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Analysis of Importance-Performance of Scenarios for Improving Patient Length of Stay in the Operating Room

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Abstract

The objective of this study is to reduce the patient's length of stay in the operating room, consequently reducing costs, increasing the revenue of the operating room, and ultimately developing the hospital.
We developed improvement scenarios by reviewing previous research and by interviewing operating room experts. A questionnaire based on the importance-performance analytical model was used for the scenarios investigation. The statistical population consisted of clinical and non-clinical staff in the operating room of a specialized hospital located in Tehran. After implementing the Importance-Performance Analysis (IPA) algorithm on the improvement scenarios, the IPA matrix and the weight of the scenarios were determined. Scenarios located in the weak area of the matrix need to be implementation more carefully for implementation. Additionally, scenarios with higher weights are more prioritized for implementation in the operating room. The results show scenarios involving resource changes (adding personnel to the department with the highest average waiting time), timely initiation of the first surgery in each shift, increasing the number of surgical beds, and changing the rules of arrival scheduling are more beneficial for implementation.

Keywords: Patient's length of stay, Operating room, Importance-performance analysis method, IPA method.

1 | Introduction

The scheduling of the operating room is crucial as it incurs the highest costs and generates the most revenue in the hospital, and the demand for surgical services is increasing. Therefore, hospitals must effectively provide high-quality care with limited resources by acquiring an efficient OR program. In most hospitals, when operating rooms are allocated to surgical groups, there is no specific mechanism to ensure the availability of lower-level resources such as special care unit beds and recovery units.

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Due to the unavailability of resources, patients cannot be timely transferred from the OR to the PACU or ICU, resulting in the blockage of both consecutive stages. It leads to significant negative impacts on OR management, such as increased waiting times, length of stay, excessive overtime, and night shifts, among others [1].

A significant portion of hospital expenses is related to the operating room. On the other hand, they constitute a major part of hospital income. Optimizing patient flow in an operating room by eliminating or reducing bottlenecks, which lead to time loss, is one of the main solutions to minimize patient length of stay in the system, reduce costs, increase efficiency, and enhance patient satisfaction [2].

In a study conducted by Saeedian et al. [3] in 2018, the cost and delay time in the operating room were analyzed. Factors affecting the delay time were examined using a factor-based simulation method. These factors included a shortage of recovery beds, emergency surgeries, surgical delays, untimely patient transfers, prolonged surgical stages, anesthesia, and pediatric surgeries. The greatest delays and time losses were due to insufficient patient tests, anesthesia and pediatric surgeries, prolonged surgical stages, and a shortage of recovery beds. Improving these factors can reduce patient length of stay and time delays.

Khasha et al. [2] presented an analytical model based on simulation to optimize patient flow in the operating room to reduce patient length of stay. To achieve this goal, they first created a workflow model of patient circulation using discrete event simulation. Subsequently, improvement scenarios were implemented in the simulated operating room model. Among the defined scenarios, a combined scenario involving the elimination of waiting time between patient entry into the operating room and the start of the acceptance process, timely initiation of the first surgery, and the addition of resources to transportation and recovery room facilities was selected as the best scenario. Simulation results indicated that implementing this scenario could reduce patient length of stay in such a system by 22.15%.

Saeedian et al. [4], in a study in 2019, identified bottlenecks in the operating room and presented scenarios for improvement. After analyzing and simulating the foundational factors, they found that adding human resources has a significant impact on managing the bottlenecks. The behavioral scenario of staff flexibility was considered the most effective scenario. Employee fatigue can hurt all criteria. The entry of emergency patients has the most negative impact, leading to increased waiting times and patient stays in the system.

Karimi et al. [5], in a study in 2020, presented a simulation method for reducing the length of stay for patients undergoing surgery. They divided the improvement scenarios into changes in regulations and changes in resources. The scenario of regulatory changes was divided into two groups: changes in scheduling regulations for patient admission and the separation of the acceptance and surgical departments. In the first group, a scheduling regulation for patient entry was proposed. In the second group, a new idea for implementing scheduling regulations for the acceptance and surgical departments was presented. Simulations showed that regulatory change scenarios reduce patient length of stay much more than what can be achieved in scenarios involving resource increases. This managerial insight is crucial as it demonstrates that using resources efficiently can increase the efficiency of the healthcare system more than increasing the number of resources.

