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BUILDING REGIONAL INNOVATION SYSTEM POLICY FOR SMART CITY THROUGH E-HEALTH PROGRAM IN DEPOK CITY

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Abstract

Urbanization and technological disruption require digital transformation within local government. Depok City has demonstrated a commitment to becoming a Smart City through its Regional Innovation System (RIS), with a particular focus on e-health. This study analyzes existing RIS policies and e-health initiatives, identifies barriers to implementation, and develops an integrated policy model using qualitative Soft Systems Methodology (SSM). Data collection included in-depth interviews with 15 key informants, non-participant observation at three community health centers and one hospital, document analysis, and focus group discussions using the Nominal Group Technique. Findings show that Depok City's Regional Innovation Index (IID) reached 51.12 (classified as innovative) with a budget realization rate of 97.21%. Despite this, e-health implementation remains incomplete. The most significant gaps are in digital standards (79%), digital policies (72%), and digital strategy (68%). Barriers identified include fragmented authority, resistance from senior medical staff, limited infrastructure (internet speeds of 5-15 Mbps), and the absence of personal data protection regulations. The proposed policy model consists of three pillars: a digital strategy (Depok Sehat Digital 2030), digital policies (covering data protection, minimum service standards, incentives, sanctions, and mass literacy), and technical digital standards based on HL7 FHIR. A draft Mayoral Regulation has been prepared. This study advances Digital Governance theory in regional innovation and offers practical recommendations for local governments.

Keywords: Smart City, Regional Innovation System, E-Health Policy, Soft Systems Methodology, Digital Governance

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INTRODUCTION

Contemporary civilization is experiencing an era of technological disruption that is fundamentally transforming government governance. The United Nations projects that by 2050, approximately 68% of the global population will reside in urban areas, presenting complex challenges such as congestion, environmental degradation, and increased demands for efficient public services, particularly in the health sector (Arista, Ermatita, Wadu, 2024). In Indonesia, the urbanization rate is 4.1% per year, positioning cities like Depok as epicenters of urban dynamics (BPS, 2021). In response, the Smart City concept has emerged as a paradigm integrating Information and Communication Technology (ICT) and the Internet of Things (IoT) to optimize city operational efficiency and enhance the quality of government services (Townsend, 2013). This concept has evolved from a technology-centric approach to a citizen-centric model (Caragliu, Del Bo, Nijkamp, 2011). Caragliu, Del Bo, and Nijkamp (2011) and Fitriati (2017) define a smart city as a territory where investments in human and social capital, modern communication infrastructure, and participatory governance collectively drive sustainable economic growth and a high quality of life. Giffinger et al. (2007) and Wahyuni & Fitriati (2021) operationalizes this concept through six dimensions: Smart Economy, Smart People, Smart Governance, Smart Mobility, Smart Environment, and Smart Living. The Smart Living dimension, encompassing healthcare facility quality, safety, housing, education, and social cohesion, is the primary focus of this study, given the health sector's broad societal impact.

Similarly, Digital Governance (DG) serves as a crucial foundation. Dunleavy et al. (2006) in Digital Era Governance (DEG) assert that public sector digitalization must shift from mere internal procedure automation toward holistic service reintegration centered on citizen needs. DEG features three pillars: reintegration of public services through one-stop portals, a life-event approach, and full digitalization of state-citizen interactions. Welchman (2015) operationalizes DG through three main indicators: digital strategy, digital policy, and digital standards. These three must integrate to create an effective, transparent, and accountable digital governance ecosystem. The Indonesian government responds to digital transformation demands through the Regional Innovation System (RIS) policy. RIS refers to a set of activities in an ecosystem aimed at building innovation capacity through cross-institutional collaboration among local governments, research and technology development organizations, universities, industry, and communities (Peraturan Wali Kota Depok Nomor 5 Tahun 2020). The legal basis is Joint Regulation of the Minister of Research and Technology and the Minister of Home Affairs No. 3 and No. 36 of 2012. Public

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sector innovation differs from the private sector, driven by political pressure, rising citizen expectations, fiscal constraints, and social or medical emergencies (Bason, 2010). Bason (2010) classifies public innovation into four typologies: service innovation, process innovation, policy innovation, and systemic innovation.

