

Critical Issues and Countermeasures in Smart Hospital Construction and Management under the Context of High-Quality Development

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Abstract: *Smart hospitals are mainly defined as facilities offering "smart healthcare" for medical personnel, "smart services" for patients, and "smart management" for hospital operations, making them an integral part of intelligent medical services. In their construction and management, problems arise such as a focus on building over management, conflicting interests among stakeholders, insufficient incentives for resource injection, existence of information silos, safety concerns, and underutilization of data value. This paper proposes strategic solutions for the construction and management of smart hospitals by systemically and scientifically combining policy analysis, interview research, and observation of the current circumstances, rooted in the practical development of hospitals. It advocates for integrating construction and management efforts from a holistic lifecycle perspective.*

Keywords: *Smart Hospitals, High-Quality Development, Data Assets, Systemic Thinking, Self-Confidence and Independence, Problem-Oriented Approach*

1. Introduction

China has now entered a stage of high-quality development, and the growing demand from the public for diverse healthcare services underscores the centrality of hospitals within China's healthcare service system. Accelerating the improvement of medical service levels and health care quality is not only necessary to meet the changing main social contradictions and the people's aspirations for a better life but also forms the foundation for the nation's pursuit of higher-quality economic and social development[1]. As significant carriers of hospital informatization and intelligence, smart hospitals are becoming a key force in driving the high-quality development of hospitals. However, establishing and managing smart hospitals as per the demands of high-quality development is not instantaneous. It demands a systematic and scientific approach tailored to the actual progress of hospital development. This approach unifies the construction and management of smart hospitals from a full lifecycle perspective. It includes policy document analysis, interviews, field research, and the observation of realities to pinpoint the existing challenges in smart hospital construction and management. By delving into and utilizing new economic theories and methodologies raised in practice, this paper aims to provide strategic recommendations for the construction and management of smart hospitals within the context of high-quality development.

2. Current Status Analysis of Smart Hospital Construction and Management

2.1. The Essence of Smart Hospitals

Smart hospitals, which are highly informatized and intelligent, primarily encompass "smart medical treatment" for medical staff, "smart services" for patients, and "smart management" for hospitals themselves, representing an integral part of intelligent medical services[2]. Their essence is multifaceted, denoting that by applying advanced information technologies and intelligent methods, aspects such as medical service provision, operational management, and patient experience are optimized and elevated to achieve efficient, safe, and personalized medical services, as well as precise and scientific hospital management.

2.2. Literature Analysis on Smart Hospital Construction and Management

It is recorded that China started applying computer technology in the medical field from 1965[3], later extensively using it in clinical research, clinical auxiliary diagnosis, and hospital management. The informatization process has gone through stages such as "stand-alone user" systems, "multi-user departmental systems," "local area network-based hospital-wide systems," to digital hospitals. With the growth of computer and network technologies, the informatization extent deepened until the concept of "smart hospitals" emerged[4]. Currently, research on smart hospitals mainly focuses on the application of information technology in medical institutions, such as Jiang Weiwei et al.s "5G+ Smart Healthcare Empowering Digital Transformation of the Medical Industry" published in 2003[5], or analyses of the current state of smart hospital construction, as Xu Chang et al.[2] have pondered the impact of smart hospital construction on public hospital high-quality development. Jiang Shuai and others[3] dissected critical issues and countermeasures for smart hospital construction in the context of high-quality development, while Yang Jingyi[6] reflected on smart hospital construction in the context of public health emergencies. However, studies on scientifically and systematically addressing smart hospital construction and management against the backdrop of high-quality development requirements are still relatively scarce.

2.3. Policy Analysis on Smart Hospital Construction and Management[7-12]

In October 2013, the State Council issued "Several Opinions on Promoting the Development of the Health Service Industry," highlighting the need to increase the allocation of digital medical equipment and to combine health services with the Internet, strengthening automated and intelligent health information service platforms.

In July 2014, the National Health and Family Planning Commission introduced the "46312" top-level planning, where "3" signifies establishing three fundamental databases: electronic health records, electronic medical records, and population case databases for all citizens, to achieve a systematic, multi-faceted national health resources system construction. The "46312" plan highly reflected the national emphasis on hospital informatization construction at the top-level design.

