

Hanafizadeh, Payam; Lankarani, Ferdos Hatami

Article

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The system of research questions in theory-oriented studies of the application of the internet of things in the healthcare sector[☆]

Payam Hanafizadeh^{*}, Ferdos Hatami Lankarani

Department of Information Technology and Operations Management, Faculty of Management and Accounting, Allameh Tabataba'i University, West End Hemmat Highway, Dehkadeh-ye-Olympic, Tehran 1489684511, Iran

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ABSTRACT

This study develops a structured framework for advancing theory-driven research on the application of Internet of Things (IoT) technologies in the healthcare sector. Despite the growing body of empirical research, prior studies lack a systematic analysis of the research questions posed and the theoretical frameworks applied. Addressing this gap, the study conducts a rigorous Systematic Literature Review (SLR) of 75 peer-reviewed articles indexed in Scopus and Web of Science. It identifies 85 distinct research questions and 36 theories used in empirical investigations, classifying them into five thematic areas: technology adoption, performance improvement, social and cultural aspects, cognitive processes, and decision-making. To enhance theoretical precision and applicability, the study introduces a decision matrix based on the framework of Hanafizadeh and Alipour (2025), which enables the alignment of research questions with suitable theories through an analysis of contextual and conceptual fit. Using this approach, the study proposes 113 alternative theories to address existing questions and introduces 38 new research questions, supported by 48 relevant theoretical frameworks. The original contribution of this research lies in its systematic mapping of theory-question relationships and the introduction of a structured model for guiding future research in IoT and healthcare. By bridging theoretical gaps and extending conceptual understanding, the study offers a valuable resource for scholars seeking to conduct more robust, theory-informed investigations in the rapidly evolving field of smart healthcare systems.

1. Introduction

Over the past decade, the Internet of Things (IoT) technology has been widely adopted in the healthcare industry to deliver improved solutions for disease prevention and treatment. The goal of employing IoT in medical and healthcare systems is to facilitate access to high-quality healthcare services for people everywhere, including in their homes (Ashfaq et al., 2022). Rapid progress in information and telecommunications technology, particularly in wireless and mobile communications, has enabled connectivity anywhere, anytime, resulting in the emergence of a new type of information infrastructure capable of supporting a range of advanced health services (Aceto et al., 2018). IoT has played a significant role in the transformation of the Healthcare 5.0 industry by connecting medical devices and equipment to the Internet, collecting and enabling data exchange. Its application has led to improved quality of care, increased efficiency, and reduced costs (Alsamhi et al., 2023). The new generation of healthcare focuses on

real-time patient monitoring, environmental and health control, and privacy through technologies such as AI, IoT, big data, and assisted networking channels (Saraswat et al., 2022). Table 1 outlines the key features of this generation of healthcare.

Due to the emerging nature of IoT technology and its applications, most studies in this area are exploratory, aiming to better understand the technology and identify relevant application plans (Fatorachian & Kazemi, 2020; Graham & Jones, 2020). Extracting research questions can significantly impact the development of IoT applications within the healthcare industry. On the other hand, due to the interdisciplinary nature of IoT, novel conceptual frameworks are needed, and the use of theories and analysis of their role in addressing research questions can significantly contribute to the advancement of studies on IoT technology applications (Sandberg & Alvesson, 2020). A systematic examination of research questions in the area of IoT in healthcare is essential, as it determines the direction of research, highlights knowledge gaps, and informs the theoretical development of the subject. Theories play a

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^{*} Corresponding author.

E-mail address: hanafizadeh@gmail.com (P. Hanafizadeh).

Table 1
Properties of the healthcare industry 5.0

Properties	Sources
Human-centric- services, Human-machine- interaction, Seamless healthcare coverage, Sustainability (sustainable healthcare services), Pervasive AI, Productivity, Fog computing, Cloud computing, Full virtualization	(Chi et al., 2023)
Decision support system, Interoperability, Integrity, Data sharing, Accountability, Transparency	(Saraswat et al., 2022)
Real time data, Patient- centric- care	(Alsamhi et al., 2023)

fundamental role in answering research questions. By providing conceptual frameworks, theories enable researchers to articulate research questions more precisely, identify specific methodologies for data collection and analysis, and gain new insights into the research topic. Theories help researchers predict the impact of this technology at different organizational levels (Sandberg & Alvesson, 2020). As Kurt Lewin asserts, "nothing is as practical as a good theory" (p. 29). A good theory provides a basis for developing best practices (Gay & Weaver, 2011). Review studies in the healthcare area (e.g., Chinnasamy et al., 2024; Hossain et al., 2021; Mir et al., 2023; Mital et al., 2017; Negm, 2023) have addressed specific aspects, including the adoption of IoT in healthcare, the use of IoT-based wearable devices and technologies, remote monitoring and control, and intelligent healthcare centers. Hanafizadeh et al. (2022) identified theories used in the literature regarding the implementation of IoT in business, although they did not specifically examine the healthcare sector. Sporadic research has been conducted on the application of theory in healthcare studies, and no study has yet systematically addressed research questions, theory selection, the role of theory in addressing these questions, and the criteria for selecting suitable theories for research on the application of IoT in healthcare. Consequently, theoretical insight into the applications of IoT in healthcare as an emerging technology remains insufficient. Of the 157 articles reviewed in this study, only 75 were entirely based on theory, and the remaining articles did not fully leverage the capacity of theories to gain deep insight into this field.

The lack of a theoretical framework may impair policymakers' and health managers' ability to devise effective strategies. It may lead to an inadequate understanding of the effects of this technology on improving the quality and efficiency of healthcare services. Additionally, no article in this area has addressed the system of questions in theory-driven research related to the application of IoT. Extracting the types of theories employed and identifying the capacity of new theories that have the potential to answer both existing and new questions can be effective in selecting theories to answer research questions. Therefore, to develop a theoretical understanding of the application of IoT in the healthcare sector, it is essential to examine research questions through the lens of established theories. This necessitates a meticulous investigation of the research questions, along with a thorough understanding of the theories and their constraints, including their assumptions and reasoning mechanisms, within this area of study.

Review of the literature indicates that despite extensive research on the implementation of IoT technology in healthcare, substantial gaps remain in this context: (1) There is a noticeable lack of a systematic review of research questions and theories employed in empirical studies concerning the implementation of IoT in healthcare. (2) The primary focus of research questions in previous studies has been on the technical and practical dimensions of the technology, with insufficient consideration given to theoretical and conceptual frameworks. (3) The methodology for selecting and implementing theories to address research questions has not been thoroughly and systematically analyzed, nor has there been a suitable analysis of the function of theories in the design and elucidation of research. (4) The current literature lacks a systematic and structured approach for formulating theory-driven research questions in this area. (5) Potential theories applicable to addressing research

questions on the implementation of IoT in healthcare have yet to be found and presented.

This study aims to develop a system of questions in theory-driven studies on the application of IoT technology in the healthcare industry. Therefore, the objective of the present study is to identify research questions and theories used in empirical research on the application of IoT in healthcare. It will also identify new and potential theories in theory-driven research on the application of IoT technology in healthcare. The findings of this study can be significant to researchers in the field from two perspectives: (1) introducing research questions, theories, and classifying them based on the application areas of healthcare that have been used in the theoretical literature, and (2) introducing new theories and research questions and using their potential for application in future research. Therefore, the present study seeks to answer the following research questions:

RQ1: What research questions and, related to each question, what theories have been used in the literature on the application of IoT in healthcare?

RQ2: What other theories can be used to answer the research questions in the application of IoT in healthcare research?

RQ3: What new questions and consequently what theories can be raised in research on the application of IoT in healthcare?

This study seeks to answer the above questions through a systematic review of research on the application of IoT in healthcare. Seventy-five articles were meticulously examined in the literature review, resulting in the identification of thirty-six unique theories. From the reviewed articles, eighty-five non-repeating questions were extracted and classified into five categories. The results of this study show that six theories were employed in the first category of questions addressing technology adoption; 13 theories in the second category focusing on performance improvement; five theories in the third category related to social and cultural issues; five theories in the fourth category concentrate on the complexities of cognitive processes; and seven theories in the fifth category concerning decision-making processes to elucidate and interpret the research questions. This study suggests the use of 90 alternative theoretical frameworks to enhance the conceptual response to the identified questions. Furthermore, to draw new research horizons, 38 new research questions are presented alongside 48 appropriate theoretical frameworks to explain them.

The present article is organized as follows: it begins with the introduction (Section 1), followed by the research method (Section 2). The next section examines the research findings and their analysis (Section 3), which constitutes the core of the study. Section 4 presents the discussion of the findings, and finally, Section 5 concludes with the results of this study, limitations, and suggestions for further research.

2. Research methodology

This study aims to develop a system of questions from a theoretical perspective in the context of studies on IoT applications in the healthcare sector. More precisely, what questions have been raised in theory-driven research in the literature to date? What is the rationale for employing specific theories to answer these questions? Moreover, what alternative theories can be considered for them? This research also attempts to identify questions for future studies and suggest appropriate theories to address them. To this aim and to achieve a comprehensive, coherent, and evidence-based view, the Systematic Literature Review (SLR) approach was employed. This approach enables a structured, transparent, and reproducible examination of the research literature, allowing for the identification of conceptual patterns, the study of theoretical gaps, and the formulation of precise and targeted research proposals (Kupiainen et al., 2015; Paul & Criado, 2020). In contrast to scoping reviews or meta-analyses, which primarily assess the scope of a topic or the statistical composition of quantitative research results, SLR allows the researcher to provide a detailed and structured overview of the theoretical landscape of the field of study by following specific steps,

including establishing inclusion and exclusion criteria, data extraction, conceptual coding, and critical analysis (Boell & Cecez-Kecmanovic, 2015).

Since this study intends to follow a structured and documented process, the proposed framework by Massaro, Dumay, and Garlatti (2016) was used to conduct a systematic literature review. This framework is specifically designed for literature reviews that focus on the detailed examination of theoretical components, such as conceptual frameworks, theoretical assumptions, and research questions (Massaro, Dumay, & Guthrie, 2016). Unlike other approaches, such as Webster and Watson (2002), which emphasize knowledge mapping, or vom Brocke et al. (2009), which focus on procedural rigor, Massaro offers a structured yet flexible method tailored to theory-oriented reviews. This was essential for this study, which analyzed 85 research questions and 36 theories in the field of IoT-healthcare research. By using the framework, theories were categorized into seven thematic areas, conceptual imbalances were identified, and cross-disciplinary synthesis across management, organizational, and behavioral sciences was also guided. Moreover, unlike broader typologies such as Paré et al. (2015) or Snyder, (2019), Massaro provides explicit guidance for uncovering theoretical gaps and formulating new research questions. Through this process, 38 new research questions and 48 potential theoretical frameworks were proposed, among them cognitive and organizational perspectives that remain underexplored and are not addressed by adoption-centric models such as TAM or UTAUT.

It is characterized by logical coherence and broad applicability in similar studies. The framework outlines the key stages of a systematic review: planning the review, conducting a structured search for sources, systematically selecting studies, extracting data, and finally analyzing and synthesizing the findings. The steps of SLR are illustrated in Fig. 2.

2.1. Planning review

First, articles dealing with the application of IoT in the healthcare industry from a theoretical perspective were reviewed in accordance with the research objectives. The next stage of the present study involved extracting research questions from the selected articles, analyzing the theory employed in the articles, and proposing an alternative theory. Proposing alternative theories involves identifying theories whose assumptions can be realized within the context of IoT technology, considering the specific characteristics of the research question in the healthcare sector. Given the significance of implementing theory in theory-driven empirical research, particularly for emerging technologies, the subsequent stage involved enumerating potential research questions that future researchers can pose to enhance understanding of the topic under study. Then, to answer each of these questions, one or more theories are posited, considering the thematic relevance and the possibility of realizing the theoretical assumptions. The matrix of Table 8 from the article by Hanafizadeh and Alipour, 2025 was used to attribute the question to the theory. Fig. 1 indicates the

system of questions in a research topic. In this study, the research topic is the application of the IoT in healthcare.

The left side of Fig. 1 represents the current state (as-is) of the research literature, wherein the research questions are posed and the theories used to explain or interpret these questions are compiled. This section reflects the theoretical approaches prevalent in previous studies about the application of IoT in healthcare. Table 4 presents additional information related to the current situation and proposed theories. The right side of Fig. 1 illustrates the future state (to-be). It consists of two sections: the first section in the upper part introduces alternative theories to elucidate or interpret the existing research questions (as-is). In contrast, the second section in the lower part presents proposed questions for future research along with suitable theories for their analysis and interpretation. Detailed explanations of these two sections are provided in Tables 4 and 6, respectively. Fig. 3 in the Discussion section displays the completed version of the system of research questions for the application of the IoT in healthcare.

2.2. Searching and selecting articles

The goal of this sub-section is to identify articles that used theories from management, organizational, behavioral, social, and business perspectives as a basis for understanding the applications of IoT in the healthcare industry. The formulated search string (Fig. 2) was applied to the titles, abstracts, and keywords of articles in the Scopus and WoS databases, with the search extending to April 2025. This search yielded 791 scientific documents in English from journals classified in the subject areas of management, decision making, social sciences, economics, and psychology.

A multi-stage screening process was implemented to ensure the relevance of the selected articles to the study objective. Initially, the titles, abstracts, and keywords of the articles were examined, resulting in the identification of 130 articles that demonstrated the application of theory in their primary structure, including the explicit statement of the theory or conceptual framework. In the second stage, the full text of the remaining 661 articles was briefly reviewed to ascertain any references to the application of theory in their various sections. Consequently, 27 articles were added to the list of selected studies due to references to phrases such as "theoretical basis", "conceptual model development", and "theoretical framework".

In the third stage, i.e., manual screening, after a detailed analysis of 157 articles, the following criteria were employed to select articles whose research questions were answered using theory:

- Research questions or suggestions for future studies focused on the application of IoT in healthcare, engaging with at least one specific theory.
- Addressed the relationship between the properties of the healthcare industry, IoT technology, and the independent and dependent variables of the theory under study.

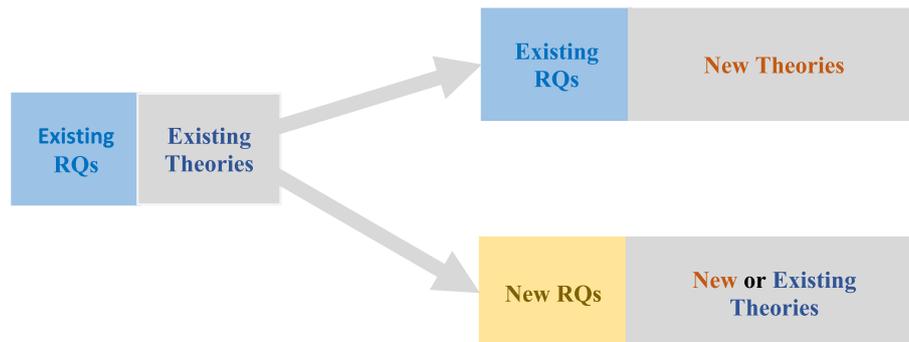


Fig. 1. The system of research questions.

