

ARTIFICIAL INTELLIGENCE AND SERVICE FLEXIBILITY IN HEALTHCARE: EXPLORING THE NEXUS

Pradeep Kumar

Birla Institute of Management Technology (BIMTECH), Greater Noida - Delhi NCR, India

Correspondence: pradeep.kumar14fpm@iimranchi.ac.in

ABSTRACT

Artificial Intelligence (AI) has the potential to revolutionize healthcare by enabling the development of more personalized, efficient, and effective medical services. One aspect of AI competence in healthcare that has received significant attention is the ability to respond rapidly to the patients' dynamic needs while injecting more flexibility into the system.

This research explores the nexus between AI and service flexibility in healthcare. The qualitative study was carried out to examine the flexibility perspectives of AI-enabled service deliveries in healthcare. The findings contribute to a nuanced understanding of the facets of service flexibility in healthcare that AI could enable. The results would guide better coordination and management of care and the ability to make more informed decisions about treatment options.

The nexus between AI and service flexibility in healthcare would sketch the new paradigms of patient value creation and evidence-based practices, which is an immediate need of healthcare organizations across the globe.

KEYWORDS

Artificial intelligence (AI), healthcare, uncertainty, service flexibility, value creation.

INTRODUCTION & BACKGROUND

In healthcare, Artificial Intelligence (AI) is increasingly being used to enhance the delivery of patient care and improve outcomes [1]. AI tools and technologies have gained momentum in the past few years and populated the healthcare literature [2,3]. It is being used for various medical applications and procedures, such as blood pressure monitoring, heart rate tracking, and prediction of diseases, to name a few [4]. The recent report of Deloitte [5] indicates that AI has significantly affected the healthcare industry across the globe. A substantial portion of clinical and administrative service automation will result from the application of AI technologies, which might lead traditional healthcare organizations to shift their operations to more

focused on patients [6,7]. However, healthcare deliveries are faced with a high degree of uncertainties that emanate from the changing needs of the patients, and it remains crucial to cope with the technological turbulence while maintaining quality services. Researchers argue that flexibility is a competitive weapon to deal with uncertainties and deliver customized services to patients [8,9]. Flexibility provides a mechanism to adjust the medical infrastructure and deliver personalized services to the patients [10]. Pervious theories on service dominant logic and customer dominant logic indicate patients (customers) not only demand flexibility but also value them [11,12]. Moreover, resource-based theory (RBV) argues that organization mechanize their value resources and infrastructure to generate flexible mechanisms [13,14]. Despite the

tremendous potential of AI to create systems that can perform clinical as well as administrative tasks in healthcare, it remains crucial to understand how AI exhibits service flexibility.

AI is the simulation of human intelligence in machines designed to think and act like humans [15,16]. AI is defined as computational agents that act intelligently to perceive, learn, memorize, reason and problem-solve toward goal-directed behavior [17]. With AI algorithms and machine learning models, healthcare providers can analyze vast amounts of patient data to gain insights into their health conditions and treatment options and even predict future health risks [18,19]. This allows for personalized and proactive patient care, improving outcomes and patient satisfaction. Many authors suggest that technology infusion in service delivery is the primary enabler of flexibility [20,21]. Particularly in the healthcare industry, AI-enabled customer services—such as call analytics, in-app monitoring of health, chat bot-driven customer services, managing high volume patient inquiries, and using patient feedback analysis—are anticipated to generate capabilities for enhanced efficiency [22]. Yet the nexus between AI-enabled deliveries and service flexibility in healthcare remains largely unexplored.

Service flexibility allows healthcare organizations to respond quickly to patient needs and market dynamics changes, leading to increased efficiency and productivity [23]. Previous researchers have emphasized that organizations utilize resources to deal with uncertainties and generate flexibility [24,25]. Researchers posit that flexibility is a competitive weapon to deal with uncertainties and deliver customized services. Many authors have explored measurement issues, financial and non-financial outcomes of flexibility, and the enablers of flexibility [20,25,26]. A significant number of studies established the linkages between manufacturing and healthcare flexibility while simultaneously indicate the utilization of recent forms of technology like AI to achieve flexibility at various levels [10,21]. However, the Technology Adoption Model (TAM) and theory on customer engagement indicate that service providers exhibit flexibility by utilizing several forms of technology [27,28]. Extant literature indicates that technology enables flexibility at various service delivery levels and creates value propositions [9,29]. It is widely accepted by scholars that three major elements characterize flexibility in a particular region: range, mobility, and uniformity [25]. In the context of healthcare, authors argue that customers (patients) experience value in use

e.g., use of services and care through numerous customizations that are possible through flexible capabilities [29], [30]. Therefore, AI in healthcare must be addressed to ensure responsiveness and exhibit flexibility. However, there is a paucity of information on the role of AI in generating several types of flexibility. Accordingly, this study examines the nexus between AI and service flexibility in healthcare and, hence, value creation perspectives.