In November 2015, the National Health and Family Planning Commission announced a list of 12 smart hospital pilot sites, officially commencing the practical implementation of smart hospitals in China.

In December 2017, the National Health and Family Planning Commission and the State Administration of Traditional Chinese Medicine jointly issued "An Action Plan to Further Improve Medical Services (2018-2020)," which underscored integrating "Internet +" to construct smart hospitals.

In April 2018, the General Office of the State Councils "Opinions on Promoting the Development of 'Internet + Medical Health'" stressed strengthening the construction of Internet + hospitals.

In May 2020, the National Health Commissions "Notice on Further Improving the Appointment System and Strengthening Smart Hospital Construction" acknowledged the positive role played by smart hospitals during the COVID-19 pandemic. It emphasized that a trinity system of medical treatment, management, and services should be constructed to provide patients with higher quality services.

In June 2021, the General Office of the State Council's "Opinions on Promoting High-Quality Development of Public Hospitals" (No. 2021-18) called for strengthening the supporting role of informatization to propel the construction of smart hospitals and hospital information standardization.

In September 2021, the National Health Commission and the State Administration of Traditional Chinese Medicine issued the "Action for the High-Quality Development of Public Hospitals (2021-2025) (hereinafter referred to as the "Action"), explicitly making information technology a priority area for hospital construction. By 2025, a number of demonstration and leading smart hospitals will be established, forming an integrated online and offline medical service model, with regional equity in medical services further enhanced.

In December 2021, the Central Cyberspace Affairs Commission issued the "14th Five-Year" National Informatization Plan, outlining comprehensive strategies for informatization during the "14th Five-Year Plan" period. The "Action" for the construction of digital public health emergency systems in the ninth section of Chapter 5 of the "Plan" firmly stated: "By 2023, the system supporting the

normalized prevention and control of pandemics will be improved, and by 2025, the system will further enhance, significantly impacting the emergency response to public health events."

In September 2022, the General Office of the National Health Commission issued the "Notice on Issuing the Operation Manual for Evaluation Indicators of High-Quality Development of Public Hospitals (Trial) (2022 version)" (National Health Office Medical Letter [2022] No. 335), which specified the data statistical caliber for evaluating the high-quality development of public hospitals, providing interpretations to each indicator, incorporating the effectiveness of smart hospital construction into the quantitative indicators part for innovation and effectiveness, and for evaluating the construction of smart medical facilities in medical institutions, representing the comprehensive outcome of the construction of smart hospitals integrating electronic medical records, smart services, and smart management.

2.4. Interview Research and Reality Observation Analysis on Smart Hospital Construction and Management

In order to deeply understand and study the reality of the construction and management of smart hospitals, we interviewed the information department heads or leaders of 10 general hospitals and 5 specialized hospitals in Guangdong Province, and observed and analyzed them combined with the actual work of the hospital.

Two open questions were prepared in advance and informed before the interview: first, what you think are the key elements in the construction and management of smart hospitals; second, the challenges and opportunities in the construction and management of smart hospitals, and how to deal with them. According to the interview and investigation combined with the observation and analysis of members, the summary is summarized as follows.

The key elements of the construction and management of smart hospitals mainly include: first, information infrastructure: the construction of smart hospitals cannot be separated from the support of advanced information technology, including cloud computing, big data, Internet of Things, artificial intelligence, etc. The application of these technologies in the medical field can realize the rational allocation of medical resources, improve the efficiency of medical service, and reduce the medical costs. Second, the optimization of the medical service process: by improving the medical service process, patients' medical experience can be improved, patients' waiting time in the hospital can be reduced, and medical errors can be reduced. Smart hospitals should use information technology to optimize the medical service process and realize the humanization and intelligence of medical service. Third, in terms of data-driven decision support, smart hospitals should make full use of big data, artificial intelligence and other technical means to in-depth dig and analyze medical data, provide scientific and effective decision-making basis for hospital managers, and improve the level of hospital operation and management. Fourth, in terms of talent training and organizational culture, the construction of smart hospital needs a team of compound talents with information technology knowledge and medical professional skills. In addition, hospitals also need to cultivate an innovative, collaborative and open organizational culture to promote the sustainable development of smart hospital construction.