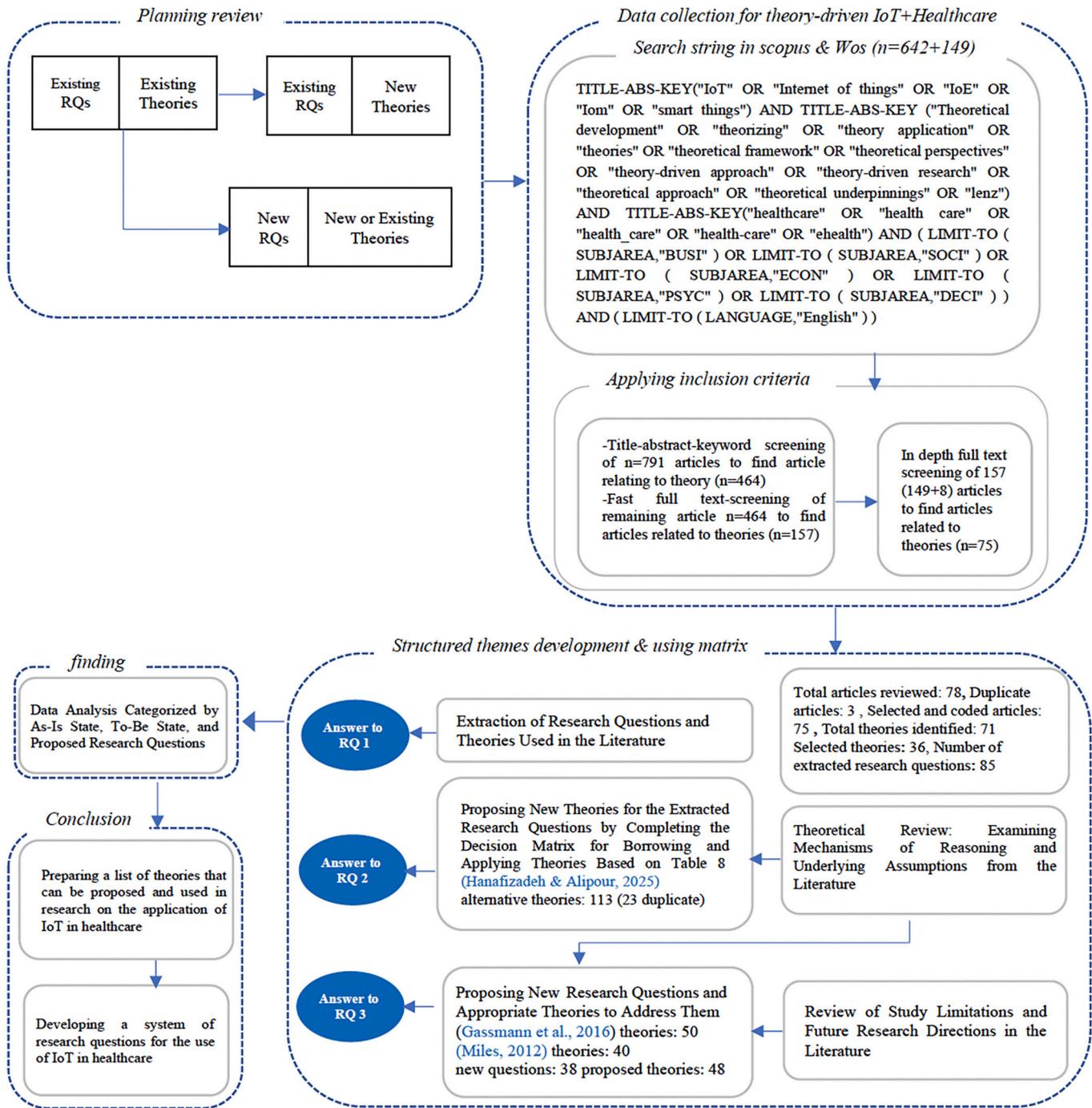


Fig. 2. The Steps of SLR.

Subsequently, 75 articles were selected for in-depth analysis based on the type of theory used. Tables 2 and 3 in Appendix B provide a quantitative and qualitative summary of previous studies and the status of the current study.

Appendix 2 (B) shows that 36 theories have been used in theory-driven research on the implementation of IoT in healthcare. According to Dutta et al. (2023), these theories have been divided into the areas of (1) organization and management, (2) trust, privacy, social norms, (3) economics, value creation, (4) performance improvement in medical sciences, psychiatry, nursing and healthcare, (5) IoT adoption in healthcare centers, applications, and (6) technical, processing, network, security. These theories can help address the implications of using IoT technology. As IoT matures, academic attention will shift from

conceptualizing and addressing the layers of technology architecture to understanding practical concepts, notably in organizations and management. Accordingly, the present study focuses mainly on theories with management, organizational, behavioral, social, and business perspectives. Hence, we did not consider theories utilized exclusively in engineering, computer science, and mathematics. In addition, theories that are predominantly applied to understand computing, energy consumption, and security issues related to IoT were excluded from our review.

For example, we removed Fuzzy set theory, used by Sathiyai et al. (2023) to indicate the correlation between variables, and Dempster-Shafer evidence theory, employed by Xu et al. (2023) to manage uncertainty and inconsistency in data. We also excluded theories with analytical modeling features, such as chaos theory and evolutionary

game theory, from the evaluation process of the articles.

Numerous articles have examined the role of theories in the application of IoT in the healthcare sector. Some of these articles have studied more than one theory. For instance, the study by Karahoca et al. (2018) employed a synthesis of four theories to investigate various behavioral and psychological aspects of the adoption of IoT products in healthcare. The integration of these theories has enabled researchers to gain a deeper perspective on the psychological, social, and technological factors affecting IoT adoption. Bamel et al. (2023) have presented a conceptual framework comprising nine theories that examine the adoption and implementation of IoT in the healthcare and treatment sector from a theoretical standpoint. In addition, research carried out by Mital et al. (2017), Hossain et al. (2021), Mir et al. (2023), Chinnasamy et al. (2024), and Negm (2023) has employed theories to address the issue of IoT adoption in the healthcare industry. These theories help identify key factors, including attitudes, social norms, and behavioral control, that influence IoT adoption and enable a comprehensive and multifaceted analysis of consumer behavior in this context. Appendix B presents a quantitative and qualitative summary of the review studies.

Furthermore, considering the focus of this study on management, organizational, economic, behavioral, and business theories, articles that addressed theories with origins other than these were removed from the list of selected articles. Table 2 presents the queries used to extract articles.

2.3. Extracting data

In this study, data were extracted from various research sources, as shown in Table 3. The information obtained from the selected research sources includes:

- Properties of the healthcare industry mentioned in the articles;
- Properties of IoT technology were identified in the studies. The findings of Hanafizadeh et al.'s (2022) study were used to delineate the properties.
- Research questions are addressed in the studies with the help of theories.
- Theories employed in the selected studies. These theories are utilized by the researchers to explain, interpret, and predict the outcomes of IoT implementation in the healthcare industry.
- Limitations, suggestions for future studies, and questions mentioned by the researchers in the research sources selected in this study.

2.4. Analyzing the data

To answer the first research question concerning the examination of research questions in the articles, 85 questions were extracted. Section 4.1 addresses these questions, their relationship with the theories employed in the articles, and the rationales for selecting the theory. Section 4.2 deals with the second research question. This section also presents alternative theories. A list of theories compiled based on Gassmann et al. (2016) and Miles (2012) was utilized to propose

alternative theories. The list of these theories is provided in Appendix A.

The prerequisite for proposing an alternative theory is the meticulous analysis of the information in the completed matrices, as outlined in the framework presented by Hanafizadeh and Alipour, 2025. Section 4.2 elaborates on the problem type and theory used, logical and tautological components of the theory, theoretical assumptions, properties of IoT technology, societal values and interests, related social events, and reasoning mechanisms. Section 4.3 presents questions derived from the limitations and recommendations of the selected articles, accompanied by suitable theories that can be applied in future studies. This section, similar to Section 4.2, utilizes the theories listed in Appendix A and the matrix in Table 8, developed by Hanafizadeh and Alipour (2024, 2025), to identify suitable theories.

3. Research findings

In this study, the system of research questions in theoretical studies of the application of IoT in the healthcare industry was derived. The examination of the 75 articles included in this review revealed that a substantial number (37 articles) focused on applying theoretical concepts to elucidate or predict performance improvements in areas such as medicine, psychiatry, nursing, and healthcare. This finding highlights the significant role of IoT in enhancing management and organizational processes within the healthcare sector.

In the area of IoT-based technologies adoption in healthcare centers and applications, 27 articles were identified, primarily highlighting the importance of adopting this technology by physicians and nurses, as well as the critical role of trust in technology. Issues related to organizational and management concepts in the health sciences (18 articles), technical, processing, network, and security dimensions (15 articles), as well as factors associated with trust, privacy, and social norms (14 articles), were also considered. Conversely, key areas such as economics, value creation, and theoretical development are the least-explored areas regarding the use of theoretical frameworks, with only two published articles to date. This conceptual gap underscores the need for in-depth, theory-driven research in this area to systematically advance theoretical knowledge in this emerging field.

3.1. Analysis of the theories used in the literature of IoT applications in the healthcare industry

By reviewing 75 selected articles, 36 unique theories were identified. With respect to the application of the theories, they can be classified into seven categories according to the findings of Gassmann et al. (2016). The classification of theories into seven categories encompasses a whole spectrum of approaches to studying IoT technology, with each category elucidating a facet of the decision-making process and the interaction of stakeholders with IoT (Gassmann et al., 2016). The categories include adoption theories, behavioral theories, organizational theories, cognitive theories, social theories, rational/strategic choice theories, and knowledge- and learning-based theories. Table 4 presents the theories and research questions employed in the literature on IoT applications in

Table 2
Keywords Combination.

Number of articles	Combination of keywords	Databases	Searches
First stage articles: 642	TITLE-ABS-KEY("IoT" OR "Internet of things" OR "IoE" OR "Iom" OR "smart things") AND TITLE-ABS-KEY ("Theoretical development" OR "theorizing" OR "theory application" OR "theories" OR "theoretical framework" OR "theoretical perspectives" OR "theory-driven approach" OR "theory-driven research" OR "theoretical approach" OR "theoretical underpinnings" OR "lenz") AND TITLE-ABS-KEY("healthcare" OR "health care" OR "health_care" OR "health-care" OR "ehealth") AND (LIMIT-TO (SUBJAREA,"BUSI") OR LIMIT-TO (SUBJAREA,"SOCI") OR LIMIT-TO (SUBJAREA,"ECON") OR LIMIT-TO (SUBJAREA,"PSYC") OR LIMIT-TO (SUBJAREA,"DECI")) AND (LIMIT-TO (LANGUAGE,"English"))	First combination	Scopus
Second stage articles: 140			
First Stage Articles: 149	Refine results for iot* (Topic) AND "theory"* (Topic) AND "healthcare"* (Topic) and Telecommunications or Management or Business or Healthcare sciences services or Psychology Multidisciplinary or Engineering industrial or	Second combination	Web of science
Second Stage Articles: 17	Medical Informatics or Operations research Management science or Psychiatry or Psychology clinical (Include – Web of Science Categories)		

Table 3
The sources and types of searched studies.

Document type	Number	Total articles selected	Time period	Resource	Number	Search step
Article	250	409	2002-2025	Scopus	642	Application of theories in research related to IoT and healthcare
Conference Paper	90					
Review	12					
Book Chapter	30					
Book	15					
Conference review	12					
Article	58					
Conference Paper	55					
Book chapter	13					
Review	6					
Book	5	140	2006-2025		409	Classification of articles in the fields of management sciences, decision-making, social sciences, economics, and psychology
Conference review	3					
Article	38					
Conference Paper	22					
Book Chapter	5					
Book	1	67	2015-2025		140	Classification of articles focusing on theories rooted in organizational, managerial, decision-making, business, social, behavioral, and economic disciplines.
Review	1					
Article	20					
Conference Paper	25					
Book Chapter	1					
Book	1	55	2013-2025		149	Application of theories in research related to IoT and healthcare
Review	8					
Article	12					
Proceeding Paper	4					
Review	1					
Article	6	17	2019-2025	Wos	55	Classification of articles in the fields of management sciences, decision-making, social sciences, economics, and psychology
Proceeding Paper	1					
Review	1					
Proceeding Paper	1	8	2021-2025		17	Classification of articles focusing on theories rooted in organizational, managerial, decision-making, business, social, behavioral, and economic disciplines.
Review	1					

the healthcare sector. Additionally, [Table 4](#) presents one or more alternative theories to provide a more comprehensive answer to the research questions from a theoretical perspective. The research questions and theories for each category will be examined in more detail below.

[Table 4](#) displays the results of a systematic review of research questions in the literature regarding the implementation of IoT technology in healthcare. These results indicate that a significant proportion of the questions focus on the adoption of IoT technology. Frameworks such as the Technology Adoption Model (TAM), the Theory of Planned Behavior (TPB), the Unified Theory of Acceptance and Use of Technology (UTAUT), and the Diffusion of Innovation (DoI) theory have significantly informed these questions. Consequently, the majority of studies concentrate on examining determinants of behavioral intention, trust, perceived usefulness, ease of use, and attitudes of users (either patients or healthcare providers) toward IoT-based technologies.

An in-depth examination of the research questions outlined in [Table 4](#) reveals repetition of certain themes in the literature related to the application of IoT in healthcare. A multitude of these questions have been reproduced using similar conceptual patterns and identical variables, albeit in different contexts or settings.

This approach is more confirmatory of existing theories and less focused on theory-building. In other words, an examination of the research questions reveals that studies often concentrate exclusively on measuring statistical relationships among standard variables, failing to address the contextual, social, or institutional complexities of IoT technology in the healthcare sector. The majority of questions predominantly focus on the micro (individual) level, with insufficient attention given to organizational, interpersonal, or health systems implications. The literature review revealed a scarcity of questions at the

macro level of analysis, including data governance, health policy-making, or medical professional structures. The implementation of IoT in the healthcare industry extends beyond behavioral dimensions of users and involves extensive institutional and organizational considerations. There is also limited diversity in the type of research questions. Over 70% of the questions were causal-predictive (e.g., what factors influence adoption?). However, questions of an interpretive nature (meaning and user experience), design-oriented (how can tools be designed more effectively?), or critical (what are the adverse effects of using the technology?) are more limited. This has hindered the development of in-depth, context-based knowledge about IoT technology in real-world healthcare contexts. The following is a discussion of how to answer these questions utilizing theories.