1.1 | Importance-Performance Analysis

The Importance-Performance Analysis (IPA) model is a statistical tool that can be used for prioritizing improvement scenarios [6]. In the IPA model, each component is assessed in terms of "importance (desired state)" and "performance (current state of factors)." The importance criterion is used to determine where resource allocation is vital [7]. The matrix role, which is essentially composed of four parts (quadrants), has a specific strategy in each quadrant and aids the decision-making process (see *Fig. 1*).

The Weakness Zone (Q1) refers to factors that, when placed in this zone, are both highly important according to experts and have a weak current performance. Improving these factors can be expected to lead to increased patient satisfaction.

The document describes different zones based on the significance-performance analysis. In the "Acceptable" zone (Q2), factors are evaluated to have an average or above-average performance according to the statistical community, and their importance is also rated as average or above average by clinical staff. Qualitative factors in this zone are both important and provide good performance in the operating room.

In the "Indifferent" zone (Q3), factors are evaluated to have low or very low performance according to the statistical community, and their importance is also rated as low or very low by experts. Factors in this zone are not very important, and although the operating room should improve in these areas, they do not play a major role in reducing the patient's length of stay in the operating room.

These zones help prioritize improvement efforts based on the performance and importance of various factors in the operating room.

The wastage area (Q4) encompasses factors that have been evaluated as average or above average by patients in the questionnaire but are considered to have low or very low importance by experts. The qualitative factors in this area are those that, while not particularly important, are still provided with good quality by the nurses [8].

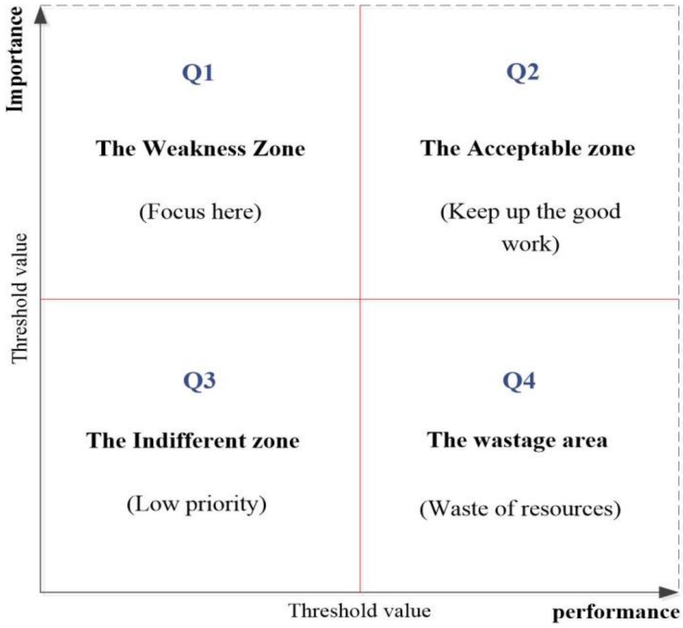

Fig. 1. IPA matrix.

2 | Method

The study includes clinical staff of the operating room, which was selected based on judgmental sampling, with ten experts from the subspecialty hospital's operating room. The second population of this research consists of all clinical and non-clinical staff of the operating room, totaling 60 individuals. The data collection tool was a revised significance-performance analytical model questionnaire completed by the experts.

The scenarios under investigation in this study include 14 items, which include reducing the waiting time before surgery, reducing the time between two surgical procedures, allocating two operating rooms to surgery, adding a recovery nurse, adding a bed to the recovery unit, adding a patient transporter, adding a cleaning staff member, changing the scheduling rules for admission, changing resources (adding a staff member to the section with the highest average waiting time), eliminating the waiting time between patient admission to the operating room and the start of the acceptance process, starting the first surgery on time in each shift, increasing the number of surgical beds, increasing the availability of operating room time, and increasing the availability of the surgical team.

