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Partial Digitalization: Innovation Attributes and Adoption Barriers in a Mobile Vehicle Tax Application in Indonesia

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ABSTRACT

Local governments in developing countries increasingly use mobile applications to deliver tax services, yet many of these applications digitize only part of the service chain. This study examines how innovation attributes shaped the uptake of SAMBARA, a mobile application for paying motor vehicle tax in West Java, Indonesia, which barriers constrained its implementation, and which measures were taken or proposed to address them. We conducted a qualitative single case study at the West Java Regional Revenue Agency between April and September 2024, combining unstructured interviews with purposively selected staff and users, observation of service delivery, and analysis of performance reports. Data were analyzed with the Miles and Huberman interactive model, using Rogers' five innovation attributes as deductive codes. The application offered clear relative advantage through remote access and shorter queues, fitted existing procedures, and was relatively easy to use. The service, however, stopped at payment: the vehicle registration certificate still had to be ratified in person within 90 days, because roadside checks recognize only ratified documents. Main barriers were limited public understanding, uneven digital literacy, and weak feedback and evaluation mechanisms. We interpret the case as partial digitalization, in which an innovation removes administrative burden at one stage while inter-agency dependence keeps it at another. Policymakers should design digital tax services end to end, including data and authority sharing with the police, and keep assisted channels for digitally vulnerable citizens. Findings come from one service office and a limited number of informants, so they transfer analytically rather than statistically.

Keywords: Partial Digitalization; Diffusion of Innovations; Administrative Burden; Mobile Government; Vehicle Tax

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INTRODUCTION

Digital transformation has become a central agenda of public administration reform. Governments introduce online portals and mobile applications in the expectation that services will become faster, cheaper, and easier for citizens to reach (Dunleavy et al., 2006; Janowski, 2015; Mergel et al., 2019). Tax administration was among the first areas to be digitized because its transactions are standardized and recur at fixed intervals (Schaupp et al., 2010). At the subnational level, digitizing motor vehicle tax matters for two reasons. For citizens, it promises to cut the time spent queuing and the informal payments demanded by brokers. For governments, it is a tool to sustain taxpayer compliance and own-

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source revenue, which in turn supports the effective and accountable institutions targeted by Sustainable Development Goal 16 (United Nations, 2015).

The digital government literature also warns that digitization does not automatically simplify citizens' dealings with the state. Digital self-service can transfer administrative work from caseworkers to citizens (Madsen et al., 2022) and can create new learning, compliance, and psychological costs (Herd & Moynihan, 2018; Moynihan et al., 2015). Early stage models of e-government already noted that fully integrated services require processes and databases to be joined across functions and agencies, not merely the addition of an online transaction channel (Layne & Lee, 2001). Adoption studies add that citizens respond differently to services at different levels of maturity, so that an application which only informs or collects payment is judged by different criteria than one which completes the whole transaction (Shareef et al., 2011). The relevant question is therefore not only whether a digital innovation is adopted, but also how much of the service chain has actually moved into the digital channel.

In Indonesia, public service innovation has a normative basis in Law No. 23 of 2014 on Regional Government, Government Regulation No. 38 of 2017 on Regional Innovation, and Ministerial Regulation of the Minister of Administrative and Bureaucratic Reform No. 30 of 2014 on Guidelines for Public Service Innovation. These rules encourage local governments to develop innovations that improve the efficiency, effectiveness, and quality of services. Motor vehicle tax is a provincial tax under Law No. 1 of 2022 on Financial Relations between the Central Government and Regional Governments, and it is one of the main sources of own-source revenue for provinces. Its administration is shared, however. The province collects the tax, while the national police register vehicles and ratify registration documents, and the two tasks are brought together in one-roof Samsat offices. This shared arrangement is the background against which any digital innovation in vehicle tax services has to be assessed. One frequently studied example is Samsat Mobile Jawa Barat (SAMBARA), a mobile application that allows owners of motor vehicles in West Java to check and pay their annual motor vehicle tax remotely. Earlier studies have assessed SAMBARA positively in terms of user acceptance (Mulyadi et al., 2021), the quality of government-to-citizen services (Alia & Utami, 2023), smart governance (Handayani et al., 2022), and public service innovation measured against Rogers' attributes (Mubarok et al., 2024). These studies are largely descriptive, however, and they do not connect the limitations of the application to the wider theoretical debate on the limits of digitizing public services.