The health sector is a priority for regional innovation. Electronic Health (e-health) represents the most transformative innovation in public services. Eysenbach (WHO, 2016) defines e-health as an emerging field at the intersection of medical informatics, public health, and business, referring to health services and information delivered or enhanced through the internet and related technologies. The scope of e-health includes four fundamental components: Health Information System (HIS), Electronic Medical Record (EMR), Telemedicine, and mobile health (Popescu et al., 2022). Popescu et al. (2022) in Lebanon show that HIS implementation significantly reduces patient identification errors ($p<0.05$) after controlling for workload and safety culture. However, e-health success depends not only on technological sophistication but also on user acceptance. Davis's Technology Acceptance Model (TAM) (16) states that behavioral intention to use technology is determined by perceived usefulness and perceived ease of use. Rogers' Diffusion of Innovations theory (Roger, 2003) adds five attributes that determine adoption rates: relative advantage, compatibility, complexity, trialability, and observability.

Depok City, as a rapidly growing buffer city for Jakarta, is strongly committed to implementing Smart City initiatives and strengthening RIS. The Depok City Government issued Mayor Regulation No. 5 of 2020 concerning the Strengthening of the Regional Innovation System. In the 2023 Regional Innovation Index Assessment (Innovation Government Award), based on the Minister of Home Affairs Decree No. 400.10.11-6287 of 2023, Depok City scored 51.12 (innovative category), up from 48.74 in 2022, exceeding the RPJMD target of 50.00). Budget realization for innovation support programs reached IDR 897,114,416 (97.21%) against a ceiling of IDR 922,891,750, with an efficiency of 2.79%. The city government submitted 20 innovative breakthroughs, including six in digital health, such as the *Sahabat Sehat* application, *e-Puskesmas*, *Depok Siaga Bencana Kesehatan*, Integrated SIMPUS, IBI Telemedicine, and the Vaccination Information System.

Despite these positive achievements, e-health implementation still faces various challenges. According to the Depok Health Office report (Laporan tahunan Dinas Kesehatan 2024), challenges include: suboptimal data integration

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across health agencies (only 3 out of 11 health centers have EMR integrated with the regional hospital); low digital literacy among the public, especially the elderly; limited ICT infrastructure (average internet speed 5-15 Mbps, below the national standard of 25 Mbps); inadequate regulations and Standard Operating Procedures (SOPs) supporting digital health; and system disharmony (at least six different systems not connected). Previous studies have largely examined Smart City and e-health separately. Arista et al. (2024) conducted a comprehensive Smart City evaluation of Depok using three global indices but did not address policy-process aspects. Fernandez-Anez et al. (2018) developed a conceptual Smart City implementation model based on stakeholder discourse in Vienna, but did not specifically address Indonesia's health sector. Hardi et al. (25) studied interoperability and Smart City governance in Yogyakarta and Makassar, finding that interoperability significantly strengthens governance (path coefficient 0.67, $p<0.01$). Suhermawan and Oktariyanda (2025) evaluated the effectiveness of an e-health program at the Sawahan Health Center in Surabaya, identifying challenges with digital access and data privacy. Fitriati & Putra (2023) analyzed the RIS policy for Smart City through an API program in Palembang, but did not discuss e-health. Thus, a research gap exists: no study integrates RIS, Smart City (Smart Living dimension), and e-health within a Digital Governance framework using Soft Systems Methodology (SSM) at the local level. This study's novelty lies in integrating these three concepts, using SSM to handle unstructured problems, and producing a draft Mayoral Regulation ready for implementation. This study poses three research questions: (1) What is the existing condition of RIS policy and e-health programs in Depok City? (2) What are the inhibiting factors for implementation? (3) What RIS policy model can be recommended based on the SSM approach?

