Review

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Pathways for embedding digital health technologies and their governance mechanisms in long-term care insurance systems: A comparative review of Japan, South Korea, and China

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SUMMARY: Rapid population aging is increasing demand for long-term care (LTC), prompting many countries to institutionalize financing and service provision through long-term care insurance (LTCI). Digital health technologies are increasingly embedded into LTCI, and yet the pathways in which they are embedded and their governance effects differ across institutional contexts. This comparative review synthesizes evidence from Japan, South Korea, and China across five operational domains—institutional foundations, eligibility determination, service management, fund oversight, and policy steering—and uses a sociotechnical systems lens to analyze how technology and institutions co-evolve. We propose a three-layer model of institutional embedding linking welfare-boundary constraints, governance mechanisms shaping data-driven operations, and path dependence in policy and implementation. In the three countries, digital health technologies have not fundamentally expanded the welfare boundary of LTCI, but they have reshaped how LTCI is administered, shifting *i*) needs assessment from experience-led judgment toward data-driven decision-making support, *ii*) service management from flexible discretion toward rules and platform-based coordination, and *iii*) oversight from ex post auditing toward process-oriented monitoring. Distinct national pathways have emerged: a supplementary-technology pathway in Japan, a state-led integration pathway in South Korea, and an exploratory co-evolutionary pathway in China. These benefits are accompanied by practical risks, including algorithmic bias, inconsistent data quality, privacy and security concerns, and potential erosion of institutional flexibility. The proposed model helps explain cross-national divergence and provides a governance-oriented basis for selecting embedding strategies and safeguards in different LTCI contexts.

Keywords: sociotechnical systems theory, model of institutional embedding, data infrastructure integration, fund oversight, algorithmic bias, policy implementation

1. Introduction

Population aging has become one of the core trends in changes to the current composition of the global population. According to United Nations World Population Prospects 2024, the proportion of the global population age 65 years and older is projected to increase from 10.2% in 2024 to 20% in 2070 (*1*). With the increase in life expectancy and the decline in the fertility rate, the size of the elderly population continues to expand, and the need for long-term care caused by chronic diseases, functional decline, and disability continues to increase. Care issues are gradually being transformed family affairs into social problems requiring institutional responses (*2*). This is the background in which the long-term care insurance system (LTCI) has been gradually created, and it has become an important institutional arrangement to deal with the risk of geriatric care.

In terms of regional distribution, the aging process differs markedly in different countries (Figure 1). Europe and the US had an aging population earlier, and the level of aging was generally high. East Asian countries, as represented by Japan, South Korea and China, have experienced a more rapid demographic transition in a relatively short period of time (*3-6*). Japan

has a profoundly aging population, South Korea has a significantly accelerated rate of aging and is expected to surpass Japan's level of aging, and China has a large and continuously growing elderly population (Figure 2). The three countries are all located in East Asia and are influenced by traditional Confucian culture, where the family has long been responsible for providing care. With the reduction in family size and the increase in population mobility, however, the family's capacity to provide care has gradually weakened, hampering its ability to deal with the rapid growth of care needs (*7*). This transition prompted the three countries to establish LTCI systems in an institutionalized manner (*8*) to respond to the intense need for care.

As LTCI expands, its operation requires more sophisticated information integration. Digital health technologies (DHTs)—ranging from information systems and data platforms to sensors, wearable devices, assistive robotics, and AI-enabled analytics—have been introduced into LTCI-related processes (*9-12*). Japan has used systems and care robots to improve care workflows and quality (*13*), South Korea has used national data integration to link services and oversight (*10*), and China has developed pilot platforms that integrate needs assessment, service records, and fund settlement (*14*). The embedding of DHTs has therefore become a key