Performance data suggest that the introduction of the application was not followed by stable revenue gains. In the Bandung II Kawaluyaan revenue office, which serves part of the city of Bandung, motor vehicle tax realization reached 102.27 percent of its target in 2018, the year SAMBARA was launched, but fell to 97.51 percent in 2019 and 85.34 percent in 2020, before recovering to 102.54 percent in 2021 and 98.95 percent in 2022 (Rudi et al., 2023). In 2019, 144,563 vehicles in the same service area, 136,809 two-wheeled and 7,754 four-wheeled, had not been re-registered because their owners had not paid the tax (Rudi et al., 2023). Preliminary observation also indicated that many taxpayers did not understand how the application worked, that most still paid in person, and that transactions through the application were often rejected or slow because the system was still being developed.

Although considerable research has examined why citizens accept or reject digital public services, less attention has been paid to how the design of the service chain conditions the advantage that an innovation can deliver. Innovation attributes explain why an innovation is accepted or resisted (Rogers, 2003), whereas the design of the service chain determines how much of that advantage users can actually obtain. Studies of SAMBARA have examined the first question without the second. Mubarok et al. (2024), for instance, also applied Rogers' attributes to the application and noted that a visit to the Samsat office remained necessary at the final stage, but treated this as one implementation obstacle among others rather than as a feature of service design that conditions every attribute. To address this gap, the study asks three questions: (1) how do the five innovation attributes appear in the implementation of a mobile application for vehicle tax payment; (2) what barriers constrained its implementation; and (3) what measures were taken or proposed to overcome those barriers?

The article makes two contributions. Conceptually, it proposes the notion of partial digitalization to describe innovations that digitize the transaction stage while keeping the verification stage face to face, and it shows how this condition limits the relative advantage that Rogers' framework would otherwise predict. Practically, it offers lessons for local governments in developing countries that design mobile tax services, especially regarding inter-agency integration and support for digitally vulnerable users. The remainder of the article reviews the literature and sets out the analytical framework, describes the

methods, presents and discusses the findings, and closes with conclusions and suggestions for future research.

LITERATURE REVIEW

Public Sector Innovation and Digital Services

Public sector innovation is understood as the introduction of new ideas, processes, or services, or the adaptation of existing ones, into public organizations with the aim of creating public value. The systematic review by De Vries et al. (2016) found that most studies concentrate on the antecedents and types of innovation, while outcomes for citizens remain under-examined. Indonesian regulation follows a similar understanding. Ministerial Regulation No. 30 of 2014 defines public service innovation as a breakthrough in the type of service, whether an original creative idea or an adaptation, that benefits the public directly or indirectly. An innovation therefore need not be an invention; it may be a contextual new approach or the extension and improvement of an existing one.

Innovation is no longer treated as an internal matter of bureaucracy. The New Public Governance paradigm stresses that public services are produced by multiple interdependent actors and organizations (Osborne, 2010), and the literature on collaborative innovation shows that cooperation across organizations can widen the pool of ideas and ease implementation (Torfing, 2019). Digitalization also changes frontline work. Decisions and encounters that once took place at the counter move into information systems, so that system design increasingly shapes what citizens experience (Bovens & Zouridis, 2002; Lindgren et al., 2019). The value that e-government creates for citizens accordingly depends on whether these systems actually improve service quality, responsiveness, and access, rather than on their technical availability alone (Twizeyimana & Andersson, 2019).

Research on e-government adoption shows that citizens' intention to use online services depends on perceived usefulness, ease of use, compatibility with existing habits, and trust in both government and technology (Carter & Bélanger, 2005; Davis, 1989; Venkatesh et al., 2003). For electronic tax services, Schaupp et al. (2010) found that performance expectancy, perceived risk, and trust shaped taxpayers' intention to file online. Shareef et al. (2011) went further, showing that the factors that drive adoption change as a service moves from publishing information to interaction, transaction, and integration. Tolbert and Mossberger (2006) linked e-government to trust in government, but only where online services improved responsiveness and access in ways that citizens could perceive. Taken together, these studies explain individual acceptance well but say little about what happens when the stage that matters most to the user is not digitized at all.

