, by identifying the factors affecting the performance evaluation of hospital emergency departments, the relationships between the intensity of the relationship were examined using the DEMATEL method. Finally, using this technique, the factors of care (understanding patients' expectations and treatment needs) and immediate service provision, which are the most influential and most influenced factors in performance evaluation, respectively, were identified. LaGanga [11] conducted a study to examine the relationship between lean management and new patient service capacity in public hospitals. Their results, using statistical tests, stated that a 27 percent increase in new patient service capacity is a result of improved lean management. On the other hand, for the leadership and management of this important unit, in addition to physical space and modern and complete equipment, it seems necessary to pay attention to the high values of human resources, skills, and managerial power of individuals in order to strive to achieve the mission and goals of the organization. Eghtesadi fard et al., [12] evaluated the performance of hospital emergency departments from the perspectives of patients (referring patients) and medical staff separately and compared the results of these two assessments to discover areas for improvement in the performance of emergency departments. For this purpose, a combined approach was presented to identify key performance indicators and evaluate emergency departments based on the SERVQUAL model. This study was conducted in four hospital centers in Shiraz, during which 15 key indicators were identified in five axes and these centers were evaluated and ranked. Finally, using the Barda technique, the ranking results obtained were combined and the final ranking was obtained. According to the findings, from the perspective of medical staff, the emergency department of Namazi Hospital and from the perspective of patients, the emergency department of Chamran Hospital had a higher rank. Leonardini et al. [13] investigated the use of optimized tools for spinal surgery in a medical center, utilizing lean principles. The results demonstrated that the optimized tools implemented in the medical center for spine surgery using lean principles are highly practical and effective. Schwal et al., [2] delved into the significance of resilience in hospital emergency departments in their study titled "Engineering resilience in health systems: Adaptive strategies for the emergency department under high workload conditions." The study's findings revealed that enhancing the flexibility and quick decision-making abilities of staff in critical situations, such as during the coronavirus outbreak, can lead to a decrease in clinical errors, improved patient safety, and enhanced overall system efficiency. The study underscores the importance of resilience as a crucial element for the survival and efficiency of healthcare systems amidst sudden changes and pressures. Sarani [3] conducted a study evaluating the performance of hospital emergency departments through an integrated approach based on resilience engineering and lean management. Initially, a conceptual model of the issue was developed by identifying key indicators; subsequently, necessary data was collected using a standardized questionnaire.

In the next step, efficiency values were calculated using an algorithm based on data envelopment analysis with all indicators present. Efficiency values were also recalculated after removing each factor. The results show that engineering commitment indicators in the resilience group and operational improvement in the lean management group have the greatest impact. Therefore, by focusing on these indicators, a significant improvement in employee satisfaction levels, and

consequently, the organization's performance, can be achieved. Namazi et al., [14] conducted a study on designing a comprehensive fuzzy model for evaluating hospital performance using a combination of balanced scorecard, SWARA, and MULTIMOORA methods. Through content analysis, an initial list of performance, sustainable development, and reputation indicators for the balanced scorecard of 907 hospitals in Iran was extracted. This list was finalized using the fuzzy Delphi method. The fuzzy SWARA method was then used to weigh each relevant indicator, and the MULTIMOORA method was used to rank hospitals based on the importance of each performance, sustainable development, and reputation indicator. The study resulted in the finalization of 81 indicators, with 28 related to the internal process aspect, and 10, 6, 8, 9, and 12 related to the financial, customer, environmental, social responsibility, and reputation aspects, respectively. Chen et al., [1] also explored the impact of lean management principles on emergency department performance in a study titled "Application of Lean Management to Improve Sustainability and Patient Flow in the Emergency Department: Evidence from Chinese Hospitals." The study revealed that implementing lean methods reduced patient waiting times, streamlined the admission and discharge processes, and conserved energy and human resources. These changes not only enhanced the quality of emergency services but also contributed to achieving sustainability goals in the health system. Ostadi and Ramezaniansani [15] investigated an intelligent framework for evaluating the integrated performance of a pharmaceutical company by considering an integrated management system and resilience engineering. They presented a model for optimizing patient and staff satisfaction in the emergency department simultaneously, utilizing data envelopment analysis and artificial neural networks. Effective management of emergency departments at various levels requires a tool for monitoring and measuring performance. Rundall et al., [16] examined the relationship between lean management, patient satisfaction, and hospital financial performance, as well as patient feedback, using the linear regression method. The study revealed a significant relationship between lean management, patient satisfaction, and hospital financial performance. Patient feedback was also analyzed using the linear regression method, with positive results.

