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Assessing Information Technology in Hospitals in Tehran: Challenges and Opportunities for Performance Improvement

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Abstract:- Purpose: This research aimed to investigate the maturity level of information technology (IT) within hospitals in Tehran. Method: The study was applied in purpose and survey-based in method. The statistical population comprised 27 experts in urban management and IT within hospitals in Tehran. A revised standard questionnaire, based on Gartner's IT management process maturity model, was used to measure IT maturity. Data analysis was performed using SPSS software (version 23). Findings: The study revealed that several aspects of IT maturity within hospitals in Tehran were generally favorable. Specifically, leadership and IT management activities, customer-oriented service, control and evaluation, configuration and asset management, security management, change management, service level management, accessible management, service and support documentation, capacity management, and strategic trends were positively evaluated. However, operations management, human resource management, supplier management, and certain IT service management components were found to be below the average level of 3. Conclusion: Overall, the research indicates that the IT maturity level in hospitals in Tehran is largely favorable. Nevertheless, improvements are needed in specific areas, such as operations management and human resource management, to enhance the effectiveness and efficiency of IT operations.

Keywords:- *Hospitals in Tehran, Information Technology Maturity, IT Management, Gartner Model, Urban Management*

I. INTRODUCTION

The pivotal role that information technology (IT) plays in accelerating processes and enhancing productivity has made its utilization an essential component for all healthcare organizations. Each year, hospitals and healthcare institutions invest substantial resources to leverage advancements in IT. "Given that the implementation of information technology requires significant investment, organizations must meticulously plan its deployment" (Qurbani and Shakri, 2009). One of the primary considerations in this context is determining how and where to invest in IT, a crucial issue due to the constraints of limited resources and the high costs associated with IT development. Evaluating the impact of IT presents a complex challenge, largely due to difficulties in measuring the value of information and the unique economic characteristics of technology (Fatir, 2018).

The widespread adoption of IT by hospitals also highlights the need to evaluate their performance concerning IT effectiveness and impact. This necessitates that healthcare institutions assess their IT operations to improve service delivery and operational efficiency (Koehler et al., 2015; Lacerda, 2018). "Understanding the stage of IT development within an organization at various points in its lifecycle and identifying the necessary information systems based on IT can significantly assist managers in making informed decisions regarding technology" (Bagheri, 2007). Maturity models facilitate this evaluation by providing a structured approach to measuring IT-related processes relative to a defined scale (Ghazanfari et al., 2010). To enhance organizational performance, it is essential to determine the current level of IT maturity and identify the necessary steps to effectively utilize internal and external resources, using IT-driven processes to achieve long-term strategic goals in healthcare (Beh Menesh, 2008; Birasnav, 2014).

Just as organizations progress through stages of development, IT itself evolves through various growth phases, with maturity indicating the completion of these phases (Fatir, 2018). Maturity models are valuable tools for assessing the current state of IT within a healthcare organization, measuring progress, and managing the incremental implementation of improvements. A maturity model includes several levels of maturity for specific objectives.

The lowest level signifies the initial stage, where a healthcare organization demonstrates limited capabilities in IT management. Conversely, the highest level represents the pinnacle of maturity. Advancing from the initial stage to the ultimate level involves gradual progress based on the organization's capabilities and resources. Thus, the maturity

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model serves as a benchmark for assessing an organization's position along this evolutionary path (Baker and Concasted, 2009; Brostrom, Emp, and Carlson, 2016).

While various maturity models exist, Nolan's stages theory is among the most recognized for assessing IT evolution in healthcare settings. Despite the extensive use of IT in healthcare, research on IT maturity levels in hospitals, particularly within Tehran, remains scarce. This gap in the literature underscores the need for a detailed examination of how hospitals employ IT to enhance patient care and operational efficiency. Understanding IT maturity in these settings is crucial, as it directly affects service delivery, hospital management, and resource optimization.