Rogers' Innovation Attributes as an Analytical Framework

This study draws on Rogers' diffusion of innovations theory (Rogers, 2003), which has also been adapted in Indonesian studies of public sector innovation (Suwarno, 2008). Rogers identified five attributes that affect the rate of adoption. *Relative advantage* is the degree to which an innovation is perceived as better than the practice it replaces, in economic terms, convenience, or satisfaction. *Compatibility* is the degree to which it is perceived as consistent with the existing values, past experience, and needs of potential adopters. *Complexity* is the degree to which it is perceived as difficult to understand and use. *Trialability* is the degree to which it can be tried on a limited basis. *Observability* is the degree to which its results are visible to others. In general, innovations with greater relative advantage, compatibility, trialability, and observability, and with lower complexity, are adopted more rapidly.

We chose this framework because it places adopters' perceptions at the center of analysis and has been applied to innovation in public organizations (Damanpour & Schneider, 2009). Its application to digital public services has one limitation that matters for this case. The attributes tend to be treated as properties of the innovation itself, whereas in public services the advantage that citizens perceive is also shaped by service stages that lie outside the innovation's control.

Partial Digitalization and Administrative Burden

To address this limitation, we complement Rogers' framework with the administrative burden perspective. Moynihan et al. (2015) define administrative burden as the costs that citizens experience in their interactions with the state. These comprise learning costs (finding out about a service and its procedures), compliance costs (meeting requirements and providing documents), and psychological costs (stress, stigma, or loss of autonomy). Herd and Moynihan (2018) argue that such burdens result from policy and administrative design choices, not merely from procedures as such.

Digitalization can reduce these burdens, but it can also shift them. Madsen et al. (2022) show that digital self-service turns citizens into "accidental caseworkers" who must complete tasks that officials previously handled. Layne and Lee (2001) show that services which digitize transactions without vertical

and horizontal integration across agencies still force citizens to deal with several separate channels. We call this condition partial digitalization: an innovation moves one or more service stages into a digital channel, while other stages still require physical presence because authority, verification, or databases have not been integrated.

Combining the two perspectives yields the analytical framework of this study. Rogers' five attributes are used to read how users and providers perceive the application. The administrative burden perspective and the notion of partial digitalization are used to explain why the relative advantage of the application may be held back by stages that remain offline, and why adoption barriers arise not only from users but also from service design and inter-agency coordination.

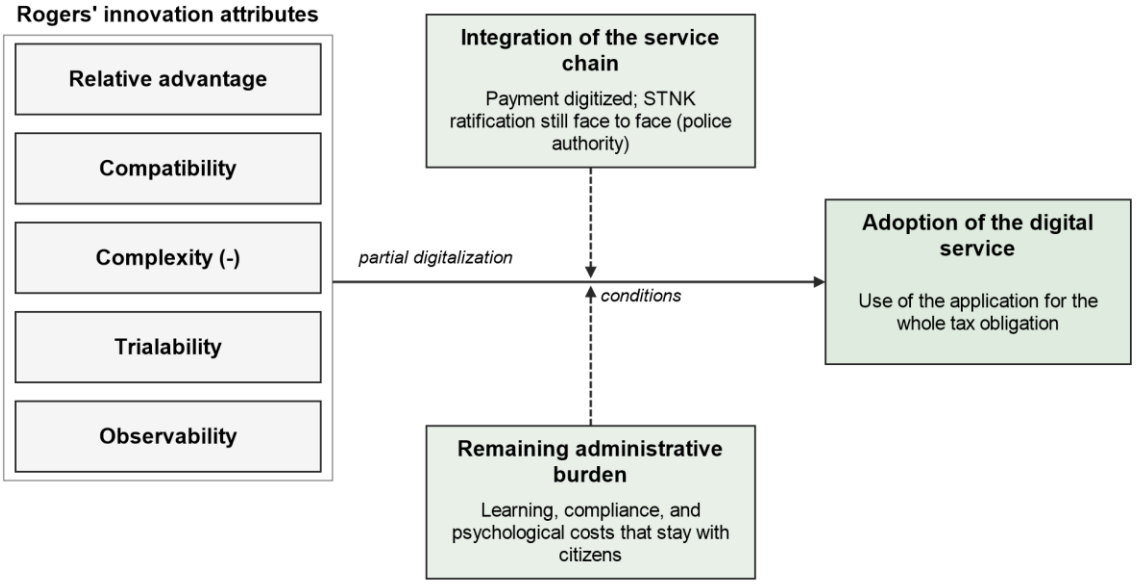

Fig. 1 Analytical framework: Rogers' five innovation attributes shape adoption, conditioned by the integration of the service chain and by the administrative burden that remains (authors' elaboration)

