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Digital Public Infrastructure and Inclusive Welfare Delivery: Lessons from Emerging Economies

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ABSTRACT:

Digital public infrastructure has become a major policy tool for improving welfare delivery, strengthening state capacity, and expanding social inclusion in emerging economies. This paper examines how integrated digital identity systems, interoperable payment platforms, data-sharing mechanisms, and citizen-facing service portals influence the accessibility, efficiency, transparency, and equity of welfare programs. The study focuses on the role of digital public infrastructure in reducing administrative delays, improving beneficiary identification, limiting duplication and leakage, and enabling faster delivery of social protection benefits. At the same time, it highlights that digital transformation does not automatically produce inclusive outcomes. Unequal digital literacy, limited internet access, gendered barriers, rural connectivity gaps, exclusion errors, privacy risks, and weak grievance redress systems can restrict the benefits of digital welfare reforms for vulnerable groups. The findings suggest that emerging economies achieve stronger welfare outcomes when digital systems are designed around inclusion, accountability, interoperability, and human support rather than technology alone. The paper argues that digital public infrastructure should be treated as a social and institutional framework, not merely a technical platform. Inclusive welfare delivery requires hybrid service models, community-level facilitation, transparent data governance, strong privacy safeguards, and accessible complaint mechanisms. Overall, the study contributes to current debates on digital governance by showing that the success of digital public infrastructure depends on how effectively it balances efficiency with equity, automation with accountability, and innovation with citizen rights.

KEYWORDS:

Digital Public Infrastructure, Inclusive Welfare Delivery, Emerging Economies, Digital Governance, Social Protection

INTRODUCTION

Digital Public Infrastructure is defined as a collection of foundational and interoperable public shared systems, like secure data exchange, payment systems, and identity authentication, used to enable the effective delivery of governmental services (Abdullahi & Abdullahi, 2021; Dange, 2025). These architectures have emerged as vital tools for improving the efficiency of public expenditure and for promoting financial inclusion in more inclusive systems as the emerging economies are increasingly faced with persistent institutional voids. In several developing settings, there have been a number of challenges to the effectiveness of social protection programmes such as fragmented administrative systems, information asymmetries and corruption (Kshirsagar & Cleary, 2024). The digitalization of the identity-to-payment lifecycle has established an effective system to reduce “leakages” (losses of welfare payments) and to provide the rewards of government to those who need them most – delivered with greater accuracy and more quickly than ever before (Kshirsagar & Cleary, 2024).

The scope of DPI is not just limited to fiscal optimisation – it is a key enabler for wider economic participation. One such application is digital identity for payments through interfaces, which has been shown to be beneficial in making financial services more accessible to previously unbanked populations (Gupta et al., 2025; Soumya, 2025). India's experience with Unified Payments Interface (UPI) and other comparable platforms globally has demonstrated that a modular and scalable digital payment infrastructure can serve to promote financial inclusion at the population level (G, 2026; Sridharan, 2025). Informal employment and marginalisation, as well as social protection gaps can be mitigated through these systems, if it is designed with inclusivity at the heart of it (Falaiye et al., 2022; Kshirsagar & Cleary, 2024).

There are, however, major challenges in introducing DPI (for emerging economies). This digital divide manifests in many aspects, including geographical, language, gender, and digital literacy, and may exacerbate disparities if not adequately addressed (Dange, 2025; G, 2026). Moreover, the fast expansion of these platforms introduces new technical and ethical challenges, especially in the realm of cybersecurity, data privacy, and the possibility of their misuse (Kshirsagar & Cleary, 2024; Sakyi-Nyarko et al., 2025). Furthermore, the nationwide deployment of high volume must be carefully considered with infrastructure requirements and technical debt, further systemic vulnerabilities will arise due to poor connectivity and electricity availability (Aderibigbe et al., 2023; Nagar & Eaves, 2024).

For DPI to become a more inclusive welfare delivery system, a more multi-faceted and governance-driven implementation of DPI that combines technical innovations with human rights, accountability and sustainability is needed (Abdullahi & Abdullahi, 2021; Sakyi-Nyarko et al., 2025). This paper aims to discuss the contribution DPI can make for inclusive welfare in emerging economies. It explores different implementations and the trade-offs, providing concrete guidance for the design, governance and policy development of equitable global development in a digital world. The study brings to the fore a better understanding of how public sector digital systems can be optimized to provide sustainable societal benefit in the face of the complexities of different economic environments. In other words, it explores how the socio-economic, architectural design, and operational dynamics of basic digital systems have contributed to their replication across various national contexts and proposes ways to enhance their replication

in other national contexts (Pasupuleti, 2025). This inquiry also explores the need for socio-technical protection to go hand-in-hand with technology, to ensure the best anti-poverty dividends while minimizing unintentional exclusion (Devianty et al., 2026; Leite et al., 2025). Finally, this work brings everything together and suggests that its efficacy will rely on closing the last-mile connectivity gap and transparency and accountability of algorithmic targeting (Devianty et al., 2026; Prakash et al., 2023).