A review of the theoretical foundations and background of the research reveals that the three approaches of sustainability, resilience, and lean management have been studied separately in efforts to improve the performance of healthcare systems, particularly in emergency departments. Domestic research has primarily focused on identifying efficiency indicators, reducing resource waste, and enhancing patient satisfaction [3 and 10]. Internationally, studies such as Schwal et al., [2] have highlighted the importance of resilience in managing critical situations, while Chen et al., [1] have explored the impact of lean management on enhancing patient flow and achieving sustainability. However, a literature review indicates that most previous research has examined only one dimension of sustainability, resilience, or lean management individually. There is limited research that has explored these three approaches simultaneously in a comprehensive model for evaluating emergency department performance. Additionally, many studies have focused on specific crisis conditions or improving isolated processes, rather than presenting a holistic 2multidimensional approach to evaluating emergency department performance [17-18]. Therefore, there is a research gap in the development and testing of an integrated model that can consider the economic, social, and environmental dimensions of sustainability, as well as the flexibility, adaptability, and resilience aspects of resilience, and the waste elimination, continuous improvement, and service value enhancement components of lean management in evaluating emergency performance.

### **3. Problem Statement**

The emergency department of any hospital is known as the most vital and challenging unit of the health system. It serves as the first point of contact between patients and the hospital, playing a

decisive role in saving lives, reducing mortality, improving the quality of medical services, and enhancing patient satisfaction. The effective performance of the emergency department not only reflects the efficiency of the entire health system but also directly impacts public trust in hospitals and national health policies. Despite its significance, the Iranian hospital system faces structural and management challenges. These include increasing treatment costs, lack of financial resources, patient overcrowding, high workload, and staff dissatisfaction. These conditions have highlighted the need to evaluate the performance of emergency departments in terms of sustainability, resilience, and the adoption of new management methods such as lean management. This has become one of the most important research and management priorities in the healthcare field. Currently, major process problems in the emergency department include delays in patient transfer, excessive movements of medical staff, long admission processes, lack of effective communication between units, and increased patient waiting times. These issues not only diminish the quality of services but also impose unnecessary costs on the system. Both domestic and foreign research underline that the primary factor contributing to the inefficiency of emergency departments is the lack of a coherent management system and a scientific approach to process design. In this context, lean management has emerged as one of the most effective management models. It is based on the principles of eliminating waste, continuous improvement, and focusing on value from the customer's perspective.

Applying lean management principles in hospitals reduces waiting times, improves productivity, service quality, and reduces human errors. Recent studies indicate that successful implementation of lean management in hospitals has reduced average response times in the emergency department and significantly increased patient satisfaction. However, lean management is only effective in stable conditions and may be less effective during crises such as epidemics or sudden influxes of patients, as the removal of safety margins and system reserves can lead to increased vulnerability. This is where the concept of organizational resilience becomes important. Resilience refers to an organization's ability to anticipate, absorb, withstand, and recover from shocks and disruptions. In the health system, resilience means continuing to operate safely during critical situations such as the COVID-19 pandemic, large-scale incidents, or resource crises. Recent research findings show that hospitals with higher levels of resilience not only return to normal more quickly, but also maintain service quality under pressure. In emergency departments, resilience means the ability to deal with sudden crises and adapt to changes in patient volume, shortages of human resources and equipment, and unpredictable environmental conditions. Improving resilience in the emergency department requires strategic planning, staff empowerment, improved intra-organizational communications, and creating a culture of continuous learning. Along with these approaches, attention to organizational sustainability has increased in the health system today. Sustainability does not only mean preserving environmental resources, but also includes economic and social dimensions. A sustainable hospital is an organization that can provide quality services in the long term without harming the environment and human resources. Recent research has shown that organizational sustainability in the health sector is directly related to increasing service quality, reducing costs, and increasing patient satisfaction. In emergency departments, implementing sustainable approaches includes optimizing energy consumption, reducing hospital waste, promoting the occupational health of personnel, and ensuring equity in patients' access to health services. Given climate change and environmental crises, the World Health Organization has emphasized that environmental sustainability in emergency infrastructure should be a main pillar of health policymaking. Therefore, the researcher, with many years of experience in treatment and research, intends to conduct this study as a preliminary part of a larger study. Given the shortcomings of research in this field, the study aims to answer the question of what a comprehensive assessment of a hospital emergency department's performance is from the

perspective of sustainability, resilience, and lean management. The innovation of this study lies in combining the three approaches and designing a comprehensive model to evaluate the performance of the hospital emergency department from the perspective of sustainability, resilience, and lean management simultaneously within an analytical framework. This study not only helps fill gaps in existing literature but also, given the importance of the emergency department as the beating heart of the hospital, can provide practical solutions for improving service quality, increasing patient and staff satisfaction, and enhancing resource efficiency in the health system.