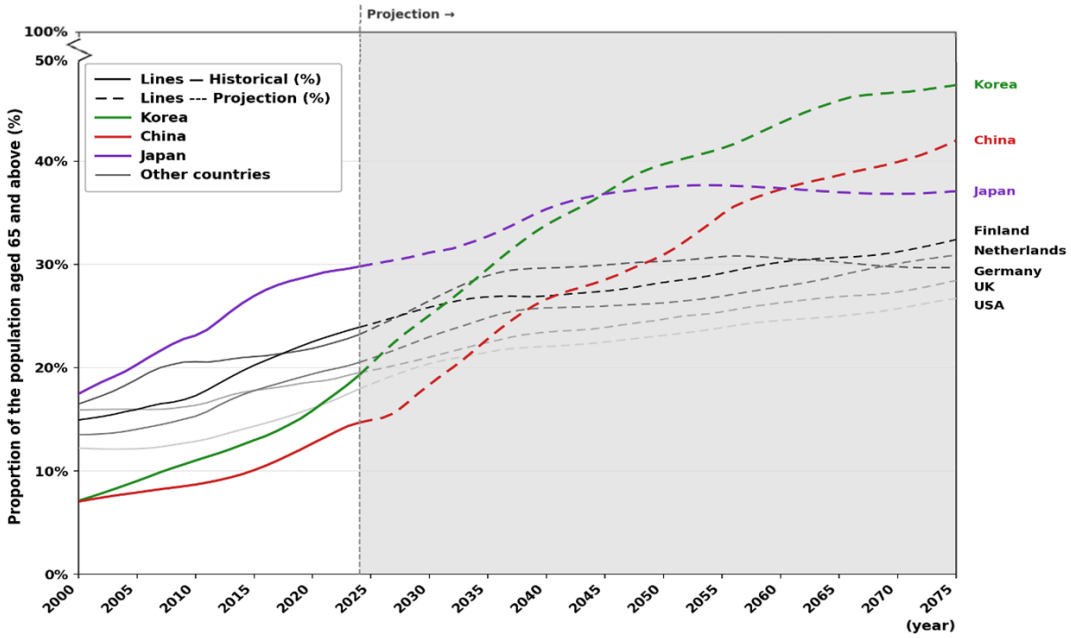

Figure 1. Levels of Aging in Japan, South Korea, and China Compared to Selected European and American Countries. *Data source*: United Nations (UN). World population prospects 2024. *https://population.un.org/wpp/Publications/Files/WPP2024_Highlights.pdf*

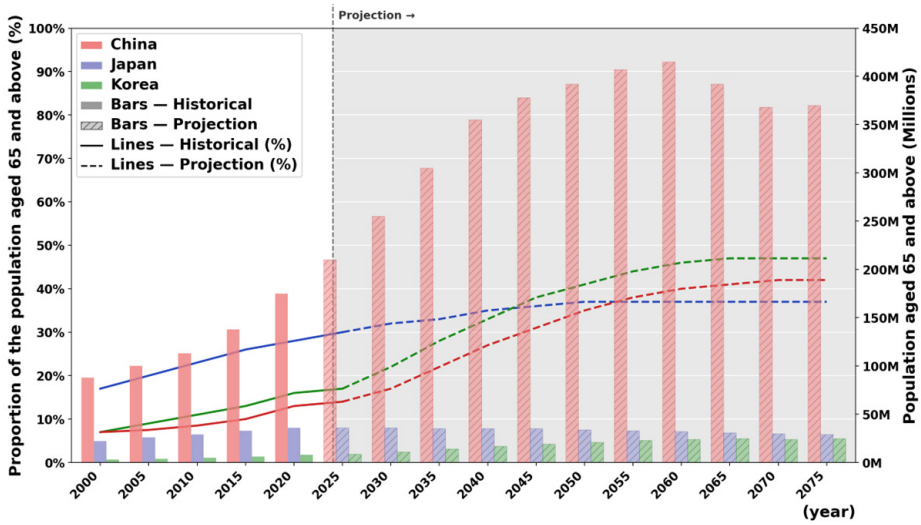

Figure 2. Population Size and Proportion of People Age 65 and Older in Japan, South Korea, and China. *Data source*: United Nations (UN). World population prospects 2024. *https://population.un.org/wpp/Publications/Files/WPP2024_Highlights.pdf*

driver of changing care governance (Figure 3).

Although a growing body of research has examined the use of DHTs in long-term care, cross-national comparisons that explain why similar technologies produce different governance effects remain relatively limited. Existing studies tend to focus on patterns of adoption or technological capabilities, while paying less attention to how institutional contexts shape the way in which these technologies operate in practice. To address this gap, this review compares Japan, South Korea, and China across five key operational domains and it develops a mechanism-oriented analytical framework to explain cross-national divergence.

2. Review design and analytical framework

2.1. Review design and information sources

This study is a comparative, policy-oriented narrative review. It synthesizes peer-reviewed articles and publicly available institutional materials, including laws, policy documents, official reports, yearbooks, and administrative guidance related to the creation of LTCI and use of DHTs in Japan, South Korea, and China. Source retrieval was updated through April 5, 2026, according to the access dates listed for the cited materials. This review used only publicly available documents and did not involve human participants, individual-level data, or animal experiments, so formal ethics approval and informed consent were not applicable.

2.2. Comparative analytical framework and pathway criteria

The comparison involved five operational domains: institutional foundations, eligibility determination, service management, fund oversight, and policy steering. Within each domain, we examined where DHTs are embedded, what aspects of governance they act upon, and the extent to which they reshape routine operations. To avoid impressionistic classification, national pathways were identified using three explicit criteria: *i*) the level of governance steering, referring to the degree of state or insurer control over standards and implementation; *ii*) data infrastructure integration, referring to the extent to which assessment, service, payment, and supervisory data are linked; and *iii*) institutional maturity and path dependence, referring to how strongly pre-existing organizational arrangements constrain new technical choices. These criteria are analytical rather than fixed labels, meaning that national pathways can evolve as institutional conditions change.

3. Key concepts and analytical dimensions

3.1. Defining DHTs in LTCI

In this review, DHTs refer to digital tools and systems used to support or transform health- and care-related activities such as data collection, information exchange, decision-making support, and coordination.