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Nolan and Kot (1992), as cited in Fatir (2018), describe the stages theory's philosophy as follows: the development of information technology in an organization occurs in stages. Each stage presents its own challenges in terms of information systems, users, technology, employees, and management tools. Consequently, the management approach needed should vary for each stage. Nolan's growth stages are characterized by growth processes. In this model, four processes of IT growth are described, which determine the development and evolution of IT in an organization. These processes are: (1) Assets of application programs: including the automated information systems the organization possesses. This process refers to the quality (functional and technical) of these systems and their support for current work processes; (2) Users: including the level of user satisfaction with the systems and their positive perceptions of these technologies; (3) Resources: including the amount, quality, experience, and relevant knowledge of employees, as well as the effectiveness and efficiency of existing technology; and (4) Management: including the organization, procedures, and instructions necessary to control the supply of information.

Assessing IT maturity in healthcare institutions such as hospitals is of particular importance. These organizations play a crucial role in patient care, operational efficiency, and interaction with healthcare stakeholders. The level of IT maturity in hospitals can significantly influence their ability to respond effectively to patient needs, enhance operational efficiency, and manage resources amidst growing technological advancements and healthcare demands. Additionally, as healthcare organizations adapt to modern medical practices, understanding their IT maturity is essential for fostering digital transformation and ensuring competitiveness in the digital age.

Nolan's model is a conceptual and useful tool for understanding the direction of change, aiding in the planning process by providing a framework for understanding transformation (Sitin et al., 2016; Chan et al., 2016). The increasing competition, higher performance standards, and technological advancements facing organizations today necessitate continuous adaptation and transformation into flexible, high-performance systems (Karimi, 2014). Hospitals,

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in particular, face mounting pressures to optimize their operations, engage with stakeholders through IT, and improve service delivery in a rapidly evolving technological landscape. Thus, evaluating their IT maturity involves not only measuring current capabilities but also identifying strategic areas for development.

To manage these challenges, hospitals must view IT as a crucial factor for enhancing efficiency, effectiveness, and responsiveness to patient needs and competitive pressures. Effective use of IT can improve communication with patients, suppliers, and other stakeholders (Delvi, Salahian, and Ganji, 2014). This study aims to address these challenges by evaluating the IT maturity of hospitals in Tehran, identifying strengths and areas requiring development. Ultimately, the findings will provide valuable insights into the IT capabilities of hospitals in Tehran and offer guidance for other healthcare institutions seeking to advance their digital transformation efforts.

Therefore, the purpose of this research is to evaluate and measure the maturity level of information technology in hospitals in Tehran.

II. RESEARCH METHOD

The current research is applied in terms of purpose and employs a survey-based method. The statistical population consisted of 35 managers from urban management and information technology fields at hospitals in Tehran. The focus of the research was to investigate the maturity of information technology, specifically regarding the maturity of the IT management process.

To measure the level of information technology maturity, a standard questionnaire designed to evaluate the maturity of IT management processes was used. This questionnaire was developed based on Gartner's IT maturity model and assesses four main criteria and 35 factors to determine the maturity level of the IT management process.

The respondents evaluated each factor using five descriptive options based on the Likert scale, ranging from the most unfavorable condition (represented by 1) to the most favorable condition (represented by 5). This approach allowed for a quantitative assessment of qualitative opinions, making the results more interpretable through statistical analysis software.

To ensure validity, the questionnaire was reviewed by eight experts from the information technology field at hospitals in Tehran and academic professors specializing in information technology. The research tools were sent to these experts, who were asked to evaluate their applicability based on two criteria: (1) the relevance of the tools to the specific context of hospitals in Tehran and (2) their ability to address the research questions and hypotheses. After receiving feedback from the experts, necessary modifications were made to the questionnaire.

Once revised, the questionnaire was further evaluated. The relationship between the questions and the research objectives was assessed, along with the clarity of the questions. Ultimately, the validity of the tool was confirmed by the experts.