#### **4. Research Methodology**

The present study is applied in terms of its purpose, as its results can be utilized by managers and decision-makers in the health sector to enhance processes and increase the efficiency of hospital emergency departments. In terms of the nature and method of data collection, it is descriptive-analytical and aims to describe and explain the current situation by using a questionnaire and analyzing the resulting data. In terms of the implementation method, the present study combines quantitative and qualitative approaches; the data were initially collected in the field and then analyzed using the Goodson model. In terms of the implementation timeline, the study was cross-sectional and took place from spring to autumn 2025 at Imam Hussein Hospital in Shahrood, Iran. The statistical population of this study includes 80 personnel, nurses, and employees working in the emergency department of Imam Hussein Hospital in Shahrood. These individuals consist of medical, administrative, and support staff who are directly involved in providing emergency services to patients. Members of the statistical population share common characteristics that distinguish them from other hospital employees, including more than five years of work experience in the emergency department, familiarity with management processes, and direct experience with the functional challenges of this department. This group was selected due to its close relationship with the research objectives, specifically evaluating performance from the perspective of sustainability, resilience, and lean management. Given the limited statistical population (80 people), the purposeful sampling method was utilized to select individuals with the most knowledge and experience on the research topic. Ultimately, 30 nurses and emergency department staff were chosen as the statistical sample. The inclusion criteria for the sample required a minimum bachelor's degree, 5 to 10 years of work experience in the emergency department, and a willingness to participate in the research. This method enables data collection from individuals directly involved in the management, operational, and environmental processes related to the research topic. Data collection was conducted through two methods: library and field. In the library phase, theoretical foundations, research background, and similar domestic and foreign studies were gathered using printed sources, scientific articles, and databases. In the field phase, data were collected using standard and researcher-made questionnaires that included three main sections: sustainability, resilience, and lean management. The questionnaires were distributed to qualified staff in person, and after explaining the study's purpose, data were collected and prepared for analysis. To assess the level of application of lean management principles and techniques in the emergency department, the standard Lean Management Questionnaire was utilized, originally designed by Holden [19] and Tiso et al., [14]. This tool consists of 11 items in two subscales: "Acceptance of lean principles" (3 questions) and "Lean management techniques" (8 questions). Respondents provide their opinions on a five-point Likert scale ranging from "very poor = 1" to "very good = 5". The content validity of this tool has been confirmed in domestic research [20], and reliability coefficients in domestic studies have been reported between 0.78 and 0.87. In the present study, Cronbach's alpha for this scale was calculated to be 0.83, indicating its desirable reliability.

To assess organizational resilience in the emergency department, the Resilience Engineering Questionnaire adapted from the Hollnagel model was utilized. This questionnaire, translated and modified in a previous studies, comprises 10 items divided into two subscales: "resilience acceptance" (5 questions) and "resilience techniques" (5 questions). Responses are rated on a five-point Likert scale ranging from 1 (very poor) to 5 (very good), with the total score indicating the level of organizational resilience. Previous international studies have reported reliability coefficients for this tool ranging from 0.85 to 0.92, while a domestic study found a coefficient of 0.84. In our study, Cronbach's alpha for this tool was calculated at 0.79, indicating acceptable internal stability. To evaluate the sustainability of emergency department performance, the Organizational Sustainability Questionnaire was employed. This questionnaire, developed based on Elkington's Triple Bottom Line model [21-22], consists of 22 items across three subscales: "social sustainability" (10 questions), "economic sustainability" (5 questions), and "environmental sustainability" (7 questions). Responses are provided on a five-point Likert scale ranging from "very poor = 1" to "very good = 5". Previous international studies have reported reliability coefficients for this tool between 0.81 and 0.88, while domestic studies have reported coefficients between 0.83 and 0.86. In our study, Cronbach's alpha value was 0.81, indicating appropriate validity and stability. To ensure content validity, the questionnaires were reviewed by five professors and experts in industrial and health management following translation and localization. Their feedback was incorporated to enhance validity. Additionally, the reliability of the tools was assessed using Cronbach's alpha coefficient, with results showing good internal consistency for all scales (between 0.79 and 0.83). Thus, the tools used are deemed valid and reliable for measuring the research variables. Data analysis in this study involved both descriptive and inferential methods. Descriptive statistics such as mean, standard deviation, frequency, and percentage were used to characterize respondents. In the inferential analysis, the Goodson Model [16 and 20] was employed. This model integrates quantitative and qualitative data to evaluate sustainability, resilience, and lean management dimensions. The Goodness of Fit Test yielded a result of 0.96, indicating a strong fit of the model with the data. Data were analyzed using statistical software and compared with the Goodson model's evaluation domains to identify strengths and weaknesses in emergency department performance.

## 5. Results

In this study, we adopted a model based on the rapid factory assessment method originally introduced by Goodson in the Harvard Business Review. This model, known in the literature as rapid total assessment, has been widely embraced by many industrial and service centers during their evaluation processes. The results of this accurate assessment method have shown a high level of validity across various assessment domains. We examined the three primary dimensions of lean, resilience, and sustainability in the rapid performance assessment of a healthcare center. Within the lean dimension, we considered two components: lean adoption and lean management techniques. In the resilience management dimension, we evaluated resilience adoption and resilience management techniques. Finally, in the sustainability dimension, we assessed three categories: social, economic, and environmental performance. The assessment questions are presented in Table 3.1.

