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SEMAR v1.0: An AI-driven Conceptual Model and Architecture for Smart Government in Indonesia Using a Mixed-Methods Approach

Assaf Arief*[1], Miftah Muhammad[2], Achmad Fuad[3] , Dana Indra Sensuse[4]

[1,3]Informatics, Universitas Khairun, Indonesia
[2]Electrical, Universitas Khairun, Indonesia
[4]Computer Science, Universitas Indonesia

Email: [1]assaf.arief@unkhair.ac.id

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Abstract

Building smart cities represents a national priority for Indonesia to enhance global competitiveness, with artificial intelligence (AI) driven smart government as a key enabler. However, implementation faces significant challenges including unmeasured organizational maturity, lack of service innovation, fragmented governance, and minimal citizen engagement leading to government institutions' failure in achieving smart city vision. This study aims to develop a holistic conceptual model to identify critical success factors and evaluate processes that integrate public services, fostering AI-driven smart government innovation at strategic level. This research employs mixed-methods exploratory sequential design combining qualitative techniques (Systematic Literature Review, expert interviews) with quantitative validation (citizen survey, statistical analysis). The model was constructed using Factor Analysis, Thematic Analysis, TOGAF framework, and multidimensional view with validation through triangulation, expert judgment, Focus Group Discussions, and statistical analysis. Results show a comprehensive model consisting of 6 dimensions, 17 key components, and 5-layer organizational architecture with high reliability (Cronbach's Alpha 0.709-0.866) and expert consensus (86% agreement in Fuzzy Delphi Method analysis). This framework, referred to as SEMAR v1.0 (Smart Government Nusantara), serves as a benchmark for assessing the maturity and readiness of local government institutions in Indonesia. It offers the potential to improve SPBE scores through systematic evaluation, while also providing a theoretical foundation for smart government scholarship and a practical blueprint for policy implementation.

Keywords: *AI-driven, A Conceptual Model, Architectures, Smart City, Smart Government.*

1. INTRODUCTION

Amidst global dynamics characterized by technological disruption and geopolitical tensions, Indonesia pursues its "Golden Indonesia 2045" vision through the "Asta Cita" strategic framework[1]. However, realization faces fundamental domestic challenges: massive urbanization rates and development disparities. National statistical projections predict 82.37% population concentration in urban areas (primarily Java Island) compared to rural areas by 2045[2]. This exponential urbanization, driven by development disparities, poses high risks of exacerbating complex problems including declining public service quality, traffic congestion, and social issues that could hinder national development goals if not managed effectively.

The complexity of current governance issues cannot be addressed by conventional, reactive, and partial approaches. The "ICT investment paradox" reflects structural failure to transform technology into public value, resulting from weak digital integration, lack of innovative leadership, and absence of sustainable, data-driven, AI-based governance[3], [4]. Therefore, paradigm shift through AI-driven smart government adoption becomes necessary as foundation for building smart and responsive smart city ecosystems[5], [6].

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Three critical gaps emerge from current implementation challenges: (1) Absence of comprehensive maturity assessment tools for smart government readiness evaluation, (2) Lack of integrated architectural framework addressing the 'ICT investment paradox' through systematic technology-governance alignment, and (3) Limited understanding of AI-driven government transformation in archipelagic contexts requiring collaborative multi-stakeholder approaches[7], [8], [9].

Despite recognized urgency, smart city and e-government implementation in Indonesia reveals significant gaps between expectations and reality. International data shows notable but not significant progress. In 2024 Cities in Motion Index (CIMI), Jakarta ranked 145th with no substantial improvement compared to neighboring countries (Malaysia-Kuala Lumpur: 104, Singapore: 9, Vietnam-Ho Chi Minh: 132, Thailand-Bangkok: 121) [10]. The 2024 UN E-Government Development Index (EGDI) placed Indonesia 64th globally and 4th in ASEAN, trailing Singapore, Thailand, and Malaysia [11]. Internally, Electronic-Based Government System (SPBE) evaluation indicates disparity between Central Government scores (average above 3 on 5-point scale) and Local Governments (many below 3), particularly in Eastern Indonesia regions[12]. Ombudsman data shows 3.92% of city/regency governments in Red Zone and 11.93% in Yellow Zone regarding public service standard compliance [13].