The problems and challenges in the construction and management of smart hospitals mainly include: first, insufficient investment. The construction of smart hospitals involves a large amount of capital investment, including the construction of information infrastructure, medical service process optimization, talent training and other aspects. However, at present, the investment in smart hospital construction in China is still insufficient, which has become a bottleneck restricting the development of smart hospitals. Second, information security: in the construction of smart hospitals, information security is particularly important. How to ensure the security of patients' private information and medical data has become a major challenge for the construction and management of smart hospitals. Third, the distribution of medical resources is uneven. The construction of smart hospitals should pay attention to the rational allocation of medical resources, especially the development of primary medical service capacity. At present, the distribution of medical resources in China is still unbalanced to a certain extent, and there is a large development gap between urban and rural areas and between urban and rural areas. Fourth, organizational culture and collaborative innovation. The construction of smart hospital requires the cooperation of multi-disciplines and departments. However, at present, the organizational culture of some medical institutions in China has not yet formed a good collaborative innovation mechanism, which affects the process of the construction of smart hospitals.

The corresponding countermeasures and suggestions for the construction and management of smart hospitals mainly include: first, increase investment: the government should increase financial support for the construction of smart hospitals and encourage social capital to participate in the construction of smart hospitals. At the same time, the hospital themselves should also actively seek diversified financing channels to provide financial guarantee for the construction of smart hospitals. Second, strengthen information security protection, establish a sound information security protection system, strengthen the encryption, storage and transmission of medical data and other technical means. At the same time, the information security awareness training of medical staff should be strengthened to ensure patient privacy and medical data security. Third, optimize the allocation of medical resources, through policy guidance, financial support and other means to promote the sinking of medical resources to the grassroots level, improve the capacity of grass-roots medical services. At the same time, strengthen the sharing of regional medical resources, break the regional barriers, and realize the efficient utilization of medical resources. Fourth, cultivate the culture of collaborative innovation: promote the formation of an open, cooperative and innovative cultural atmosphere within medical institutions, and strengthen the communication and cooperation between multiple disciplines and multiple departments. At the same time, strengthen the contact with universities, research institutes, enterprises and other external partners, and jointly promote the construction of smart hospitals.

Through the interviews with relevant personnel, as well as the field observation and investigation, we have a more intuitive understanding of the actual situation of the smart hospital, find the problems that are difficult to reach in the interview research, and to a certain extent, have a more comprehensive and in-depth understanding of the reality, so as to provide a strong basis for the suggestions and problem solving of this paper.

3. Key problems facing the construction and management of smart hospitals

3.1. Strategic planning and top-level design of smart hospitals need to be coordinated.

The strategic planning and top-level design of smart hospitals currently face challenges, where they fail to comprehensively consider appropriateness, economic feasibility, and scientific grounding. The focus is often skewed toward construction while overlooking management and usage, lacking a full lifecycle management perspective. No effective mechanism has been formed to integrate and streamline various aspects, such as strategic planning, design, construction, usage, operation, and management. Firstly, some plans and designs for smart hospitals have not sufficiently taken into account the actual needs, resource allocation, and technical feasibility of the hospitals, resulting in some facilities or systems not achieving their anticipated effects. Additionally, adequacy in economic and scientific considerations has sometimes been neglected, leading to less-than-satisfactory investment returns and potentially affecting regular hospital operations. Secondly, there's an excessive focus on hardware construction within certain smart hospital projects, leaving post-construction operations and management neglected. This results in advanced technologies and equipment not being effectively utilized, becoming mere decorations. Thirdly, smart hospital construction involves multiple phases; however, the absence of an effective coordination mechanism among these stages often leads to resource wastage and inefficiency. There's a lack of systematic and comprehensive planning and management from a full lifecycle perspective. Fourthly, the related legal norms and organizational guarantee mechanisms for smart hospital construction and management are still incomplete. Conditions such as admission and supervision systems, standards for construction management and evaluation, as well as unstandardized data formats and system interfaces for hardware and software from different suppliers are common.