RESEARCH METHOD

This study uses a qualitative approach with Soft Systems Methodology (SSM) developed (Checkland and Poulter, 2006, 2010 & 2020). SSM excels at handling complex, unstructured problem situations involving multiple stakeholders with different perspectives. Unlike "hard" systems methodologies that seek optimal solutions for well-defined goals, SSM is a learning process that helps groups understand problematic situations, identify desirable and feasible changes, and formulate action for improvement. This descriptive-analytical research uses a single-case study strategy (Lincoln & Guba, 1985; Yin, 2014) because Depok City is a critical case: it has a specific RIS regulation, significant

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improvements in IID, is located in Jakarta's buffer zone, and has various e-health programs that remain unintegrated (Kemenkes RI, 2024).

The research will take place in Depok City, West Java Province, from January to June 2025. Participant selection followed a purposive sampling approach based on the following criteria: direct involvement in RIS/e-health policy, at least 2 years of experience, representation across stakeholders, and willingness to sign an informed consent form. Based on data saturation principles (Kemenkes RI, 2024), the study recruited 15 key informants: Head of Health Office (INF01), Head of P2P Division (INF02), Head of Health Services Division (INF03), Bappeda representatives (INF04, INF05), Health Center Heads (INF06, INF07), nurses/midwives (INF08, INF09), Diskominfo representative (INF10), academics in public health and informatics (INF11, INF12), a private hospital representative (INF13), and community application users (INF14 elderly, INF15 general). Additionally, one Focus Group Discussion (FGD) involved 20 participants from various agencies, facilitated by the Nominal Group Technique (NGT) to prevent individual dominance and ensure equal voice (Kijsanayotin, 2024). NGT comprises four steps: silent generation (individual idea writing), round-robin recording (sequential idea sharing without debate), serial discussion (brief clarification), and voting/ranking (secret prioritization).

Data collection employed three main methods (Lincoln & Guba, 1985; Yin, 2014). Semi-structured in-depth interviews used a guide developed based on Digital Governance indicators and inhibiting factors. A pilot test of the guide involved two informants outside the sample. Interviews lasted 60-90 minutes, the research team recorded them with permission and transcribed them verbatim. Non-participant observation took place at three health centers (Sukmajaya with integrated EMR, Beji with partial EMR, Pancoran Mas with limited infrastructure) and one regional general hospital (RSUD Depok), each for five working days, totaling 20 days. Observation focused on registration workflow, EMR usage, system response time, technical obstacles, and staff-patient interactions. The document study included Mayor Regulation No. 5/2020, the Ministerial Decree, the RPJMD, Health Office financial reports, SOPs, and related publications. The FGD lasted 4 hours at the Bappeda Hall, facilitated by NGT.

Data analysis followed Braun and Clarke's six-phase thematic analysis (Nursyahidah, Fauziah & Rahmawati, 2025): data familiarization, initial coding, theme identification, theme review, theme definition, and report writing. Two researchers independently coded the first 20% of transcripts, achieving an initial agreement of 84% and, after discussion, a final agreement of 96%. The analysis

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also employed the CATWOE framework (Customers, Actors, Transformation, Worldview, Owners, Environmental constraints) to document diverse stakeholder perspectives (26). Gap analysis between the ideal condition (from FGD) and reality involved five experts (public policy academics and ICT practitioners) rating 10 DG sub-indicators on a 0-100 scale.

Trustworthiness followed Lincoln and Guba's criteria (1985; Yin, 2014)): credibility through source triangulation (comparing different informants) and method triangulation (interviews, observation, documents), member checking (confirming findings with informants), prolonged engagement (two weeks of initial observation); transferability through thick description (detailed context description); dependability through audit trail (documenting all research processes); confirmability through a reflexive journal and linking conclusions to raw data. All participants signed informed consent after receiving explanations of the purpose, procedures, risks, and benefits. Identity confidentiality is guaranteed through codes and encrypted data storage, and participants may withdraw at any time.