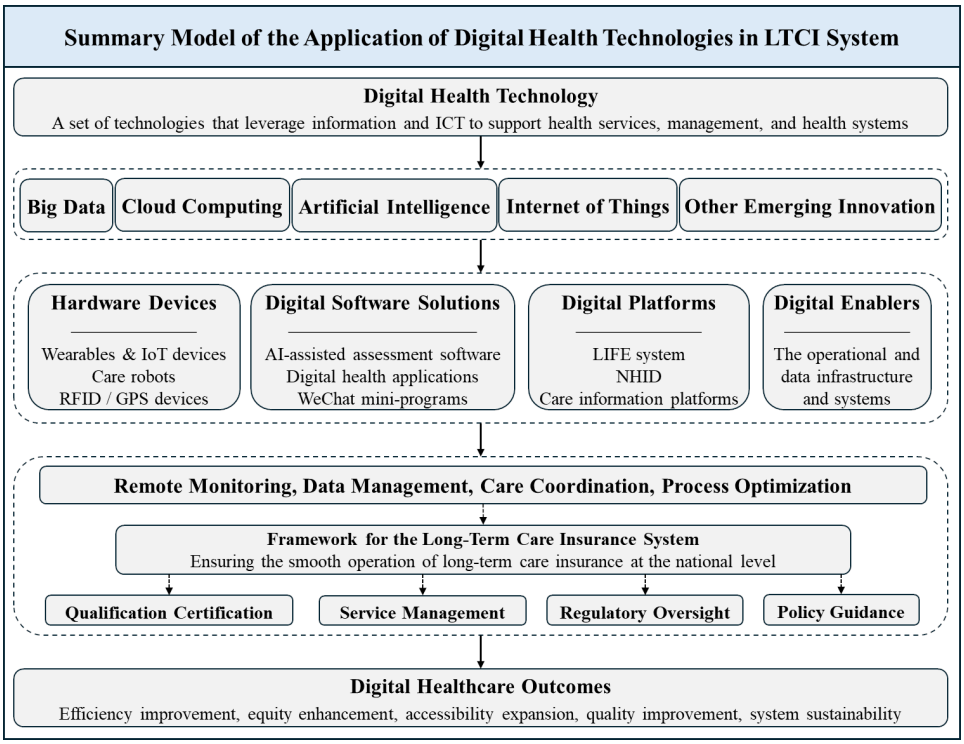

Figure 3. Diagram illustrating the integration of digital health technologies into LTCI. *Data source*: World Health Organization (WHO). Global strategy on digital health 2020-2027. *https://www.who.int/publications/i/item/9789240116870*. Status and Trends of the Digital Healthcare Industry. *https://doi.org/10.4258/hir.2024.30.3.172*

For analytical clarity, DHTs in LTCI are limited to technologies embedded in assessment, management, settlement, or oversight rather than all technologies used in elderly care. They are grouped into three functional categories: *i*) data capture and remote monitoring technologies, such as sensors and wearable devices; *ii*) information and workflow infrastructures, such as application systems, settlement platforms, and interoperable databases; and *iii*) intelligent decision and assistance technologies, such as AI-enabled scoring, fraud detection, care robots, or algorithm-assisted supervision.

3.2. Key LTCI operational links and governance effects

DHTs are not embedded into an abstract insurance system but into specific operational links: needs assessment and certification, care planning and service delivery, payment and settlement, and quality or fund supervision. Their governance effects depend on the aspects they act upon. In practice, DHTs reshape information flows, alter the basis of decision-making, and redistribute accountability by making some behaviors more evident, comparable, or auditable than before. This perspective helps distinguish between technology that merely supports existing tasks and technology that reorganizes how those tasks are governed.

3.3. Why a sociotechnical systems perspective?

The comparative findings described above require a framework that goes beyond simple adoption counts or policy diffusion narratives. Sociotechnical systems theory is useful because it treats technologies, organizational routines, decision rules, and governance arrangements as mutually constitutive rather than independent variables. In the present context, the question is not only whether a country uses AI, robotics, or platforms, but how these tools become operative within insurance eligibility, service coordination, and accountability relations. This perspective is especially suitable for explaining cross-national divergence because similar technical devices can have very different institutional effects when insurer composition, data governance, implementation authority, and policy priorities differ. It therefore provides the theoretical bridge between the descriptive comparison of systems and the later construction of an explanatory model.