MATERIALS AND METHODS

Research Design and Case

We used a qualitative descriptive approach with a single case study design. A case study suits research that seeks to understand a contemporary phenomenon in its real-life context, especially when the boundary between phenomenon and context is not clear (Yin, 2018). The case is SAMBARA, developed by the Regional Revenue Agency (Badan Pendapatan Daerah, Bapenda) of West Java Province, Indonesia. The standalone application can be downloaded from Google Play for Android devices; on iOS the service is reached through the provincial super-app Sapawarga (Mubarok et al., 2024). It provides motor vehicle tax information for two- and four-wheeled vehicles, payment codes, schedules of mobile tax offices (Samsat Keliling, SAMLING, and Samsat Gendong, SAMDONG), office locations, and a channel for complaints and suggestions. Earlier studies report that the application was launched in 2018 (Handayani et al., 2022; Mulyadi et al., 2021).

The case was selected for two reasons. First, SAMBARA is a typical example of a mobile application introduced by a subnational government for tax services in a developing country. Second, its design separates the payment stage, which is digital, from the ratification of the vehicle registration certificate (Surat Tanda Nomor Kendaraan, STNK), which is face to face. This separation makes it possible to observe where the digitalization of a public service stops and why.

Informants and Data Collection

Fieldwork took place at the Bapenda office of West Java Province in Bandung over approximately six months, from April to September 2024. Informants were selected purposively for their knowledge of how the application was managed and used. They included staff of the Samsat service office, staff of the Planning and Development Division of Bapenda, other relevant officials, and members of the public who used the application.

Data were collected through three techniques. First, unstructured interviews were conducted with an open interview guide, audio-recorded, and transcribed. Interviews were held in Indonesian, and the

excerpts reported below were translated into English by the authors. Second, participant observation of the service process and of the use of the application was recorded in field notes. Third, we analyzed documents, namely the Government Agency Performance Reports (Laporan Kinerja Instansi Pemerintah, LKIP) of Bapenda West Java for 2020 and 2021, the agency's official website, relevant regulations, and prior studies.

Data Analysis and Trustworthiness

Data were analyzed with the interactive model of Miles and Huberman (1994), which consists of three concurrent streams of activity: data condensation, data display, and conclusion drawing and verification. During condensation, field notes and transcripts were summarized, coded, and sorted according to Rogers' five attributes (deductive codes) and according to categories of barriers and measures that emerged from the data (inductive codes). During display, the coded data were arranged in matrices by attribute and by category. During conclusion drawing, patterns and relationships between categories were interpreted and checked repeatedly against the data.

The two sets of codes served different purposes. The deductive codes allowed each account to be located within Rogers' framework, while the inductive codes captured what the framework did not anticipate. The most important of these was the ratification requirement. It surfaced in accounts coded under trialability, but in the display matrices it also bore on relative advantage and complexity, although none of the five attributes refers to it directly. During interpretation we therefore traced how this requirement qualified the findings under each attribute, and this step led to the notion of partial digitalization used in the Discussion.

Trustworthiness was addressed through source triangulation, comparing the accounts of staff with those of users, and method triangulation, comparing interviews, observation, and documents (Lincoln & Guba, 1985). Where staff accounts and observation diverged, for example on how often transactions failed, we report both and treat the discrepancy as a finding rather than resolving it in favor of one source. The fieldwork was carried out by a member of the research team as part of an undergraduate thesis project. Interviews were conducted with an open guide so that informants could raise issues beyond the initial framework.

Research Ethics

All informants took part voluntarily after being told the purpose of the study, and their identities are anonymized in this article. The study was conducted with the cooperation of the agency, and data were used only for the purposes of this research.

RESULTS AND DISCUSSION

The results are presented in the order of the three research questions: how the five innovation attributes appeared in implementation, the barriers encountered, and the measures taken or proposed. Table 1 summarizes the findings for each attribute. The discussion that follows interprets these findings against the analytical framework.