**Table 1**

Questions of the hospital emergency rapid assessment process from the perspective of the three dimensions of lean management, resilience, and sustainability

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<b>Num.</b>	<b>Question</b>
1	Is the way emergency department staff deal with patients and their companions respectful and satisfying?
2	Is the emergency center equipped with the necessary safety measures for medical staff and providing services to patients and their companions?
3	Are maintenance and repair processes for resources in the emergency department well-considered?
4	Are the executive processes for managing emergency department operations well-integrated?
5	Is the internal and external environment of the emergency department properly organized and clean?
6	Is the process of moving patients and equipment during treatment in the emergency department efficiently designed?
7	Is the inventory level of medicines and medical equipment systematically monitored and controlled in the emergency center?
8	Is there a specific mechanism for managing conditions in the emergency department in complex situations and sudden changes?
9	Is the human resource management system, including organizational structure, motivation systems, and other similar items for employees, well-designed in the emergency center?
10	Are there visual systems available to emergency department staff to display key performance and productivity information?
11	Is operational planning in the emergency department carried out in a coherent and accurate manner?
12	Is the senior management of the emergency department committed to continuous improvement of service quality and support for stakeholders?
13	Is there a culture of reporting and error management without fear of reprimand among emergency department staff?
14	Is the organizational learning structure properly implemented to record and transfer experiences in the emergency department?
15	Are emergency department staff sufficiently aware of organizational tasks, processes, and goals?
16	Is the emergency department fully prepared to deal with emergencies and high patient volumes?
17	Is the emergency department structure flexible and able to adapt to environmental changes?
18	Are there structures in the emergency department that allow each department to operate independently and self-organize?
19	Is teamwork among different emergency department staff carried out in full coordination?
20	Has the necessary provision been made for redundancy of resources and equipment to prevent service interruptions?
21	Has the possibility of errors been considered in the design of services and solutions have been foreseen to reduce their impact?
22	Are safety instructions properly implemented when using hazardous materials such as radioactive drugs?
23	Are processes implemented to control and reduce infections in the emergency department?
24	Are there implementation measures to reduce the negative effects of hospital waste on the environment in the center?
25	Are specific implementation processes designed to continuously improve the quality of medical services in the emergency department?
26	Does the emergency department play an active role in human resource development by creating sustainable job opportunities?
27	Is the design and development of medical services in the emergency department based on patient feedback and needs?
28	Is there a mechanism for staff participation in management decisions in the emergency department?
29	Is there a commitment to professional ethics in the provision of services in the emergency department?

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30	Are the emergency center's policies for the use and control of special drugs such as antibiotics, analgesics, etc. specified and implemented?
31	Are the legal and ethical rights of patients and the community respected in emergency processes?
32	Have plans and measures been implemented to reduce energy consumption in the emergency center?
33	Are the costs of collecting, processing, and disposing of medical waste effectively managed in the center?
34	Is there a mechanism for the economical purchase of consumables and supplies in the emergency center?
35	Are indicators defined in the emergency center to increase the productivity of human resources and equipment?
36	Are processes implemented to prevent environmental fines in the center?
37	Is the rate of medical waste recycling in the emergency center monitored and optimized?
38	Is the separation of hazardous medical waste from the public sewage system carried out carefully?
39	Are environmentally friendly products and equipment used in the center?
40	Are there measures in place to control environmental hazards such as leakage of contaminated or radioactive materials in the emergency department?
41	Does the emergency department adhere to environmental standards in its daily operations?
42	Is energy consumption monitored and controlled in the various emergency departments?
43	Is there a specific plan in place to reduce the production of general and hospital waste in the emergency department?

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The relationship of each evaluation question to the indicator and evaluation dimension is also shown in Table 2.3.

**Table 2**  
 Classification of questions for the rapid assessment of hospital emergencies from the perspective of the three dimensions of lean management, resilience, and sustainability

Dimension	Measure	Related questions
Lean Management	Lean Adoption	1-3
	Lean Management Techniques	4-11
Resilience Management	Resilience Adoption	12-16
	Resilience Techniques	17-21
Sustainability Management	Social Performance	22-31
	Economic Performance	32-35
	Environmental Performance	36-43

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The primary assessment tool in this rapid evaluation process is a questionnaire and a criteria assessment sheet provided to the visiting team at the emergency center. These must be completed promptly following the objective inspection. Prior to conducting the assessment, all members of the evaluation team must be thoroughly familiar with the criteria and principles of lean, resilient, and sustainable management through comprehensive training. It is important to note that the criteria for assessing lean, resilience, and sustainability were selected based on findings from previous studies on management and performance evaluation of health and treatment centers. Subsequently, the

questionnaire was refined to estimate the application of best practices for implementing lean, resilience, and sustainability principles, incorporating input from health and treatment experts. The general stages of the assessment process are illustrated in Figure 1.3. The number of affirmative responses in the questionnaire, along with the total score on the criteria sheet—ranging from 129 to 1204, with an average of 532—indicates the level of implementation of lean, resilience, and sustainability principles in the emergency center under evaluation. It should be noted that the score obtained for each criterion accurately reflects the improvement priorities related to the specific indicator and dimension being assessed. An overview of the rapid performance evaluation steps for the emergency center under study is also shown in Figure 1.3. The Goodson method is a qualitative validation and assurance technique that utilizes results obtained via the Likert scale combined with fuzzy logic to quantify outcomes. Instead of simple yes/no answers, linguistic expressions are used to capture experts' opinions on each questionnaire item, such as very poor, poor, average, good, very good, and best, each assigned a score ranging from 3 to 33. The expert group then re-evaluates the questions more precisely, considering these linguistic categories, and the results are recorded in the criteria assessment sheet according to the scores derived from the defined Likert scale. The score ranges corresponding to each linguistic category are presented in Table 3.