4. Comparative findings: Institutional foundations and embedding of DHTs

4.1. Institutional foundations as enabling and constraining conditions

Japan, South Korea, and China differ substantially in when LTCI was introduced, how it is governed, and how mature the system is (Table 1). Japan has the longest-running LTCI system and a relatively stable division of

Table 1. Institutional foundations and governance structures of LTCI in Japan, South Korea, and China

Dimension	Japan	South Korea	China
System launch	Legislated and implemented in 2000	Legislated and implemented in 2008	Pilot efforts launched in 2016; moving toward nationwide unification[a]
Governance model	Municipalities serve as insurers	Unified administration by the NHIS	Central coordination with local implementation
Population covered	Age ≥ 65; age 40–64 with specified diseases	Age ≥ 65; below age 65 with specified geriatric conditions	Progressive expansion toward universal coverage, prioritizing severe disability[b]
Financing	Premiums plus taxes (50% each)	Premium-based financing plus about 20% fiscal subsidy	Multi-source financing (employers, individuals, and government)[c]
User co-payment	10% (20%-30% for higher-income groups)	15% for home care; 20% for institutional care	Dynamically adjusted[d]
Service types	Home care, institutional care, community-based integrated services (home care prioritized) (*16*)	Home care, institutional care, partial cash benefits (home care prioritized) (*19*)	Home, community, and institutional care ("9073" pattern of elderly care)
Benefit classification	Support levels 1–2; care levels 1–5	Levels 1–5 plus cognitive support level	Three disability levels: mild, moderate, severe[e]
System scale[f]	About 7.49 million beneficiaries certified; 2.40 million workers	About 1.16 million beneficiaries certified; 0.70 million workers	More than 308 million enrollees; over 3.3 million beneficiaries; nearly 0.37 million workers

Notes: [a]Pilot efforts began in 15 cities in 2016 and expanded to 49 cities in 2020; the 2026 Opinions marked a shift toward institutional implementation nationwide. [b]During the pilot phase, coverage mainly extended to employees and urban-rural residents, with priority given to people with a severe disability. [c]Pilot financing included proportional, fixed, and mixed models; the 2026 Opinions specify shared financing by employers, individuals, and government. [d]Local co-payment levels differed substantially during the pilot phase and are now subject to dynamic adjustment. [e]Earlier local standards were inconsistent; a unified national assessment framework is now being promoted. [f]Data dates: Japan (July 2025), South Korea (December 2024), China (March 2026).

Table 2. Eligibility assessment and use of digital health technologies in LTCI

Dimension	Japan	South Korea	China
Certifying body	Municipal governments	NHIS	Government-led with participation of multiple actors[a]
Assessment tools	Standardized questionnaire	Structured scale	Gradual rollout of unified national standards[b]
Technical use	Computer-assisted preliminary assessment	Computer analysis generating standardized scores	Information systems supporting application and review[c]
Assessment process	Computer pre-assessment followed by committee review	On-site assessment, computer analysis, committee review	Online application, administrative review, on-site assessment, further review and disclosure
Intelligent exploration	GPT-assisted pilot assessments	Information systems supporting eligibility review	Support from a national unified system[d]

Notes: [a]Includes government agencies, designated institutions, and third-party assessors. [b]Pilot practices used different scales and questionnaires; a unified national disability assessment standard is now being promoted. [c]Local exploration has included WeChat-based portals, mini-programs, and mobile applications; current arrangements are moving toward unified online application and review by medical insurance agencies. [d]The long-term care insurance subsystem under the national medical insurance information platform is expected to integrate intelligent assessment and data-validation.

responsibilities in which municipalities act as insurers (*15-17*). South Korea introduced LTCI later, but the system's reliance on the National Health Insurance Service (NHIS) and linked national databases allows it to be steered more centrally (*18,19*). China is still in the stage of pilot programs and scaling; localities have differed widely in the populations covered, financing arrangements, methods of assessment, and services supply, although recent national policy documents indicate movement toward a more unified system (*20-23*). These institutional differences are not background details alone. They shape the depth to and direction in which technologies are embedded by defining who can set standards, who controls data, and how easily routine workflows can be standardized across providers and regions.

4.2. Eligibility determination and assessment mechanisms

Eligibility determination is the entry point to LTCI because it converts care needs into certified benefit levels (Table 2). Japan has long used computerized preprocessing to support care-needs certification, while final decisions are reviewed through committee-based deliberation (*24,25*). South Korea uses structured assessment and system-supported scoring within a more centralized administrative framework (*26,27*). In China, assessment remains more inconsistent. Local pilot efforts have relied on different scales and administrative arrangements, while digital systems have primarily supported application receipt, documentation, and process control rather than fully standardized certification; national efforts are now directed toward harmonizing disability assessment standards and information support (*21,22,28,29*). In all three countries, DHTs are embedded first in data capture and preprocessing, but they have greater influence on the final decision where standards and institutional authority are more unified.

4.3. Service management, interoperability, and resource allocation

Service management involves care documentation, inter-organizational coordination, and payment-related data linkage (Table 3). In Japan, a system to exchange care plan data is used to connect providers and streamline the electronic flow of care management information (*30,31*). In South Korea, NHIS-linked data infrastructures facilitate integration between medical and LTC information and support the linking of service records and reimbursement processes (*32,33*). China has developed numerous local platforms for service records, dispatching, and settlement, but interoperability remains inconsistent across cities and provinces, and the quality of operational data depends greatly on local implementation capacity (*22,34,35*). The comparative pattern suggests a clear causal logic: where data infrastructures are nationally integrated, technology serves as a coordinating mechanism for services and payment; where systems remain locally fragmented, technology primarily supports recording and experimentation rather than fully standardized allocation.