The source under review states that after finalizing the scenarios, the IPA algorithm was used to analyze them. The indicators (scenarios) were selected based on experts' opinions and previous research reviews, and the IPA model was used for their classification. Data analysis was performed using Excel 2016 software.

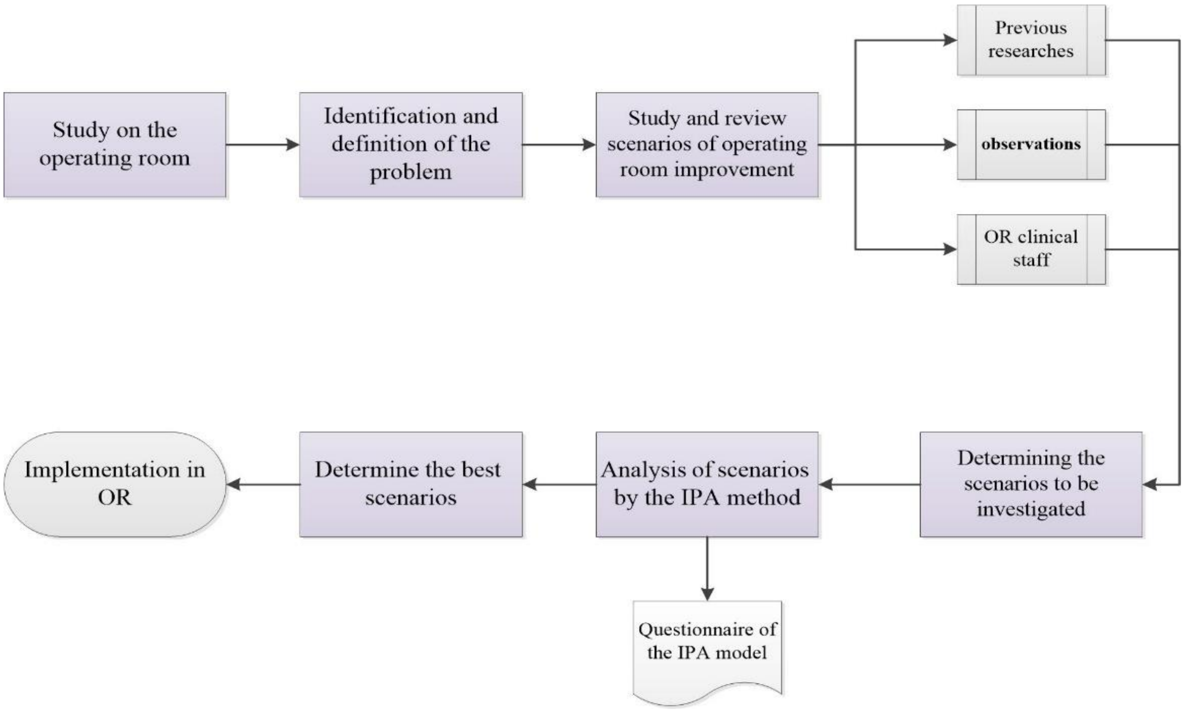

Fig. 2. The framework of the research.

In *Fig. 2*, you can see the framework of the research. After several months of observation and study in the hospital, a map was prepared that depicted the activities before, during, and after the operation, as well as the patient's length of stay, use of consumables and surgical sets, and the start and end of patient transfer, among other things (*Fig. 3*). Following the observations, the operating room system was analyzed. One of its problems was the increased length of patient's stay in the operating room. Therefore, the goal of this research was to identify processes to improve the patient's length of stay.