3.1.1. The applications of IoT and questions answered using theories

In the literature on the application of the IoT in healthcare, theories have been used in various application domains. Among them one can point to facilitating the effective adoption and implementation of IoT-based technologies ([Abed, 2024](#); [Ben Arfi et al., 2021](#); [Chinnasamy et al., 2024](#); [Mir et al., 2023](#); [Negm, 2023](#); [Karahoca et al., 2018](#)), identifying strategic resources to improve operational efficiency, enhance patient care, and achieve competitive advantages in a data-driven healthcare environment ([Binci et al., 2022](#); [Solangi et al., 2017](#); [Masmali & Miah, 2019](#)), considering the interests of various stakeholders, including healthcare providers, patients, technology developers, and policymakers using the theory of stakeholders ([Alrabhi et al., 2020](#)), patients' concerns about privacy ([Marakhimov & Joo, 2017](#)), developing a smart healthcare supply chain ([Mir et al., 2023](#); [Bamel et al., 2023](#); [Gal et al., 2018](#); [Sathiya et al., 2023](#)), improving the quality of hospital services through workflow optimization ([Cáceres](#)

Table 4

Research questions, theories, IoT characteristics, and healthcare industry features used in the literature on the application of IoT in the healthcare industry, along with the proposed theoretical frameworks.

Category	theory	Theory assumption	Research questions under investigation	Proposed theories	IoT properties	Healthcare properties
Adoption	UTAUT	This theory includes three variables that predict behavioral intention: Performance Expectancy (PE) Effort Expectancy (EE) Social Influence (SI) Additionally, it includes a variable that has a direct relationship with Facilitating Conditions (FC) (Venkatesh et al., 2003)	<p>What factors affect RFID adoption by healthcare professionals? (Yee-Loong Chong et al., 2015)</p> <p>How can theoretical models like UTAUT, personality traits, and demographics predict IoT adoption? (Yee-Loong Chong et al., 2015)</p> <p>What is the role of trust-risk in patients' intention to use IoT in healthcare? (Arfi et al., 2021)</p> <p>What facilitates or hinders patients' adoption of IoT in healthcare? (Alaiad & Zhou, 2017)</p> <p>What barriers exist to IoT adoption in healthcare? (Ben Arfi et al., 2021)</p> <p>What factors influence the use of contact tracing apps? (Chan et al., 2021)</p> <p>What affects IoT wearable adoption among elderly patients with chronic diseases? (Chinnasamy et al., 2024)</p> <p>What drives patients' adoption of IoT-based health devices? (Solangi et al., 2017)</p> <p>What challenges and enablers exist for IoT healthcare adoption in developing countries? (Kante & Ndayizigamiye, 2021)</p> <p>How is IoT healthcare adoption evaluated in hospitals? (Solangi et al., 2017)</p> <p>How can a conceptual model be designed for the acceptance of smartwatches among older adults and identify the factors influencing the acceptance of this technology based on the UTAUT model? (Cristescu & Bajenaru, 2021)</p> <p>What factors influence the adoption and use of Internet of Things-based wearable health devices (IoTWHD) among patients in Iraq? (Noor et al., 2024)</p> <p>What theoretical frameworks have been used in research on adoption of IoT in healthcare? (Kante & Ndayizigamiye, 2021)</p>	Self-efficacy theory, TAM, TPB, IDT, Extended UTAUT (UTAUT2)	Context awareness, Smart object, Availability, Accessibility, Interoperability, Interaction, Data access, Real-time analytics, Integration, Wireless network, Data sharing, Context awareness, Automation	Pervasive AI, Human-centric services Interoperability, Real-time data, Patient-centric care, Productivity, Decision support system/tool/function, Real-time data, Patient-centric care, Sustainability
	TAM	This theory is designed to explain and predict user behavior in the acceptance and use of new technologies. The model posits that an individual's intention to use a system is based on two key beliefs:	<p>Which model is suitable for studying IoT adoption? (Mital et al., 2017)</p> <p>What factors influence the intention to adopt IoT-based health products? (Aasim et al., 2023)</p> <p>How can behavioral models</p>	Self-efficacy theory, Task-technology fit (TTF),DoI UTAUT, IDT, TPB, TAM2, TAM3	Integration, Smart object, Context awareness, Wireless network, Data access, Real-time analytics	Cloud computing, Transparency, Real time data, Decision support system/tool/function, Cloud computing

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Table 4 (continued)

Category	theory	Theory assumption	Research questions under investigation	Proposed theories	IoT properties	Healthcare properties
		<p>Perceived Usefulness (PU) - the degree to which a person believes that using the system will enhance their job performance.</p> <p>Perceived Ease of Use (PEOU) - the degree to which a person believes that using the system will be free of effort.</p> <p>These two beliefs jointly influence the user's attitude and behavioral intention toward adopting the technology, thereby offering a useful framework for understanding technology acceptance (Venkatesh & Davis, 2000).</p>	<p>and theories be used to better understand the adoption of health technologies? (Karahoca et al., 2018)</p> <p>How do variables such as perceived benefits, perceived risks, ease of use, and compatibility affect IoT adoption? (Karahoca et al., 2018)</p> <p>How do individual differences, such as technological innovativeness or health behaviors, play a significant role in IoT adoption? (Karahoca et al., 2018)</p> <p>How do theories like PMT, IDT, and TAM complement each other in explaining this process? (Karahoca et al., 2018)</p> <p>What factors influence the intention to adopt special devices in smart health? (Hossain et al., 2021)</p> <p>What factors affect consumer adoption of IoT? (Abed, 2024)</p> <p>What is the key consumer-related factors influencing IoT adoption? (Abed, 2024)</p> <p>What factors affect healthcare technicians' readiness to adopt IoT health technologies in rehabilitation? (Rodić et al., 2023)</p> <p>Which factors influence consumer adoption of IoT across different contexts, and how do these factors interact within an integrated theoretical model? (Ladeira et al., 2025)</p>			
	TPB	<p>According to the Theory of Planned Behavior (TPB), an individual's intention is the primary determinant of their behavior. The theory assumes that people behave rationally, their actions are consciously guided, and they consider the consequences of their behavior before acting. Furthermore, individuals are assumed to have a sense of perceived control over their actions (Ajzen, 1991).</p>	<p>What factors influence the adoption of monitoring devices in smart health? (Hossain et al., 2021)</p> <p>Which technological and psychological mechanisms affect IoT adoption? (Negm, 2023)</p> <p>How can a dynamic model predict behavior change in IoT usage? (Fu & Wu, 2016)</p> <p>How can IoT improve data collection for behavioral interventions in households? (Fu & Wu, 2016)</p> <p>What factors affect healthcare technicians' readiness to adopt IoT health technologies in rehabilitation? (Rodić et al., 2023)</p> <p>What influences the adoption of IoT wearables among elderly individuals with chronic diseases? (Chinnasamy et al., 2024)</p>	<p>Self-determination theory, TRA, SCT, Value-belief-norm theory, Protection motivation theory</p> <p>Attitude-behavior-context (ABC) theory</p>	<p>Integration, Smart object, Context awareness, Wireless network, Data access, Real-time analytics, Availability, Layered architecture, Interoperability, Interaction, Semantic-oriented</p>	<p>Cloud computing, Decision support system/tool/ function, Pervasive AI, Patient-centric- care, productivity, Data sharing, Real time data</p>

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Table 4 (continued)

Category	theory	Theory assumption	Research questions under investigation	Proposed theories	IoT properties	Healthcare properties
			How do various factors affect elderly patients' intention to adopt IoT technologies? (Parra-Sánchez, 2024) How can a model be used to design personalized health improvement systems? (Russo & Eriksson, 2016)			
	TRA	Individuals are assumed to have full autonomy in deciding whether or not to perform a given behavior. Behavioral intention is considered the best predictor of actual behavior. This intention is primarily influenced by two key factors: attitude toward the behavior and subjective norms (Fishbein & Ajzen, 1975).	How is the Internet of Things being adopted in India across different sectors? (Mital et al., 2017) How can competing models (TAM, TRA, TPB) explain IoT adoption? (Aasim et al., 2023), Which factors drive the adoption of CGM devices in smart healthcare? (Hossain et al., 2021)	TPB, SCT, UTAUT DoI	Integration, Smart object, Context awareness, Wireless network, Data access, Real-time analytics	Cloud computing, Decision support system/tool/ function
	DoI	Innovation adoption is a social process. It occurs gradually over time, rather than instantaneously. The characteristics of the innovation itself significantly influence its adoption. Moreover, communication channels play a facilitating role in the diffusion of innovations (Rogers, 2003).	How do attitude, advantage, and value co-creation influence young doctors' adoption of IoT in health services? (Hasan et al., 2023) What are the technical and cultural factors influencing the acceptance and integration of IoT in healthcare service delivery in Saudi Arabia? (Masmali & Miah, 2021) How are these factors reflected in healthcare managers' experiences with IoT devices? What factors influence the acceptance and integration of IoT technology in healthcare service delivery in Saudi Arabia, and how do these factors manifest in the real-life experiences of healthcare managers using IoT devices? (Masmali & Miah, 2019) What factors influence the intention to adopt IoT-based health products, and how can behavioral models and theories be used to better understand the acceptance of health technologies? (Karahoca et al., 2018), (Yesmin et al., 2022)	TAM, UTAUT, TPB Social network theory (SNT) Institutional theory, Critical mass theory, Knowledge transfer theory, Structuration theory	Availability, Real-time analytics, Big data analytics, Distributed, Data storage, Accessibility, Smart object, Wireless network, Interoperability, Interaction, Context awareness,	Pervasive AI, Data sharing Patient-centric care, Decision support system/tool/ function, Real time data, Cloud computing, Accountability, Transparency,
	Disruptive innovation theory (DIT)	At the initial stage of market entry, disruptive technologies are typically inferior in performance compared to mainstream technologies. They usually emerge in niche markets that have specific and often underserved needs. Over time, disruptive technologies improve and evolve to a level where their performance becomes sufficient to meet the demands of mainstream	How has research on DDI implementation in healthcare progressed over time? (Bamel et al., 2023)	Actor-network theory, Social cognitive theory, TPB, DoI	Availability, integration	Sustainability, patient-centered care, Pervasive AI, Virtualization, Data sharing, Accountability, system/tool/ function, Real-time data

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Table 4 (continued)

Category	theory	Theory assumption	Research questions under investigation	Proposed theories	IoT properties	Healthcare properties
Behavioral theories	Coping theory	markets and customers. (Christensen, 1997) Stress arises from the interaction between the individual and the environment, and it occurs when the individual perceives that environmental demands exceed their personal abilities or resources to cope with them. (Lazarus, 1984)	What causes stress for consumers regarding wearable health devices? (Marakhimov & Joo, 2017) How do consumers manage this stress, and how does it affect adoption? (Marakhimov & Joo, 2017)	Self-determination theory, Behavioral activation theory, Resilience theory	Smart object, Context awareness	Real time data
	BRT	This theory posits that an individual's behavior is a result of their attitude toward the expected outcomes of that behavior and the social norms surrounding it. (Ajzen & Fishbein, 1980)	How do acceptance factors and barriers influence the use of IoT-based wearables for elderly? (Sivathanu, 2018)	Behavioral decision theory, Motivational theory, TPB, Social cognitive theory,	Context awareness, Smart object,	integrity
	Behavior theory	Behaviors are shaped through learning and experience, and are influenced by environmental factors and reinforcements. In other words, behaviors are primarily determined by stimuli and consequences (rewards or punishments). Therefore, to change behavior, one must modify the environment and the stimuli. (Skinner, 1953)	How can an IoT-based monitoring system be designed and implemented for managing organ disorders, leveraging principles of Behavioral Theory to improve patient management? (Jonas et al., 2023)	Social cognitive theory, Cognitive dissonance theory, TPB, Structuration theory, Actor-network theory	Smart object, Data access, Interaction	Real time data
	Push pull and mooring (PPM) theory	Negative factors at the origin push individuals away, while positive factors at the destination attract them. (Bansal, 2005)	What drives Gen Z customers to adopt wearable health devices? (Nayak et al., 2022)	Behavioral decision theory, Motivational theory, Social cognitive theory, TPB	Smart object, Integration, Real-time analytics	Decision support system/tool/ function
	Place attachment theory	The core assumption of Attachment Theory is that individuals are inclined to form deep and enduring emotional bonds with others. Early attachment experiences in childhood have long-term effects on social relationships and stress levels in adulthood. Attachment is a strong emotional tie that persists over time and distance, typically involving one-way or mutual behaviors (Miles, 2012).	How can smart technologies improve the patient experience in healthcare using Place Attachment Theory? (Jorgensen & Geropanta, 2021)	Sense of place theory, Attachment theory, Identity theory	Smart object	Patient-centric care
	Prospect theory	When individuals are required to choose between alternatives, they typically frame their decisions in terms of gains or losses relative to a reference point. (Miles, 2012) The value function is based on the idea that the psychological value of an outcome depends on its magnitude and direction, rather than its objective value (Miles, 2012). Individuals tend to exhibit risk aversion in the domain of gains and risk seeking in the domain of losses (Kahneman & Tversky, 1979). Furthermore, low	How can clinical decision support systems reduce the risks and cognitive biases in the adoption of artificial intelligence in healthcare? (Curiello et al., 2025)	Dual process theory, TBP, Structuration theory, Institutional theory, Sociotechnical system theory	Smart object	Decision support system/tool/ function

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Table 4 (continued)