For reliability, the Cronbach's alpha coefficient was calculated after collecting data from the completed questionnaires. The overall Cronbach's alpha for the IT Management Process Maturity Assessment questionnaire was 0.85, indicating good internal consistency. The specific Cronbach's alpha values for the individual categories were as follows:

- Preparation Level: 0.87
- Tool Levers: 0.90
- Support and Delivery Service Process: 0.81
- Policies and Documentation: 0.84

The data analysis was conducted using descriptive statistics (mean, standard deviation, etc.) to describe the current maturity level of the IT processes. Inferential statistics (e.g., regression analysis, ANOVA) were used to explore the relationships between maturity levels and various influencing factors.

The combination of expert feedback and statistical analysis provided robust insights into IT maturity within hospitals in Tehran, helping guide future improvements in IT management processes.

Table 1: Demographic Breakdown of Respondents

Category	Frequency	Percentage
Gender		
Male	18	51.4 %
Female	17	48.6%
Level		
Bachelor's Degree	16	45.7%
Master's Degree	12	34.3
Doctorate Degree	7	20%
Work Experience		

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More than 10 Years	12	34.3%
5 to 10 Years	5	42.9%
3 to 5 Years	8	22.9%

III. RESULT

In the current research, 35 specialists in urban management from hospitals in Tehran were surveyed. To ensure the validity of the research tool, the questionnaire was initially presented to eight experts specializing in information technology and knowledge management within hospitals in Tehran, as well as professors in information technology.

The process involved sending the research tools to these experts and requesting them to assess the applicability of the questionnaire based on two dimensions: (1) its relevance to the operational context of hospitals in Tehran, and (2) its ability to effectively address the research questions and hypotheses. Based on the feedback collected from these experts, necessary modifications were made to enhance the clarity and alignment of the questionnaire with the research objectives.

After these modifications, the tool was re-evaluated using two methods: (1) scoring the alignment between the questionnaire items and the research objectives, and (2) assessing the clarity and readability of the questions. Once the tool's validity was confirmed, it was distributed in person to 35 specialists in urban management for further data collection.

After collecting the responses, distorted and incomplete questionnaires were excluded from the analysis. This resulted in 32 valid questionnaires, which were entered into SPSS software for statistical analysis in alignment with the research objectives.

➢ *Demographic Breakdown*

- Gender: Of the 32 respondents, 16 were male and 16 were female.
- Education Level:
- 18 respondents held bachelor's degrees,
- 10 respondents held master's degrees,
- 4 respondents held doctorate degrees.
- Work Experience:
- 12 respondents had more than 10 years of work experience,
- 15 respondents had between 5 to 10 years of experience,
- 5 respondents had 3 to 5 years of experience.

➢ *First Question: What is the Maturity of Information Technology in Hospitals in Tehran?*

To determine the favorable or unfavorable status of each of the factors and criteria assessed by the Gartner IT Management Process Maturity Evaluation Questionnaire, a one-sample t-test was applied. This test allowed us to compare the mean score of each factor with a theoretical neutral point (typically a score of 3 on a Likert scale, which represents neither favorable nor unfavorable) to determine if the maturity levels significantly deviated from this neutral point.

Table 1. Definition of Statistical Hypotheses and Conditions for Accepting Hypotheses

Statistical Hypothesis	Acceptance Condition	Description	The Status of the Criterion Under Review
H0: μx=3	Pi value greater than 0.05		Undesirable
H1: μx≠3	Pi value less than 0.05	If the upper and lower limits are both positive, then the assumption is greater than 3.	Optimal
		If the upper and lower limits are both negative, then the assumption is smaller than 3	Undesirable
		If the lower limit is negative and the upper limit is positive, then the assumption is equal to 3.	Undesirable

- Null Hypothesis (H_0): The mean score for the population is equal to 3 (neutral condition).
- Alternative Hypothesis (H_1): The mean score for the population is significantly different from 3 (indicating a more favorable or unfavorable condition).

Based on the analysis results, each of the criteria related to the maturity of the IT management process within hospitals in Tehran was assessed, identifying strengths and weaknesses across the four main criteria evaluated in the questionnaire.