This study develops a comprehensive model that identifies key components and integrates a layered organizational architecture based on the TOGAF framework to address implementation challenges in a structured and systematic manner. The primary objectives are to design a conceptual Smart Government model for assessing the readiness and maturity of local governments in implementing Smart City initiatives, and to construct an integrated organizational architecture that supports the proposed model in fostering a sustainable and effective smart government ecosystem [14], [15]. The scope of the investigation focuses on municipal and regency-level governments in Indonesia that have initiated Smart City programs or have achieved at least a “good” rating in the Electronic-Based Government System (SPBE) evaluation.

2. METHOD

2.1. Research Design

This study employs mixed-methods exploratory sequential design ensuring comprehensive research question addressing [16], [17]. This strategy was chosen because the initial qualitative phase fundamentally informs and establishes basis for subsequent quantitative phase, ensuring instrument relevance and validity. Figure 1 illustrates the sequential exploratory mixed-methods design, showing the flow from qualitative phase (SLR, interviews) to quantitative phase (survey validation) and final integration through FGD.

The research design was systematically structured using sequential exploratory approach to ensure rigor and validity in conceptual model development. The initial phase began with qualitative exploratory study through Systematic Literature Review (SLR) identifying initial components and research gaps, forming basis for preliminary conceptual model development. This model was refined through qualitative data collection from in-depth interviews and expert judgment. Based on this refined model, quantitative survey instrument was developed for empirical testing. Final validation encompassed triangulation of qualitative and quantitative data, resulting in theoretically sound and empirically relevant model [18], [19].

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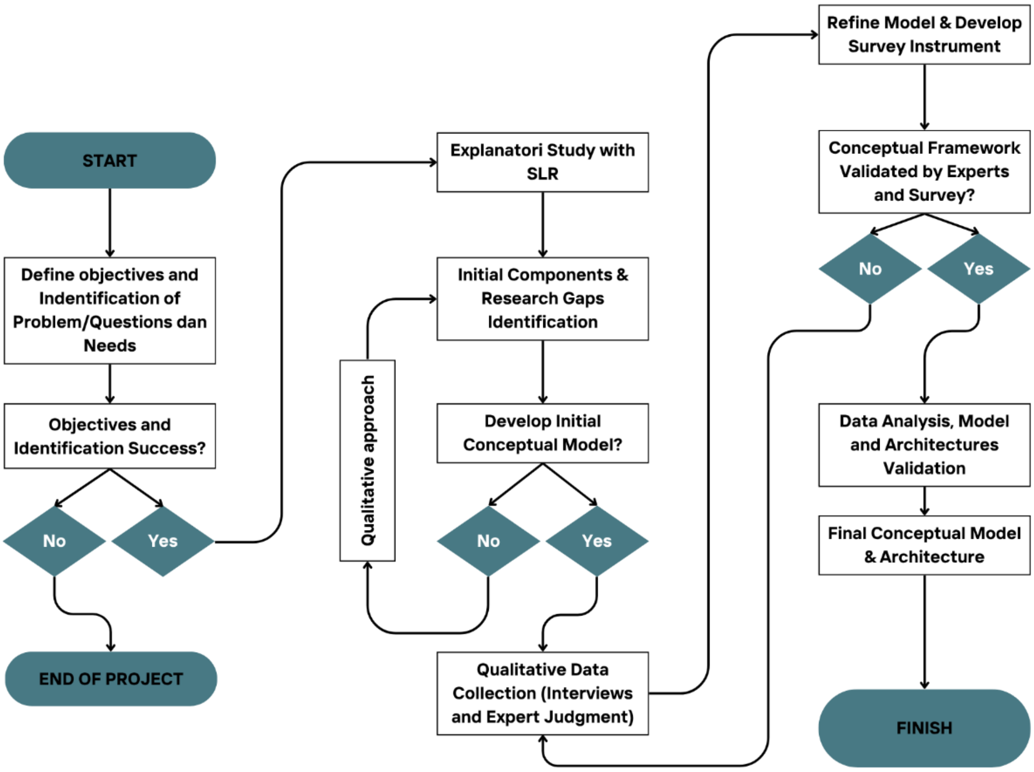

Figure 1. The Sequential Exploratory Mixed Method Research Design

2.2. Research Stages

Phase 1: Exploration and Initial Conceptual Model Development (Qualitative)

a) Identification of Initial Factors/Components: A Systematic Literature Review (SLR) was conducted across Scopus and Scholar indexed international databases to identify initial factors. This was supplemented by a gap analysis between secondary data (EGDI, SPBE, CIMI rankings) and the actual conditions in Indonesia.
b) Initial Model Construction: An initial conceptual model was built using the Critical Success Factor (CSF) approach and integrated with relevant theoretical frameworks such as TOE (Technology, Organization, Environment) and TPI (Technology, People, Institution)[20], [21]. The components of this initial model were then validated and refined through the Delphi method involving an expert panel via FGD.