RESULTS AND DISCUSSION

Existing conditions of RIS policy and e-health programs. Document analysis and interviews show that Depok City's IID in 2023 reached 51.12 (innovative category), exceeding the RPJMD target of 50.00. Budget realization for innovation support programs reached 97.21% (IDR 897,114,416 out of IDR 922,891,750). However, the specific allocation for e-health accounts for only 18.5% of the total health innovation budget, with 60% for hardware procurement (servers, computers), 25% for applications, and only 15% for training and socialization. Out of 20 innovations submitted for the 2023 IGA, only six relate to digital health. Observation reveals that only two innovations are regularly used: the *Sahabat Sehat* application and *e-Puskesmas,* in 11 out of 32 health centers (34.4%). IBI Telemedicine ceased operation after grant funds ended. INF03 (Head of Health Services Division) stated: "IBI Telemedicine was just a pilot project. After the funds ran out, no operational budget remained available." Observations at three health centers show striking variation. Sukmajaya Health Center (with integrated EMR) uses *Sahabat Sehat,* with an average of 120 users per day (15% of total visits), but the EMR serves only new patients. Beji Health Center uses a mix of manual and digital: online registration but paper medical records, resulting in a service time of 25 minutes per patient (compared to 15 minutes for a fully manual). INF07 (Head of Beji Health Center) complained: "From online registration, then manual examination, then re-input into the computer. This

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process lacks efficiency." Pancoran Mas Health Center, located in a peripheral area with unstable internet speed of 5-10 Mbps, remains fully manual. INF08 (nurse) reported: "Poor signal makes *Sahabat Sehat* unusable. Patients arrive at dawn at 6 AM to queue."

Inhibiting factors for implementation. Expert assessment of 10 DG sub-indicators shows an average gap of 73.7%, with breakdown: digital standards 79%, digital policies 72%, digital strategy 68%. The study identified four categories of inhibiting factors. *Structural barriers*: authority fragmentation among the Health Office (at least six different information systems: SIMPUS, e-Puskesmas, SIKDA Generik, vaccination application, referral system, epidemiology dashboard), Diskominfo (excluded from early planning), and Bappeda (only provides recommendations without technical authority). INF10 (Diskominfo) complained: "They only call Diskominfo when the server goes down, not involve it in planning." Consequently, data duplication occurs: health workers must enter the same patient data into three different systems, wasting 45-120 minutes per day. *Cultural barriers*: senior doctors' resistance (75% prefer manual writing), high computer anxiety, and elderly digital literacy is only 18% (according to Health Office data). INF07 (doctor, age 55) stated: "Writing prescriptions manually for 30 years; typing causes neck and eye strain." In contrast, younger staff (<35 years) hold positive perceptions of usefulness. On the community side, INF14 (elderly, age 65) reported not understanding how to use the application because the font is too small. *Technological barriers*: internet speed only 5-22 Mbps (standard need 25 Mbps), only 3 out of 11 health centers have backup servers, no interoperability due to different data formats (e-Puskesmas uses JSON, RSUD's SIMPUS uses XML). INF13 (private hospital) reported: "Referrals from health centers arrive as paper printouts or PDFs, requiring 30-45 minutes of retyping per patient." RSUD internal data shows 15% of referred patients experience delays due to missing or incomplete data. *Regulatory barriers*: of the 37 SOPs analyzed, only 2 address digital aspects (Online Registration SOP and Epidemic Data Reporting SOP). No SOP exists for personal data protection, access rights, storage procedures, or data breach reporting mechanisms. INF11 (academic) explained: "The PDP Law remains too general; its derivatives for the health sector do not exist yet. Local governments face confusion." No sanctions apply to agencies or staff who violate standards (though standards do not exist), so e-health budgets face easy cuts.

Recommended policy model. The FGD with NGT yielded three highest-scoring changes: (1) issuance of a Mayor's Regulation on e-health optimization