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Table 2. Assessing the Maturity of Information Technology in Hospitals in Tehran by Sub-Criteria Using a One-Sample T-Test

Agents		Number	Average	Standard Deviation
Level of preparation	Information technology management activities in Hospitals in Tehran	27	4.12	1.015
	operation management	27	2.55	0.845
	Customer oriented service	27	3.45	0.830
	Human resources management	27	2.35	0.25
	Supplier management	27	2.3	0.001
	Introduction, provision and dissemination of information technology services	27	2.4	0.910
Tool levers	Control and evaluation	27	3.35	0.512
	Problem tracking systems	27	3.5	0.152
	Asset management	27	3.45	0.172
	Infrastructure assessment and testing	27	2.60	0.021
	Security management	27	3.10	1.447
Service support and delivery process	Management of events and events	27	2.55	0.435
	Change management	27	3.05	0.258
	Copy management	27	2.12	0.445
	Service level management	27	4.26	0.478
	Accessible management	27	3.62	0.460
	Capacity management	27	3.16	0.241
	Information security management	27	2.18	0.253
Policies and documentation	Service and support documentation	27	4.12	0.001
	Quality requirements and commitments and policies	27	2.18	0.154
	Strategic trends	27	3.27	0.183

To address the first research question, the data collected from the questionnaires assessing the maturity of the information technology management process were analyzed using a one-sample t-test. This statistical test was employed to determine whether the maturity levels within hospitals in Tehran were above or below the average threshold, which was set at three based on prior research (Rostami Majin, 2016; Sadeghi and Mousavian, 2013; Barqaei, Saatian, and Mohammadyari, 2019).

The analysis revealed that aspects such as leadership and IT management activities, readiness of customer-oriented service agents, control and evaluation, configuration and asset management, security management, change management, service level management, accessible management, service and support documentation, capacity management, and strategic trends showed a favorable status.

Table 3: Assessing the Maturity of Information Technology in Hospitals in Tehran by Main Criteria Using a One-Sample T-Test

Standard Deviation	Average	Number	Criteria
0.312	2.75	27	Level of preparation
0.298	3.15	27	Tool levers
0.315	3.10	27	Service support and delivery process
0.317	3.20	27	Policies and documentation

As detailed in Table 3, the sections covering instrumental levers, the support and delivery services process, and policies and documentation within hospitals in Tehran were found to be in a favorable condition. This indicates that these areas are relatively well-developed and managed.

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Table 4: Assessing the Maturity of Information Technology in Hospitals in Tehran Using a One-Sample T-Test

Standard Deviation	Average	Number	Criteria
0.302	3.10	27	Level of preparation

The average score for all sections of the questionnaire was calculated to assess the general state of IT maturity in hospitals in Tehran, as shown in Table 4. The results indicated that the overall level of technological maturity is higher than the threshold of three, suggesting a generally favorable status of IT maturity.

Table 5: Inferential Statistics Related to the Community Average Test for the Investigated Criteria

Criteria	Inferential test					
	The Test Value is Equal to 3					
	T	Degrees of Freedom	Significant Number	Difference in Averages	%95Confidence Interval for the Difference	
					Lower Limit	Upper Line
Level of preparation	0.85	26	0.4	0.052	-0.08	0.18
Tool levers	-8.71	26	0.0001	-0.516	0.64	0.39
Service support and delivery process	21.35	26	0.0001	0.528	0.48	0.58
Policies and documentation	-2.05	26	0.004	-0.177	0.30	0.05

Table 5 summarizes the results of the inferential statistics related to the community average test for the various criteria:

- Readiness Level: The p-value was greater than 0.05, indicating that the state of IT management process maturity in this sub-criterion was evaluated as unfavorable.
- Instrumental Levers, Support and Delivery Services, and Policies and Documentation: For these sub-criteria, the p-values were less than 0.05, and both the upper and lower limits were positive, reflecting a favorable status for these areas.