Phase 2: Empirical Validation and Final Model Design (Quantitative)

a) Qualitative Validation: In-depth interviews were conducted with key experts (academics, practitioners, and policymakers) and representatives from 10 Regional/Local Governments, selected through purposive sampling, to refine and deepen the contextual understanding of each model component[22].
b) Quantitative Validation: An online survey was distributed to a sample of citizens (n=135) to test and measure the validity and public perception of the refined model components. Data analysis employed descriptive statistics, correlation matrix analysis, and reliability testing using Cronbach's Alpha (>0.7 for all dimensions)[16]. Validity was confirmed through inter-item correlation analysis meeting recommended criteria. Survey limitations include demographic bias with 80% respondents from Java Island, which may affect generalizability to eastern Indonesia contexts.

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c) Final Model Design: The final model was designed based on the triangulation of data from the SLR, interviews, and survei results[23].

Phase 3: Finalization of Model, Architecture, and Validation

a) Architecture Design: An organizational architecture for smart government was designed to support the implementation of the AI-driven model. This architecture adopts The Open Group Architecture Framework (TOGAF) to ensure the integration of processes, data, applications, and technology[24].
b) Final Validation: A Focus Group Discussion (FGD) was conducted involving an expert panel from the triple helix (government, academia, and industry) to perform a holistic validation of the entire research output, namely the proposed conceptual model and architecture.

3. RESULT

This chapter presents main findings from mixed-methods methodology application. Results are presented systematically following methodological sequence: Phase 1 (Qualitative Analysis), Phase 2 (Quantitative Analysis), Phase 3 (Model Development and Validation).

3.1. Phase 1: Qualitative Analysis Result

Qualitative data analysis was conducted to confirm, explore, and investigate initial model components through structured in-depth interviews with key experts (n=3) and representatives from 10 Local Governments.

Table 1, shows the demographic profile of expert respondents, ensuring credibility through diverse expertise across government, academia, and industry. Informant credibility and relevance were ensured through demographic profiles including educational background, work experience, and position.

Table 1. Expert Respondent Profiles

No.	Institution/Position	Code	Role/Expertise
1.	Academic and Consultant	Interview _Ekoji	Professor in CS and IS
2.	Academic and Consultant	Interview_Marsudi	Professor in IT dan EA
3.	Ministry of PAN-RB	Interview_Sigit	Coordinator of SPBE Evaluation
4.	Pemkot Bogor	Interview_Bogor	City Government
5.	Pemkot Depok	Interview_Depok	City Government
6.	Pemkot Surabaya	Interview_Surabaya	City Government
7.	Pemkot Semarang	Interview_Semarang	City Government
8.	Pemkot Yogyakarta	Interview_Yogya	City Government
9.	Pemkot Tangerang	Interview_Tangerang	City Government
10.	Pemkot Denpasar	Interview_Denpasar	City Government
11.	Pemkot Ternate	Interview_Ternate	City Government
12.	Pemkot Timika	Interview_Timika	City Government
13	Pemkab Pemalang	Interview_Pemalang	Regency Government
14.	BUMN Telkom	Interview _Telkom	State-Owned Enterprise

Collected qualitative data comprising 14 transcripts were systematically analyzed using thematic analysis.

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Table 2, summarizes the key themes extracted from thematic analysis, showing common problems and contextual challenges identified across interviews. This codification process successfully extracted key factors and contextual challenges of smart government in Indonesia.