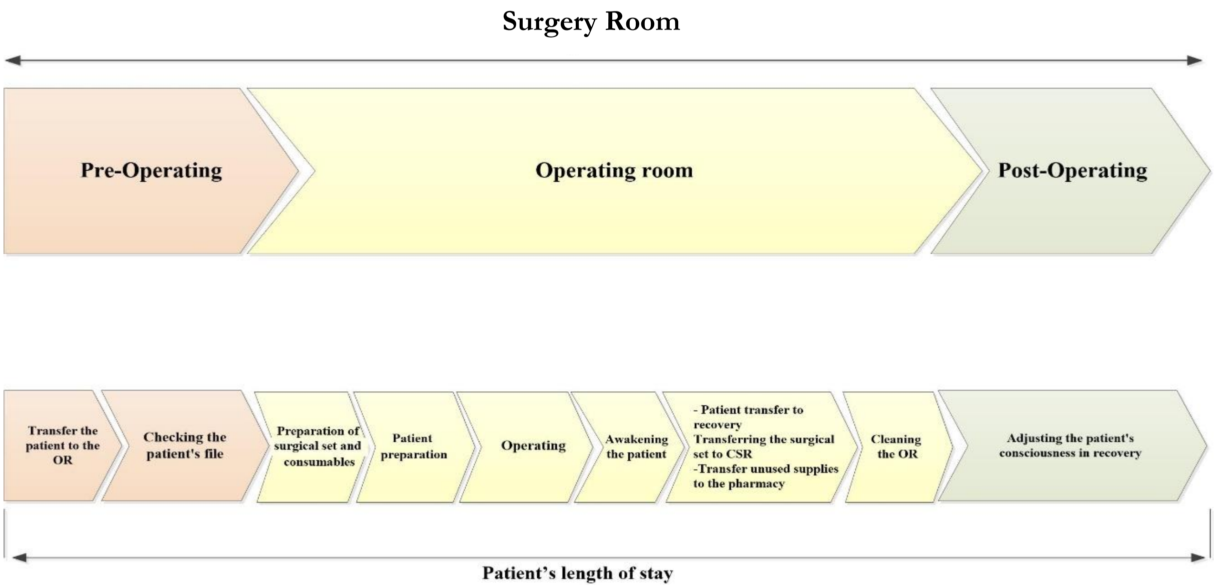

Fig. 3. Cross-process time.

By directly observing the operating room system and utilizing research conducted in previous years, the improvement scenarios presented in previous studies were compiled in *Table 1*. The improvement scenarios identified by experts in the operating room were reviewed, and the final improvement scenarios were determined.

The scenarios were analyzed using the significance-performance analysis method explained in the previous section. The IPA questionnaire, completed by patients and operating room experts, serves as the input data for the significance-performance analysis method. The basis of this method is the weighting of each indicator.

The weight of each scenario is determined using Eq. (1).

$$OW_j = |(b_j - c_j) \times b_j|. \quad (1)$$

With the help of these weights, the scenarios can be prioritized. For ease of use, the weights are normalized, and the scenarios with higher SW_j values are given higher priority for implementation.

$$SW_j = \frac{OW_j}{\sum_{j=1}^{m} OW_j}, \quad 0 \leq SW_j \leq 1, \quad \sum_{j=1}^{m} SW_j = 1. \quad (2)$$

The best scenarios for implementation and optimizing the patient's length of stay in the operating room are identified and will ultimately be executed in the operating room.

Table 1. Scenarios for improving patient length of stay in the operating room in recent research.

No	Scenarios for Improving Patient Length of Stay in the Operating Room	References
1	Add a recovery nurse	[2], [4], [5]
2	Add a bed in the recovery unit	[2], [4]
3	Add a patient transporter	[2], [4], [5]
4	Adding a cleaner	[4], [5]
5	The effect of employee fatigue on operating room performance and patient waiting time	[4]
6	Prioritizing emergency patients	[4]
7	The effect of flexible service time	[4]
8	Changing admission scheduling rules	[5]
9	Change in resources (adding personnel to the section with the highest average waiting time)	[5]
10	Elimination of waiting time between patient admission to the operating room and the start of the acceptance process	[2]
11	Timely start of the first surgery in each shift	[2]
12	Increasing the number of resources for patient transport, such as patient transfer beds	[2]
13	Increase in the number of operating beds	[9]
14	Increase in the available time for the operating room	[9]
15	Increase in the availability of the surgical team	[9]

3 | Result

The general operating room of the hospital under study has 8 operating rooms, two of which are equipped for general surgical procedures. This study focuses on abdominal surgeries.