**Table 3**  
 Range of equivalent scores for each linguistic expression  
 Definition of each domain

Definition of each domain					
Very poor	Poor	Average	Good	Very good	Best in category
3<=x<8	8<=x<13	13<=x<18	18<=x<23	23<=x<28	28<=x<=33

To verify the accuracy of the rapid performance evaluation model and its results, the questionnaire was administered again using the Likert scale method. Additionally, to ensure the reliability of the findings, a goodness-of-fit test was conducted. In each case, a strong agreement was observed between the results of the proposed model and the test outcomes. Based on the results from other performance evaluation models and the alignment of outcomes according to lean, resilience, and sustainability criteria, the criteria were scored, and the goodness-of-fit test was applied. This test assesses the consistency of the new model's findings compared to data obtained from previous performance evaluation models (i.e., the historical performance evaluations of this center) and is presented in Equation 1.

$$\chi^2 = \sum_{i=1}^n \frac{(O_i - E_i)^2}{E_i} \tag{1}$$

$$E_i = (F(Y_i^u) - F(Y_i^l)) \cdot N \tag{2}$$

In the above relations,  $Q_i$  is the data from the new model,  $E$  is the data from the past performance evaluation (expected data), and  $E_i$  is obtained from Equation 2. In Equation 2,  $F$  is the cumulative distribution function for the distribution being tested,  $Y_i^u$  is the upper limit of class  $i$ ,  $Y_i^l$  is the lower limit of class  $i$ , and  $N$  is the sample size. The goodness-of-fit test result for the model is 0.96; since this value is greater than 0.5, there is no significant difference between the observed ratios from the

past performance evaluation results for this center and the results from the current model. The comparison of the results is illustrated by the radar chart in Figure 1.

To conduct an analysis using the Goodson rapid assessment method, the following steps should be followed:

1. Calculate the score for each question based on the responses given. For instance, count the number of "Yes" responses as positive unit scores, and the number of "No" responses as negative unit scores.

Aggregate the scores at the level of indicators and dimensions according to the mapping in Table 2.3. Compare the scores to the Goodson assessment domains to determine the rank, such as very poor, average, good, etc. Overall analysis of emergency department performance in three evaluation dimensions including lean management, resilience, and sustainability. Finally, the analysis of the results of the emergency department questionnaire based on the Goodson rapid performance assessment method is as follows:

Resilience management scored 19, evaluated at a good level.

Lean management scored 13, evaluated at an average level.

Sustainability management scored 39, exceeding the range defined in the Goodson model (33 is the highest value). Therefore, the performance of this dimension is estimated to be higher than the best in the category.

Additionally, the evaluation level will be determined for each indicator within each dimension. The results indicate that the highest score pertains to the sustainability dimension. The resilience dimension is evaluated as good, while the lean management dimension is assessed as average. Based on these findings, the following management analyses can be made:

**Lean Management:** The overall score is 13, indicating an average evaluation level. This suggests that lean principles have not been fully implemented in the emergency center under evaluation. Potential weaknesses may exist in admission processes, waiting times, discharge procedures, interdepartmental coordination, time and resource wastage, or the application of lean techniques such as waste reduction, workflow improvement, and standardization. In this context, tools like kaizen, 5S, and value stream mapping have not been fully utilized. Practical recommendations in this area include:

Redesigning the admission process to reduce queues and waiting times, such as using rapid triage, standardizing tasks, such as providing clear instructions for admission, sampling, and patient transfer, implementing 5S in the workplace, such as sorting and eliminating unnecessary items in the emergency department, continuous monitoring of key time indicators, such as patient waiting time and transfer time to wards, and creating continuous improvement groups to identify and eliminate routine waste.

**Resilience Management:** An overall score of 19 and a good assessment level indicate that the emergency center under evaluation performs well in preparing for unexpected situations and quickly returning to a stable state. Factors such as staff training, process flexibility, and the presence of rapid crisis response protocols contribute to this success. In other words, the emergency center has demonstrated strong resilience. Staff appear capable of handling critical and unforeseen situations, although there remains room for improvement to reach a "very good" level. Practical suggestions for enhancement in this area include:

Simulating crisis scenarios such as large-scale traffic accidents or natural disasters for staff readiness,

Continuous training in psychological resilience to reduce staff stress in stressful situations,

Flexibility in allocating human resources, including the ability to shift forces between tasks based on workload intensity,

Creating a bank of experiences from past incidents and using them in future training, and  
Improving psychological support systems for staff after encountering stressful events.