Table 2. Thematic Analysis Key Findings Summary

Theme	Key Problems Identified	Frequency	Representative Quote (originally in Bahasa Indonesia)
Problems of Smart/e-Government in Indonesia	Low e-Government rankings, lack of optimization	High	"The ranking issue is caused by non-optimal implementation..." (“*..masalahnya rangking itu penyebabnya apakah karena* ***tidak optimal*** *atau karena memang pemerintah* ***tidak mengimplementasi****, bedakan tidak optimal..*”)
	Absence of generic organizational architecture	High	"Nationally, there's no architectural framework available..." (“*..karena secara nasional tidak ada namanya* ***arsitektur nasionalnya nga ada****, pedoman arsitekturnya seperti apa nga ada, baru sekarang di tim Kominfo mengerjakan itu di direktoral e-gov itu bikin arsitektur nasional e-gov, akhirnya kita buat* ***arsitektur yang lebih generik aja****..*”)
	No smart government model for Indonesia	High	"There's indeed no model for smart government in Indonesia..." (“***..ngak ada memang model untuk smart government*** *di Indonesia..*” “*..nah pertumbuhan masalah yang ada lebih cepat dari pada sistem yang konvensional (e-Gov) sekarang..*”)
	Lack of component integration	Medium	"All elements need integration from every smart government component..." (“*..untuk semua elemen ini* ***butuh integrasi*** *dari setiap elemen/komponenya smart government itu..*”)
	Minimal public service innovation	Medium	"The main problem is lack of innovation in public services..." “*..iya, yang* ***masalah SPBE*** *memang lebih bayak diukur indikator layanan, masalahnya adalah* ***kurangnya inovasi*** *pada layanan publik..*”
	Minimal citizen engagement and participation	Medium	"Issue of minimal engagement and participation..." (“*..masalah* ***minimnya engagement*** *dan partisipasi, saya setuju..*”)

3.2. Phase 2: Quantitative Analysis Results

Quantitative analysis was conducted through online survey distributed to Indonesian citizens from various cities/regencies, resulting in 135 participants via WhatsApp groups. Table 3 shows respondent demographic profile dominated by highly educated individuals (Master's: 52%, Bachelor's: 31%) with 80% residing on Java Island, which represents a limitation for generalizability to eastern Indonesian contexts.

Table 3. Survey Respondent Profile

Gender	Count (%)	Age	Count (%)	Education	Count (%)	Domicile	Count (%)

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Male	70 (65)	<17	0	Bachelor's (S1)	55 (31)	Java Island	100 (80)
		17-30	33 (23)				
Female	55 (35)	31-40	57 (44)	Master's (S2)	56 (52)		
		41-50	26 (24)			Outside Java	25 (20)
		>50	9 (8)	Doctorate (S3)	14 (13)		
Total				*135 respondents*			

Before further analysis, research instrument reliability and validity were confirmed. Table 4 demonstrates reliability testing using Cronbach's Alpha showing values above 0.7 for all dimensions (ranging 0.709-0.866), while inter-item correlation validity testing met recommended criteria.

Table 4. Reliability and Validity of the Questionnaire Instrument

No.	Dimensions	Questions code	Items	N	Cronbach's Alpha	Korelasi antar item (kisaran)	Conclusion
1	Foundation/Dasar	P1 – P7	8	135	0,866	0,671-0,805	Reliable and Valid
2	Focus Area/Stakeholder	P9 - P11	3	135	0,799	0,821-0,872	Reliable and Valid
3	Application	P12 -P13	2	135	0,845	0,928-0,932	Reliable and Valid
4	Goal	P14 - 19	6	135	0,709	0,516-0,806	Reliable and Valid

Data analysis using descriptive statistics and correlation matrix revealed significant relationships between model components, providing empirical justification for model construction from user perspective.

3.3. Phase 3: Final Model Construction and Validation

Through data triangulation process, this research successfully constructed final, comprehensive conceptual model for AI-driven smart government. The model's limitations include demographic bias in survey respondents (80% from Java Island) and need for contextual adaptation across diverse regional conditions. Implementation strategies include phased rollout and regional customization approaches.

Preliminary validation suggests potential SPBE score improvements of 0.5-1.0 points through systematic implementation of the model's components, based on expert consensus analysis during FGD sessions.

3.3.1. Finding 1: Semar v1.0 Conceptual Model for AI-driven Smart Government

Figure 2, visualizes the final Smart Government Nusantara (Semar v1.0) model built upon 6 validated dimensions and 17 key components. This model represents paradigmatic evolution from conventional e-government to AI-driven smart government through fundamental shifts in Technology, People/Organization, and Environment aspects.