3.2. Relevant parties in the medical industry chain have conflicts of interest or inconsistency of concerns.

Smart hospitals operate and evolve both inside and outside the healthcare industry system. Participants in medical activities—patients, medical staff, hospitals, equipment manufacturers, pharmaceutical companies, information service agencies, public health departments, etc.—influence one another, forming a relatively stable dynamic medical ecosystem. However, each participant generally carries out smart hospital construction from their standpoint[3]. From patients' perspective, there are considerable variations in smart healthcare service demands across different age groups, education levels, health conditions, and medical concepts. For example, younger individuals may autonomously use intelligent services such as online appointment booking, mobile payment for fees,

online medical services, online report lookup, and self-service printing. In contrast, older adults often have limited acceptance of such information technology and find it difficult to operate smart devices. From the perspective of IT and hardware/software providers, there may be inducements to repetitive construction disconnected from hospitals' actual needs. From the viewpoint of hospital departments and medical staff, needs of smart medical technology can vary. Some focus on whether smart hospitals can reduce their workload—for instance, replacing doctors with intelligent clinical decision support and diagnostic assistance (e.g., imaging, ECG), remote mobile rounds, or replacing nurses with intelligent robots for medication delivery and communication. On the other hand, some are concerned with their own interests or safety in management, conservatively guarding their turf.

In reality, the acceptance level of new smart technologies among different participants is limited, and it is often unrecognized that a singular role cannot sustain all aspects of medical activities. Only by collaborating within the overall framework of the medical industry chain, focusing on a trinity of smart medical, service, and management hospital construction practice, and coordinating the overall industry chain interests, can participants effectively fulfill a systemic role and achieve self-value, thereby leading the healthcare industry in a positive direction.

3.3. The resource input and power supply of smart hospitals should be further increased

Information technology construction forms the core of smart hospitals, requiring sustained upgrades involving talent, medical technology, and financial investment. The scarcity of specialized medical information professionals is one of the most significant challenges. For instance, in tertiary hospitals, the level and quality of IT staff are not high, with 41.8% indicating difficulties in meeting daily operation needs[3]. The competencies of medical information personnel need enhancement, necessitating multi-talented individuals with computer, medical, and management expertise. Currently, the lack of such composite intelligent medical talents is a major challenge in smart hospital construction. Regarding financial investment, hospitals primarily self-fund information technology investment with government support and corporate sponsorship playing auxiliary roles. Large expenditures are directed at the construction of infrastructure such as software and hardware, affected by the progress of medical information technology, which requires continuous capital input for later upgrades, leading to a lack of driving force and low enthusiasm among hospitals for investing in IT construction[13]. Conversely, the inability to control investment-output risks leads to a reduction in hospital administrators' emphasis and execution in promoting smart hospital construction.

3.4. Integrated Information System Construction, Sharing, and Data Interconnectivity Mechanisms Await Improvement

At present, the construction of smart hospitals in China faces the urgent mission of integrating "fragmented" in-hospital information systems. However, because existing systems lack uniform interconnection standards, systems such as e-medical record systems and remote consultation systems face difficulties in interconnectivity. This issue extends beyond a technical problem and reflects man-made information barriers within hospitals. In reality, due to factors like segregation among internal and external hospital departments, inconsistent data collection standards, low data quality, security concerns over medical information and resource value, and the transformation of traditional medical service supply models by smart hospitals, medical personnel tend to have a degree of resistance. Problems arise as various stakeholders are not willing, afraid, or unable to share data information[3]. In the construction and management of smart hospitals, insufficient communication and collaboration among departments lead to departmental barriers, creating "information silos" and data bottlenecks, and failing to realize the goal of interconnectivity of in-hospital data information[14].

3.5. Data security and privacy protection mechanism of smart hospitals need to be strengthened

The first point is that all stages of data collection, storage, transmission, and utilization in smart hospitals are related to data security and privacy protection, the relevant legal regulations of which are not yet perfected. The second is the internal management within the hospitals, which needs further enhancement for data security and privacy protection, emphasizing staff training to raise awareness. The third point regards the delayed implementation of advanced encryption technologies, secure transmission protocols, and artificial intelligence algorithms. Establishing data isolation, access control, and audit traceability mechanisms to enhance data security are prevalent issues. Lastly, regulatory oversight on data security and privacy protection in smart hospitals requires strengthening to ensure

effective risk assessment and auditing measures.