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(score 9.4/10); (2) establishment of a cross-sectoral e-health task force with a minimum budget of 2% of the health APBD (score 9.1); (3) development of an integrated API using HL7 FHIR standards (score 8.8). The study translates these three recommendations into a three-pillar model. *Pillar One: Digital Strategy "Depok Sehat Digital 2030"*. A formal document outlines the vision: "Toward an Integrated, Inclusive, and Sustainable Digital Health Ecosystem for All Depok Citizens by 2030." Measurable targets: Phase 1 (2026-2027): 100% of health centers have integrated EMR, internet speed ≥25 Mbps at every health center, 50% of health workers trained; Phase 2 (2028-2029): 80% of adults enrolled in a personal health record, telemedicine available at 50% of health centers; Phase 3 (2030): full interoperability across facilities, 90% citizen satisfaction. *Pillar Two: Digital Policies*. Five specific policies: (i) Personal health data protection (referencing Law No.27/2022), mandating digital informed consent, 10-year storage limit, fines up to IDR 500 million; (ii) Minimum e-health service standards: response time ≤2 seconds, 99.5% uptime; (iii) Incentives for EMR adoption: 30% subsidy for server costs and 50% for training (max IDR 100 million per health center) from DBHCHT funds; (iv) Sanctions for standard violations: 10% budget cut for the following year for agencies, or temporary license revocation for private facilities; (v) Mass digital literacy: monthly programs in every subdistrict using peer educators and audio-visual materials for the elderly. *Pillar Three: Technical Digital Standards*. Following the Ministry of Health standards (33): HL7 FHIR R4 API for interoperability; AES-256 encryption for data at rest and in transit; ISO 27001 certification within 3 years; two-factor authentication for staff access. The study operationalizes this model into a draft Mayoral Regulation (11 chapters, 34 articles) that has undergone two harmonization meetings with Bappeda and the Depok City Law Division, ready for submission to the Mayor.

Discussion

The findings confirm that although Depok City's IID reaches 51.12 (innovative category), e-health implementation remains uneven, with the highest gap in digital standards (79%). This pattern indicates that Depok's e-health remains at an early stage of transition from e-government 1.0 (internal procedure digitization) toward Digital Era Governance 2.0 (citizen-centric service reintegration) (Welchman, 2015). The lack of interoperability reflects low compatibility attributes in Rogers' Diffusion of Innovations theory (2003). Hardi et al. (2025) in Yogyakarta and Makassar also found that interoperability significantly strengthens Smart City governance (path coefficient 0.67, $p<0.01$). The present study complements this with quantitative evidence that the absence of API standards causes health workers to lose 45-120 minutes per day on

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redundant data entry, equivalent to a productivity loss of approximately IDR 187.5 million per day if calculated nationally (assuming 500 workers, IDR 50,000/hour wage, 1.5 hours lost/day). The IID evaluation never accounts for this social cost.

The cultural barriers of senior doctors' resistance and low elderly digital literacy align with Davis's TAM (1989). Low perceived ease of use due to complex interfaces results in low behavioral intention. Suhermawan and Oktariyanda (2025) in Surabaya reported that 40% of elderly people cannot use online registration applications without assistance. However, the present study finds that age is not the sole determinant: education level and daily use of gadgets (WhatsApp, YouTube) positively correlate with adaptation, even among the elderly. This suggests that digital literacy interventions must target specific segments, not a one-size-fits-all. Recommendation: training using video tutorials with slow speech and large text, cadre assistance, and an elderly-friendly application mode (large icons, high contrast).

Regulatory barriers (the absence of data protection SOPs and the lack of sanctions) support Kijsanayotin's (2024) findings in Thailand that digital health governance mechanisms must align with the national health system context. Unlike Thailand, which has a national Digital Health Governance Committee and has issued a Digital Health Policy 2023-2027, Indonesia follows a decentralized approach without adequate technical guidance from the center. Nursyahidah et al. (2025) compared Indonesia's decentralized approach with Malaysia's centralized approach and concluded that decentralization requires stronger national policy integration. The present study's findings support this conclusion: the absence of national e-health record standards leads each region—even each health center within a city—to develop incompatible systems. The central government needs to urgently issue a Ministerial Regulation on Electronic Health Record Standards mandating the HL7 FHIR format (Kemenkes RI, 2024).

