Research Article

Human-machine Dynamics in Local Digital Governance: Evidence from North Kalimantan's SPBE

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Abstract.

One of the efforts to improve the quality of public services is the implementation of the electronic-based government system (SPBE). However, in its implementation, various regions experienced different obstacles, including North Kalimantan Province. This obstacle is primarily related to the capacity of employees in the government and the community in adapting to and adopting technology, which tends to indicate that there is still resistance to the use of digital systems in public service processes. The lack of human resources with technological capacity also remains an obstacle in the implementation of the SPBE in North Kalimantan. This situation causes government agencies to prefer collaborating with third parties for the preparation and development of related applications. In addition, the quality of technological infrastructure is also not yet adequate, with only 65% of the areas in North Kalimantan Province having stable internet access.

Keywords: electronik-based government system, human resources, technology, organization

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1. Introduction

In the last two decades , developments digital technology has change governance landscape government fundamentally . Governments in various countries are required For adopt technology information and communication (ICT) for speed up service public , improve efficiency bureaucracy , and build better governance transparent as well as accountable [1]; [2]. Transformation This known as digital governance, namely approach strategic that integrates digital technology with practice administration public For create adaptive and data- driven governance [3]; [4].

In Indonesia, the policy System Government Based on Electronics (SPBE) becomes part from the reform agenda digital bureaucracy , as poured out in Regulation Presidential Decree No. 95 of 2018. SPBE aims to push efficiency and integration service public based on technology [5]. However , its implementation Still face various challenges

, including readiness infrastructure , inequality ASN digital competence , as well as fragmentation policy between levels of government [6]; [7]. This reflect gap between policy national and reality local in digitalization bureaucracy.

One of aspects that are often ignored in studies and also practice digitalization government is dimensions interaction between humans and technology or known as as Human-Machine Interaction (HMI). In context bureaucracy public , HMI reflects How apparatus civil servants (ASN) interact , adapt , and respond use digital system in tasks administrative them [8]; [9]. If aspect This No managed with okay then technology at risk fail support reform bureaucracy and precisely add complexity service [10]; Roy [11].

Respond complexity In this regard , Vigoda-Gadot and Mizrahi [12] offer an integrative digital governance model that places interaction between humans , machines , and organizations as component main success digital transformation . Two draft important in this model is the Digital Governance Footprint (DGF)— namely perception actor bureaucracy to impact digital technology in task them —and the Mental and Emotional Models (MEMOs) that describe reaction psychological and emotional user to technology [13]; [14]. With understanding DGF and MEMOs, implementation technology can oriented to be more inclusive , adaptive , and user - centered .

Although thus , many digital governance studies still focus on aspects technical or structural , and not yet explore in a way deep How perception and emotion man as user system influence success adoption technology [15]; [16]. Perspective behavioral public administration encourages dimensions cognitive , emotional , and social from the bureaucrats under consideration in a way Serious in design and implementation digital systems [17]. Without understanding to behavior users , digital transformation is at risk become inefficient or even rejected by bureaucracy Alone .

The context of North Kalimantan illustrates with clear How challenge digitalization nature multidimensional . Province This take notes SPBE index 2022 only by 2.3— far from the national target of 3.5—and only about 65% of its area own adequate internet connectivity (BPS, 2023; Ministry of PANRB, 2023). More Furthermore , around 60% of ASN in the province the Not yet own adequate basic digital skills. This show that adoption technology without readiness man will creating a “governance gap” between digital policies and realities on the ground .

Situation This to emphasize importance mapping HMI in ecosystem digital governance . Referring to Vigoda-Gadot and Mizrahi [12], the failure of in bridge gap between ability engine and readiness man will impact on low performance organization, low ASN

participation , and resistance to changes . Therefore that , it is necessary an approach that is not only nature technocentric , but also human-centric, through understanding to perception and response ASN's emotional attitude towards technology.