**Sustainability Management:** The emergency center received an overall score of 39, exceeding the defined benchmark of 33, indicating excellent performance in this area. The center has made significant investments in social responsibility, patient safety, employee satisfaction, and environmental sustainability. These results demonstrate outstanding achievement across social, environmental, and human resource dimensions. This success is attributed to targeted investments in environmental protection, safety, social responsibility, and employee well-being. Practical recommendations for further enhancing sustainability include:

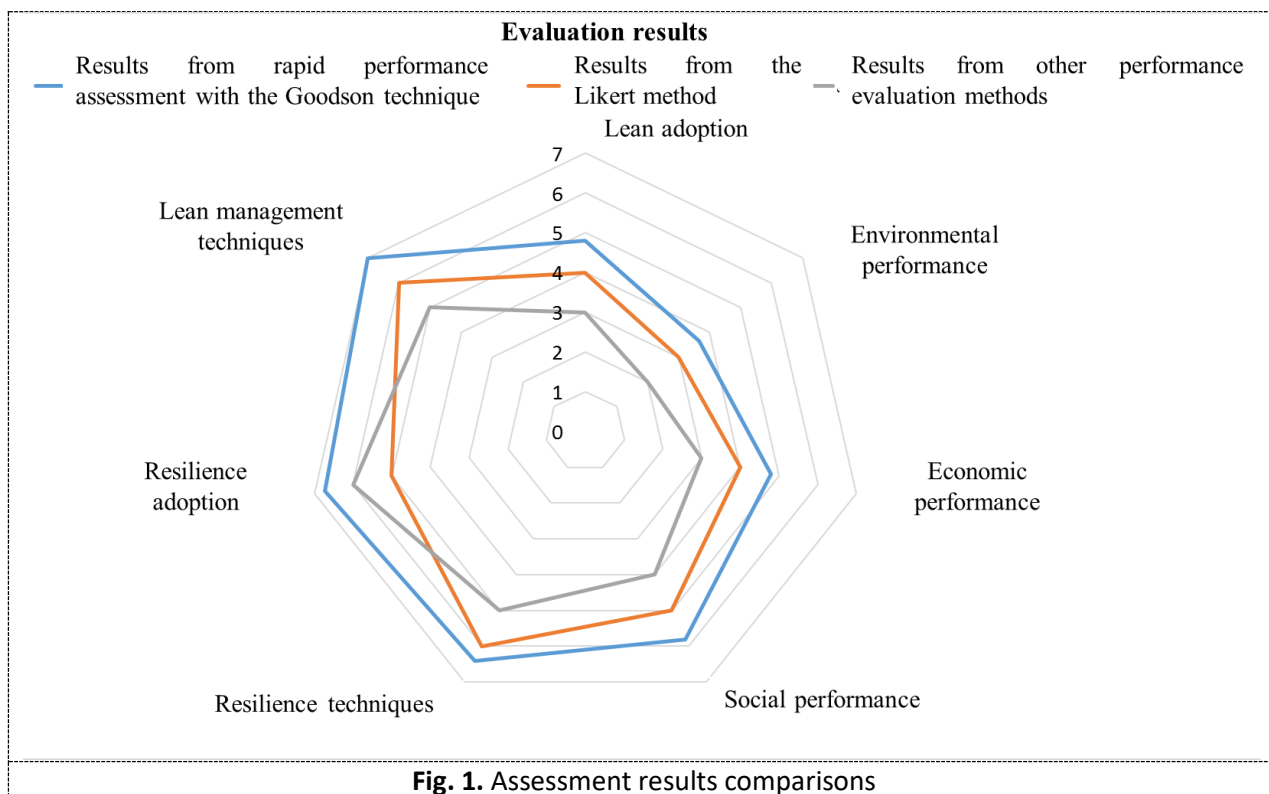
Continuing safety and environmental programs such as hospital waste management and efficient energy consumption,

Expanding social responsibility activities such as public health education,

Creating an employee motivation system to maintain a high level of participation and commitment,

Developing a local reference model, and sharing experiences with other hospitals to model and maintain and improve employee work-life balance to prevent burnout.

The results of the study indicate that the main strength lies in sustainability beyond the standard, achieving the desired state in the resilience dimension with a good assessment. The area in need of improvement is the lean management dimension, which received a moderate score. Therefore, the overall suggestion is to concentrate on teaching lean principles, enhancing workflow, and eliminating waste in emergency operational processes to enhance overall performance. The final strategic conclusion underscores the primary focus for improvement, which includes lean management to reduce waste and improve workflow. It also stresses the importance of maintaining and enhancing resilience from good to very good or best. Additionally, it highlights the need to establish and model the sustainability dimension as a main strength for potential application to other sectors. Furthermore, the findings from the Likert scale criteria assessment sheet indicate that the results align with the rapid emergency performance assessment model, and the priority areas for improvement have remained unchanged.