Operating room experts reviewed the scenarios presented in *Table 1*, scenarios were confirmed for analysis in this study. Additionally, three scenarios were added by the clinical staff of the operating room: assigning two rooms to a surgeon, reducing the time between two surgical procedures, and reducing the waiting time for the patient before surgery.

The scenarios examined in this research include: 1) reducing the waiting time before surgery, 2) reducing the time between two surgical procedures, 3) allocating two operating rooms for surgery, 4) adding a recovery room nurse, 5) adding a bed to the recovery unit, 6) adding a patient transporter, 7) adding a cleaning staff member, 8) changing the scheduling rules for admission, 9) changing resources (adding personnel to the section with the highest average waiting time), 10) eliminating the waiting time between patient admission to the operating room and the start of the acceptance process, 11) timely initiation of the first surgical procedure in each shift, 12) increasing the number of surgical beds, 13) increasing the availability of the operating room, and 14) increasing the availability of the surgical team. After finalizing the scenarios, an IPA algorithm was used to analyze them, see in *fig. 4*.

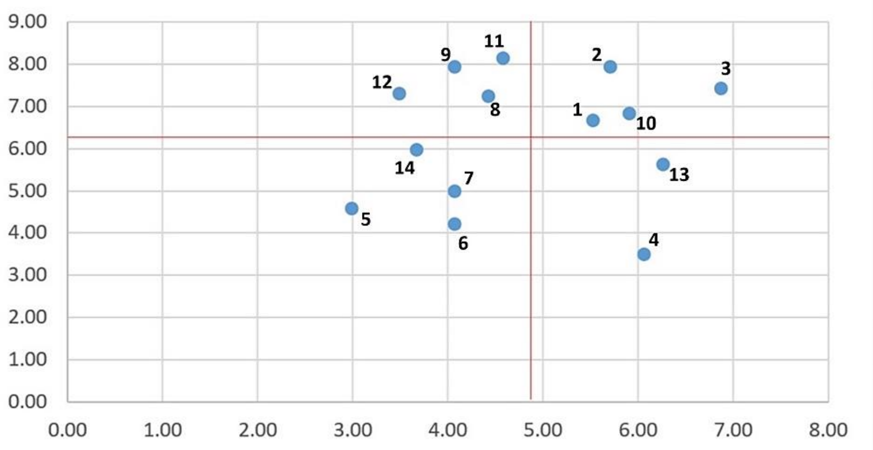

Fig. 4. IPA matrix.

The scenarios that have occurred in the first quarter (weak area) need improvement, and we should focus on them; 8) change in admission scheduling rules, 9) change in resources (adding personnel to the section with the highest average waiting time), 11) timely start of the first surgery in each shift, and 12) increase in the number of operating beds.

Scenarios in the second quarter indicate a good trend in performance and are important: 1) reduction of waiting time before surgery, 2) reduction of the time between two surgeries, 3) specialization of two operating rooms, and 10) elimination of waiting time between patient admission to the operating room and the start of the acceptance process.

Scenarios in the third quarter have a lower priority for implementation: 5) adding a bed in the recovery unit, 6) adding a patient transporter, 7) adding a cleaner, and 14) increasing the availability of the surgical team.

And scenarios in the fourth quarter, although they have a high performance, they have low importance, and their implementation would waste resources: 4) adding a recovery nurse, and 13) increasing the available time for the operating room.

According to the Eqs. (1) and (2), the weight of each scenario and then its normalized value according to *Table 2* were obtained.