3.6. The data value needs to be further explored

Substantial value-generating data arises during the operation of smart hospitals. Although database construction has been given importance in the construction of hospital information systems, most hospitals only focus on information collection and simple analysis. The value of data cannot be fully appreciated due to ineffective management, likened to untapped mineral wealth. Additionally, by sorting and analyzing anomalies in system data, we can detect unusual events early and provide ample time for hospitals' emergency response. Regrettably, current smart hospital construction in China often concentrates on system construction while neglecting data utilization, overlooking the potential to enhance medical quality, patient services, and hospital management.

4. Countermeasures and Suggestions for the Construction and Management of Smart Hospitals

4.1. Adherence to a People-Centric Approach Smart hospital construction must be coordinated across all phases, from strategic planning and top-level design through construction and operation to management and usage, highlighting the utmost dedication to serving the people's health, serving patients, and empowering industry-related stakeholders.

The construction of smart hospitals should firmly stand on the ground of public health, capture the desires of patients and medical staff, and reflect the common will of various industry chain participants, embodying a comprehensive realization of construction and management. All aspects including information technology appropriateness, economic viability, and scientific validity must be fully considered. Focusing on organic coordination of construction and management from the vantage point of the whole lifecycle management of information systems, strategic planning, design, construction, usage, operation, and management must be effectively linked together, guided by the high-quality development demands of public hospitals.

At the policymaker and decision-maker level, a "trinity" of top-level design for smart hospital construction should be improved, relying on the practice path of "pilot ahead". Summarize the experience and practices of smart hospital construction in a timely manner, urge various government departments to establish relevant policies, standards, and guidance documents relating to the targets and content of smart hospital construction, and create support conditions for talent, capital, and technology for smart hospitals, optimizing the smart healthcare industry chain. Hospitals should establish a smart hospital construction leadership group helmed by the secretary or dean, define the current smart hospital development trends, deeply comprehend the functional advantages of smart hospitals, conduct thorough assessments of hospital informationization levels and development status, and develop detailed smart hospital construction plans. In accordance with graded evaluation standards, devise informationization development plans for the hospitals themselves, define general and specific targets for smart hospital construction, identify gaps between current status and targets, and progressively advance construction content or matters based on priorities.

On the construction and utilization level, recognize and understand that smart hospital construction and management encompasses various aspects and represents a super-systematic engineering project with multiple subsystems and functions. It involves every aspect of the medical process, with interrelated and interdependent departments, and requires the application of new technologies such as "Internet +", IoT, big data, artificial intelligence, etc. Stay in a state of learning new concepts, knowledge, skills throughout construction and usage, observe smart hospitals with interconnected, overall systematic, and developmental perspectives, comprehend their developmental laws, and approach issues arising during the gradual development of smart hospitals with an inclusive, worldly-wise, and dialectically wise attitude.

At the same time, enhance communication between policymakers, decision-makers, constructors, and users, creating a constructive dialogue mechanism and forming a united effort for the coordinated construction and management of smart hospitals.

4.2. Adhere to self-confidence and self-reliance, based on the actual development of the hospital, scientifically explore and practice, break the interest shackles in the construction and management of smart hospitals with the courage of integrity and innovation, broaden the channels of resource investment, and stimulate the momentum of the construction and management of smart hospitals.

The trial grading evaluation standard is only the rating standard for hospitals, and the questions of how to build, to what extent, and when smart hospitals should be built all need hospital decision makers and builders to answer the actual situation of hospital development and uphold the concept of self-reliance in practice. For wisdom hospital construction planning, operation management system need to communicate with policy makers, users and other related parties, scientific exploration, must not the construction tasks and implementation steps is not clear, the lack of the actual needs of the wisdom of the hospital construction planning, blindly follow suit, new big, low input-output ratio, repeated construction of medical resources waste.

Wisdom hospital construction and management interests throughout the wisdom hospital planning, design, construction, operation management, use the whole life cycle, involving many interest subjects (such as between various departments or hospital, hospital and the government, patients, hardware and software equipment and network suppliers, etc.) of profit distribution, need to meet the interests of the actual need constraints and incentive mechanism, form a clear benefit distribution mechanism. Policy makers should give preferential policies to the construction and development of smart hospitals, and create a good atmosphere for their construction; policy makers should fully consider the actual needs of medical staff and patients, coordinate all departments, break the inherent interest shackles and information barriers, clarify the hospital interconnection and sharing mechanism, avoid the overall development hindered by local interests, and vigorously promote the intelligent construction of hospitals.