This research attempts to answer the research question:
RQ: How does the integration of AI in healthcare exhibit service flexibility?

STUDY CONTEXT:

AI-enabled technology is no longer regarded an emerging technology in India. Chat Bots driven customer service, media delivery, e-commerce, tourism, agriculture, and healthcare are just a few industries where it is being used more frequently. To increase adaptability in the healthcare market, many Indian organizations have been employing AI even for contextual understanding (such as by insurance service providers to give discounts for safe driving or real-time feedback) [31]. AI-enabled services are predicted to completely reshape the Indian health care sector [4]. In describing the future of the Indian healthcare business, it is predicted that patients' acceptance of AI-driven solutions will expand exponentially in the coming years [32]. The paradigm shifts in healthcare following COVID-19 will create new opportunities for AI-enabled devices and solutions. Given this background and context, it is justified to explore the AI-enabled service flexibility in the Indian healthcare sector. 0

RESEARCH DESIGN

The study investigated AI-enabled service flexibility in healthcare through the development of a case study. Researchers argue that a case study provides an in-depth understanding of the study phenomena [33]. The study primarily aimed to determine how AI in healthcare organizations creates patient-oriented responsiveness by adapting to their dynamic needs. The sample organization has significantly adopted AI-based tools and technologies for patient-related services in the past two years [20]. Semi-structured interviews (n=35) of healthcare professionals were conducted to collect the data. The study participants (Table 1) were recruited based on their background, knowledge of the topic being studied, and the nature of their current organizational roles. The snowball sampling was utilized to approach and invite the study participants.

The author approached the medical institute (Rajendra Institute of Medical Sciences, Ranchi, Jharkhand, India) on 2nd and 3rd of September 2023 for a permission and ethical approval. By acknowledging the academic importance, the ethical committee clearance was given to the author on 13th December 2023 and the author was awarded a research travel grant by the parent institute (Birla Institute of Management Technology, Greater Noida, India) to facilitate and support their scholarly pursuits.

DATA COLLECTION

The questions for the semi-structured interviews were created using the critical literature on the studied topics (such as AI, responsiveness, flexibility, and customization). The semi-structured interview questions were shown to a small group of healthcare professionals and their feedback was taken into consideration to improve the list of questions. The interviews took place in July and August of 2023. Most discussions took 45 to 50 minutes on average, and only a small number were repeated for data reliability and clarity. Three phases (Table 1) were included in the data collection process.

TABLE 1: PHASES OF DATA COLLECTION IN THIS STUDY

Phase	Organizational position	Working experience	Interviewees	Interviews	Focus of interview questions
Field sensitization	Senior	>10 Years	5	6	AI usage in healthcare organizations
	Middle	05-10 years	5	5	
	Lower	0-05 years	3	5	
Data gathering	Senior	>10 years	6	7	Role of AI in coping uncertainties and flexible response
	Middle	05-10 Years	7	7	
	Lower	0-05 Years	4	6	
Validation	Senior	>10 Years	3	3	Validation of findings
	Middle	05-10 Years	2	3	
	TOTAL		35	42	

DATA ANALYSIS

The data analysis was focused on exploring the nexus between AI and facets of service flexibility. The study examined the various dimensions of service flexibility that AI could enable. The basis of exploration were the three elements (range, mobility, and uniformity) of flexibility [25] that AI could generate. The qualitative data were transcribed and imported into the database. The analysis of qualitative data was performed through NVivo (v10) software. Because NVivo is so user-friendly and allows for document extraction directly from word processing software, it was selected over other products for data analysis [35].