Based on above exposure, research This aiming For to study in a way deep How pattern interaction between man and machine in SPBE system affects effectiveness of digital governance in North Kalimantan, with placing DGF and MEMOs as variable main . Question research submitted is : How pattern interaction between humans and digital technology shape perception , emotion , and performance bureaucracy in the context of SPBE in North Kalimantan?

2. Methods

This research uses a qualitative research design with a descriptive analysis approach to explore and comprehensively understand the implementation of an electronic-based government system from the perspective of an integrative model in digital governance, particularly regarding the human-machine interaction that occurs in North Kalimantan Province, Indonesia. This study aims to analyze the challenges from the aspects of humans and machines (technology), preparedness, efforts, and strategies implemented to achieve successful implementation of the electronic-based government system. [18]; [14]. By using the integrative model theory in digital governance, this research aims to understand, explore, and interpret the interactions, dynamics, and challenges that occur among people, in this case, human resources working within the scope of digital systems, society as users, and also the readiness of machines or technology to be operated by humans. [11]. To this end, the researchers conducted interviews with 7 informants consisting of 4 civil servants from 4 different regional offices, 1 individual from the private sector, and 2 members of the community. The research informants were selected using purposive sampling technique, where the research informants are individuals or groups considered to have the capacity in terms of knowledge and experience in electronic government systems.

Primary data is in the form of interview results and secondary data from various relevant documents, then analyzed through several stages, namely the process of organizing and preparing data, reading through all data, coding data based on type, source, and the information provided or obtained to then enter the process of interpreting the meaning of the existing data, referred to as the process of Interpreting the Meaning of Themes/Descriptions [18].

3. Results and Discussion

In general, the existing condition based on the SPBE maturity achievement value in North Kalimantan Province in 2023 shows a value of 2.83 with a Good category. However, this condition in reality does not show that all aspects or domains in the SPBE assessment also show the same thing. This existing condition can be seen in the Table 1 below:

TABLE 1: Existing Condition of SPBE in North Kalimantan Province in 2023.

Domain	Value	Category
SPBE Policy Domain	3.00	Good
SPBE Governance Domain	2.40	Enough
SPBE Management Domain	1.00	Poor
SPBE Service Domain	3.69	Very Good

Source: SPBE Existing Architectural Condition Document, 2023.

The existing conditions of the SPBE domain in North Kalimantan Province are generally good, especially in the areas of policy and services. This condition indicates that the implementation of SPBE in North Kalimantan Province is supported by adequate regulations, ranging from Governor Regulations, the SPBE Architecture Plan map, to various other policies such as the establishment of a coordination team for SPBE implementation. In terms of services, the North Kalimantan provincial government has shown a positive trend in developing several applications that support more effective public service processes. However, the governance and management domain still show concerning values. In the governance domain, there is a strategic planning aspect that shows a concerning value of 1.75 or in the poor category. This condition is also caused by the insufficient fulfillment of indicators in the strategic planning aspect/domain, one of which relates to human resource competencies. In addition, information and communication technology is one of the aspects of the assessment domain. In this domain, the Provincial Government of North Kalimantan received a score of 2.75, which falls into the good category, but with a note that there is still a need for improvement in the aspect of ICT infrastructure.

The above conditions indicate that one of the main challenges in implementing SPBE in North Kalimantan Province is related to the availability and competence of human resources, including aspects of technology adoption and adaptation by the community

as service users and related to information and communication technology infrastructure that still needs to be optimized.

3.1. Human-Machine Interaction Patterns

Overall, the interaction between state civil apparatus (ASN) and digital systems in North Kalimantan shows gradual adaptation dynamics, but still faces significant challenges. The use of several applications such as Srikandi, SIMPEG, SIKARA, PESONA, and E-Monev shows that ASN has begun to form a system-based work pattern. However, this interaction is still adaptive-partial, not synergistic, as reflected in the large number of repeated data entries because the system has not been integrated. This was stated by informan AA from the Regional Civil Service Agency of North Kalimantan Province.