This study shares similarities with Fernandez-Anez et al. (22) in Vienna, which used stakeholder discourse to develop a conceptual Smart City model, but the current study goes further by accommodating differences through NGT to produce collective priorities. Unlike Arista et al. (2024), who used global indices, this study uses SSM to explain "why" gaps occur and "how" to address them contextually. The API integration finding aligns with Fitriati & Putra (2023) in Palembang, but the present study specifically recommends HL7 FHIR—the global standard adopted by the Ministry of Health (2024). In contrast, the meta-analysis by Rabbani et al. (2025) reported high telemedicine satisfaction in

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developed countries (SMD=0.62); in Depok, only 45% were satisfied due to inadequate ICT infrastructure (low internet speed) and regulations limiting the issuance of prescriptions. The implication: telemedicine effectiveness depends heavily on an enabling environment that must be prepared in advance.

Islamic perspective. In Islam, digital health innovation must align with the principles of *maslahah* (public interest) and *hifdz al-nafs* (preservation of life) as part of maqasid al-shariah. QS. Al-Maidah:2 commands *ta'awun* (cooperation) in righteousness, underpinning the cross-sectoral collaboration recommended in this study (Health Office, Diskominfo, Bappeda, private sector). The principle of *amanah* (responsibility) demands the protection of patient health data, as every leader bears accountability (HR. Bukhari). Justice (*'adalah*) as in QS. Al-Hujurat:13 requires that e-health services not discriminate against vulnerable groups with low digital literacy. Offline bypass services for the elderly and disabled embody *raf'u al-haraj* (removal of hardship). Integrating these values strengthens the recommendation that the Mayor's Regulation should include Islamic ethics in digital health services.

Theoretical and practical contributions. The theoretical contribution of this study is an integrated model of RIS, Smart City (Smart Living dimension), and e-health within a Digital Governance framework with three operational indicators. This model shows that at the local level, the absence of digital standards (79%) is more critical than the absence of strategy (68%) or policy (72%)—a novelty rarely highlighted in public administration literature. Methodologically, SSM proves adaptable to public problems in Indonesia, and NGT successfully accommodates conflict without forcing false consensus. The most concrete practical contribution is the participatory draft Mayoral Regulation, which contains measurable targets, a task force structure, interoperability obligations, funding mechanisms, and sanctions. This draft has been validated and is ready for submission. Other local governments can adopt this model with contextual adjustments.

Limitations and future research. This study has several limitations: (1) limited generalizability due to a single locus (Depok City), although thick description enables transferability; (2) short duration (6 months), so long-term impact measurement of the policy model remains absent; (3) dominance of government perspectives (10 out of 15 informants), underrepresenting private sector and marginalized groups (disabled, homeless); (4) lack of economic analysis (cost-benefit). Recommendations for further research include: (a) multi-site studies in 3-5 cities with different characteristics; (b) longitudinal evaluation over 3-5 years to measure implementation of the Mayor's Regulation; (c) quantitative survey with a sample exceeding 300 users to measure satisfaction

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representatively; (d) return on investment (ROI) or social return on investment (SROI) analysis of e-health investment; (e) research on e-health accessibility for people with disabilities using a universal design approach.

CONCLUSION

This study concludes three main points. First, the existing condition of RIS policy and e-health programs in Depok City shows positive macro achievements (IID 51.12, budget realization 97.21%), but on-the-ground implementation remains partial, unintegrated, and uneven across regions. The gap between ideal conditions and reality reaches 73.7%, with the highest gap in digital standards (79%). Second, inhibiting factors fall into four categories: structural (authority fragmentation, data duplication), cultural (senior resistance, low digital literacy), technological (slow internet, no interoperability), and regulatory (minimal SOPs, no sanctions). Third, the recommended policy model consists of three integrated pillars: digital strategy "Depok Sehat Digital 2030" with measurable targets, digital policies (data protection, minimum service standards, incentives, sanctions, mass literacy), and technical digital standards (HL7 FHIR API, AES-256 encryption, ISO 27001). The study operationalizes this model into a validated draft Mayoral Regulation. This study provides a theoretical contribution to Digital Governance and a practical contribution in the form of a ready-to-use regulation. For the Depok City Government, the study recommends immediately enacting the Mayor's Regulation, allocating a minimum of 2% of the health APBD to e-health, forming a cross-sectoral task force, piloting FHIR API at three health centers, and launching a mass digital literacy program involving elderly posyandu cadres.

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