4.4. Fund oversight and supervisory capacity

The embedding of DHTs is also changing how LTCI systems supervise quality and fund integrity (Table 4). Japan uses the LIFE system to collect and analyze care-related information and to link data use with quality improvement and payment adjustment (*36,37*). South Korea relies on centralized data comparison, claims review, and related supervisory mechanisms within the NHIS/NHID architecture (*32,33,38*). China has moved

Table 3. Use of digital health technologies in the management of LTCI services

Dimension	Japan	South Korea	China
Data carrier	System to exchange care plan data	National Health Information Database	National unified system being created[a]
Data integration	Inter-institutional exchange of business data	Unified integration of medical and LTC data	Primarily local platform integration; cross-regional interoperability still evolving[b]
Form of use	Electronic care plans and settlement	Automatic retrieval of service records with linked settlement	Promotion of full-process digital management
Use scenarios	Care planning, confirmation of service content, settlement	Retrieval of service records, claims submission, institutional assessment-result inquiry	Service-record management, intelligent dispatching, quality feedback[c]
Infrastructure character	Efficiency-oriented workflow optimization	Integration-oriented linkage of services and payment	Support-oriented, platform-driven standardization of operations

Notes: [a]During the pilot phase, local governments built their own platforms; a national LTCI subsystem is now being advanced under the national medical insurance information platform. [b]Some localities have achieved data integration, but cross-regional interoperability remains inconsistent. [c]Local exploration has included intelligent dispatching, cross-regional service coordination, and service-quality feedback; future national systems are expected to standardize operational workflows and data collection.

Table 4. Digital health technologies in LTCI supervision and governance

Dimension	Japan	South Korea	China
Supervisory body	Multi-level local supervision	Unified NHIS management	Central coordination, local implementation, multi-actor participation[a]
Supervisory tool	LIFE system	NHID	National unified system being created[b]
Technical use	LIFE-based analysis of the quality of care and functional improvement, linked to payment add-ons and electronic review	Automatic comparison and detection of anomalies in service records and claims, including fraud detection logic	Behavior recognition and intelligent verification approaches exploring real-time monitoring and data validation[c]
Supervisory process	Pre-set standards, in-process data recording, post hoc review and guidance	Uploading of service records, automated validation, centralized payment review, tracking of anomalies	Setting standards, recording processes, system review, ex post recovery
Supervisory focus	Appropriate benefit use and improvement of quality	Fund risk control and curtailment of improper claims	Fund security and fraud prevention[d]
Information disclosure	Institutional and policy information disclosed through LIFE and Q&A materials	Regular online disclosure of institutional assessments and regulatory information	Primarily local disclosure with gradual movement toward unified national disclosure

Notes: [a]Includes medical insurance administrative agencies and third parties. [b]Local pilot platforms remain in use while the national LTCI subsystem is being developed. [c]Local experimentation has included GPS tracking verification, facial recognition, video supervision, and cloud-based patrol systems. [d]Priority targets include fraudulent services, falsified assessments, identity theft, and improvement of performance evaluation and standardization.

toward digitally supported supervision through service-record platforms, post-payment review, and local experimentation with behavioral verification, video review, or intelligent monitoring, but these practices remain highly inconsistent across cities and are being gradually folded into a more unified national framework (*34,35,39-43*). This means that China is not simply "lagging behind"; rather, it illustrates how fragmented pilot efforts can generate innovation while also producing inconsistent data quality, inconsistent enforcement, and variable local governance capacity. This fragmentation is not only a technical issue but also reflects a broader governance structure characterized by decentralized experimentation and regionally differentiated policy implementation.

4.5. Policy steering and national development priorities

National policy priorities further shape the role assigned to DHTs (Table 5). Japan has emphasized care robots and Internet of Things (IoT) devices to relieve labor shortages and improve the quality and precision of care within an already mature insurance system (*44,45*). South Korea

Table 5. Policy orientation of and national pathways for use of digital health technologies

Dimension	Japan	South Korea	China
Service delivery focus	Care robots and IoT-based care devices	Smart elderly care platforms and AI remote terminals	Internet + nursing care and smart elderly care platforms[a]
Priority use	Supporting labor input and improving the precision of care	Enhancing data integration and linking services to payment	Expanding service coverage through remote nursing and regional coordination[b]
Role of technology	Improving the efficiency of services and quality of care	Enhancing fund supervision and standardizing system operation	Improving service accessibility and supporting institutional development[b]
Institutional effect	Embedded within the existing system as supplementation and optimization	Embedded in core institutional links and reshaping operational governance	Being promoted along with institutional implementation in a co-evolutionary manner
Pathway type	Supplementary technology pathway	State-led integration pathway	Exploratory co-evolutionary pathway