"There are several applications that have the same purpose, but must still be used together [...] because they are not well integrated". (5/5/2025)

Based on the theoretical approach of Vigoda-Gadot & Mizrahi (2024), human-machine interaction in the implementation of SPBE in North Kalimantan Province shows an adaptation pattern that has not been systemically integrated. ASN has used various digital applications in their work routines, but this use is still partial and uncoordinated across OPDs. This causes redundancy in data input and excessive administrative burdens, reflecting a coordination gap between technology and organizational structure. On the other hand, the pattern of use is still partial and reactive, not based on comprehensive integration. This indicates that although digital transformation has begun, the relationship between humans and systems is still task-command, not reaching the ideal collaborative stage.

In addition, most ASN experience several obstacles such as confusion, digital fatigue, and even frustration with the many applications with overlapping functions. They feel burdened, especially when the application runs unstable or experiences downtime. This condition is related to the concept of Mental and Emotional Models (MEMOs), namely how human perception and emotions affect the effectiveness of interaction with machines. This reality is based on the statement of informant SW from the North Kalimantan Provincial Development Planning Agency.

"Because there are many applications, we often don't understand or know how all the applications work."(5/5/2025)

Thus, in terms of psychology and emotion, ASN often face mental stress and anxiety due to the many applications that must be used simultaneously without clear integration. This condition is exacerbated by repeated technical disruptions such as downtime and hacking, which in turn reduce trust in the digital system. The existence of this emotional reaction indicates that ASN's psychological unpreparedness for the digital ecosystem has not been adequately addressed. Technical training has not been accompanied by efforts to form a positive perception or awareness of the long-term benefits of the digital system. Without transformation in the mental-emotional aspect, resistance will continue to emerge, even if the technology is improved.

Limited technical capacity at the local level is also a major challenge. Many OPDs still rely on vendors or third parties in application development due to the lack of internal experts, especially in the fields of IT and cybersecurity. Therefore, most applications are developed by external vendors. This condition was expressed by informan DM from the Investment and Integrated One-Stop Service Office of North Kalimantan Province.

"We use the application owner vendor for the system, and for the server we contact Diskominfo." (5/5/2025)

This causes human-machine interactions to not be fully controlled by the institution itself, but rather dependent on external responses. The absence of internal control disrupts the human-machine trust cycle. ASN become passive users who wait for solutions from outside, not active actors in the technology adaptation cycle. This causes high dependency and limits government control over the systems they use. In addition, this dependency weakens the organization's ability to build healthy relationships between humans and machines within the bureaucratic structure.

Although there are examples of good practices, such as the PESONA and SIPLAKU systems at DPMPTSP which are efficient and easily accessible to the public, these innovations are still fragmented. The absence of a systematic mechanism for disseminating and replicating innovations between OPDs has led to stagnation of collective learning and the slow formation of a comprehensive digital ecosystem. This strengthens the argument that the integration of digital innovation requires a cross-organizational approach and stronger policy coordination.

Overall, these findings confirm that the success of SPBE cannot be solely determined by the sophistication of the technology used. Instead, the main key lies in how ASN responds to and interacts with digital systems in a supportive organizational structure. In the context of North Kalimantan, digital reform efforts need to be directed towards

a more people-centered approach (people-centered digital transformation), through strengthening emotional capacity, positive perceptions of technology, and collaboration between institutions in a systemic and sustainable manner.

3.2. The Role of Mental and Emotional Models (MEMOs)

Analysis of the role of Mental and Emotional Models (MEMOs) in human-machine interaction in the implementation of SPBE in North Kalimantan Province revealed that emotional factors and subjective perceptions of ASN play a very crucial role in the success or failure of digital transformation of bureaucracy. According to Vigoda-Gadot & Mizrahi [12], MEMOs function as a mediating mechanism between exposure to technology and organizational outcomes, including performance and participation. The research findings show two emotional poles experienced by ASN: frustration and anxiety on the one hand, and motivation and optimism on the other. The state of frustration and anxiety was expressed by informan FA from the Library and Archives Service of North Kalimantan Province.