Category	theory	Theory assumption	Research questions under investigation	Proposed theories	IoT properties	Healthcare properties
Cognitive theories		probabilities are typically overweighted, while high probabilities are underweighted (Rieger & Wang, 2006; Tversky & Kahneman, 1992; Wakker, 2003).				
	Certainty theory	Individuals prefer to make decisions in situations where the outcomes are clearly defined or known in advance. (Tversky & Kahneman, 1992)	How can priority queues reduce latency in fog computing compared to cloud computing? (Golkar et al., 2022)	Prospect theory, Ambiguity aversion theory, Expected utility theory, Regret theory, Dual-process theory	Data access, Smart object,	Decision support system/tool/ function
	Self-efficacy theory	Individuals with a strong sense of self-efficacy tend to perform better when facing challenges. The primary sources of self-efficacy include performance accomplishments, vicarious experiences (modeling), social persuasion, and physiological and emotional states. (Bandura, 1997)	What factors influence the adoption of monitoring devices in smart health? (Hossain et al., 2021)	SCT, Goal setting theory, Self-determination theory, Resilience theory	Context awareness, Smart object, Data access, Real-time analytics	Interaction, Data sharing
	PAD theory	Individuals experience specific emotional states based on physical and social environments. These emotional states-Pleasure, Arousal, and Dominance (PAD)-influence individual behaviors, such as avoidance or attraction to a given environment. Human behaviors, such as the desire to stay, to make purchases, or to flee from an environment, are strongly influenced by these affective responses. (Mehrabian & Russell, 1974)	What are the key facilitators and barriers to patients' adoption of WSN-SHHS? (Alaiad & Zhou, 2017) How can the technology acceptance model be adapted for WSN-SHHS? (Alaiad & Zhou, 2017) What technological and psychological mechanisms influence IoT adoption? (Negm, 2023)	Cognitive appraisal theory, Affective events theory, Self-determination theory	Smart object, Wireless network, Data access, Real-time analytics, Context awareness, Smart object, Interaction, Availability	Decision support system/tool/ function Pervasive AI, Productivity, Decision support system/tool/ function, Real time data, Patient- centric-care, Data sharing,
Social theories	Cognitive selective permutation theory	The human mind operates selectively, and this selectivity is guided by cognitive priorities. Moreover, the organization and sequence of information also play a crucial role. (Eysenck & Keane, 2015)	How can a MIMO detector be designed for wearable IoT health applications with high performance, energy efficiency, and low computational complexity? (Tipparti & Lokam, 2021)	Attention theory, Dual-process theory, Signal detection theory, Prospect theory, Cognitive load theory, Information Integration theory, Resource allocation theory	Smart object, Integration Wireless network	Cloud computing
	Social cognitive theory	Learning occurs through observation and is shaped by a triadic reciprocal interaction between behavior, the environment, and personal factors such as beliefs and expectations. Behaviors can be modified through positive or negative reinforcement, which may be either direct (rewards/punishments) or indirect (observing the rewards/punishments given to others). (Bandura, 1986)	How can a COMBI model be used to design a personalized consumer-centered health improvement system? (Russo & Eriksson, 2016) How can this model integrate interactions with health professionals and users' social? (Russo & Eriksson, 2016)	Cognitive learning theory, TPB, Self-determination theory	Context awareness, Integration, interaction	Real time data
	Appraisal theory	Emotions arise from cognitive appraisals. (Lazarus, 1991; Scherer, 2001) Appraisals are dynamic and subject to change. (Lazarus, 1991)	how can consumer relationships be systematically integrated and analyzed through a meta-analytic approach in adoption of IoT? (Ladeira et al., 2025)	UTAUT, TAM, Consumer culture theory, Social exchange theory	Integration, Smart object	Interaction
Social theories	Privacy calculus theory	Individuals assess the potential costs and benefits of disclosing information in a rational manner before	How do consumers balance privacy risk and benefit when sharing personal information? (Kim et al.,	TAM, UTAUT, Social exchange theory, Communication privacy management theory	Smart object, Accessibility, Heterogeneous devices, Interaction, Data access	Pervasive AI, Data sharing Real time data Sustainability, Decision (continued on next page)

Table 4 (continued)

Category	theory	Theory assumption	Research questions under investigation	Proposed theories	IoT properties	Healthcare properties
		doing so. Privacy-related decisions are influenced by situational factors (e.g., the type of information) and personal characteristics (e.g., attitudes toward privacy). (Dinev & Hart, 2006)	2018) Why do consumers prioritize privacy risk and benefit based on personalization levels? (Kim et al., 2018) Is Privacy Calculus Theory suitable for evaluating user decisions in smart healthcare technologies? (Princi & Krämer, 2020)		Integration, Interoperability, Wireless network	support system/tool/ function, Interoperability, Real time data
	Socio-technical theory	Social and technical interactions function as interdependent systems, and the duality in system design—addressing both human and technical needs—is essential for achieving sustainable success. (Trist & Bamforth, 1951) An optimal fit between the technical and social subsystems leads to improved performance, productivity, and satisfaction. (Cherns, 1976)	What factors affect the adoption of remote monitoring in chronic disease management? (Binci et al., 2022) How do privacy concerns affect the intention to use an eHealth device? (Binci et al., 2022) How can these factors be understood from a sociotechnical perspective? (Kronlid et al., 2024)	Systems theory, Actor-network theory, Complexity theory, Organizational learning theory	Context awareness, Smart object, Accessibility, Heterogeneous devices, Interaction, Data access	Real time data Sustainability, Decision support system/tool/ function,
	Theory of sensor networks	Sensors operate in a distributed manner within the environment. Data processing is performed locally at the sensor to reduce energy consumption. The network must be adaptable to an increasing number of sensors or environmental changes. (Akyildiz et al., 2002)	How can wireless sensor networks be used to develop a medical imaging system for healthcare and evaluate its efficiency in remote disease monitoring and rapid diagnosis? (Singh et al., 2023)	Cyber-physical systems (CPS) theory, Distributed systems theory, Network theory, Game theory, Energy harvesting theory, Self-organizing system theory, Optimization theory	Smart object, wireless network, integration	Pervasive AI
	Actor-network theory	Each actor, whether an individual, an object (including software, hardware, and technical standards), or an organization, holds equal importance within a social network (Latour, 2005). The role and identity of each actor are shaped through relationships and dependencies on others (Law, 1999). The dynamics and variability of networks: this theory assumes that network structures are not stable and change with the alteration of actors' relationships (Latour, 1987).	What key themes in DDI ^l implementation literature can guide future healthcare research and practice? (Bamel et al., 2023)	Cyber-physical systems (CPS) theory, Distributed systems theory, Network theory, Game theory, Energy harvesting theory, Self-organizing system theory, Optimization theory	Availability, integration	Sustainability, patient-centered care, Pervasive AI, Virtualization, Data sharing, Accountability, system/tool/ function, Real time data
	Structuration theory	structures and agents have a dialectical relationship. Structures are defined as rules and resources in society, consisting of two dimensions: interpretive rules and resources. The duality of structure means that structures function both as constraints and as tools that actors can use. Human action is conscious and reflexive. (Giddens, 1984).	How can human-city interaction concepts in cyber-physical systems and social computing improve healthcare? (Woolliscroft & Polovina, 2017)	Actor-network theory, Practice theory, Institutional theory, Systems theory, Social Cognitive theory, Contingency theory	Smart object, Interaction, Data access	Productivity, Accountability
Rational/ strategic choice theories	Real options theory	Options give individuals the right to take an action in the future without creating an obligation to do so. This	How can real options analysis with type-2 fuzzy logic evaluates medical	Prospect theory, Decision theory, Transaction cost theory, RBV, Game theory	Integration	Sustainability, Data sharing

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Table 4 (continued)

Category	theory	Theory assumption	Research questions under investigation	Proposed theories	IoT properties	Healthcare properties
		approach considers the aspects of rapid change and risk assessment. (Amram & Kulatilaka, 1998) Every system (whether mechanical or human) has a goal or a reference state it aims to reach. Systems continuously measure their state through feedback. Feedback loops in human or organizational systems are organized hierarchically. (Miles, 2012)	devices under uncertainty? (Tolga, 2020)			
	Control theory	Every system-whether human, technical, or organizational-has a goal it aims to achieve or maintain. Therefore, the system must regularly measure its current state or performance relative to that goal. Using feedback loops, the system determines whether adjustment or correction of its behavior is necessary. (Miles, 2012)	How can advanced technologies like IoT, Health 4.0, and simulations reduce overcrowding in emergency departments? (Cáceres Flórez et al., 2020) How can a model predict patient numbers to manage and prevent overcrowding in emergency departments? (Cáceres Flórez et al., 2020) How can combining DES, forecasting models, and automation address resource management in emergency departments? (Cáceres Flórez et al., 2020) How can telemedicine and automation enhance service quality in emergency departments? (Cáceres Flórez et al., 2020) How can the use of a multi-agent system and the SHAP algorithm enhance root cause analysis performance compared to existing models? (Bulla & Birje, 2022)	Decision theory, Information boundary theory, Resource dependence theory, Cybernetics theory, Privacy calculus theory	Smart object, Automation, Interoperability, Real-time analytics	Productivity, Virtualization Decision support system, Interoperability, Real time data, Data sharing
	Game theory	The costs and benefits of a strategic decision in a game depend on the behavior of the parties involved. The actors participating in a game are rational and strive to maximize their outcomes. (Tadelis, 2012)	How can computational tasks be allocated in a fog network to ensure a uniform distribution of computational load and minimize delay? (Soni et al., 2024)	Decision theory, Behavioral theory, Negotiation theory	Smart object, Automation, Availability, Interaction, Real-time analytics	Fog computing, Cloud computing, Decision support system/tool/function, Real time data
	Matching theory	Each member of the group has a set of preferences. The final matching must be stable, meaning that no pair should be able to improve their situation by switching. The preferences of each group remain fixed throughout the process. (Gale & Shapley, 1962)	How can sleep optimization algorithms be used to control energy consumption in Machine-to-Machine (M2M) communication systems? (Kumar & Mahdi, 2017)	RDT, Institutional theory, Game theory, Equity theory, Social exchange theory, Contingency theory, Network theory	Real-time analytics, Heterogeneous devices, Smart object	Fog computing, Real-time data
	Theory of probability	There exists a probability space that consists of a set of events. (Bertsekas & Tsitsiklis, 2002)	How can telemedicine and automation enhance service quality in emergency departments? (Farooq & Zhu, 2020)	Fuzzy theory, Possibility theory, Information theory, Decision theory,	Smart object, Automation, Data access, Real-time analytics	Real time data
	Optimization & decision theory	Optimization involves an objective function that must be maximized or minimized. Decision-making is based on rationality, the presence of decision criteria, and interaction among agents. (Hillier & Lieberman, 2015)	How can advances in neuroscience, modern psychometrics, and technology be leveraged to transform neuropsychological assessment methods and improve accessibility, diagnostic accuracy, and	Game theory, Fuzzy theory, Prospect theory, RBV, Contingency theory, Behavioral decision theory	Smart object, Integration, Wireless network, interaction	Cloud computing

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Table 4 (continued)

Category	theory	Theory assumption	Research questions under investigation	Proposed theories	IoT properties	Healthcare properties
	Item response theory - IRT	An individual's ability or skill is related to their responses to questions. All item responses stem from a single latent trait. The response to a particular item is not influenced by responses to other items, provided the individual's ability level remains constant. (Embretson & Reise, 2000)	integration with modern healthcare systems? (Bilder & Reise, 2018) What factors create challenges in adopting health information technology (HIT)? (Alrahbi et al., 2020)	Task-technology fit (TTF), Protection motivation theory (PMT), TAM, UTAUT	Smart object, Integration, Interaction, big data analytics	Decision support system/tool/ function, Data sharing, Accountability
Org. theories	Stakeholder theory	Each firm must identify its internal and external stakeholders who are affected by its decision-making processes. To meet stakeholders' expectations, the firm needs to collect more information about them. (Miles, 2012; Sarkis et al., 2011)	Which factors are most significant in adopting health information technology (HIT)? (Alrahbi et al., 2020) How does self-construal influence individuals' willingness to disclose personal information in healthcare? (Zhang et al., 2021)	Actor-network theory, Institutional theory, Resource dependence theory, Transaction cost theory, Social network theory, Socio-technical systems	Smart object, big data analytics, Integration, Availability, Context awareness	Productivity, Real-time data, Patient-centric care
	Information boundary theory	Individuals' mental boundaries determine how much information is shared and with whom. Information boundaries can be closed, open, or flexible. These boundaries are influenced by social and cultural contexts. Both individuals and organizations seek a balance between the need for transparency (to facilitate communication) and the protection of privacy (to prevent potential harm). (Child & Starcher, 2016)	How does regulatory focus mediate the effect of self-construal on the willingness to disclose personal information? (Zhang et al., 2021) How does message framing impact individuals' willingness to disclose personal information based on their self-construal? (Zhang et al., 2021) What key themes on implementing DDIs in healthcare can guide future research and practice? (Bamel et al., 2023)	Communication privacy management theory, Privacy calculus theory, Boundary spanning theory, Institutional theory, Human-computer interaction (HCI) theory	Context awareness, Smart object, Data access, Real-time analytics	Interaction, Data sharing
	Change management theory	Change is an inevitable process and must be carried out systematically and in a planned manner. Resistance to change is natural, and change should occur gradually and step by step. Strong leadership is critical in managing change. Employee participation and engagement in the change process are essential. (Kotter, 1996; Lewin, 1947)	Why did a culture of secrecy around medical errors persist until 1999, and how did the IOM report shift this culture? (Jarvis, 2016)	TAM, Resistance to change theory, Socio-technical systems theory, Institutional theory, and Dynamic capabilities theory	Availability, integration	Sustainability, patient-centered care, Pervasive AI, Data sharing, Virtualization, Real time data, Decision support system/tool/ function, Accountability,
	Institutional theory	Organizations in an institutional environment gradually become similar to each other due to isomorphic pressures—coercive, mimetic, and normative. These pressures encourage organizations to adopt structures and processes that others are following (DiMaggio & Powell, 1983; Hawley, 1968). Organizational structures and processes become meaningful and persistent	How can the Universal Village framework and the technologies available in smart cities address the environmental challenges of urban lifestyles and improve the harmony between humans and nature? (Cao et al., 2018)	Resource dependence theory, Contingency theory, Stakeholder theory	Data access	Interaction, Decision support system/tool/ function, Accountability

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Table 4 (continued)

Category	theory	Theory assumption	Research questions under investigation	Proposed theories	IoT properties	Healthcare properties
		not necessarily because of their efficiency or effectiveness, but due to social acceptance and legitimacy within the institutional environment (Lincoln, 1995; Scott, 1995). To survive and gain access to resources, organizations seek legitimacy, which is achieved by conforming to societal norms, laws, and shared beliefs (DiMaggio & Powell, 1983).				
	Systems theory	Systems are composed of interrelated components. The whole is greater than the sum of its parts. Feedback plays a crucial role in the regulation and stability of systems. (von Bertalanffy, 1968)	How can the concept of a smart community help improve the efficiency of healthcare systems in the UK? (Wooliscroft, 2020)	Complexity theory, Chaos theory, Actor-network theory	Smart object, Integration, Automation, Availability, Wireless network, Interaction, Data access, Real-time analytics, big data analytics, Context awareness	Sustainability, Cloud computing, Decision support system/tool/function, Data sharing
Knowledge and learning based Theories	Absorptive capacity theory	Absorbing new knowledge can help organizations become more innovative and flexible, achieving higher levels of performance than they would without such absorption (Cohen & Levinthal, 1989, 1990; Miles, 2012). Firms with greater absorptive capacity have a competitive advantage over those with lower capacity. Organizations require a knowledge base to effectively absorb and utilize new knowledge (Schumpeter, 1942).	How can companies use deep learning-based prescriptive analytics to harness external knowledge and improve innovation and performance? (Raeesi Vanani & Majidian, 2021)	Dynamic capabilities theory, Knowledge-based view of the firm, Organizational learning theory, Innovation diffusion theory, Social capital theory, Ambidexterity theory, Systems theory	Smart object, Data access Real-time analytics	Data sharing

^a Disruptive digital innovation.

Flórez et al., 2020) and paying attention to smart healthcare centers as one of the important components of a smart city (Latif et al., 2018). Furthermore, theories have facilitated addressing many questions in studies on the application of IoT in healthcare. This study examines the application of theories in depth by considering not only their assumptions and reasoning mechanisms but also the characteristics of technology and the healthcare industry, as well as their impact on realizing theory assumptions (Hanafizadeh et al., 2022). Table 5 presents an overview of the data extracted from the articles studied.