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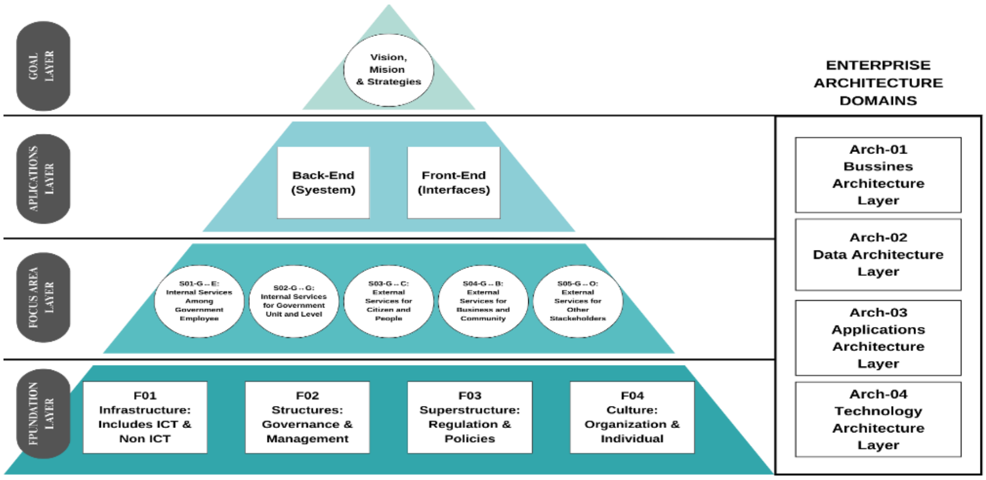

Figure 2. Smart Government Nusantara (SEMAR v1.0) Core Model.

Table 5, details the dimensions and components of the Smart Government Nusantara model, each developed through elaboration and conceptual synchronization from SLR findings and empirical analysis. These six dimensions include: (1) Foundation dimension as basic prerequisite comprising infrastructure, structure, superstructure, and culture; (2) Focus Area dimension adopting Penta-Helix concept for service interactions; (3) Application dimension distinguishing front-end and back-end service innovations; (4) Goal dimension contextual to regional vision and mission; (5) Enterprise Architecture dimension ensuring vertical integration; and (6) Implementation Strategy dimension providing systematic deployment approach.

Table 5. Dimensions and Components of SEMAR v1.0 Model

No	Dimensions	Components	Description	Source
1.	Foundation	1. Infrastructure 2. Structure 3. Superstructure 4. Culture	Basic prerequisites for smart government implementation including ICT/non-ICT infrastructure, organizational governance, legal regulatory framework, and cultural/literacy aspects	SLR results, data analysis
2.	Focus Area	5. G↔G 6. G↔E 7. G↔C 8. G↔B 9. G↔O	Service scope adopting Penta-Helix concept with bidirectional collaborative interactions emphasizing co-creation and mutual cooperation.	SLR results, data analysis
3.	Application	10. Front-end 11. Back-end	Digital service innovation covering public service applications and internal administration, including shared common applications and contextually specific developments	SLR results, data analysis
4.	Goal	12. Vision, Mision and Strategi	Strategic targets derived from regional Vision, Mission, and Strategy, varying from service effectiveness/efficiency to innovation and sustainability	SLR results, data analysis
5.	Enterprise Architecture (EA)	13. Business Architecture 14. Data Architecture 15. Application Architecture 16. Technology Architecture	Integrated blueprint mapping business processes, data, applications, and technology ensuring alignment and comprehensive integration eliminating silos	SLR results, data analysis

6. Implementation Strategy	17. Implementation Strategy	Critical component determining successful implementation through appropriate strategic approaches preventing organizational failure	SLR results, data analysis

As core feature, the model introduces "Smartness Level" measurement framework mapping five implementation maturity levels (Initial, Growing, Integrated, Mature, Smart) for each component.