"Sometimes there is trial and error in its use, and this is what sometimes makes us need to learn again." (5/5/2025)

Frustration and anxiety arise especially in situations when the digital system experiences technical failures such as downtime, hacking, or unresponsive features, or when ASN are faced with repetitive data entry processes due to lack of system integration. This emotional response gives rise to a negative attitude towards the digital system, which in the long term can hinder further technology adoption. This condition shows that the perception of the system as "burdensome" is a trigger for cognitive and emotional resistance to digital transformation.

On the other hand, optimism and motivation arise from the belief that the digital system makes tasks easier, especially in terms of time savings and monitoring efficiency. ASN feel the real benefits of the SPBE system such as time efficiency, ease of coordination, and reduction of manual bureaucratic processes. This positive perception strengthens user attachment to the system, while increasing ASN's confidence in adapting to technology. This was expressed by informant SW from the North Kalimantan Provincial Development Planning Agency.

"The presence of this application basically makes it easier for us to monitor everything according to our duties, so in the future it needs to be continued and optimized."(5/5/2025)

Based on these two findings, the success of bureaucratic digitalization does not solely depend on the completeness of the infrastructure or the sophistication of the application, but also on how the technology is perceived, understood, and emotionally accepted by its users. In this regard, technical training needs to be balanced with interventions that build positive perceptions of digitalization such as providing user feedback space, psychological support when system changes occur, and active involvement of ASN in application development. Thus, the MEMOs analysis in the context of SPBE North Kalimantan shows the importance of a digital governance strategy based on empathy and responsiveness to user experience. This approach can be the key to reducing resistance, accelerating technology adoption, and strengthening ASN digital capabilities sustainably.

3.3. HMI (Human-Machine Interaction) Challenges

Analysis of research findings on the Human-Machine Interaction (HMI) aspect in the implementation of SPBE in North Kalimantan Province shows that the interaction between humans and technology still faces various structural, technical, and psychological obstacles. Referring to the Vigoda-Gadot & Mizrahi model, these challenges appear in the form of barriers and biases that hinder effective integration between human users and machine systems. In the context of North Kalimantan, one of the main obstacles is the limited human resources (HR) who have digital competence. Many ASN are not incapable, but experience mental blocks or resistance because the digital system is considered to increase the workload without direct incentives for their welfare. This was expressed by informant MU from the Communication and Information Service of North Kalimantan Province.

"There are still several OPDs that do not understand well and are not willing to implement SPBE." (5/5/2025)

In addition, the findings show that the large number of applications that have similar functions but are used simultaneously actually creates overlapping and redundant processes. ASN must fill in data on several applications that are not integrated, thus triggering digital fatigue and administrative confusion. This situation not only reduces productivity but also weakens ASN's motivation to innovate or actively participate in the

digitalization process. This condition refers to the statement of informant SW from the North Kalimantan Provincial Development Planning Agency.

"There are several applications that have the same purpose, but must still be used together. This is a challenge in itself, because we have to keep filling everything because it is not well integrated." (5/5/2025)

On the other hand, the limitations of digital infrastructure, especially network and system security, are other factors that worsen the quality of human-machine interaction. Cases of server disruptions and hacking not only cause service dysfunction, but also reduce the level of ASN trust in the reliability and security of existing digital systems. This shows that the success of HMI is not only determined by user readiness, but also by the technical capacity of the system that supports it. The steps taken are to form a team, but it is not certain whether the handling can be done alone or ask for help. This was expressed by AA from the Regional Civil Service Agency of North Kalimantan Province.

"We have an online gambling server attack. We formed a team, then processed whether it can be done by us or ask for help from the center". (6/5/2025)

Thus, human-machine interaction in SPBE North Kalimantan is still in a vulnerable transitional phase, where humans are not yet fully facilitated mentally and technically to collaborate with technology optimally. To overcome this, a holistic approach is needed that not only improves infrastructure and technology, but also builds a supportive digital culture through training, emotional support, and incentive policies that are aligned with user needs.