Table 6. Inferential Statistics Related to the Community Average Test for the Maturity of the Information Technology Management Process

Criteria	Inferential test					
	The Test Value is Equal to 3					
	T	Degrees of Freedom	Significant Number	Difference in Averages	95 %Confidence Interval for the Difference	
					Lower Limit	Upper Line
Maturity of information technology management process	-0.78	26	0.0001	-0.028	0.11	0.06

The overall state of IT management process maturity was further evaluated and the results are presented in Table 6. The p-value for the maturity of the IT management process was less than 0.05, with both limits positive, confirming that the state of IT maturity processes was evaluated as optimal.

Table 7. Findings About the Status of Factors Investigated in Evaluating the Maturity of the IT Management Process

Agents		Average
Level of preparation	Leadership and information technology management activities in Hospitals in Tehran	Optimal
	operation management	Undesirable
	Customer oriented service	Optimal
	Human resources management	Undesirable
	Supplier management	Undesirable
	Introduction, provision and dissemination of information technology services	Undesirable
Tool levers	Control and evaluation	Optimal
	Problem tracking systems	Optimal
	Configuration and asset management	Optimal
	Infrastructure assessment and testing	Undesirable
	Security management	Optimal
Service support and	Management of events and events	Undesirable

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delivery process	Change management	Optimal
	Copy management	Undesirable
	Service level management	Optimal
	Accessible management	Optimal
	Capacity management	Optimal
	Information security management	Undesirable
Policies and documentation	Service and support documentation	Optimal
	Quality requirements and commitments and policies	Undesirable
	Strategic trends	Optimal

The findings regarding the status of each factor in the IT management process are detailed in Table 7. According to these results, hospitals in Tehran exhibited a favorable status in 12 sub-criteria and an unfavorable status in 9 sub-criteria. This shows a mixed overall picture of IT maturity, with some areas performing well while others require improvement.

IV. DISCUSSION

The purpose of this research was to assess the maturity level of information technology (IT) within hospitals in Tehran. Utilizing SPSS software version 22 and the IT management process maturity model developed by the Gartner Institute in 1999, the study employed a standard questionnaire to evaluate various aspects of IT maturity. The following discussion synthesizes the findings derived from inferential statistics and explores their implications for IT management in hospitals.

V. FINDINGS AND IMPLICATIONS

➢ *Overall IT Maturity Evaluation:*

The study sought to identify whether various factors affecting IT maturity within hospitals in Tehran were favorable or unfavorable. The one-sample t-test results provided a nuanced view of the IT maturity across different criteria and sub-criteria.

➢ *Level of Preparation:*

- Information Technology Leadership and Management Activities: These were evaluated positively, suggesting that leadership and management practices in IT effectively support hospital operations. This reflects a strong strategic alignment in IT initiatives.
- Operations Management: Found to be unfavorable, indicating significant challenges in IT operational processes. Addressing these challenges is crucial for enhancing overall IT effectiveness.
- Customer Service: Evaluated positively, showing that IT-related customer service is well-managed, which is essential for patient satisfaction and service delivery.
- Human Resource Management: Considered unfavorable, pointing to issues in managing IT personnel, which could affect IT performance and innovation.
- Management of Suppliers: Also found unfavorable, revealing difficulties in managing relationships with IT suppliers and vendors, which could impact the procurement and maintenance of IT systems.
- Introduction, Provision, and Dissemination of IT Services: Evaluated as unfavorable, indicating inefficiencies or gaps in how IT services are deployed and utilized within hospitals.

➢ *Tool Levers*

- Control and Evaluation: Evaluated positively, suggesting that hospitals have effective mechanisms for monitoring and assessing IT performance. This is critical for continuous improvement and accountability.
- Problem Tracking Systems: Found desirable, indicating effective systems for tracking and resolving IT issues, which is important for minimizing disruptions and maintaining operational efficiency.
- Management of Configuration and Assets: Evaluated positively, reflecting strong practices in managing IT assets and configurations, which supports overall IT stability and performance.
- Evaluation and Testing of Infrastructure: Considered unfavorable, suggesting weaknesses in the assessment and testing of IT infrastructure, potentially impacting system reliability and performance.
- Security Management: Evaluated positively, highlighting the effectiveness of IT security measures, which is crucial for protecting sensitive health information and maintaining compliance.