Notes: [a]Recent national policy has proposed exploring the inclusion of intelligent LTC services and supportive assistive devices within reimbursement arrangements, extending the focus of technology from service provision toward institutional support. [b]Because pilot areas face shortages of professional caregivers and an uneven distribution of services in urban and rural areas, DHTs in China partially compensate for supply shortages and limited services, which differs from the logic of technology use in more mature systems such as Japan and South Korea.

has prioritized national platform building, integrated service-payment linkage, and AI-IoT initiatives for older adults in local communities (*46,47*). China has promoted smart elderly care platforms and "Internet + nursing care" not only to improve efficiency but also to expand access amidst disparities in service availability and continuing institutional implementation (*48,49*). Policy orientation therefore interacts with institutional structure: mature systems tend to deploy technology for optimization, centralized systems for integration and rule enforcement, and pilot-based systems for both service expansion and organizational experimentation.

4.6. Interim synthesis: From institutional differences to pathway differences

Taken together, these findings suggest that differences in national pathways cannot be explained simply by the level of technological sophistication. In Japan, the combination of a mature system and decentralized insurers tends to channel DHTs into incremental and supportive roles. In contrast, South Korea's centralized governance and integrated data environment allow technology to be further incorporated in core institutional processes. China presents a different picture: ongoing institutional development creates room for experimentation but also results in fragmentation, inconsistent data quality, and variation in local implementation. These patterns highlight that the effects of DHTs are shaped as much by institutional conditions as by the technologies themselves. Differences in institutional structure, data infrastructure integration, and policy orientation jointly shape distinct national pathways by which DHTs are embedded (Figure 4).

5. Mechanisms and the three-layer model of institutional embedding

5.1. Why similar technologies have different governance effects

Describing national pathways alone is not sufficient without clarifying how technology actually interacts with institutional structures. From a sociotechnical perspective, DHTs do not operate on a neutral administrative foundation. Instead, they are interpreted and reshaped through existing welfare objectives, organizational arrangements, and governance rules (*50*). As a result, the same type of technology may play a limited, supportive role in one system while becoming structurally transformative in another. What matters, therefore, is not only the presence of technology, but how it becomes embedded within institutional processes.

5.2. Needs assessment: From experience-led judgement to data-supported decision-making

In early-stage LTCIs, needs assessment depended heavily on home visits, paper records, and expert judgement (*24*). As DHTs become embedded, information is recorded more systematically and processed more consistently, and digital scoring or algorithm-assisted suggestions increasingly support certification decisions (*25*). And yet this does not mean that human judgement disappears. Rather, the decision-making basis is rebalanced. In settings with more unified criteria, digital tools reinforce standardization and reduce inter-assessor variation; in settings where standards remain heterogeneous, digital systems coexist with case-by-case judgement and may expose inconsistencies rather than eliminate them (*21,22,51*).

5.3. Service management: From discretionary coordination to rule- and platform-based coordination

LTCI service management initially leaves room for

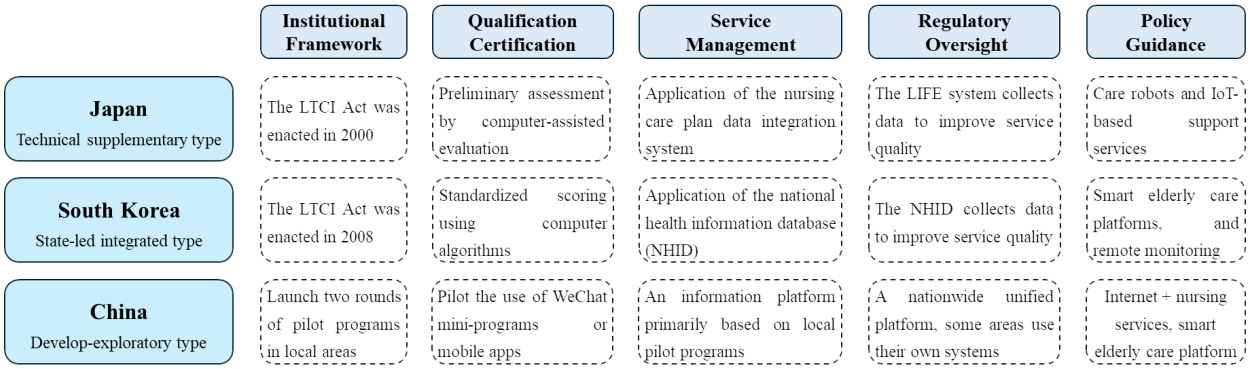

Figure 4. Summary of how digital health technologies are integrated into LTCI in different countries.