Innovation Attributes in the Implementation of the Application

Relative Advantage

The relative advantage of the application lay in allowing taxpayers to reach motor vehicle tax services without visiting a service office. Through the "Info PKB" menu, users enter the vehicle registration number to see vehicle details and the amount of tax due, and then obtain a payment code that can be used through SMS banking, internet banking, or e-Samsat. The application also lists the schedules of SAMLING and SAMDONG, office locations, phone number updates, ownership protection, user guides, payment receipts, and a complaints channel. A staff member of the Planning and Development Division described the core service as follows:

> *"SAMBARA stands for Samsat Mobile Jawa Barat. When it was first launched it was an Android-based system, so we provided motor vehicle tax payment through the Android application, where taxpayers or the public can obtain a payment code to pay their vehicle tax." (Informant 1, Planning and Development Division)*

By building on the mobile phone, which has become an everyday instrument for transactions, the service moved closer to citizens and became available at any time and place. The application had limits, however. It displayed only tax-related information, could not be used to check the name or identity of the

vehicle owner, and as a standalone application was available only for Android, with iOS users directed to the Sapawarga super-app.

Compatibility

The application was developed in response to problems that taxpayers faced: long queues, convoluted procedures, hours spent renewing the STNK, and costs inflated by brokers. It extended earlier innovations, namely a web-based tax information service on the Bapenda website, which did not support transactions, and e-Samsat, which allowed tax payment and STNK ratification through partner bank ATMs. Payment through the application followed in principle the same procedure as payment at the office; what differed was the tool used. These observations indicate a high degree of compatibility with existing procedures and with citizens' everyday use of mobile phones.

Complexity

The application was easy to download from the Play Store and could be used immediately. Most of its features were easy to understand, and the procedure was almost identical to payment at the office, while being faster because no queuing was needed. Staff nevertheless reported that implementation in the community met problems, and these are taken up in the barriers described below.

Trialability

Users we interviewed found the application fairly easy to use and helpful, mainly because it removed the need to queue. The application also allowed a low-commitment trial. A taxpayer could download it free of charge, open "Info PKB," enter the registration number and plate color (black for private vehicles, red for government vehicles, yellow for public transport), and see the tax and non-tax charges due before deciding to proceed. Only after selecting "Continue online registration?" and entering the identity card or taxpayer number and the last five digits of the chassis number did the user receive a payment code.

What could not be tried in this way was the full service. After payment, the taxpayer received an e-mail notification of the payment status, which had to be printed and brought to a Samsat office together with the original STNK, an identity card, and photocopies, so that the STNK could be ratified within 90 days of payment. Ratification remained necessary because, during roadside checks, the police recognize only ratified vehicle documents, even when the tax system shows that the tax has been paid. Users identified this stage as the part of the service that still caused difficulty.

Observability

The application was developed to help raise own-source revenue from motor vehicle tax at a time when, according to Bapenda data, about 30 percent of vehicle owners were in arrears. Bapenda ran other innovations with the same aim in 2020. Staff reported that the application was widely used and was recognized as making payment easier, so that its benefits were visible not only to citizens but also to the

provincial and district governments. The fluctuating revenue figures reported in the Introduction, however, indicate that these benefits did not translate consistently into aggregate results.

Table 1. Summary of findings by Rogers' innovation attributes

Attribute	Main finding	Supporting conditions	Limiting conditions
Relative advantage	Remote access to vehicle tax services; payment code; service information	Mobile phones already used for daily transactions	Standalone app for Android only; tax information only
Compatibility	Same procedure as office payment; continues the web service and e-Samsat	Responds to queues and brokerage	Does not yet reach citizens who prefer conventional channels
Complexity	Easy to download; most features easy to understand	Procedure already familiar to taxpayers	Transactions sometimes rejected or slow
Trialability	Tax due can be checked before committing to payment	Clear step-by-step process	STNK ratification remains face to face (within 90 days)
Observability	Widely used and recognized as easier	Supported by other revenue innovations	Revenue fluctuates; about 30 percent of vehicles in arrears

Source: compiled from research data, 2024.

Barriers to Implementation

Three main barriers emerged. The first concerned public awareness and acceptance. Some citizens did not fully understand the mobile service or were not comfortable using it, and people of different generations, places of residence, and backgrounds needed time to move from conventional to digital service. The second concerned social and cultural constraints. Some groups were not used to technology or preferred traditional ways of paying, so equal access across the population was not guaranteed. The third concerned feedback and evaluation. Without sound mechanisms for collecting user feedback and evaluating performance, the agency found it difficult to judge whether the innovation was effective and met public needs, which risked leaving the service undeveloped. In addition, observation recorded technical problems, as transactions were often not processed or the service responded slowly while the system was still under development.