3.4. Finding 2: An Organizational Architecture for Smart Government

To translate the conceptual model into an operational framework, this research yields a second finding in the form of a generic organizational architecture. This architecture, visually mapped in Figure 3, was designed using The Open Group Architecture Framework (TOGAF) approach to address the issues of fragmentation and silos that are the root of the "ICT investment paradox." The architecture consists of 5 main integrated layers: (1) a Business Layer that aligns business processes with strategic goals; (2) an Information and Data Layer that ensures the availability and security of integrated data; (3) a Technology and Infrastructure Layer as the technical foundation; (4) a Security Layer that guarantees comprehensive cybersecurity; and (5) a Smart Layer that forms the core of intelligence, enabling integration, collaboration, and data-driven innovation.

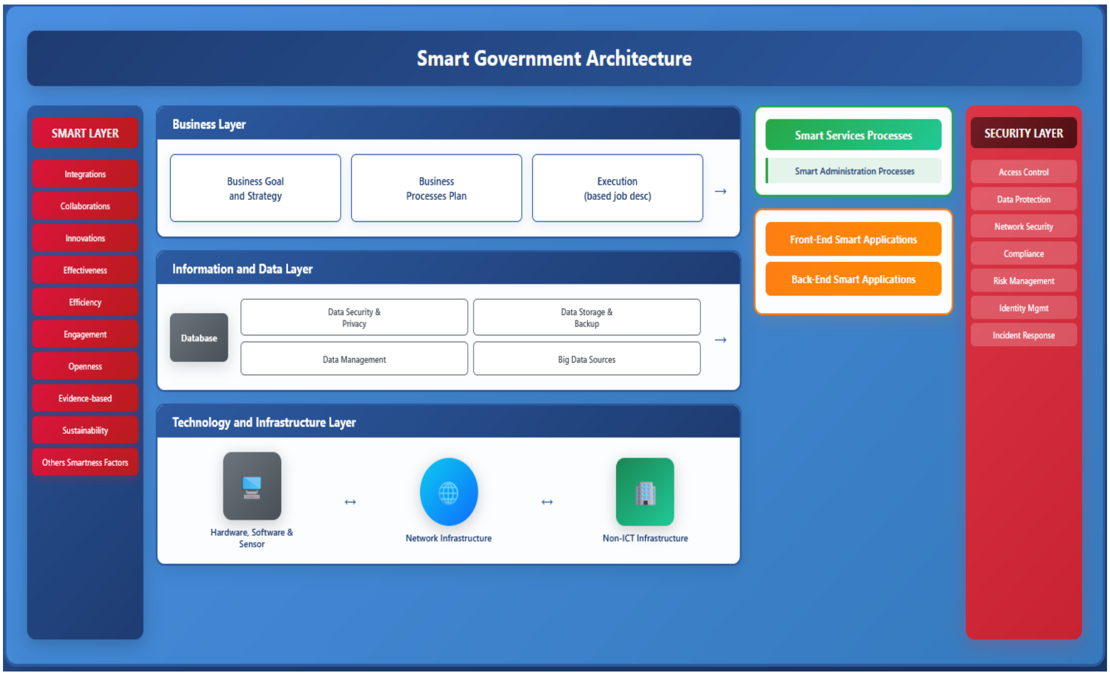

Figure 3. Organizational Architecture in the SEMARv1.0.

Table 6 presents expert consensus calculation results using Fuzzy Delphi Method (FDM) showing average d-value of 0.125 and acceptance percentage of 86% for all constructs, indicating strong expert consensus on proposed smart government architecture components.

Table 6. Expert Consensus Results Using FDM

Expert	Organizational Architecture Dimensions				
	Business	Data	Application	Infrastructure	Smartness
A	0.22	0.26	0.22	0.26	0.26
B	0.09	0.04	0.09	0.04	0.04
C	0.22	0.04	0.09	0.04	0.26
D	0.09	0.04	0.09	0.04	0.65

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E	0.09	0.04	0.09	0.04	0.04
F	0.09	0.04	0.22	0.04	0.26
G	0.09	0.04	0.09	0.04	0.04
Average d-value	0.12	0.07	0.12	0.07	0.22
Defuzzification Value	4.60	4.60	4.60	4.60	4.60
Average d-value = 0,125 and Construct acceptance percentage = 86%					
Ranking	2	3	4	1	5

The results of the expert panel in the FGD forum, analyzed using the Fuzzy Delphi Method, show that the average d-value for each item is 0.125 and the acceptance percentage for all constructs is 86%, which is below 0.2 and above 75%. These results indicate a consensus among the experts in the FGD regarding the components of the smart government architecture.