➢ *Service Support and Delivery Process:*

- Management of Events and Incidents: Found unfavorable, indicating potential deficiencies in managing IT-related events and incidents, which could affect service continuity.
- Change Management: Evaluated positively, suggesting effective management of change processes, which is important for adapting to technological advancements and evolving needs.
- Rejection Management: Considered unfavorable, pointing to challenges in managing rejected IT processes or requests, which could hinder efficiency and service delivery.

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- Service Level Management: Evaluated positively, reflecting good practices in managing IT service levels, which is vital for ensuring reliable and responsive IT support.
- Accessible Management: Found desirable, showing that IT accessibility is adequately addressed, supporting inclusive and equitable access to IT resources.
- Capacity Management: Evaluated positively, indicating effective management of IT resources and capacity, which supports operational efficiency and scalability.
- Information Security Management: Considered unfavorable, suggesting needed improvements in IT security management to safeguard sensitive information and maintain compliance.

➢ *Policies and Documentation:*

- Documentation of Services and Support: Evaluated positively, reflecting good documentation practices for IT services, which is essential for consistency and quality assurance.
- Quality Requirements, Commitments, and Policies: Found unfavorable, which may indicate issues with adhering to quality standards and policies, potentially impacting overall IT performance and service delivery.
- Strategic Trends: Evaluated positively, suggesting effective management of strategic IT trends and alignment with organizational goals, which is important for long-term IT planning and development.

Overall, while certain areas of IT maturity within hospitals in Tehran are performing well, others require significant improvements. Addressing these gaps is essential for enhancing IT effectiveness, optimizing resource use, and ultimately improving patient care and hospital operations.

VI. LIMITATIONS

- Sample Size and Scope: The relatively small sample size of 31 respondents limits the generalizability of the findings. A larger and more diverse sample from various departments and hospitals could provide a broader perspective on IT maturity.
- Self-Reported Data: The reliance on self-reported data introduces potential bias. Respondents might have provided assessments influenced by personal perceptions or workplace pressures, affecting the objectivity of the findings.
- Focus on One Municipality: The study's focus on hospitals in Tehran may limit the applicability of the results to other geographic or organizational contexts. The challenges faced by hospitals in Tehran might differ from those encountered in other regions.
- Cross-Sectional Design: The cross-sectional design captures IT maturity at a single point in time, not accounting for changes over time due to technological advancements or shifts in management practices.
- Limited Scope of Maturity Model: The Gartner model, while useful, may not encompass all factors affecting IT development and management. Future research might benefit from integrating additional models that consider organizational culture, innovation, and strategic alignment.

RECOMMENDATIONS

- Expand the Study Population: Future research should involve a larger and more diverse sample, including various departments and officials across multiple municipalities. This would improve the generalizability of the findings and offer a more comprehensive view of IT maturity across different contexts.
- Longitudinal Studies: Conducting longitudinal studies would allow researchers to track changes in IT maturity over time. This approach can identify progress, emerging challenges, and the impact of technological advancements and management practices on IT maturity.
- Comparative Studies: Comparative studies involving different municipalities within Iran and internationally can provide a broader perspective on IT maturity in urban management. Understanding IT management practices across different regions could reveal best practices and areas needing improvement.
- Addressing Subjectivity: To mitigate the bias of self-reported data, future research should incorporate objective measures such as performance metrics, external audits, or third-party assessments. Combining qualitative interviews with quantitative analysis can offer a richer, more nuanced understanding of IT maturity.
- Integration of Additional Models: Future studies could integrate various maturity models or frameworks that consider a broader range of factors, such as organizational culture, agility, and innovation. This would provide a more comprehensive view of IT capabilities and readiness for future challenges.
- Training and Development: In light of the identified deficiencies in areas such as operations management and human resources, it is recommended that hospitals in Tehran invest in targeted training and development programs. Enhancing the skills and competencies of IT staff can address these gaps and improve overall IT management practices.

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