Table 4 categorizes the theories into seven groups: (1) Adoption, (2) Behavioral theories, (3) Social theories, (4) Cognitive theories, (5) Rational/strategic choice theories, (6) Organizational theories, and (7) Knowledge and learning based theories. This classification is based on the findings of Gassmann et al. (2016).

3.2. Alternative theories to answer questions in the literature on IoT applications in the healthcare industry

The application of IoT technology in various industries, including healthcare, is accompanied by numerous complexities and ambiguities. Hanafizadeh et al. (2022) suggest that insights gained from the application of theories in business studies can help mitigate these complexities. In addition, using theories whose assumptions have moved one step closer to realization, given the characteristics of IoT technology, can be effective in a more detailed study of the IoT-based business applications (Hanafizadeh, Hatami Lankarani and Nikou, 2022). The findings

of Hanafizadeh and Alipour, 2025 study revealed that it is suitable to borrow a theory when a significant relationship exists between the research area/focus, i.e., the type of problem, and the new attributes of the context (industry), along with the assumptions and reasoning mechanisms of the theory. In this regard, they advocate employing the decision matrix for theory evaluation across research fields, encompassing both technology-driven and non-technology-driven sectors (Hanafizadeh & Alipour, 2024, 2025). The rows and columns of the matrix are completed by the researcher for each theory, deriving the propositions by meticulous analysis of the problem type, the characteristics of the context, and their relationships with the theoretical assumptions.

When researchers select an appropriate theory based on the decision matrix, they can also gain insight into the development of the theory propositions through Table 5 (sample completed matrix). Insights into the proposition development are obtained through a close examination of the problem type and context characteristics (matrix columns) and their relationships to the assumptions and reasoning mechanisms of the theory (matrix rows) (Hanafizadeh & Alipour, 2024a, 2024b).

This study offers a deep understanding of the application of IoT technology to managers and decision-makers in healthcare settings. The application of theories in healthcare studies can extend beyond the current status quo and involve the consideration of novel theories. To this end, this section presents theories that may serve as alternatives in the reviewed studies to answer the research questions. Table 4 proposes one or more alternative theories to better answer the research questions

Table 5
Sample completed matrix for the DoI theory (Hanafizadeh & Alipour, 2024, 2025; Miles, 2012).

Tautological and logical justification components of the theory	Research domain/focus			
	Type of problem	Context properties		
		Emerging technology properties	Research aim	Community values and interests
<p>Theory assumptions</p> <p>The assumption of this theory defines five key attributes for the innovation process: relative advantage, compatibility, complexity, trialability, and observability. (Rogers, 1983; ROGERS, 2004)</p>	<p>Availability, real-time analytics, big data analytics, distributed data storage, accessibility, smart object, wireless network, interoperability, interaction, context awareness</p>	<p>Adoption</p>	<p>The DoI theory is used to identify the level of technology adoption and to evaluate the impact of technology-based products, services, and smart processes. Analyzing technology adoption requires understanding the interaction between the environment and the level of IoT technology acceptance, which is achieved through data collection from the environment to gain awareness. Based on the concepts of this theory, applying IoT in organizations enables the assessment of the adoption level of innovations and novel processes (Hanafizadeh et al., 2022).</p>	<p>With an increasing number of innovation adopters, social pressure on others to adopt it also rises. This phenomenon is known as the "diffusion effect."(Rogers, 1983)</p>
<p>Theory reasoning mechanisms</p> <ul style="list-style-type: none"> - Gradual transfer of information (Rogers, 1983) - Stages of innovation decision-making: knowledge, persuasion, decision, implementation, confirmation(Rogers, 1983) - Differences in individuals' reactions and timing of adoption (Rogers, 1962; Rogers, 1983) - Factors influencing the rate of innovation adoption(ROGERS, 2004; Rogers, 1983) - Network effects and critical mass (Mahler & Rogers, 1999; ROGERS, 2004) - Diffusion through social networks (Rogers & Kincaid, 1981; Peres et al., 2010) - The phenomenon of reinvention (ROGERS, 2004) 				

from a theoretical perspective.

To study the theories more precisely, the tautological and logical justification elements of the theories, including assumptions and reasoning mechanisms, as well as the research domain/focus, including industry characteristics and problem types, are examined according to the matrix of Table 8 presented in Hanafizadeh and Alipour (2024a, 2024b). The results of their study indicate that to apply (borrow) a theory in a study, an appropriate relationship must exist between the research domain/focus, i.e., the type of problem, and the characteristics of the new context, and the assumptions and reasoning mechanisms of the theory. In this matrix, the characteristics of the new context are not limited to those of emerging technologies, but also include the research objective, the values and interests of the research community, and important social events. Table 5 has been completed as an illustration of the DoI theory. Table 5 comprises two columns: problem type and context characteristics. The problem type column includes the cells related to the theory assumptions and reasoning mechanisms.

A completed row in Table 5 exemplifies the assumptions of the DoI theory. Theory assumptions are tautological statements (Hanafizadeh et al., 2022) that formulate the meaning and function of constructs and interrelationships (Hanafizadeh & Alipour, 2024, 2025). Theory assumptions are the most critical elements in selecting a theory, especially for new technologies like IoT (Hanafizadeh & Alipour, 2024, 2025). The finalized matrix for the DoI theory delineates five key characteristics of

the innovation process: comparative advantage, adaptability, complexity, testability, and observability (Rogers, 1983) and (ROGERS, 2004). The second column of this table deals with the characteristics of the IoT technology. The column of emerging technology characteristics is used solely to assess the application of the theory in emerging technology-driven areas (Hanafizadeh and Alipour, 2025).

This column highlights the following IoT characteristics: big data analytics, wireless network, distributed data storage, accessibility, smart objects, interoperability, interaction, context awareness, availability, and real-time analytics. These features have been used in articles on the application of IoT in healthcare to answer research questions through the lens of DoI theory. The next column outlines the research objective, referred to as "adoption" due to the application of this theory in research. In the column of values and benefits to society, the role of DoI theory in assessing the level of technology adoption and evaluating the impact of technology-based products, services, and smart processes is highlighted. The column of social events examines the impact of social pressures on adoption.

By completing Table 5 for each theory using the source of the theories explained in Gassmann et al. (2016) and Miles (2012), a list of alternative theories is proposed to address the questions raised in the literature on the application of IoT in the healthcare sector. An illustrative example of one of the theories derived from Table 5 is provided in Appendix A. Table 5 facilitates decision-making about the formulation

Table 6
Potential future directions for theory-driven IoT research in healthcare

Type of questions	Potential research questions	Proposed theories
Trust, Information Security, and Privacy in IoT-Enabled Healthcare Applications	How can events such as the COVID-19 pandemic affect the relationship of trust in the acceptance of the Internet of Things? (Arfi et al., 2021)	Crisis management theory, social cognitive theory, expectancy theory, the social shaping of technology (SST)
	From a theoretical perspective, how can the relationship between trust and privacy in the adoption of IoT in healthcare be described? (Masmali & Miah, 2021)	Social exchange theory, protection motivation theory
	How can management theories be used to study IoT applications in healthcare? (Solangi et al., 2017)	ANT, stakeholder theory, RBV, TOE
	How can theories that have the capability to describe and predict the future explain patient self-management considering the application of IoT in healthcare? (Jonas et al., 2023)	Complex adaptive systems (CAS) theory, data-driven decision-making (DDDM) theory
	How can the concept of trust and its influence by IoT technology in healthcare be explained with the help of management theories? (Arfi et al., 2021)	Stakeholder theory, TAM, institutional theory, trust theory, socio-technical systems, diffusion of innovation theory, change management theory, information boundary theory
	How can trustworthy beliefs, other theoretical models, or different theories help in understanding trust in the Internet of Things? (Arfi et al., 2021)	Social exchange theory, TAM, trust theory
	What factors related to risk and trust affect healthcare professionals' adoption of AI systems like CDSSs? (Curiello et al., 2025)	Sociotechnical systems theory, prospect theory, TAM
	How can theory and evidence help reduce bias and build trust in AI adoption in healthcare? (Curiello et al., 2025)	Trust theory, prospect theory, dual-process theory, sociotechnical system theory
	How does patient gender influence IoT applications in healthcare? (Mital et al., 2017)	UTAUT, TAM, TPB, social cognitive theory
	Why do constructs related to the application of IoT change under the influence of public acceptance of e-health? Can this change be described using management theories? (Arfi et al., 2021)	Institutional theory, stakeholder theory, social cognitive theory, TPB
Examining Attitudes, Behaviors, and Demographic Influences on IoT Adoption in Healthcare	How can changes in user perceptions before and after using IoT be theoretically described? (Mital et al., 2017)	Social cognitive theory, expectancy theory,
	How can gender and culture influence IoT applications from a theoretical perspective? (Kim et al., 2018)	Hofstede's cultural dimensions theory, social identity theory, gender schema theory
	What individual characteristics may influence the adoption of IoT in healthcare? (Mir et al., 2023)	TAM, UTAUT, TPB
	What cultural and innovation-related factors influence the acceptance and use of IoT technologies? (Ladeira et al., 2025)	Innovation diffusion theory (IDT), UTAUT2, Hofstede's cultural dimensions theory
	From a theoretical perspective, how can the ontological strategies related to the adoption of the Internet of Things in the healthcare industry be studied? (Devendra Dhagarra et al., 2020)	Actor-network theory, structuration theory, sociomateriality theory
	How do IoT devices like pedometers, sleep trackers, and wearables affect the acceptance and adoption of IoT in daily life? (Princi & Krämer, 2020)	Social cognitive theory, social exchange theory, UTAUT, TAM
	How can the role of actual user behavior in the adoption of IoT-based wearable devices be analyzed and predicted from the perspective of management theories? (Sivathanu, 2018)	TAM, UTAUT, TPB,
	How does user awareness of IoT capabilities influence its adoption? (Kronlid et al., 2024)	TAM, UTAUT, cognitive load theory, TPB, DoI
	How do factors affecting e-health acceptance influence IoT acceptance, and which factor has the greatest impact? (Arfi et al., 2021)	TAM, DoI, UTAUT
	How can IoT applications in healthcare be effective regardless of patient gender? (Princi & Krämer, 2020)	TAM, TPB, DoI,
Designing and Developing IoT-Driven Smart Healthcare Systems	How does the attitude difference between adopters and non-adopters of IoT services impact its acceptance and usage, and how can this be theoretically explained? (Mital et al., 2017)	social cognitive theory, TAM, UTAUT, TPB, DoI
	How can requests be dynamically switched between queues based on their waiting time using a CF-based mechanism? (Golkar et al., 2022)	Queuing theory, resource allocation theory
	How can the theoretical expansion of IoT utilization facilitate the development of smart healthcare? (Dhaggara et al., 2020)	Actor-network theory (ANT), technology-organization-environment (TOE) framework, structuration theory, DoI
	Which management theories can explain the application of IoT in healthcare, including smart wearables, environments, elderly support, and social welfare? (Jonas et al., 2023)	Social exchange theory, stakeholder theory, TOE, process virtualization theory (PVT)
	What challenges exist in designing healthcare systems with the help of IoT, and how can management theories be used to examine them in the adoption of IoT in the healthcare industry? (Solangi et al., 2017)	Stakeholder theory, RBV,
	How does the IoT-based HH (hand hygiene) support system affect infection rates in healthcare units? (Yesmin et al., 2022)	Sociotechnical systems theory, TPB, DoI
	How can the role of IoT technology in enhancing the healthcare industry be explained with the help of management theories? (Arfi et al., 2021)	Technological innovation theory, resource-based view, institutional theory, stakeholder theory
	How can the resilient elements of the healthcare system be identified using knowledge management in the healthcare ecosystem? From a theoretical perspective, how can the role of IoT technology be described in relation to these elements? (Alrahbi et al., 2020)	Knowledge management theory, dynamic capabilities theory, resilience theory, sociotechnical systems theory

(continued on next page)

Table 6 (continued)

Type of questions	Potential research questions	Proposed theories
Cognitive and Social Analyses of User Behavior in IoT-Based Healthcare Systems	How can patient monitoring using various machine learning algorithms and analysis of IoT sensor data be effective in daily care and patient health? (Jonas et al., 2023)	Complex adaptive systems (CAS) theory, dynamic capability theory
	How can the performance improvement resulting from the implementation of eGAP be described in smart healthcare applications from a theoretical perspective? (Fawagreh & Gaber, 2020)	Dynamic capabilities theory, performance measurement theory, RBV, game theory
	How, from a theoretical perspective, can the inconsistency between decision-making data and real-world information be resolved with the help of modern technologies such as the Internet of Things? (Sathiya et al., 2023)	Real-time data processing theory, cognitive load theory, utility theory
	How can IoT-based e-Government enable the improvement of social systems in rural communities? (Masmali & Miah, 2021)	Stakeholder theory, RBV, social shaping of technology
	How can the theoretical expansion of IoT usage facilitate smart healthcare? (Mital et al., 2017)	TOE, RBV, actor-network theory (ANT)
	How can IoT applications in healthcare be effective regardless of patient gender? (Kim et al., 2018)	TAM, TPB, DoI
	What analytical criteria can be used to examine the literature on DDI in the healthcare sector? (Bamel et al., 2023)	RBV, stakeholder theory, critical success factors (CSF) theory,
	What is the role of different stakeholders in studying the challenges of developing healthcare with the help of Internet of Things technology? Which management theories can be used in this analysis? (Alrahbi et al., 2020)	Stakeholder theory, institutional theory, RBV, Social exchange theory
	How can the impact of environmental and individual factors on post-adoption satisfaction with IoT in healthcare be described from a theoretical perspective? (Hossain et al., 2021)	TAM, UTAUT, expectation confirmation theory, social cognitive theory
	What are the limitations of existing meta-analytic approaches in studying IoT acceptance, and how can they be addressed in future research? (Ladeira et al., 2025)	Complexity theory

of propositions through a careful examination of the problem type and the characteristics of the context (columns of the matrix) and their relationships with the assumptions and reasoning mechanisms of the theory (rows of the matrix).

The alternative theories presented in Table 4 are derived from completing the corresponding matrix in Table 5, which includes all theories from two main sources: Gassmann et al. (2016) and Miles (2012). Introducing alternative theories to answer the research questions results in a transition from established yet limited theories to more flexible ones with higher explanatory power. This shift in approach can be beneficial from both the perspective of developing theoretical knowledge and the practical application in the design, implementation, and evaluation of IoT systems in healthcare. In other words, considering the characteristics of IoT technology (derived from the IoT technology characteristics column) and the institutional complexities of the healthcare industry (based on data from the healthcare characteristics column), the proposed theories can provide richer conceptual frameworks for answering new and complex questions in this field. These theories have the potential to better elucidate human-technological interactions, decision-making behaviors under uncertainty, and institutional structures affecting technology implementation, while also facilitating the development of implementable operational models for smart healthcare systems. Hence, the informed and context-specific selection of theories will play a key role in enhancing research quality and realizing the potential of IoT technology in advancing healthcare.