4. DISCUSSIONS

The discussion focuses on significance of model and architecture findings in realizing AI-driven smart government addressing identified fundamental problems. The proposed conceptual model directly addresses SPBE evaluation criteria through comprehensive coverage of infrastructure, governance, and service innovation components[25], potentially improving Indonesia's position in international e-government rankings including EGDI advancement from current 64th position.

The proposed conceptual model represents paradigmatic evolution from conventional e-government to AI-driven smart government. The difference lies not only in advanced technology adoption but also in fundamental shift across three main aspects based on TOE/TPI framework[26]. In Technology aspect, there is shift from merely building physical infrastructure to developing intelligent ecosystem. In People and Organization aspect, focus shifts from reactive, government-centric services to proactive, AI-based predictive services centered on stakeholder needs (need-centric). In Environment aspect, the model promotes transformation from siloed work culture to synergistic collaborative ecosystem (Cyber-Cognitive-Physical-System) where all elements align with organizational strategic goals[27].

Implementation requires three-phase approach: (1) baseline assessment using the model's maturity framework for systematic readiness evaluation, (2) gap analysis and prioritization identifying critical improvement areas, (3) systematic development following architectural guidelines ensuring integrated technology deployment[28]. Critical limitations include substantial resource requirements and change management challenges in traditional government structures requiring cultural transformation and capacity building initiatives.

Further implications lie in organizational architecture designed as operational foundation for AI-driven smart government realization. This TOGAF-based architecture specifically addresses e-government implementation failure root causes: process fragmentation, unintegrated data, and misaligned ICT investments[29]. By providing integrated layer blueprint (Business, Data, Application, Technology), this architecture creates technical and organizational prerequisites for Intelligence Layer operation, enabling AI for predictive analysis and intelligent automation. This architecture systematically dismantles silos, ensures quality data availability, and ensures every technology initiative generates data-driven public value, preventing "ICT investment paradox" recurrence.

Comparative analysis with international best practices shows alignment with Estonia's X-Road interoperability platform[30] and Singapore's Smart Nation architecture[31], validating the model's comprehensive approach while addressing Indonesia's unique archipelagic challenges through decentralized yet integrated governance structures.

This combination of conceptual model and AI-ready architecture offers clear and manageable transformation path for local governments in Indonesia, providing systematic approach to overcome historical implementation barriers while building sustainable smart government capabilities.

5. CONCLUSION

This study examines key challenges in e-government implementation in Indonesia and proposes a conceptual model and organizational architecture aimed at supporting the realization of an AI-driven smart government. Through empirical validation and expert consultation, the research identified six dimensions and seventeen components, demonstrating acceptable reliability (Cronbach's Alpha ranging from 0.709 to 0.866) and a high level of expert agreement (86% consensus in FDM analysis). In addressing the first research question presented in Chapter 1, the study introduces a holistic model comprising these dimensions and components, contributing to a contextualized understanding of smart governance in Indonesia and highlighting foundational elements for the development of advanced services, including AI-based predictive capabilities. In response to the second research question, the study outlines a TOGAF-based organizational architecture designed to establish the necessary technical and institutional conditions for implementation, particularly in relation to longstanding issues of integration and fragmentation.

Theoretically, the main contribution of this study is provision of integrated framework (model and architecture) bridging the gap between smart government concept and technical realization of AI capabilities. This framework defines fundamental prerequisites that must be met before government organization can effectively adopt and utilize AI, enriching literature in public sector digital transformation field. Practically, these findings provide actionable blueprint for policymakers. By using this model and architecture, government institutions can systematically assess readiness, identify weaknesses such as data and process silos, and build solid foundation ensuring future AI investments are effective, integrated, and aligned with strategic goals to accelerate "Golden Indonesia 2045" vision.

Practical recommendations include establishing smart government maturity assessment centers at national and regional levels, developing context-specific implementation guidelines for diverse Indonesian regions, and creating inter-governmental collaboration platforms facilitating knowledge sharing and best practice dissemination. Future research should explore sector-specific model adaptations (health, education, transportation), longitudinal impact studies measuring actual SPBE score improvements, and integration frameworks with emerging technologies including Internet of Things (IoT), blockchain, and big data analytics.

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