Findings from studies on lean management implementation in emergency departments typically show reduced wait times and improved patient flow. However, the success of implementation depends on leadership, staff engagement, and continuity of efforts [23]. The average status assessed in this study aligns with cases of incomplete or superficial implementation. Resilience literature suggests that hospitals and emergency departments often operate at an average to good level and require systematic training, scenario-based exercises, and organizational structures to achieve an excellent level [24]. The “good” assessment result obtained in this study is consistent with this pattern, though there remains potential for improvement. Regarding environmental and organizational sustainability, recent studies indicate that many emergency departments are still in the early stages of green initiatives, and comprehensive data are scarce [6]. The very high score in the evaluated set indicates an excellent and above-average status compared to what is reported in the literature. Conversely, the lean management status of the center under evaluation is recorded as average. Similar studies show that implementing lean management in emergency centers can reduce waiting times and length of stay while improving patient flow. However, effectiveness is highly dependent on implementation factors such as leadership, organizational culture, employee engagement, and sustainability of changes [25]. Many studies report positive initial results, but sustaining and expanding these outcomes has been challenging [17]. The “average” score of the evaluated emergency center aligns with these findings: some processes may have improved, but full institutionalization is incomplete in areas such as leadership, benchmarking, and fostering a culture of continuous improvement. Therefore, targeted managerial and methodological interventions are expected to drive improvement. Research indicates that focusing on change leaders, involving multi-professional executive teams, and continuously measuring time-based indicators can make a significant difference. Implementation priorities should include small, targeted continuous improvement projects on key processes, recording before-and-after indicators (based on waiting

time and length of stay data), and training and involving employees. This could involve training middle managers in lean leadership, forming multidisciplinary groups of nurses, doctors, and support staff, using value stream mapping to identify waste, and implementing 5S workplace organization techniques.

Studies on the resilience of health centers indicate that organizational resilience encompasses the abilities to predict, respond, learn from incidents, and maintain flexibility in human resources. Many successful centers enhance resilience through simulation exercises and systematic documentation of experiences. The evaluation of the emergency center's resilience management dimension suggests that the department is prepared and responsive; however, achieving a higher level of resilience requires additional training and formal structuring, such as regular simulations, after-action reviews, and maintaining a knowledge repository. To elevate resilience to a higher level, recommended actions include implementing regular disaster and incident simulation programs, including scenarios of sudden crowding or system collapse, documenting outcomes and lessons learned, establishing a feedback and learning system through post-event meetings to develop practical solutions and update protocols, providing psychosocial support for staff, and systematically recording experiences to foster lasting improvements in resilience.

A review of the results of studies conducted in the field of sustainability of medical centers shows that many emergency centers are developing sustainability programs. However, full coverage of measures such as staff training, equipment replacement, carbon footprint calculation, and green procurement policies is still rare. Only a portion of emergency centers have reached advanced levels. The score obtained by the medical center at the excellent level indicates that the center in question has performed outstandingly and is relatively advanced in this dimension. This surpasses what is reported in many international surveys. However, implementation recommendations include converting this success into internal standardization and becoming a model for other sectors. Developing a medical center sustainability program with quantitative goals, documenting measures and results such as waste reduction, energy consumption reduction, purchasing green products, greenhouse gas reduction, and cost savings is recommended. Launching a sustainability ambassador in shifts and providing continuous staff training to increase acceptance and disseminate experiences as a local model for other hospitals is also suggested. In conclusion, indexing and monitoring are essential for all dimensions under consideration. A set of short-term and medium-term key performance indicators need to be defined and managed in a smart management dashboard.

#### **4. Conclusions**

The present study aimed to evaluate the performance of the hospital emergency department, a frontline medical service that plays a vital role in saving patients' lives and enhancing the quality of healthcare. The findings revealed that the department's performance is influenced by several factors, including response time, patient satisfaction, human resource efficiency, medical equipment, and management processes. Data analysis identified key strengths such as rapid initial admission, strong commitment from medical personnel, and the presence of standardized protocols for managing critical cases. Conversely, challenges like patient congestion, insufficient staffing during night shifts, and poor interdepartmental communication have hindered optimal performance. By employing both quantitative and qualitative assessment tools, this study provided a comprehensive overview of the current situation and laid the groundwork for management decisions aimed at improving performance. From a human resource efficiency standpoint, despite high staff commitment, heavy workloads and understaffing during certain shifts have led to decreased productivity and increased employee fatigue. Regarding patient satisfaction, the moderate level of satisfaction reflects effective

staff efforts; however, waiting times and the quality of interpersonal communication require improvement. In terms of physical and technological infrastructure, limited physical space and underutilization of advanced patient management technologies pose obstacles to performance enhancement. From a management perspective, the absence of dynamic performance evaluation systems and regular feedback mechanisms has reduced transparency in decision-making. Overall, the findings indicate that the emergency department's performance varies across different dimensions:

- **Lean Management:**
  - The emergency center scored 13 in this dimension, which is considered an level.
  - The processes of patient admission, discharge, and transfer face challenges, particularly in reducing waiting times and improving coordination between departments.
  - Lean techniques such as 5S and Kaizen have not been fully implemented in this center, indicating that there is still potential for process optimization.
- **Resilience Management:**
  - The score obtained in this dimension was 19, which was rated as
  - This indicates that the emergency center has performed relatively well in managing crises and unexpected events.
  - Crisis preparedness protocols and resilience training programs for employees are generally in place, but there are still areas that could be strengthened.
- **Sustainability Management:**
  - In this dimension, the emergency center scored 39, which exceeds the defined range of the Goodson model and indicates excellent performance in social responsibility, patient safety, and environmental sustainability.
  - The center operates effectively in optimizing resource use, reducing energy consumption, and promoting social responsibility.
  - Employee satisfaction also appears to be addressed in this dimension, as welfare and support programs are provided for employees.
  - The results of the study indicate significant differences in the performance of the emergency center in three different dimensions:
    - In lean management, the emergency center is in a relatively weak position in terms of waste reduction and process optimization and needs further review and improvement.
    - In resilience management, the emergency center has performed well and has been able to respond effectively to critical situations in many cases, but there is still a need to strengthen these capabilities.
    - In sustainability management, the emergency center has performed very well and has performed even beyond the usual standards in many areas, especially in the areas of social responsibility, patient safety, and environmental compatibility.

Overall, these results indicate that while the emergency center has achieved good results in the sustainability dimension, it needs further improvement and strengthening in the two dimensions of lean and resilience. This can be achieved by applying optimal methods and techniques in processes and further training for employees. According to the findings and analyses conducted, this study shows that the emergency center has an outstanding performance in the field of sustainability, but improvements can be made in the fields of lean management and resilience. The following are summarized:

1. Sustainability: The emergency center has performed excellently in this field and has exceeded expectations, especially in areas such as social responsibility and environmental protection.
2. Resilience: The emergency center has been able to respond to the needs of crises to some extent, but there is still a need for further training for employees in this field.
3. Lean Management: In this dimension, the emergency center needs more efforts to reduce waste and improve efficiency due to the lack of sufficient use of lean techniques and process optimization.

According to the results obtained, the following suggestions are presented to improve the performance of the emergency center in various dimensions:

- Suggestions for improving lean management:
  - Reviewing admission and discharge processes: It is suggested that these processes be optimized using lean principles to reduce waiting time and eliminate redundant processes.
  - Using continuous improvement tools: Such as Kaizen and 5S techniques to improve the work environment and reduce waste.
  - Continuous monitoring and supervision: To identify waste and weaknesses in processes, it is suggested that key performance indicators be continuously monitored.
- Suggestions for improving resilience:
  - Conducting regular crisis simulations: In order to be more prepared for crises, regular simulations should be held for all employees.
  - Psychological resilience training: Strengthening the psychological resilience of employees through appropriate training helps them perform better in crisis situations.
  - Strengthening human resource flexibility: Creating the ability to quickly move forces in emergency situations can strengthen the resilience of the emergency center.
- Suggestions for improving sustainability:
  - Further development of environmental programs: Expanding programs that help improve environmental performance, including reducing energy consumption and hospital waste management.
  - Greater support for employees: Maintaining work-life balance and strengthening welfare programs for employees in order to increase job satisfaction and reduce burnout.
  - Supporting social responsibilities: It is recommended that the emergency center be more active in the field of social responsibilities, including holding workshops and training sessions for the community on public health.

Despite its significant achievements, this research faced limitations that affect the generalizability of the results: (1) Limited sample size: This study was conducted at only one emergency center. Future research should examine the performance of multiple emergency centers to obtain more generalizable results; (2) Limited use of assessment tools: The tool used in this study may not have captured all aspects of the emergency center's performance. Future research should employ a broader range of tools for a more comprehensive assessment; and (3) Qualitative research: To better understand the challenges and opportunities related to lean, resilience, and sustainability, qualitative research involving more in-depth interviews with employees and managers is recommended. This study showed that the emergency center performed very well in sustainability but requires improvements in the areas of lean and resilience. These findings can serve as a guide for managing and improving emergency center processes in other hospitals and healthcare facilities.

### Author Contributions

Conceptualization, M.Nazemi and A.Hasani.; methodology, M.Nazemi and A.Hasani.; software, M.Nazemi and A.Hasani.; validation, M.Nazemi and A.Hasani.; formal analysis, M.Nazemi and A.Hasani.; investigation, M.Nazemi and A.Hasani.; resources, M.Nazemi and A.Hasani.; data curation, M.Nazemi and A.Hasani.; writing—original draft preparation, M.Nazemi and A.Hasani.; writing—review and editing, M.Nazemi and A.Hasani.; visualization, M.Nazemi and A.Hasani.; supervision, A.Hasani. All authors have read and agreed to the published version of the manuscript.

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### Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

### Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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