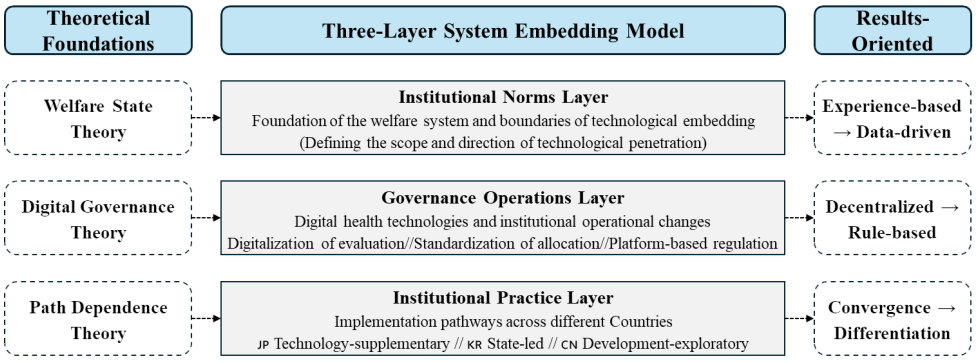

Figure 5. The three-layer model of institutional embedding and its mechanism of action.

discretionary adjustment because older adults have heterogeneous and changing needs (*52*). Once services, care plans, provider records, and settlement operations are combined into common digital infrastructures, coordination increasingly follows platform rules and standardized data formats (*53*). The result is greater traceability, faster settlement, and more comparable records across providers. However, these gains can also narrow the space for locally negotiated or professionally improvised adjustments, and especially when platform logic becomes tightly linked to payment rules (*54*). The shift is most visible where payer authority and data infrastructure are already centralized, but similar tendencies are emerging in China as local platforms are brought in line with the national information architecture.

5.4. Oversight: From ex post auditing to process-oriented monitoring

Conventional fund supervision often relies on ex post review, sampling inspection, or manual verification, which become increasingly difficult as system scale and claims become more complex (*55*). The embedding of DHTs changes this supervisory logic by allowing rapid comparison of service records, claim patterns, and behavioral tracking, thereby enabling earlier detection of anomalies and more continuous forms of monitoring (*32,33,36,37,56*). This does not simply make oversight faster. It also changes the temporal structure of governance by having control exercised closer to the point at which service is provided. In China, however, the move toward intelligent supervision has highlighted the importance of local data quality and implementation capacity; without stable standards and reliable inputs, real-time monitoring can increase the administrative burden without enabling equally reliable control.

5.5. The three-layer model of institutional embedding

To explain these differences systematically, we have integrated welfare state theory, digital governance theory, and path dependence to construct a three-layer model of institutional embedding (Figure 5) (*57-59*). The model is not a restatement of empirical findings. Rather, it explains how the findings are generated at the institutional level. Specifically, the institutional norms layer explains why the tripartite welfare boundary remains stable despite dramatic technological changes. The governance operations layer explains why the governance effects vary in intensity and direction between the areas of assessment, service management, and monitoring. The institutional practice layer explains why the three countries' paths diverge instead of converging on a single model.

5.5.1. Institutional norms layer

In the institutional norms layer, welfare boundaries define what technology is allowed to do. LTCI is a welfare system designed to socialize the risk of care through collectively organized financing and entitlement rules. DHTs can improve how the system functions, but they do not themselves redefine who is covered, what risks are collectively pooled, or where the political boundary of entitlement lies (*57,60,61*). This is why technology in all three countries operates primarily within, rather than beyond, the welfare logic of LTCI.

5.5.2. Governance operations layer

In the governance operations layer, digital infrastructures reshape decision-making bases, workflow coordination, and accountability structures (*58*). Here, DHTs have the greatest impact: data platforms standardize inputs, algorithmic tools support certification and detection of anomalies, and interoperable systems connect assessment, service delivery, and payment. The key point is that governance effects occur not as a result of technology alone but from the coupling of technology with administrative authority, database architecture, and enforcement rules. This explains why greater integration is evident in South Korea than in Japan and why integration is more inconsistent in China despite rapid experimentation.

5.5.3. Institutional practice layer

In the institutional practice layer, earlier institutional choices lock in subsequent trajectories (*59*). Mature municipal insurer arrangements in Japan channel DHTs into the supplementary optimization of existing routines (*30,31,44,45*). South Korea's centralized governance reinforces state-led integration because new tools can be incorporated into already unified administrative pathways (*32,33,46,47*). China's pilot program-based evolution produces a more exploratory co-evolutionary pathway in which technical systems and institutional rules are still being shaped together, but this same openness also leads to fragmentation and inconsistent implementation (*22,34,35,39*).

5.5.4. Explanatory power of the model

The model clarifies why the three pathways should not be treated as fixed descriptive labels alone. They are the practical outcome of how welfare boundaries, governance mechanisms, and path dependence interact. If governance steering is more centralized, if data infrastructures are more interoperable, or if institutional routines stabilize, the pathway by which technologies are embedded in a country may also shift. The model therefore explains both cross-national divergence and the conditions under which future convergence might occur. For example, a decentralized system that becomes more data-integrated and centrally coordinated may shift from a supplementary pathway toward a more state-led integration pathway.