Then, the values of SW_j were sorted from large to small (*Table 3*). Scenarios with higher normalized weights have higher priority for improvement. These scenarios include a change in resources (adding personnel to the section with the highest average waiting time), a timely start of the first surgery in each shift, an increase in the number of operating beds, and changes in admission scheduling rules.

Table 2. Scenario analysis using the IPA model.

No.	Scenarios for Improving Patient Length of Stay in the Operating Room	Importance Degree (bj)	Performance Degree (Cj)	Owj	|Owj|	SW_j
1	Reducing waiting time before surgery	6.65	5.53	7.47	7.47	0.041
2	Reducing the time between two surgeries	7.94	5.72	17.61	17.60	0.097
3	Specialization of two operating rooms	7.42	6.88	4	4	0.022
4	Adding a recovery nurse	3.56	6.07	-8.99	8.99	0.05
5	Adding a bed in the recovery unit	4.59	3.72	9.29	9.29	0.04
6	Adding a patient transporter	4.22	2.08	0.59	0.59	0.003
7	Adding a cleaner	4.99	4.08	4.58	4.58	0.025
8	Changing admission scheduling rules	7.24	4.44	20.26	20.26	0.112
9	Change in resources (adding personnel to the section with the highest average waiting time)	7.94	4.08	30.65	30.65	0.169
10	Elimination of waiting time between patient admission to the operating room and the start of the acceptance process	6.82	5.92	6.19	6.19	0.034
11	Timely start of the first surgery in each shift	8.14	4.59	28.90	28.90	0.159
12	Increase in the number of operating beds	7.30	3.50	27.75	27.75	0.153
13	Increase in the available time for the operating room	25.6	6.27	-3.67	3.67	0.02
14	Increase in the availability of the surgical team	5.96	3.68	13.61	13.61	0.075

*μb= 6.31, μc= 4.84, Ave=181.54

Table 3. Prioritization of scenarios for improvement.

Scenarios for Improving Patient Length of Stay in the Operating Room	SW_j
Change in resources (adding personnel to the section with the highest average waiting time)	0.169
Timely start of the first surgery in each shift	0.159
Increase in the number of operating beds	0.153
Changing admission scheduling rules	0.112
Reduction of the time between two surgeries	0.097
Increase in the availability of the surgical team	0.075
Adding a recovery nurse	0.050
Reducing waiting time before surgery	0.041
Adding a bed in the recovery unit	0.040
Elimination of waiting time between patient admission to the operating room and the start of the acceptance process	0.034
Adding a cleaner	0.025
Specialization of two operating rooms	0.022
Increase in the available time for the operating room	0.020
Adding a patient transporter	0.003

4 | Conclusion

The operating room incurs the highest cost, and also the lowest income for a standard patient, and the demand for its services is increasing. Since this department deals with human lives, any mistakes in performing surgeries and any changes in its programs may incur irreparable consequences.

Recent studies have presented various scenarios aimed at reducing patient length of stay. Each scenario alone may improve the operating room, but the importance and feasibility of their implementation are different.

On the other hand, the operating room and the hospital manager consider the cost of implementation in the real world. If the proposed scenarios are economical and reduce costs, the manager will be ready to take necessary actions to improve the efficiency in the operating room.

In this study, with the presentation of 14 scenarios, we focused on them using the IPA method. The prioritization of scenarios for improvement was as follows:

I. Change in resources (adding personnel to the section with the highest average waiting time).

II. Timely start of the first surgery in each shift.

III. Increase in the number of operating beds.

IV. Changing admission scheduling rules.

Some key suggestions for future research include:

I. Simulation of the improvement scenarios developed from this study.

II. Optimization of the flow for surgeons, surgical equipment, and consumables.

III. Investigation of changes in admission scheduling rules.

Author Contribution

S. R. M. research design, conceptualization and data gathering. M. M. S. computing, validation and editing. And S. E. N Software, resources and formal analysis. The authors have read and agreed to the published version of the manuscript.

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Data Availability

All data supporting the reported findings in this research paper are provided within the manuscript.

Conflicts of Interest

The authors declare no conflicts of interest.

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