3.3. Proposed research questions accompanied by suitable theories for future studies

Given the significance of theoretical frameworks in studies related to IoT, this section presents a series of research questions, accompanied by relevant theories, to address them. The questions were derived from the empirical articles, particularly from the sections of suggestions for future directions. Additionally, the matrix developed by Hanafizadeh and Alipour, 2025, as presented in Table 8, along with the theories proposed by Gassmann et al. (2016) and Miles (2012), were employed to identify suitable theories for addressing new questions.

The suggested questions can be classified into five principal domains: (1) investigating the facets of trust, information security, and privacy in health-related applications of IoT, (2) assessing user attitudes and behaviors, as well as the influence of demographic factors on the adoption of this technology in healthcare, (3) designing and developing smart healthcare systems based on IoT, (4) the role of IoT in enhancing knowledge management and fostering innovation within the health system, and (5) conducting social and cognitive analyses of user behavior in healthcare system contexts. Table 6 delineates prospective avenues for theoretical research concerning the implementation of IoT in healthcare.

Table 6 presents new research questions that extend beyond traditional IoT adoption frameworks to tackle fundamental issues, including trust during crises, privacy, culture, gender, social justice, optimization of smart system performance, and the promotion of institutional capabilities. Due to the progressive maturation of IoT technology, this directional shift can be promising for a transition from individualistic assessments to structured, analytical evaluations. The presented theories also enable researchers to examine power dynamics, human-technology interactions, institutional frameworks, and the capacities for organizational adaptability and innovation, instead of reiterating classical frameworks. Furthermore, the use of theories such as game theory, cognitive load theory, and real options theory can offer an effective analytical framework for addressing questions in optimum decision-making, technical system design, and uncertainty analysis. In summary, the research questions and proposed theories outline a novel research trajectory in IoT for healthcare, while also suggesting that future studies should focus more on complexities such as cultural diversity, decision-making processes, and human-technology interactions within the healthcare sector.

4. Discussion

4.1. Theoretical implications

The results of this study reveal that, despite substantial advancements in research on the application of IoT in healthcare, the theoretical

aspects of this area remain underdeveloped. In numerous instances, research lacks a cohesive theoretical framework to guide future studies in this field. Previous studies (e.g., [Chinnasamy et al., 2024](#); [Hossain et al., 2021](#); [Mir et al., 2023](#); [Negm, 2023](#)) have predominantly concentrated on specific areas such as the adoption of IoT in healthcare, the application of IoT-enabled wearable technologies, remote monitoring and control, and the establishment of smart healthcare centers. Despite certain endeavors in applying theories to healthcare studies, systematic studies on the selection of theories, their role in addressing research questions, and the criteria for selecting suitable theories in the realm of IoT in healthcare are lacking. Reviewing articles across other industries indicates that the majority of research has concentrated on the practical and operational functionalities of IoT in the context of industrial smartization, whereas theoretical analyses have received comparatively less attention ([Hognelid & Kalling, 2016](#); [Atzori et al., 2010](#)). Hence, the theoretical framework for implementing IoT as an emerging technology in healthcare systems remains inadequate. Of the articles analyzed, only 75 have clearly employed theoretical frameworks, whereas the other studies have not utilized the conceptual potential of theories to enhance understanding in this domain. This theoretical gap may result in the development of inefficient strategies by health managers and policymakers, as well as a limited understanding of the potential effects of this technology on the quality and efficiency of healthcare services.

The present study examined the research questions and theories found in the literature on IoT applications in the healthcare sector. To harness the potential of alternative theories, theories from [Gassmann et al. \(2016\)](#) and [Miles \(2012\)](#) were employed, followed by the introduction of novel research questions and theories for future research. [Fig. 3](#) illustrates the three stages of analysis cohesively: assessing the current situation and presenting alternative theories ([Table 4](#)), and formulating future research directions ([Table 6](#)). In the following, the extracted categories of theories will be systematically analyzed.

4.1.1. Classification of theories

4.1.1.1. Adoption. IoT technology is swiftly proliferating across various sectors, including healthcare. Healthcare is an important and promising area for the application of this emerging technology, as it facilitates a revolution in patient monitoring techniques and enhances the quality of healthcare services. Furthermore, IoT has played a significant role in enhancing the efficiency of medical procedures and facilitating the delivery of more effective and intelligent care. Despite its myriad advantages, the challenges of adopting and implementing this technology in hospitals and healthcare facilities have emerged as a primary focus of research in this domain. Among the reviewed articles, 42.3% focused on the adoption of IoT. This group of studies has addressed the factors influencing the adoption and implementation behavior of IoT through the use of UTAUT, TAM, TPB, TRI, DOI, and DIT theories.

A review of the literature from a theoretical perspective indicates that the factors influencing the adoption of the Internet of Things (IoT) in the healthcare sector can be categorized into technology-related perceptual factors, as well as social, psychological, and contextual factors. Technology-related perceptual factors, such as Perceived Usefulness and Perceived Ease of Use, which hold significant importance within the Technology Acceptance Model (TAM), have been identified in studies by [Mital et al. \(2017\)](#) and [Karahoca et al. \(2018\)](#) as key predictors of the intention to use IoT.

[Mital et al. \(2017\)](#) identified the key factors affecting IoT adoption, including attitude, social norms, perceived behavioral control, and perceived usefulness, through the application of three theories: TAM, TRA, and TPB. Their study examines which model is most suitable for analyzing the adoption of IoT in India, utilizing three theories: TAM, TRA, and TPB. The integration of these three theories provides a thorough and multidimensional examination of consumer behavior in the

adoption of IoT. The findings of this study indicate that PU, PEOU from TAM, along with norm and attitude as articulated by the TRA, are significant predictors of the intention to utilize smart devices in the future. The findings of this study also indicate that perceived behavioral control is not a significant predictor of the desire to utilize IoT.

The primary question addressed in the research conducted by [Karahoca et al. \(2018\)](#) concerns the factors influencing the intention to adopt IoT-based health products, as well as the application of behavioral models and theories to enhance the understanding of health technology adoption. Researchers analyzed diverse behavioral and psychological factors influencing the adoption of IoT goods in healthcare by integrating TAM, IDT, and the Theory of Innovation. TAM was employed to investigate the influence of ease of use and perceived usefulness on IoT adoption. They used IDT to assess the impact of adaptability and testability on IoT adoption. They applied the Protection Motivation Theory to explore perceived vulnerability and privacy risk in technology adoption. Privacy computing theory was employed to examine how users strike a balance between the benefits and risks associated with privacy when adopting technology.

In addition, social, psychological, and contextual factors—such as Social Influence, Subjective Norms, personality traits (e.g., extraversion and conscientiousness), and Trust in Technology—have been highlighted in studies such as [Yee-Loong Chong et al. \(2015\)](#) and [Arfi et al. \(2021\)](#) as influential in the adoption of IoT technologies.

The findings of [Yee-Loong Chong et al. \(2015\)](#), which utilize the UTAUT theory, reveal that individuals' personal characteristics, such as neuroticism, conscientiousness, agreeableness, and extraversion, as well as demographic factors like age and gender, significantly impact the adoption of IoT. Their study addresses two research questions utilizing UTAUT theory: What factors influence the adoption of RFID technology by physicians and nurses in the operational procedures of the healthcare sector? How can various theoretical models, such as UTAUT, be combined with personal characteristics and demographic data to predict the adoption of IoT? [Yee-Loong Chong et al. \(2015\)](#) address this requirement by incorporating UTAUT with users' personal and demographic characteristics. Theories such as TAM, Self-efficacy theory, and the TPB can be employed to address these questions.

[Arfi et al. \(2021\)](#) addressed the following research question using UTAUT theory: What is the role of the trust-risk relationship in patients' intention to use IoT within healthcare, and which factors, such as performance expectations, perceived effort, social influences, and facilitating conditions, are most critical in patients' adoption of technology? This study integrated the UTAUT theory with the risk-trust relationship to model users' psychological factors and concerns, including trust in technology and risk perception, and offer deeper insights into IoT adoption in e-health. UTAUT2 or the Self-efficacy theory may serve as an alternative theory.

[Alaiad and Zhou \(2017\)](#) discovered multiple novel constructs about the adoption of smart health systems utilizing wireless sensor networks (WSN-SHHS). These constructs encompass concerns related to human separation, privacy, quality of life expectations, and financial considerations. The research questions of this study were: What are the primary facilitators and obstacles to patients' adoption of smart health systems based on wireless sensor networks (WSN-SHHS)? How can a universal model of technology adoption be customized to reflect the distinct characteristics of the WSN-SHHS domain? These questions were addressed through the UTAUT theory. The principal findings of the study indicate that concerns about human separation are the most significant determinants of patients' adoption of these systems, surpassing the influence of performance expectations.

A comparative analysis of the theories applied in the reviewed studies reveals that the TAM framework explains variables related to functionality and ease of use; however, it requires supplementation with frameworks such as UTAUT or trust-risk models to adequately capture social dimensions and risk perceptions ([Arfi et al., 2021](#)). In contrast, UTAUT, by incorporating dimensions such as Facilitating Conditions

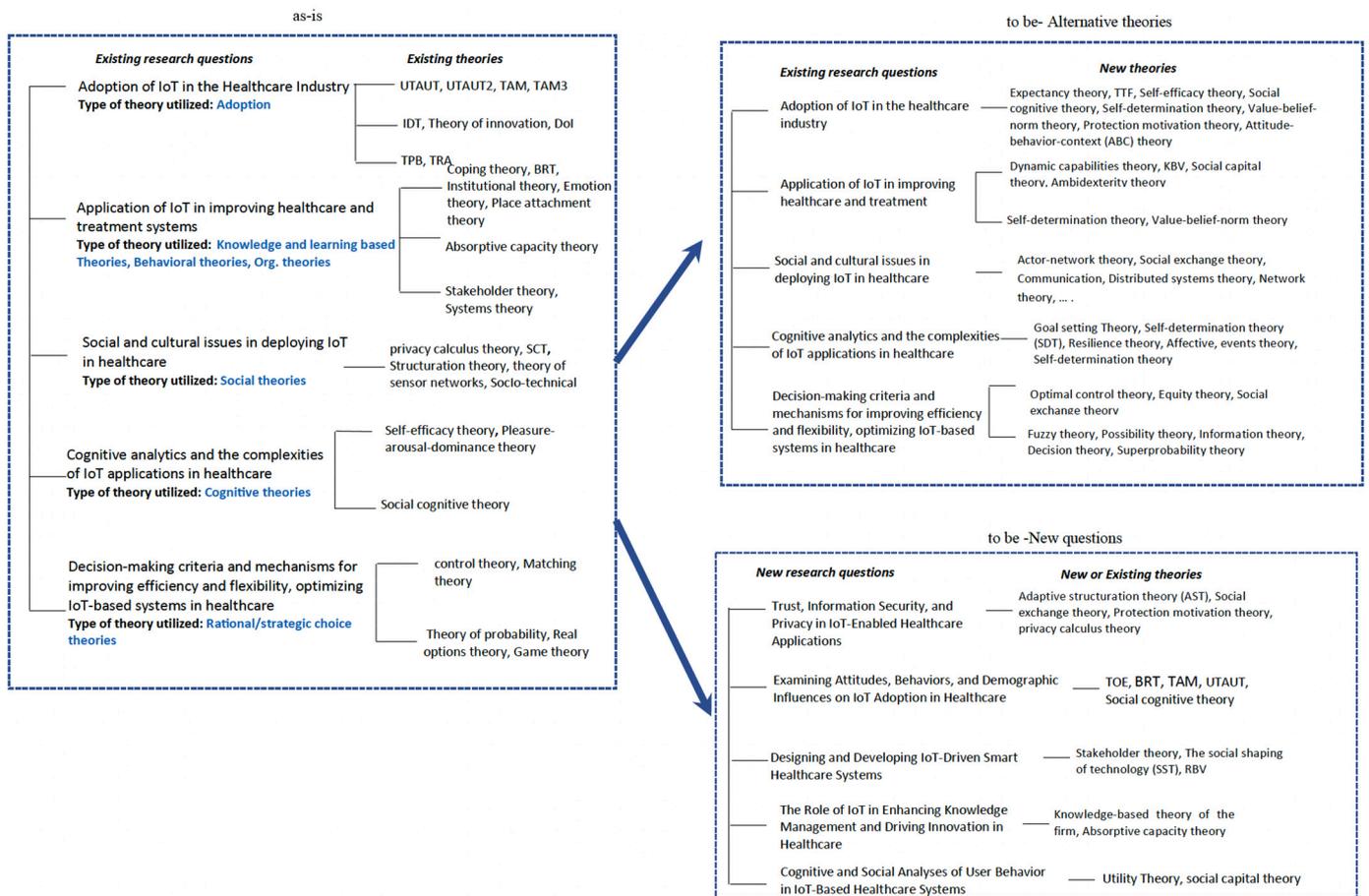


Fig. 3. Structured System of Research Questions on IoT Applications in the Healthcare Industry from a Theoretical Perspective

and Social Influence, demonstrates greater explanatory power for technology adoption in complex environments such as hospitals (Yee-Loong Chong et al., 2015). In studies such as Karahoca et al. (2018), hybrid models integrating behavioral theories with security and privacy frameworks—such as Protective Motivation Theory or Privacy Calculus Theory—indicate that security and privacy concerns can have a significant negative impact on adoption intentions, even when the technology is functionally desirable. Furthermore, empirical evidence shows that demographic variables (e.g., age, gender, level of experience) and individual characteristics can serve as important moderating factors in adoption models (Yee-Loong Chong et al., 2015). These findings suggest that multidimensional and interdisciplinary approaches to analyzing technology adoption can provide a more accurate explanation of IoT adoption behavior in the healthcare domain (Mital et al., 2017).

4.1.1.2. Behavioral theories. Behavioral theories comprise a collection of models and theories that help to analyze human behavior across diverse contexts. These theories are applied across various areas like psychology, social sciences, marketing, information technology, and health. 12% of the reviewed articles have examined the behavior of stakeholders in IoT technology. Researchers in this class of studies employ Place attachment theory, BRT, coping behavior theory, and Push-pull and mooring (PPM) theory to examine user behavior. These theories explain how psychological, social, and contextual factors influence the adoption and continued use of IoT-based healthcare solutions.

The study by Jorgensen and Geropanta (2021) addresses the questions: (1) What are the significant factors contributing to consumer stress over wearable health devices from the consumers' perspective? (2) How can customers assess and manage stress resulting from the

hidden detrimental impacts of wearable health devices? (3) What are their coping strategies in the face of the extensive adoption of wearable health devices? They demonstrated that smart technologies can enhance the beneficial link between individuals and health-related contexts, resulting in improved patient well-being. To replicate this experience in healthcare settings, factors such as customization, privacy, and control are considered. This article employs Coping theory.

Sivathanu (2018) employed BRT to examine the role of adoption factors and barriers on the utilization of IoT-enabled wearable devices for elderly healthcare. This study elucidated the reasons for and against IoT adoption, demonstrating that marketers should focus on alleviating concerns and obstacles associated with this technology, while also highlighting the advantages of IoT devices.