Strategically, strengthening HMI must be a priority in the design of SPBE policies in the region. The North Kalimantan Provincial Government needs to invest in developing HR capacity based on user experience (user-centered training), simplifying applications through cross-OPD system integration, and improving the security and reliability of digital infrastructure. With this approach, human-machine interaction can develop from a transactional relationship to a collaborative relationship, as mandated by the integrative theory of digital governance.

3.4. Impact on Effectiveness and Productivity

Suboptimal human-machine interaction causes work efficiency and duplication of processes to be hampered. However, ASN who are accustomed to it show an increase

in service speed and reporting accuracy. Based on these findings, the effectiveness and productivity of SPBE implementation in North Kalimantan are greatly influenced by the quality of interaction between humans and machines, which in this case refers to ASN as users of the digital system. When this interaction is not optimal, the work process becomes inefficient. This is indicated by duplication of data input, the need for manual re-filling, and the length of time to complete administrative tasks that should be automated.

However, other findings also show that ASN who are accustomed to the system tend to be more productive. They show an increase in the speed of public service and more accurate reporting. This shows that the learning curve in human-machine interaction has a direct impact on the quality of bureaucratic performance. Thus, productivity is not sufficiently driven by technological or policy factors, but rather depends on the perception and direct experience of users. This indicates that the success of SPBE in the regions cannot be separated from how technology is understood and interpreted by its users. Therefore, the SPBE strengthening strategy must include a communication approach that improves the image and understanding of digital systems, as well as system simplification so that ASN can really feel the benefits directly.

The success of SPBE implementation in North Kalimantan Province is highly dependent on the quality of interaction between humans, machines, and organizations. These three elements form the main foundation of the Human-Machine-Organization model developed by Vigoda-Gadot & Mizrahi [12], where failure to synergize the three will result in double workload, data redundancy, and digital fatigue. These conditions ultimately lead to a decrease in public service productivity. In the context of North Kalimantan, the unintegrated interaction between ASN as users, digital application systems, and institutional policies has resulted in duplication of data input, overlapping systems, and disruption of coordination across OPDs. This finding supports the argument of Vigoda-Gadot & Mizrah that digital transformation without systemic integration actually creates administrative dysfunction rather than providing real benefits to public services.

Structurally, this study also highlights the important role of psychological aspects in human-machine interaction. Many ASN experience emotional stress such as frustration, confusion, and fatigue when dealing with the SPBE system which is considered burdensome. According to the Mental and Emotional Models (MEMOs) theory, Vigoda-Gadot stated that individual perceptions and emotions towards digital systems are important determinants in the success of technology adoption. ASN resistance to SPBE is not solely due to technical limitations, but rather due to mental blocks. This finding is in line

with Davis's [19] argument that perceptions of the ease and usefulness of technology determine whether someone will accept and use the technology effectively.

Some of the above conditions are exacerbated by the use of various digital applications that are not integrated with each other. ASN must fill in data in parallel in different systems that have similar purposes. This phenomenon confirms the existence of a design-reality gap, as explained by Heeks [8], namely the mismatch between system design and operational reality in the field, including user capacity and available technological infrastructure. Limited digital infrastructure and security risks also increase emotional barriers in implementing SPBE. Network disruptions in remote areas and data hacking incidents reduce ASN's trust in the reliability of digital systems. This condition is also in line with the findings of Picard [20] which states that users' emotional discomfort with technology has a direct impact on the effectiveness and sustainability of system use.

On the other hand, there is also positive evidence that ASN who are used to it and receive training show increased motivation and productivity. When the system is proven to make tasks easier, ASN tend to be more adaptive. This strengthens the concept of Digital Governance Footprint (DGF), where positive perceptions of the existence and benefits of digital systems will encourage active ASN involvement. However, institutional issues remain a central issue. Dependence on third parties in application development makes ASN only act as passive users. Their lack of involvement in the system design and development process hinders the creation of a participatory digital culture. In this case, the principle of digital public innovation according to Janssen et al. [21] emphasizes the importance of building internal organizational capacity to be able to respond to user needs adaptively and sustainably.