Further, a thematic analysis was employed to identify meaningful patterns from the qualitative data. The recommendations of Braun and Clark [36] were followed to identify the patterns, and themes (Table 2) were

identified based on those authors recommendations of using a six-step process of looking at the meaning of patterns. Three coders (one professor and two research scholars) were involved in the coding process. In order to improve clarity and reliability, interviews were carried out repeatedly [37]. We collected information from multiple sources in order to undertake data triangulation [38]. Data was gathered from the medical records and other documents. In regard to clinical procedures and treatment modalities, relevant information has been gathered via websites, a medical education unit, telemedicine, and other nursing units. When relatively few new insights were obtained—that is, when the researchers could predict the informant's response before they stated it (data saturation)—the data collecting process was stopped [33]. To ensure validity and reliability, we adhered to recommendations of

Denzin (1998) [39]. Finally, the Kappa score was ascertained to establish inter-coder reliability.

TABLE 2: INTERVIEW RESPONSES AND CODING OF DATA IN THIS STUDY

Example quotes	2 nd order coding	Coding Categories
<p><i>"AI-powered capabilities are revolutionizing the healthcare industry. It enables us to optimize our operations by dynamically adjusting resources and services to meet patient needs. AI, for example, can assist us in allocating people and resources more effectively amid an unexpected patient spike, ensuring that everyone receives the treatment they require".</i></p> <p><i>"Artificial Intelligence has improved our capacity to manage higher patient numbers in the radiology department. AI systems can help us satisfy demand without sacrificing diagnostic quality by helping us prioritize and interpret imaging tests more efficiently".</i></p>	<p>AI and Operational efficiency, AI for staff optimizations, AI for better resource allocation, AI for quick adjustments on multiple fronts, AI for shorter waiting time</p>	<p>AI-enabled Volume flexibility</p>
<p><i>"AI plays a crucial role in clinical requirements. It allows us to customize treatment regimens for each patient, resulting in better care. Additionally, it simplifies administrative work and enhances inter-departmental responsiveness while providing patient care".</i></p> <p><i>"Increased responsiveness made possible by AI directly impacts patient treatment. It enables us to customize therapy regimens to meet the particular requirements of every patient, increasing treatment efficacy and lowering adverse event rates. Better patient outcomes and general satisfaction follow from this".</i></p>	<p>Clinical workflow optimization, AI-driven clinical decision making, better treatment outcomes.</p>	<p>AI-enabled Clinical flexibility</p>
<p><i>"AI-enabled recovery processes significantly impact patient care. It guarantees that treatment programs are customized to each patient's needs, leading to more successful and efficient rehabilitation. Consequently, this leads to enhanced patient results and general contentment".</i></p> <p><i>"AI in nursing aids in creating rehabilitation plans tailored to each patient's needs and evolving with them. Better patient outcomes result from this, as it promotes more effective recoveries and better treatment".</i></p>	<p>AI for improved recovery, tracking of patient complaints, quick attention for recovery, AI-driven interventions</p>	<p>AI-enabled Patient recovery flexibility</p>

CASE STUDY FINDINGS AND DISCUSSION

The study focused on a healthcare organization aligned with the Ministry of Health, Medical Education and Research, Government of India's index. The case organization has emerged as one of the leading institutions based on parameters such as patient registrations, bed capacity, and an extensive range of clinical, para-clinical, and auxiliary services. Notably, substantial investments have been directed towards the integration of Artificial Intelligence (AI) within the organization, reflecting a strategic commitment to advancements in healthcare technology. Healthcare professionals within this organization have acknowledged the implementation of flexible practices that align with patient preferences, and there is a growing recognition of the potential for AI to

enhance and enable such flexibility. The extant literature underscores the multi-dimensionality of service flexibility, yet this study contributes by elucidating the specific dimensions of service flexibility that can be effectively harnessed through the adoption of AI-enabled tools and technologies. The findings shed light on the nuanced ways in which AI applications can foster adaptability in healthcare services, thereby contributing to a more comprehensive understanding of the intersection between AI adoption and service flexibility in the healthcare sector.

AI-ENABLED VOLUME FLEXIBILITY

The use of AI to optimize and modify the distribution of resources and services in healthcare settings in response to shifting demands and needs is known as "AI-enabled volume flexibility in healthcare." [21, 40]. In healthcare,

where resource allocation and service delivery can be intricate and dynamic, this idea is especially pertinent. AI can forecast patient loads, disease outbreaks, and other healthcare demands by analyzing historical and current data. Healthcare systems can better meet shifting needs by using this information to allocate resources, such as staff, equipment, and beds. Appointment slots and rescheduling can be optimized using AI-driven scheduling systems to account for fluctuations in patient loads. This adaptability guarantees that patients receive care when needed and cuts down on waiting periods.