6. Risks and governance challenges

6.1. Algorithmic bias and assessment inequity

As DHTs become more deeply involved in assessment and supervision, LTCI operations rely more heavily on data quality, variable selection, and model design. If underlying datasets are incomplete or systematically skewed, algorithm-assisted tools can reproduce or amplify inequities in certification and service allocation (*62-64*). This concern is not abstract. In Japan, emerging discussion around AI-assisted care-needs assessment has already raised questions about accuracy, explainability, and the appropriate boundary between algorithmic recommendation and committee judgement (*25*). In South Korea, the automated fraud detection logic embedded in the NHIS claims review raises similar issues of false positives, as well as procedural burdens on providers when challenging algorithmic results (*38*). In China, local pilot adoption of facial recognition, GPS tracking verification, and video surveillance has raised questions about the proportionality of biometric data collection and the accountability framework for use in monitoring at the benefits level (*39-43*).

6.2. Data quality, fragmentation, and differing local capacity

A second challenge concerns inconsistent data quality and institutional capacity. China is the clearest example because local pilot programs have adopted different assessment instruments, service platforms, and supervisory tools, which makes cross-regional comparability difficult and complicates national scaling (*21,22,34,35*). But fragmentation is not only a Chinese issue; even in more mature systems, inconsistent coding practices, incomplete records, or provider-level variation can diminish the reliability of digitally mediated governance. Without clear standards, better technology may merely digitize existing inconsistencies.

6.3. Privacy and security

Large-scale collection and linkage of sensitive data results in substantial privacy and security issues (*65*). LTCI systems increasingly handle information on disability, family support, service use, and sometimes behavioral or biometric patterns. The more that assessment, payment, and supervision are integrated, the more important that governance safeguards regarding legitimate access, data minimization, cross-departmental

sharing, and accountability for breaches become. Privacy protection is therefore not an external ethical add-on; it is an essential element of the justification for embedding DHTs.

6.4. Standardization versus institutional flexibility

Finally, digital governance can erode institutional flexibility. Standardized platforms improve comparability and administrative efficiency but they may also narrow the discretionary space needed to accommodate heterogeneous and changing care needs. In LTC, some degree of professional judgement and local adjustment remains essential. The governance challenge is therefore not to choose between digitization and flexibility, but to specify which decisions should be standardized, which should remain reviewable by human actors, and how appeal or override mechanisms should be designed.

7. Institutional embedding and cross-national variation in DHTs

This review shifts the analytical focus from technology adoption to institutional embedding. Existing studies often catalogue digital tools used in elderly care or discuss general digital transformation in healthcare systems. In contrast, the present review explains how DHTs become consequential only when they are linked to welfare objectives, administrative authority, and operating rules. A comparison of Japan, South Korea, and China has shown that cross-national divergence is best understood through the joint effects of the level of governance steering, data infrastructure integration, and institutional maturity rather than through any simple hierarchy of technological advancement.

The findings also have practical implications. In mature but decentralized systems such as Japan's, the priority is not wholesale technological overhaul but interoperability, coordination, and careful integration that does not undermine professional discretion. In highly centralized systems such as South Korea's, the main challenge is to balance efficiency gains from integration with transparency, fairness, and safeguards against excessive dependence on automated classification or monitoring. In pilot program-to-scaling systems such as China's, the first-order tasks are harmonizing standards, enhancing local implementation capacity, and staged governance arrangements that improve data quality before expanding algorithmic control.

Several limitations should be acknowledged. First, this is a narrative review rather than a formal systematic review or meta-analysis, so the purpose is explanation and synthesis rather than exhaustive estimation of effects. Second, this analysis has focused on three East Asian countries and therefore does not cover European LTCI models or mixed public-private arrangements elsewhere. Third, China is still in an evolving policy phase, so some institutional effects are still emerging. Nevertheless, these limitations do not diminish the value of the proposed model as a framework for future comparative work on digitalization in welfare systems.

8. Conclusions

DHTs are increasingly embedded in LTCI in Japan, South Korea, and China. They have not fundamentally expanded the welfare boundary of LTCI, but they have changed how eligibility is assessed, how services are coordinated, and how fund use is supervised. The three national pathways - supplementary technology in Japan, state-led integration in South Korea, and exploratory co-evolution in China - reflect not only different technological choices but also different welfare boundaries, governance mechanisms, and institutional trajectories. The three-layer model of institutional embedding developed here helps explain that divergence and underscores a central policy lesson: digitalization in LTCI should be designed not only for efficiency but also for fairness, privacy, data reliability, and the preservation of appropriate institutional flexibility.

Although our analysis has focused on East Asia, the three-layer model may also offer a transferable analytical framework for welfare systems in other countries undergoing a transition in digital governance. By breaking down institutional embedding into an institutional norms layer, a governance operations layer, and an institutional practice layer, researchers can more clearly judge how to more accurately assess governance interventions in specific situations.

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