This finding also shows that technical training alone is not enough to shape ASN digital readiness. An approach is needed that forms positive perceptions through psychological support, open dialogue, and active involvement in the digitalization process. This is in line with the idea of Cordella & Tempini [22] that digital transformation is socio-institutional and cannot rely solely on technological solutions. Furthermore, the people-centered digital transformation approach proposed by the OECD is very relevant to encourage user involvement in every stage of digital system development. Digital transformation is not just about replacing manual systems with electronic ones, but also ensuring that the system answers real needs and simplifies the work process of ASN as end users.

Meanwhile, when viewed from a policy perspective, this finding indicates the importance of repositioning SPBE from a technology-centric approach to one based on user experience. Local governments need to adopt a user-centered design strategy, simplify applications, reduce redundancy, and strengthen security architecture to build ASN trust in the system. Based on these conditions, Venkatesh et al. [23] revealed that technology adoption is influenced by performance expectations, organizational support, facility conditions, and social influences. Weakness in any of these elements will weaken the overall implementation of SPBE.

The effectiveness of SPBE must also be assessed not only from digital performance indicators, but also from changes in bureaucratic behavior. ASN is not just a technology implementer, but also an agent of change in the digitalization process. Therefore, the strategy to strengthen SPBE needs to combine technical, emotional, and organizational dimensions simultaneously to create a healthy and sustainable digital bureaucracy. Thus, SPBE in North Kalimantan is at a critical point between opportunities and challenges. Digital transformation can strengthen the performance of local governments if accompanied by a holistic policy approach that is oriented towards user experience. The government needs to manage this change adaptively and participatively by making ASN not only an object, but also the main subject of the digital transformation process.

The success of the implementation of SPBE in North Kalimantan Province is highly determined by the synergy between humans (civil servants and society) and machines (technology). The failure of integration and interaction between these two aspects leads to a double workload, digital fatigue, and administrative dysfunction. Psychological factors such as negative perceptions, mental blocks, and emotional discomfort also serve as obstacles in technology adoption. This condition is further exacerbated by the mismatch between system design and field realities, as evidenced by inadequate infrastructure and suboptimal digital security. Although there are civil servants showing positive adaptation, the dominance of third parties still indicates that the capacity and availability of human resources, in this case civil servants, are not optimal in supporting the implementation of SPBE.

4. Conclusion

From the description above, the success of SPBE implementation in North Kalimantan Province is greatly influenced by the quality of interaction between humans and machines (technology). This SPBE implementation faces serious challenges from the

readiness, quantity, and capacity of human resources in adapting to technology. This condition is partly caused by psychological factors of state civil servants such as confusion, mental blocks, and digital fatigue due to non-integrated systems (technology). Moreover, misconceptions regarding the SPBE implementation, which is seen as merely sectoral, still dominate, often leading to apathy from other agencies that are not the leading sector. Additionally, the public, as one of the target groups in SPBE, still shows resistance towards technology, particularly in the use of applications in the public service process.

To this end, civil servants and the community in the digital transformation process must be viewed as key change agents that determine the sustainability of the SPBE (Electronic Government Management System). The provincial government of North Kalimantan needs to shift from a technocentric digital approach to a more human-centric approach. This can be achieved by enhancing the capacity of civil servants through user-centered training that not only focuses on technical skills but also builds a positive perception of the benefits of SPBE. Additionally, it is important to ensure the integration of applications and simplification of systems, so as not to add to the administrative burden on civil servants. The systems being built should also ensure feedback and active participation from civil servants and the community. Lastly, technological infrastructure including data security systems also needs to be improved, thereby increasing the trust and positive perception of all parties in the use of related applications. These efforts can serve as a strategy to enhance the quality of collaborative human-machine (technology) interactions, so that the implementation of e-Government in North Kalimantan can run optimally.

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