AI-ENABLED CLINICAL FLEXIBILITY

By evaluating patient data, including test results, patient histories, and medical imaging (such as X-rays, MRIs, and CT scans), AI algorithms can help medical personnel diagnose medical disorders. Healthcare professionals can diagnose patients more quickly and accurately with this support, giving them more freedom to make decisions. AI can analyze large datasets to forecast patient outcomes and the course of a disease. Artificial intelligence (AI) makes more proactive and adaptable treatment planning possible by giving medical professionals these predictions. AI can analyze patient data and recommend treatments in real-time to enhance clinical decision-making. This support aids medical practitioners' decision-making process, particularly in intricate or quickly changing clinical situations. Thus, AI-enabled clinical flexibility allows a rapid response to the patient's clinical conditions and provides a range of clinical services effectively and efficiently [10].

AI-ENABLED PATIENT RECOVERY FLEXIBILITY

The recovery of patients when something goes wrong has happened remains crucial in healthcare [41]. Therefore, a

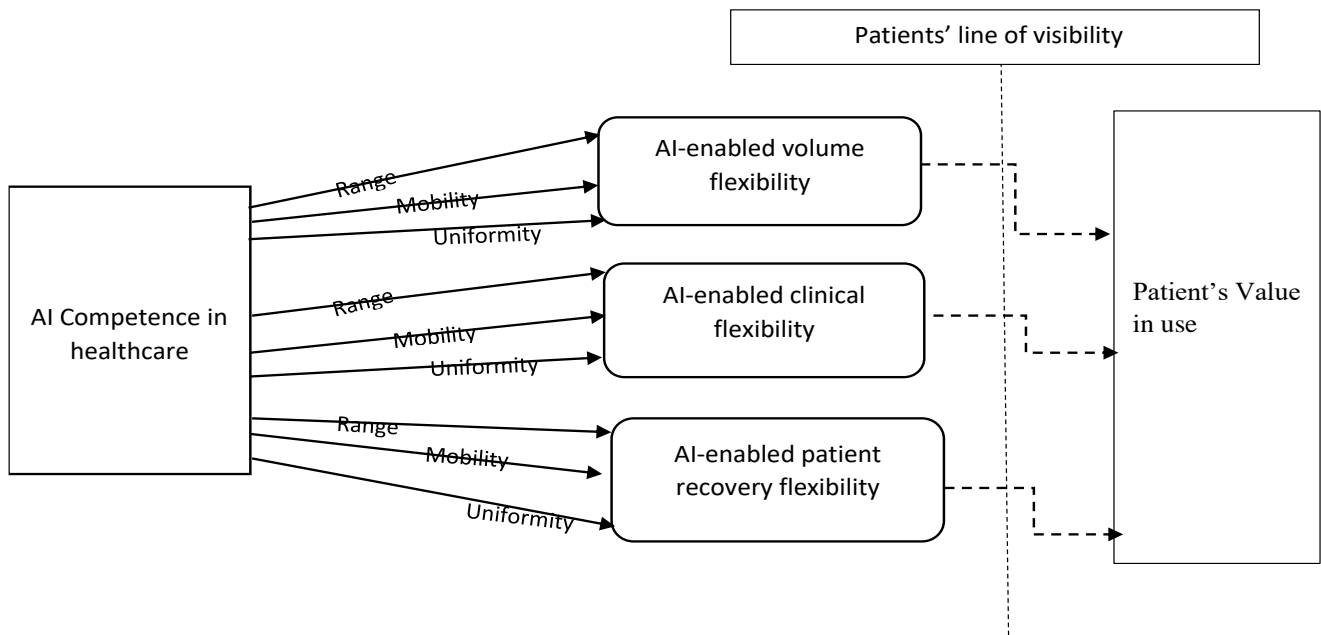
different level of flexibility is required to cope with uncertainties like re-admittance, patient complaints, or other post-discharge issues. AI technologies make it possible to deal with such uncertain conditions. AI offers tools and methods that enhance the overall recovery process; it can have a substantial impact on the flexibility of patient rehabilitation in the healthcare industry. This eliminates the need for frequent in-person visits by enabling medical professionals to monitor patients' progress toward recovery and make any required modifications to the treatment plan. AI-powered rehabilitation programs can track patients' progress and offer personalized workout plans. The AI's ability to modify the workouts as patients heal to fit their evolving requirements and capacities promotes an adaptable and patient-centric approach to rehabilitation.