Measures to Overcome the Barriers

Informants described four kinds of measures, some already under way and others proposed. The first was education and outreach, through campaigns on the benefits and use of the application, combined with technical assistance through a service center or helpdesk. The second was stronger security, using encryption and regular security audits to protect personal data and transactions. The third was inter-agency coordination, in particular closer cooperation with the police and other government agencies to integrate services. The fourth was a user feedback system and periodic evaluation of service performance and system effectiveness, followed by adjustments based on the results.

Relative Advantage Held Back by an Offline Stage

The finding that the application had relative advantage, compatibility, and low complexity agrees with earlier studies of the same application (Handayani et al., 2022; Mulyadi et al., 2021) and with adoption research that treats usefulness and ease of use as the main drivers of uptake (Carter & Bélanger, 2005; Davis, 1989). Following Rogers (2003), such a configuration of attributes should have led to rapid adoption. Observation nevertheless showed that many taxpayers still paid in person.

Our findings offer an explanation for this apparent paradox. The relative advantage of the application was held back by STNK ratification, which still had to take place face to face. For a taxpayer, the application removed one queue, but a visit to the office remained necessary. Compared with paying at the office, where payment and ratification are completed in a single visit, the application offered less than its features suggested. This reading suggests that, in public services, relative advantage is not solely a property of the innovation; it also depends on the design of the whole service chain. The point is consistent with the observation by Shareef et al. (2011) that citizens evaluate services differently at different maturity levels, but it locates the source of the difference in inter-agency arrangements rather

than in user perceptions. Read this way, Rogers' framework gains an institutional dimension that diffusion studies of public sector innovation seldom address.

Partial Digitalization as a Shift in Administrative Burden

From the administrative burden perspective (Herd & Moynihan, 2018; Moynihan et al., 2015), the application reduced compliance costs at the payment stage, namely time spent queuing and the cost of brokers. At the same time, it added new learning costs, such as downloading the application, understanding the steps, and identifying plate colors and chassis numbers, and it kept compliance costs at the ratification stage, which required printing the receipt, bringing original documents and photocopies, and visiting within 90 days. This pattern mirrors the finding of Madsen et al. (2022) that digital self-service can transfer administrative work to citizens. In this case, citizens had to manage two separate channels to discharge a single obligation.

The cause of partial digitalization in this case was institutional. STNK ratification involves the authority of the police, so an innovation developed by one agency could not complete the whole service chain on its own. This situation reflects the warning by Layne and Lee (2001) that fully functional digital services require horizontal integration across agencies, and the New Public Governance argument that service outcomes depend on interactions among multiple organizations (Osborne, 2010). The inter-agency coordination identified in this study is therefore not a supporting measure but a precondition for the full relative advantage of the innovation to reach users. The point is underlined by developments outside the province. The national police later offered electronic ratification through their own application, SIGNAL, yet in 2026 the head of Bapenda West Java still explained that payment through SAMBARA produced only an electronic proof of payment and that ratification required a visit to a Samsat office or to a police partner (IDN Times Jabar, 2026). The technical means for a digital ratification thus existed, but in a separate channel controlled by another agency, so that the citizen, not the system, had to connect the two.

Adoption Barriers: From Digital Literacy to Weak Feedback

Limited understanding and socio-cultural constraints indicate that adoption was shaped by the digital divide, which concerns not only access to devices but also skills and motivation to use them (Van Dijk, 2020). The fact that the standalone application ran only on Android, with iOS users sent to a separate super-app, may also have confused users of other devices. These findings suggest that conventional channels should remain available for digitally vulnerable groups, so that digitalization does not create new inequalities in access to services. The point also bears on the public value of e-government, since an application that serves only skilled and well-equipped users produces efficiency for some citizens while leaving others with the old burdens (Twizeyimana & Andersson, 2019).

Weak feedback and evaluation mechanisms are consistent with the observation by De Vries et al. (2016) that the outcomes of public sector innovation are rarely measured systematically. The fluctuating revenue figures in the Kawaluyaan office, above target in 2018 and 2021 but below it in 2019, 2020, and 2022, cannot be attributed directly to the success or failure of the application, because tax revenue depends on many other factors, including economic conditions during the COVID-19 pandemic in 2020. This limitation underlines the need for specific evaluation indicators, such as the number of transactions through the application, the share of successful transactions, and user satisfaction, so that the contribution of the innovation can be assessed properly.