Marakhimov and Joo (2017) suggest that concerns about consumer health and privacy trigger a coping process among customers. The coping strategies are categorized into two domains: problem-focused (actions aimed at resolving or mitigating the issue) and emotion-focused (actions aimed at alleviating stress and emotional distress). These initiatives substantially influence the prediction of prolonged use of wearable devices within the healthcare sector. The research questions are: (1) What are the factors that induce stress regarding wearable technologies in the health sector from the customers' perspective? (2) How can customers evaluate and mitigate stress resulting from the hidden detrimental impacts of wearable health devices? (3) How are their coping strategies associated with the extensive adoption of wearable health devices? Their study established that coping theory is a legitimate framework for analyzing consumer behaviors regarding the use of wearable IoT devices.

Nayak et al. (2022) employed the principles of push-pull and mooring (PPM) theory to investigate the factors affecting the adoption of

wearable health devices among Generation Z consumers in India. They indicated that the prerequisites for the adoption of wearable health devices comprise three primary elements: the push factor of real-time health information accessibility, the pull factor of a normative environment that encourages device adoption, and the mooring factor of self-efficacy in decision-making, which reflects confidence in one's ability to make appropriate adoption choices. This study also analyzed the relationship between factors: the mooring factor is associated with the push factor, but not with the pull factor, and the mooring factor, in turn, influences Generation Z customers' readiness to use wearable health devices. The results highlight the complexities involved in adopting wearable health devices and the influence of various societal, cultural, and individual factors on these decisions. The BRT focuses on cognitive reasoning processes that occur before decision-making, elucidating the pre-adoption stage. As such, it serves as a complement to understanding the entire adoption cycle. In contrast, Coping Behavior Theory concentrates on behavioral factors that emerge after adoption. Similarly, the Push–Pull–Mooring (PPM) theory conceptualizes the adoption process as the outcome of push factors (e.g., the need for real-time health information), pull factors (e.g., social norms), and mooring factors (e.g., self-efficacy) (Nayak et al., 2022).

Jonas et al. (2023) employed behavioral theory to address the question: How can an IoT-based monitoring system for managing neurogenic disorders be designed and deployed utilizing design principles grounded in behavioral theory to enhance patient management?

Ultimately, the study by Jonas et al. (2023) demonstrates that patient management in specialized medical domains, such as the monitoring of neurogenic disorders, can be enhanced through the application of behavior-based principles informed by behavioral theory. Overall, the examination of behavioral theory applications in these studies indicates that such theories in IoT-enabled healthcare research do not operate in isolation; rather, they possess a complementary and synergistic nature. For instance, Coping Behavior Theory explains stress management following the adoption of IoT technology, whereas BRT is suitable for describing the reasoning and decision-making processes preceding adoption. As a complementary framework, the PPM theory can be employed to elucidate the multidimensional influences on the IoT adoption process. Integrating these perspectives provides a more comprehensive understanding of IoT adoption in the healthcare industry, encompassing the entire trajectory from initial motivation for adoption to decision-making and, ultimately, to the analysis of the multidimensional outcomes of adoption. This underscores the necessity of employing multi-theoretical frameworks that integrate cognitive, emotional, and contextual factors.

4.1.1.3. Cognitive theories. Cognitive theories examine mental processes like perception, memory, learning, decision-making, and problem-solving. These theories explain the mechanisms by which individuals process information and behave accordingly. 9.4% of the reviewed studies focused on examining cognitive processes. This group of studies employs the Self-efficacy theory, the PAD Theory, the Cognitive Selective Permutation Theory, and the Social Cognitive Theory to examine behavior.

Hossain et al. (2021) employed the reasoning mechanism of the Self-efficacy theory to examine the reciprocal impact of trust, two significant determinants in predicting individuals' attitudes towards the use of wearable technologies, such as Continuous glucose monitoring (CGMs). The authors synthesized the Self-efficacy theory, TRA, TAM, and TPB to address the question: What factors affect the intention to adopt CGM devices in the area of smart health?

Negm (2023), employing Pleasure-arousal-dominance theory, TAM, and TPB, addressed the following questions: (1) What technological mechanisms influence the intention to adopt IoT? (2) What psychological mechanisms affect the intention to adopt IoT? The findings of this study indicate that attitude, dominance, perceived usefulness,

innovativeness, and insecurity significantly affect customers' intention to adopt IoT. Negm (2023) indicated that parameters like subjective norms, perceived behavioral control, pleasure, arousal, perceived ease, optimism, and discomfort do not significantly influence the intention to adopt IoT.

Tipparti and Lokam (2021) used the assumptions of Social Cognitive Theory (SCT) to address the question of how a MIMO detector can be designed for IoT applications in wearable health, ensuring high quality of performance (QoP), energy efficiency, and reduced computational complexity.

Russo and Eriksson (2016) demonstrated that smart and customized health systems, utilizing IoT and robust theoretical frameworks, can enhance user health. This study employed the theories of SCT, TPB, RPM, and HBM to develop the COMBI Behavior model, establishing a framework for constructing smart behavior modification systems.

Overall, these studies indicate that cognitive theories play complementary roles in IoT-based healthcare research. Self-Efficacy Theory and Social Cognitive Theory emphasize individuals' ability and confidence in using technology, whereas the PAD Theory focuses on emotional and psychological states that influence adoption decisions. Most studies have integrated these frameworks with adoption-related models (such as TAM and TPB) to connect cognitive mechanisms with behavioral intentions. Furthermore, some research has concentrated on pre-adoption reasoning (e.g., perceived benefits and risks), while others have focused on post-adoption optimization through system design and behavior modification. Collectively, these perspectives demonstrate that cognitive theories are essential for explaining the entire adoption cycle in the healthcare industry—from information processing and motivational assessment to sustained engagement in the adoption and use of IoT-based solutions.

4.1.1.4. Social theories. Social theories examine the impact of society, culture, groups, and social relationships on human behavior. These ideas elucidate how social interactions, norms, values, and structures influence individual decisions and behaviors. 10.5% of the reviewed articles examined cognitive processes. This group of studies examines how human behavior is influenced by theories of Privacy Calculus, Sensor Network Theory, Socio-technical Theory, Actor-Network Theory, and Structuration Theory.

Princi and Krämer (2020) employed Privacy Calculus theory to examine patient privacy within healthcare facilities, demonstrating that the perception of control over personal data significantly influences individuals' propensity to utilize healthcare IoT devices, more so than actual control. Furthermore, users' decision-making is shaped by the evaluation of the risks and advantages associated with the disclosure of personal information. In other words, users' decision-making is directly associated with the assumptions of Privacy Calculus Theory.

Kim et al. (2018), using the same theoretical assumptions, indicated that individuals are inclined to share their personal information in exchange for enhanced personalized services, often disregarding the perceived risks associated with privacy violations. In the healthcare sector, where the likelihood of privacy breaches is significantly higher, individuals tend to exercise greater caution and refrain from disclosing their personal data. This suggests that in areas involving more sensitive information, individuals are more inclined to safeguard their privacy. The findings of this study suggest that decisions to disclose personal information in IoT services are influenced by a trade-off between the perceived risk of privacy breaches and the benefits of obtaining personalized services.

Singh et al. (2023) applied the theory of sensor networks to develop a medical imaging system in healthcare that utilizes wireless sensor networks. This technology facilitates remote surveillance of illness status and expedites the diagnosis and therapy. Their proposed model demonstrates superior efficacy relative to alternative strategies. This study primarily examines the theory of Wireless Sensor Networks and its

applications in health monitoring and medical imaging. The research is founded on communication theories and the development of wireless networks for transmitting physiological data and medical images to monitoring stations, enabling the tracking of disease status and facilitating rapid diagnosis and treatment.

The study by [Binci et al. \(2022\)](#) employed socio-technical theory to investigate the adoption process of remote monitoring. This study poses two research questions: (1) What factors affect the adoption of remote monitoring in chronic illness management within the healthcare sector? Moreover, (2) How does the remote monitoring procedure impact patients and medical personnel? The findings of this study resulted in the development of a model for the adoption of this monitoring type, utilizing Socio-Technical Theory.

[Woolliscroft and Polovina \(2017\)](#) employed the Structuration theory to address the question, "How can the concept of a smart society help improve the efficiency of healthcare systems in the UK?" The results of this study suggest that to enhance the efficiency of healthcare systems, it is essential to adopt a broader perspective that considers both structural and community-based factors. Structuration theory helps analyze the mutual effects of human, urban, and technological factors on the improvement of healthcare services more profoundly.

The evidence indicates that social theories provide a complementary approach to explaining and facilitating the adoption and implementation of the Internet of Things (IoT) in the healthcare industry. Privacy-focused frameworks, such as the Privacy Calculus theory, elucidate how the perception of risks and benefits influences data-sharing decisions, highlighting the tension between service personalization and privacy protection. Sensor network theories shift the focus toward the infrastructures and technological drivers of remote healthcare. In contrast, socio-technical theory emphasizes the mutual shaping of technology and social systems in the adoption process. Structuration theory extends the analysis to the macro level of social structures, illustrating how social and institutional mechanisms interact with technology to enhance the quality of healthcare services. Overall, these theories encompass the social dimensions of IoT-based healthcare—from micro-level concerns regarding user privacy to macro-level societal integration—and underscore the necessity for multilevel frameworks that integrate individual, organizational, and social contexts in the design and adoption of smart healthcare solutions.

4.1.1.5. Rational/strategic choice theories. Rational and strategic choice theories suggest that individuals and organizations make decisions based on rational and cost-benefit analysis. These theories assume that individuals possess distinct objectives in decision-making, aiming to optimize gains and mitigate losses. Among the reviewed articles, 14.1% focused on examining decision-making through cost-benefit analysis. The articles in this category employ Real options theory, Control theory, Game theory, Matching theory, Probability theory, Optimization and Decision theory, and Item Response theory to analyze decision-making in resource allocation.

[Tolga's \(2020\)](#) research, which utilizes Real Options theory, demonstrates that integrating Interval Type-2 fuzzy logic with real options analysis is effective for assessing medical equipment in situations characterized by uncertainty and inadequate data. Medical devices used in treatment often require substantial investment from the medical center due to their high costs. Such substantial capital goods are typically irreversible investments. The assessment of medical equipment necessitates a sophisticated evaluation technique known as real options, contingent upon the strategic viewpoint and irreversibility. Nonetheless, numerous uncertainties arise during the investment phase and data collection for assessment. This study presents an integrated real option analysis utilizing type-2 fuzzy logic for the assessment of medical devices. The expected mean and variance of type 2 fuzzy sets were used to analyze real options. This article presents a real-life situation within the healthcare system, accompanied by a sensitivity analysis from various

perspectives. The findings of this study illustrate how a healthcare institution might make investment decisions regarding the acquisition of medical devices, either currently or in one year.

[Cáceres Flórez et al. \(2020\)](#) demonstrated that employing Control theory to examine the application of IoT in healthcare settings can yield outcomes such as enhanced use of hospital resources, decreased patient stay, reduced mortality rates in emergency wards, and improved quality of hospital services through the optimization of emergency ward workflows.

Numerous studies have benefited from the potential of Game theory for cost-benefit analysis and optimal decision-making within the literature about the implementation of IoT in healthcare. For instance, [Bulla and Birje \(2022\)](#) introduced a Game Theory-based model that outperformed previous methods in anomaly detection and main cause analysis. Evaluation of this model indicated that it is dependable in terms of both accuracy and interpretability. [Soni et al. \(2024\)](#) employed Game theory and Matching theory in their article to model the resource allocation problem in healthcare settings, aiming to minimize delays and ensure equitable task distribution.

[Kumar and Mahdi \(2017\)](#) utilized the Theory of Probability to develop a target prediction algorithm named TYM-2. Their objective was to regulate sleep, optimize energy efficiency, and improve reliability in machine-to-machine (M2M) communication systems.

[Farooq and Zhu \(2020\)](#) examined the significant potential of IoT and 5G technologies to revolutionize urban systems, particularly smart healthcare centers. Their study integrates sophisticated methods from several scientific disciplines to enhance the design of smart cities across multiple dimensions, aiming to realize key objectives such as efficiency, security, resilience, and economic viability.

Collectively, these studies indicate that rational and strategic choice theories furnish diverse and robust frameworks for directing resource allocation, optimizing workflow processes, and scheduling investments within IoT-enabled healthcare systems. Real Options theory emphasizes the importance of strategic timing under conditions of uncertainty. Control theory focuses on operational efficiency and system stability. Game theory and Matching theory examine competitive dynamics and the equitable distribution of resources, whereas Probability theory facilitates predictive modeling in uncertain environments. Rather than functioning in isolation, these theories interact synergistically to construct a comprehensive, multidimensional framework that enables decision-makers to forge a coherent linkage between routine operational decisions and long-term strategic planning in the implementation of IoT-based healthcare solutions.

4.1.1.6. Organizational theories. Organizational theories are frameworks for understanding, analyzing, and predicting organizational behavior. These theories analyze organizations' structure, operations, decision-making processes, and interactions with their environment. By employing these theories, managers and policymakers can formulate more effective plans for implementing IoT-based services in healthcare. 10.5% of the reviewed articles focused on analyzing organizational behavior. In this category, researchers employ Stakeholder theory, Information boundary theory, change management theory, Institutional Theory, and Systems theory to examine and predict organizational behavior.

Investigating the findings of a study by [Alrahbi et al. \(2020\)](#) through the assumptions of Stakeholder Theory indicates that organizational strategy significantly influences the adoption of IoT. This article utilizes Stakeholder Theory to address the following research questions: (1) What factors create challenges to the adoption of Health Information Technology (HIT)? (2) What variables are most significant in the adoption of HIT?

Using Information boundary theory, [Zhang et al. \(2021\)](#) demonstrated that Self-construal and Regulatory focus are key determinants of individuals' willingness to disclose personal information. Plus, the

message type, whether framed as a means of acquiring benefits or evading losses, can yield effective tactics for organizations and companies to motivate individuals to share their information.

The findings of [Bamel et al. \(2023\)](#) align with the establishment of a theoretical framework that can inspire and facilitate future research on the deployment of DDI in the healthcare sector. This approach can be applied in future healthcare research, utilizing Change management theory and theories such as actor-network theory, the Theory of disruptive innovation, and the theory of Top management teams.

[Jarvis \(2016\)](#) examined the emergence of a phenomenon termed institutional shame through the lens of Institutional theory. This phenomenon results from physicians' concealment of malpractice, which diminishes the reporting of medical errors and exacerbates issues within medical culture. This study addressed the research questions, "How does organizational culture contribute to the concealment of medical errors, and how could the IoM report effectuate a cultural shift through the invocation of shame?" utilizing the assumptions of Institutional theory and Emotion theory.