AI is becoming increasingly integrated into the present healthcare ecosystem, as demonstrated by a number of studies [42,43]. Several studies in the field of healthcare have shown that the broad implementation of artificial intelligence (AI) leads to enhancements throughout the entire care spectrum, including robotic surgery, clinical trials, rare illness therapy, medication development, and customer services ([18,44]). AI-enabled devices and technology have improved the healthcare supply chain, automated treatment processes, and provided individualized care [45]. AI-based tools and technologies increase the range, mobility, and uniformity in the following three facets and hence, create flexible mechanisms (Table 3).

TABLE 3: GENESIS OF AI-ENABLED SERVICE FLEXIBILITY IN HEALTHCARE

AI-enabled service flexibility	Range	Mobility	Uniformity
Volume flexibility	Number of patients admitted, rate of discharge from medical units	reduced waiting time, short queue,	Quality of treatment, lower mortality rates
Clinical flexibility	The number of clinical services.	Inter-departmental responsiveness,	Improved efficiency of clinical services
Patient recovery flexibility	Variety of support channels for patients, rate of re-admissions.	Quick support to patient complaints, attentiveness, and AI-based assistance	Effective management of patient's complaint, effective recovery

FIGURE 1: AI COMPETENCE AND SERVICE FLEXIBILITY IN HEALTHCARE



THEORETICAL IMPLICATIONS

This study provides several implications for theory. First, the study responds to recent calls from researchers regarding the dynamics of flexibility in healthcare [31]. The study's findings reveal three unique facets of patient-oriented service flexibilities in terms of volume flexibility, clinical flexibility, and patient recovery flexibility. Thus, the results contribute to the healthcare literature by clarifying the genesis of patient-oriented flexibilities at various levels. Second, previous studies argue that AI provides a response mechanism to several uncertainties in the care processes while simultaneously increasing the effectiveness and efficiency of medical resources [17]. The current study's findings extend this conceptualization and establish the relationships between AI and service flexibility by justifying the distinctive dimensions of service flexibility. Recent studies on AI in healthcare call an exploration into healthcare providers service flexibility, that AI could enable [28,31]. The findings explain the three facets of healthcare flexibility. Further, the results established the elements of AI-enabled volume flexibility, AI-enabled clinical flexibility, and AI-enabled patient recovery flexibility [10,21,41]. Third, previous studies merely mention that flexible capabilities provide numerous customizations in response to changing demand patterns [8,29]. This study goes beyond that and establishes how AI plays a significant role in addressing the changing demand patterns in a healthcare context and exhibits a multitude of flexibilities as a response.

PRACTICAL IMPLICATIONS

An integrative model of service flexibility and artificial intelligence in healthcare would encompass the utilization of AI technologies and flexible service offerings to enhance the delivery of healthcare services. The model would aim to strike a balance between the benefits of AI, such as improved efficiency and accuracy, and the need for personalized, flexible healthcare services that cater to the unique needs of patients. For example, AI algorithms can automate repetitive tasks such as data entry, freeing healthcare providers to focus on more critical tasks such as patient diagnosis and treatment, thus allowing them to develop volume-flexible capabilities [28]. Additionally, this results in better patient outcomes, reduced costs, utilization of medical resources more effectively, and thus responding more flexibly. In addition, AI-enabled clinical flexibility is essential to respond to various clinical conditions of the patients. The study's findings clarify how AI injects more flexibility into the system to recover patients quickly if something wrong happens. For example, AI-powered telemedicine services can provide remote patient consultations, reducing the need for in-person visits and making healthcare more accessible.

CONCLUSIONS

This study provides a 'flexibility' perspective of AI in healthcare. The semi-structured interviews of healthcare professionals were conducted to explore how AI could enable different types of flexibility in healthcare deliveries.

The findings suggest three crucial dimensions of flexibility that AI could enable in a healthcare setting. However, future studies should explore other facets of AI-enabled service flexibilities and assess the strength of the relationships through quantitative techniques. The qualitative data was gathered from healthcare professionals, and patient's perspectives were not included. Therefore, it is urged to build a holistic view of AI-enabled service flexibility by compiling patients' data in the study.

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