Measures to Address the Barriers in Light of the Framework

The measures reported by informants map onto the barriers in uneven ways. Outreach and helpdesks address learning costs, which are the most visible part of administrative burden for first-time users (Moynihan et al., 2015). They do little, however, about the compliance costs of the ratification stage, which arise from service design rather than from users' lack of knowledge. An outreach campaign that teaches taxpayers how to obtain a payment code without changing the requirement to visit an office within 90 days would improve the experience of the digital stage while leaving the offline stage as it was.

The emphasis on security reflects the role of trust in the adoption literature. Carter and Bélanger (2005) found that trust in the government and in the internet both affect intention to use e-government, and Schaupp et al. (2010) found that perceived risk lowers taxpayers' willingness to file electronically. Security measures can therefore support uptake, but only among users who already have the skills and devices to reach the application. Their effect on the digital divide described above is likely to be limited.

Inter-agency coordination is the only measure that addresses the cause of partial digitalization directly. Its inclusion among the measures suggests that providers were aware that the application could not deliver its full advantage while ratification remained offline. Yet coordination with the police lies beyond the authority of the revenue agency, and its outcome depends on arrangements negotiated at the

provincial and national levels. Feedback and evaluation, finally, would make the effect of these measures visible over time. Without them, the agency cannot tell whether outreach increases use, whether security concerns deter users, or how many payments made through the application are followed by timely ratification. The measures are thus complementary, but only coordination and evaluation reach the institutional conditions that our analysis identifies as decisive.

Theoretical and Practical Implications

Theoretically, the study suggests that Rogers' innovation attributes need to be read together with the design of the service chain and the administrative burden that remains when they are applied to digital public services. The notion of partial digitalization offers a concept that can be examined in other services involving several agencies, such as licensing, civil registration, and social security.

For local governments developing mobile tax services, three practical implications follow. Innovations should be designed end to end, including data integration and agreements on authority with other agencies, so that verification can also take place digitally. Outreach, helpdesks, and assisted channels should be provided for digitally vulnerable groups. Data security and indicator-based feedback and evaluation should be built in from the start, so that the innovation can be improved continuously. These steps also serve the sustainability of local revenue, because a tax service that citizens can complete without brokers and repeated visits lowers the cost of compliance for the many vehicle owners who are currently in arrears.

CONCLUSION

This study found that the mobile vehicle tax application examined had clear relative advantage, fitted existing procedures and citizens' habits, was relatively easy to use, could be tried before committing to payment, and was recognized by users and government as beneficial. The service, however, stopped at payment, while STNK ratification still had to be done in person. This condition of partial digitalization held back the relative advantage of the application and preserved part of the administrative burden on citizens. Barriers to implementation stemmed from limited public understanding and acceptance, socio-cultural constraints in the use of technology, and weak feedback and evaluation mechanisms. Measures taken or proposed included outreach and technical assistance, stronger system security, inter-agency coordination, and evaluation based on user feedback.

The main contribution of the article is to show that the adoption of digital public service innovations depends not only on their attributes but also on the extent to which the whole service chain is integrated across agencies. Where the decisive stage of a service remains offline, a well-designed application can deliver only part of the benefit that diffusion theory would predict.

SUGGESTION FOR FUTURE RESEARCH

The study has several limitations, each of which points to further research. As a qualitative single case study with a limited number of informants, its findings transfer analytically to similar settings but cannot be generalized statistically. Future studies could test an adoption model that combines Rogers' attributes with measures of administrative burden on a larger sample of taxpayers, for example through a survey of registered vehicle owners in several service areas.

Data were collected at a single service office and drew more on providers than on users, which may have led to a more favorable picture of the application than users would give. Research that gives greater weight to users, including those who have stopped paying vehicle tax, would show whether partial digitalization contributes to arrears. Comparative research between provinces, or between countries that have and have not integrated vehicle document ratification into digital channels, would allow the effect of integration to be isolated.

Finally, the study did not measure the use of the application or its relationship with tax revenue. Analysis of administrative transaction data, linking application use to payment timeliness and arrears,

would make it possible to assess the contribution of the application to tax compliance more directly than interviews allow.

CO-AUTHOR CONTRIBUTION

The authors declare no conflict of interest in this article. All authors contributed to the conception and design of the study, the analysis and interpretation of the data, and the writing and revision of the manuscript, and all authors approved the final version.

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