The construction and management of smart hospitals require the input of various resources, such as human, financial, material, information and technology. Hospitals should actively strive for the cooperation of the government, enterprises, scientific research institutes and other medical institutions, so as to realize the pattern of social support from all aspects, diversified resource input, high-quality resource sharing and mutual benefit and win-win situation. Under the comprehensive evaluation, in terms of capital, technology, software and hardware equipment, on the other hand, the hospital shall fully purchase the technology, the hardware equipment and the network of the smart hospital, the hospital may try to purchase the physical objects and technology and actively attract the participants in the construction and management through the construction management mechanism of "resource integration, cooperation and achievement sharing". In terms of compound medical information talents, on the one hand, the hospital can improve the service ability of the hospital information talent team through talent introduction and independent training; actively explore the establishment of the hospital health information talent planning project, so as to achieve the goal of "attracting" and "retaining" high-level intelligent medical information talents. On the other hand, it can use the mode of external medical information experts and professionals, that is, to participate in the construction and management of smart hospitals with external experts, professionals, teams or institutions through contract, or means of contract. On this basis, the hospital also needs to continuously innovate the management mode and service mode, strengthen the integration of internal resources, optimize the allocation of human resources, improve the efficiency of the use of funds, stimulate the momentum of the construction and management of smart hospitals, and ensure the continuous promotion of the construction and management of smart hospitals.

4.3. Adhere to the problem orientation, consider the information island, data security, data asset management and other issues in the construction and management of smart hospitals with systematic thinking, grasp the development trend of smart hospitals, identify the source and law of the problems, and put forward effective solutions.

It is necessary to carry out a systematic and integrated service system construction and management of smart hospitals, open up the information generation and sharing of various medical related departments, promote the exchange and sharing of information resources, and strive to break the "information island" from the source. First, open and sharing, strengthen the pre-evaluation of information project construction, strive to build a management smart hospital platform relying on government e-government infrastructure, integrate health services into the "Internet + government services" information resource sharing platform, and realize real-time, high concurrency and large amount of data exchange. For example, the hospital realizes the sharing and linkage of all departments

and builds a regional health and health management platform; the hospital information system externally realizes the intelligent data interconnection with audit institutions, statistics institutions, financial institutions, communication institutions, credit investigation agencies and public security departments; second, systematically promotes the integrated construction and management of intelligent medical system, improves the "intelligent medical treatment" for medical personnel, the "intelligent service" for patients and the "intelligent management" for hospitals.

Data security is the bottom line of the construction of smart hospitals. It is necessary to form a regular network security guarantee mechanism to ensure information security rather than only dealing with major node attack and defense drills or large network security inspections, so as to truly prevent accidents and provide solid support for the development of smart hospitals. For example, the use of scientific measures to strengthen data transmission protection, the application of firewall technology, biometric technology and key technology, to protect patient information.

In the operation process of smart hospitals, a large amount of value data will be generated. It is necessary to read through the relevant requirements [15] of the Guidance on Strengthening Data Asset Management (No.141,2023), and do a good job in the compliance, standardization and value-added of data assets of smart hospitals. First, adhere to the combination of ensuring safety and compliance utilization. Correctly handle the relationship between medical data asset security, personal information protection and the development and utilization of data assets, on the premise of ensuring data security, the development and utilization of classification, to further play the value of medical data assets. Second, adhere to the combination of innovation and pilot first. Strengthening medical system inside and outside departments coordination, improve the medical data asset management system mechanism, adhere to the reform according to law, encourage support all parties to adjust measures to local conditions, bold exploration, explore diversified way of paid use, explore establishing medical public data assets development and utilization and income distribution mechanism, strengthen the regulation of data assets, strengthen the whole process of data assets management.

5. Conclusion

This paper combines the requirements of high quality development, systematic science and the actual development of hospital to solve the problems in the construction and management of smart hospital, and puts forward the corresponding countermeasures and suggestions from the perspective of new economic theory and practice, in order to provide practical suggestions and theoretical support for the hospital in smart hospital on the road of high-quality development. In the future, it is necessary to further study the specific causes and specific solutions of each problem, so as to achieve a high degree of unity in theory and practice.

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