The findings of [Woollicroft \(2020\)](#), which employ Systems Theory, indicate that a smart society is characterized by the collaboration of human and non-human elements, such as smart technologies, to achieve fundamental transformations. A smart society can enhance the efficiency of the healthcare system by increasing patient engagement and using real-time data. Utilizing digital tools and cyber interactions contributes to more effective engagement among patients and professionals in service provision. Issues of privacy, social control, and the dangers of information commercialization constitute significant hurdles for these systems. The study of [Cao et al. \(2018\)](#) analyzed smart city technologies and the Universal Village framework through the lens of Systems theory to enhance the synergy between humans and nature. The implementation of information feedback loops and material cycles reduces resource consumption and waste, thereby positively impacting the environment and human well-being.

Organizational theories collectively offer a multifaceted perspective that elucidates how healthcare organizations adopt IoT technologies and integrate them with their specialized operational processes. Stakeholder theory and Information Boundary theory focus on organizational strategy and individual behaviors related to information sharing, emphasizing the roles of perception and framing in communication. Change Management theory and Actor-Network theory illuminate the processes and actors involved in innovation implementation, revealing the dynamics of organizational change. Institutional theory addresses the cultural and normative dimensions that influence behaviors, such as error reporting. In contrast, Systems theory expands the viewpoint to encompass the complex socio-technical interactions within the healthcare domain and society at large. Collectively, these theories emphasize the crucial importance of integrating strategic, cultural, communicative, and systemic considerations for the successful adoption of IoT in healthcare, underscoring the need for multilevel frameworks that bridge individual, organizational, and societal contexts.

4.1.1.7. Knowledge and learning-based theories. Theories centered on knowledge and learning investigate the processes of knowledge creation, transfer, storage, and application at individual, organizational, and societal levels. These theories are crucial in knowledge management, innovation, and the adoption of technology. According to the reviewed publications, 1.2% focused on knowledge retention within organizations.

[Raeesi Vanani and Majidian \(2021\)](#), through the assumptions of Absorptive Capacity Theory and integrating the potential to acquire external knowledge with deep learning and prescriptive analytics capabilities, demonstrated that smart technologies can substantially assist organizations in establishing competitive advantage and enhancing their performance. Such technologies can boost the positive connection between the individual and the hospital setting, hence promoting

patient well-being. To replicate this experience in healthcare settings, the principles of personalization, privacy, and control are crucial, and they can be achieved through the implementation of smart technologies.

Although studies in this category are fewer compared to others, they highlight the vital role of knowledge processes in empowering healthcare organizations to effectively leverage smart technologies. Absorptive Capacity Theory emphasizes the importance of an organization's ability to acquire, assimilate, and apply external knowledge. Integrating this capability with advanced analytical tools enhances such capacity. The focus on personalization, privacy, and control reflects the intricate balance necessary to maintain trust and optimize technology adoption within sensitive healthcare contexts. Overall, knowledge and learning theories provide foundational insights that complement organizational and behavioral perspectives in research on IoT applications within the healthcare industry.

4.1.2. Classification of research questions

The research questions of the reviewed articles can be classified into five categories, as illustrated in [Fig. 3](#) (as-is): The first category of research questions pertains to the adoption of IoT technologies within the healthcare sector. Analysis of the studies addressing these questions indicates that a wide range of questions have emerged regarding the determinants of adoption, including geographical features, industry characteristics, and the role of decision-makers in the adoption process. This category possesses the highest number of research questions. The second category of research questions is related to efficacy and performance improvement. This category emphasizes the significance of utilizing IoT to enhance patient health and optimize healthcare systems. The third category comprises questions that focus on social and cultural aspects. This set of questions examines the social and cultural implications of using IoT in healthcare. The fourth group involves questions that deal with the cognitive analysis and complexities. This category addresses questions regarding users' cognitive processes and the technical and human intricacies of IoT applications in healthcare. The final group of research questions pertains to decision-making criteria and mechanisms. These questions relate to establishing decision-making criteria, enhancing efficiency and flexibility, and optimizing IoT systems within the healthcare sector.

Researchers have employed various theories to address the five categories of research questions and to offer suitable theoretical frameworks. The first group employs theories of technology adoption. Behavioral theories, knowledge and learning theories, and organizational theories have been employed in the majority of questions within the second category. It exhibits the most diverse array of theories. The questions in the third group have typically been examined through Social theories. The questions in the fourth category have been analyzed through cognitive theories. Lastly, in the final category, researchers have employed rational/strategic choice theories. [Table 4](#) presents further details regarding the questions and theories employed.

Additionally, the upper section on the right side of [Fig. 3](#) presents answers to the as-is questions utilizing new theories. This section of [Fig. 3](#) presents new theories to address the as-is questions. The complete list of alternative theories is presented in [Table 4](#). The lower right section of [Fig. 3](#) (to-be) displays a different classification for the new questions. The suggested questions are categorized into five key categories: The questions in the first group investigate the facets of trust, information security, and privacy within health-related applications of IoT. The questions concerning the analysis of user attitudes, behaviors, and the influence of demographic variables on the adoption of this technology in the healthcare sector fall into the second category. The third group encompasses questions related to the design and development of smart healthcare systems that utilize IoT. The fourth category of questions focuses on the role of IoT in enhancing information management and driving innovation within the healthcare system. Finally, the fifth group encompasses questions related to social and cognitive analyses of user behavior within the context of healthcare systems. [Table 6](#) outlines

prospective avenues for theoretical research on the deployment of IoT in healthcare, along with the relevant theories.

4.2. Practical implications

The healthcare sector has swiftly adopted IoT technologies. The overall magnitude and complexity of this market illustrate the revolutionary potential of IoT in a critical sector like healthcare¹. Consequently, the role played by IoT in various healthcare domains has generated numerous research questions, leading to the application of diverse theories to address them.

The present study addressed a varied array of research questions. An analysis of the research questions reveals that five research areas within the realm of IoT applications in the healthcare sector have attracted the interest of researchers: (1) adoption of IoT in the healthcare sector, (2) utilization of IoT to improve healthcare and treatment systems, (3) addressing social and cultural issues in the implementation of IoT in healthcare, (4) employing IoT to assess the understanding and complexities of IoT technology application in healthcare, and (5) decision-making processes aimed at enhancing the efficiency, flexibility, and optimization of IoT-based systems in healthcare.

The diversity of IoT applications in the smartification of healthcare operations highlights the significant potential of this technology to enhance healthcare quality and improve system efficiency. Applications such as remote patient monitoring, medical alerts, medication use tracking, hospital patient monitoring systems, medical equipment management, and disease diagnosis and prediction have substantially enhanced health monitoring. Developing the applications of IoT in healthcare requires the effective adoption and utilization of this technology inside healthcare facilities. The adoption of IoT in the healthcare sector can benefit from the assumptions of extended UTAUT, self-efficacy theory, TAM2, TAM3, task-technology fit (TTF), self-determination theory, value-belief-norm theory, protection motivation theory, attitude-behavior-context (ABC) theory, critical mass theory, and knowledge transfer theory. Alternative theories, including actor-network theory, motivational theory, social cognitive theory, sense of place theory, attachment theory, identity theory, privacy calculus theory, and boundary spanning theory, may also be employed in research concerning the application of IoT to enhance healthcare and treatment systems.

IoT, by developing a communication platform among medical devices, sensors, and information systems, allows for continuous and real-time patient status monitoring, accurate assessment of medical equipment performance, and enhanced data-driven clinical decision-making. This technology significantly enhances the quality and efficacy of healthcare systems by enabling remote health services, reducing the need for in-person visits, and optimizing the allocation of healthcare resources. Theories related to the application of IoT have made the most significant contributions to the advancement of research on enhancing healthcare and smart treatment systems.

As the application of IoT technology in healthcare evolves, strategic concepts such as interaction with stakeholders (including physicians, patients, and medical personnel) and resource and supply chain management will gain prominence. Consequently, behavioral theories like coping theory, BRT, and place attachment theory, along with systemic theories such as stakeholder theory and institutional theory, as well as theories like RBV, resource dependency theory, and dynamic capabilities, will become increasingly significant. In the area of IoT applications, theories like self-efficacy theory, PAD theory, social cognitive theory, and various others addressing social and cultural challenges in healthcare IoT implementation, such as socio-technical theory, sensor network theory, and structuration theory, will be crucial for analyzing

the understanding and complexities of IoT technology in healthcare. Additionally, several theories related to decision-making aimed at enhancing the efficiency, flexibility, and optimization of IoT-based systems in healthcare, such as real options theory, control theory, matching theory, and optimization and decision theory, will gain more significance.

Despite its numerous advantages, implementing IoT technology in healthcare presents considerable cognitive and organizational challenges. These complications pertain not just to technical concerns such as data integrity, information security, and infrastructure compatibility, but also to users' behavioral and perceptual aspects. An in-depth investigation of cognitive processes, including perceived usefulness, ease of use, trust, and technology adoption, is essential for understanding the interactions among physicians, nurses, patients, and management with connected technologies. The application of IoT encompasses theories such as self-efficacy theory, PAD theory, social cognitive theory, and various theories addressing social and cultural issues in IoT applications in the healthcare sector, including socio-technical theory, sensor network theory, and structuration theory. Additionally, theories pertinent to decision-making to enhance the efficiency, flexibility, and optimization of IoT-based healthcare systems, such as real options theory, control theory, matching theory, and optimization and decision theory, will be more significant.

To advance the application of theories and achieve the maturity of IoT technology, it is essential to meticulously assess the potential of new theories, such as transaction cost theory, decision theory, equity theory, social exchange theory, resource allocation theory, self-determination theory, actor-network theory, contingency theory, and cognitive learning theory, and recommend them to researchers in this domain for future studies.

Regarding the use of theories to address social and cultural issues in the implementation of IoT within the healthcare sector, emerging theories such as complexity theory, organizational learning theory, self-organizing system theory, optimization theory, socio-technical systems theory, and social network theory can be employed. Additionally, several theories can be applied to the use of IoT in resource and supply chain management within the healthcare sector, including knowledge-based view (KBV) theory, resource dependency theory, and dynamic capability theory. Furthermore, theories such as goal-setting theory, self-determination theory, and resilience theory can be employed to examine the understanding and complexities of implementing IoT technology in healthcare. Utilizing new theories, such as prospect theory, transaction cost theory, privacy calculus theory, social exchange theory, fuzzy theory, and behavioral decision theory, can yield novel theoretical insights for decision-making, thereby enhancing the efficiency, flexibility, and optimization of IoT-based systems in healthcare.

Medical personnel and administrators of healthcare facilities can utilize IoT more efficiently and effectively by applying management theories. The proposed alternative theories demonstrate the possibility of employing various management approaches in this area, indicating that considering them can enhance the maturation of IoT technology. The analysis of the research questions suggests that future studies on the application of this technology can not only discover new challenges but also uncover potential opportunities.

5. Conclusions

The application of theories in IoT-based healthcare research is crucial for the theoretical development of this area. This study systematically reviewed the existing literature and analyzed the research questions, yielding new insights regarding the employed theories, methods for addressing the research questions through these theories, the potential of alternative theories to answer current research questions, and the prediction of future research questions. Fig. 3 illustrates the system of research questions in the theoretical studies on the implementation of IoT in healthcare. This figure provides a

¹ <https://www.comparitech.com/internet-providers/iot-statistics/>

comprehensive overview of the current state (as-is), the proposed alternative theories, and the desired future state. According to Fig. 3, in the current state, the questions are classified into five primary categories. The first category focuses on the adoption of IoT technology in the healthcare sector. The questions in this group explore factors such as geographical attributes, industrial characteristics, and the role of decision-makers in the adoption process. The second category of the research questions examines the efficacy and enhancement of the healthcare system performance through the utilization of IoT. This category involves the analysis and assessment of the impact of this technology on service quality and the efficiency of the healthcare system. The third group of questions emphasizes the social and cultural aspects of IoT utilization in healthcare. These questions are typically addressed through social theoretical frameworks to assess the social, cultural, and behavioral effects of modern technology on society, social institutions, and human interactions. The fourth category emphasizes cognitive analysis and the complexities of human behavior in the application of IoT in healthcare. This analysis employs cognitive theories to enhance understanding of human interaction with technology and its influence on user decisions and behaviors. The fifth category pertains to the criteria and mechanisms for decision-making within the area of IoT in healthcare. Research questions in this category focus on finding and establishing useful criteria for decision-making, enhancing the efficiency and flexibility of IoT systems, and optimizing healthcare procedures. Rational and strategic choice theories are employed to address these questions. These theories elucidate decision-making processes by emphasizing limited rationality, purposeful selections, and cost-benefit analysis.

This comprehensive classification of research questions provides a profound insight into the diversity of topics examined in IoT healthcare studies, helping researchers pinpoint under-explored areas and formulate novel research trajectories. A literature review indicates that the majority of questions focus on adoption, while the least pertain to cognitive analysis and human complexities. A contributing factor is the intricate cognitive and human characteristics linked to human interaction with technology. This complexity encompasses users' cognitive processes, human-technology interactions, and the analysis of technical and human issues associated with the utilization of IoT in healthcare settings. Utilizing the potential of alternative theories, including cognitive appraisal theory, affective events theory, self-determination theory, attention theory, dual-process theory, signal detection theory, prospect theory, cognitive load theory, information integration theory, and resource allocation theory, can profoundly contribute to the examination of cognitive approaches.

Identifying the employed theories and research questions enables the evaluation of the adaptability and efficacy of these theories in addressing technical issues. Furthermore, proposing alternative theories can establish a foundation for uncovering and utilizing underexplored yet potentially beneficial theoretical viewpoints within this area. The research questions posed in this study can help researchers identify emerging and foreseeable concerns, thereby establishing a foundation for guiding future studies. This approach will facilitate the exploration of novel research avenues in the field of IoT in healthcare, perhaps enhancing the quality and efficacy of studies in this area. In the to-be section of Fig. 3, future questions are classified into five dimensions: trust and privacy, user behavior analysis, developing smart healthcare systems, the role of IoT in promoting knowledge management within the healthcare sector, and social and cognitive analyses of user behavior in healthcare systems.

This study encountered some limitations in the theoretical literature review on the implementation of IoT in the healthcare sector: The first limitation pertains to the origins of the hypotheses. Since the present study focused solely on studies on organization, management,

economics, organizational behavior, psychology, business, decision sciences, cognitive sciences, and social sciences, only the relevant theories have been dealt with. Consequently, theories utilized solely within engineering, computer science, and mathematics have been excluded from the study. Furthermore, in light of the research questions of this study and the necessity to concentrate on theories, analytical models and frameworks have been removed from the theories examined in this paper.

CRediT authorship contribution statement

Payam Hanafizadeh: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Methodology, Investigation, Formal analysis, Conceptualization. **Ferdos Hatami Lankarani:** Writing – review & editing, Writing – original draft, Visualization, Software, Investigation, Formal analysis, Data curation, Conceptualization.

Declaration of competing 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.

The author is an Editorial Board Member/Editor-in-Chief/Associate Editor/Guest Editor for this journal and was not involved in the editorial review or the decision to publish this article.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.digbus.2025.100157>.

Data availability

No data was used for the research described in the article.

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