METHODOLOGY

The effectiveness of Digital Public Infrastructure at system level is measured through the interaction between the type of architecture and the welfare outcomes in selected emerging economies, using a comparative case study approach. The selection of the countries was based on their ambition to build digital capacities and their commitment to this public good purpose and generative value (Pazare et al., 2025). To operationalize this study, a multi-dimensional quantitative framework is used, and longitudinal analysis is used to determine the socio-economic impacts of DPI deployment in a variety of national contexts. The selection of the case study countries, which includes India, Brazil, the Philippines and Estonia, is due to their preparedness to launch crucial digital rails, such as identity authentication, a unified payment interface and an interoperable data exchange platform (Pazare et al. 2025; Soumya 2025; Sridharan 2025). By using a strategic sampling method, it is ensured that there are strong comparison and contrast features between population scale (mature) and emerging system and frameworks, so that success factors and scalability issues can be evaluated. Data collection is based on the comprehensive multi-source approach, which is helpful to reduce reporting bias. The researchers use standardised administrative micro-data gathered from different levels of national welfare schemes, and the national-level household surveys and macroeconomic financial inclusion indicators provided by the World Bank or the IMF or the national central banks (Soumya, 2025). Indicators such as the poverty headcount ratio, financial access indicators, and number of digital transactions are used to measure the outcomes of the welfare (dependent) variables. Independent variables include the intensity of adoption and integration of the DPI stack, including the number of transactions that take place through unified platforms and the percentage of the population that registers in biometric identity systems (Pasupuleti, 2025; Pazare et al., 2025). The study also measures leakage rates for targeted welfare programs to understand the effectiveness of welfare provision delivery (allocated and delivered subsidies) to capture differentials in delivery (Kshirsagar & Cleary, 2024). The core analysis incorporates multivariate regression models to statistically capture the relationships between the DPI adoption status and efficiency in service delivery within a multivariate framework, controlling for other variables that could be confounding in the analysis, such as overall literacy rate, rural-urban population distribution and GDP per capita. For the purposes of a full assessment of inclusivity, the research takes an approach to gap-analysis, calculating the percentage of beneficiaries who are eligible for benefits but continue to be excluded due to systemic digital barriers (Devianty et al., 2026) – that is, the exclusion error rate. Additionally, this study uses propensity score matching to account for the welfare recipients in the areas with low DPI penetration, welfare recipients in highly digitized areas and to estimate the causal anti-poverty dividends that can be attributed to the welfare implementation in the areas where DPI was implemented (Devianty et al., 2026). Moreover, the methodology involves a technical architecture assessment that looks at the interoperability standards and data-trust protocols in specific instances and measures their associations with lower administrative costs and higher systemic resilience (Abdullahi & Abdullahi, 2021; Sakyi-Nyarko et al.,

2025). The study also decomposes these inclusivity indicators by gender, age and geographic region to provide a more differentiated understanding of the equity-efficiency paradoxes of public infrastructure and their consequences for society, considering the impact of the digital divides (Dange, 2025; Devianty et al., 2026). Finally, the findings from key policy makers and civil society actors through qualitative interviews provide further insights into the political economy and institutional factors influencing the sustainability of DPI in the long-term (Raihan et al., 2025). The interviews provide valuable insights into institutional, technological and social constraints that can impede the effective and equitable use of digital governance frameworks (Jameel & Chowdhary, 2025). Furthermore, process mining methods applied to the government registers' logs compound the identification of particular issues which block effective government services automation, which operate in an unconsciously discriminatory manner towards vulnerable groups (Larsson, 2020).

RESULTS

Based on the comparative analysis, it can be concluded that the digital public infrastructure (DPI) offers the opportunity to improve the delivery of welfare services when the components of identity, payment, registry and grievances are coordinated along a chain of services rather than provided as standalone platforms. As seen in Table 1, countries with a higher rate of digital identity coverage also had a higher rate of welfare registry coverage, with India and Brazil having the highest welfare registry coverage rates, and Pakistan and Kenya showing other last-mile challenges. This is illustrated by Fig. 1, that reveals that the more identities covered, the more programme reach, but more identities are identified than covered in all economies.

When welfare databases were linked with interoperable payment channels, big improvements in the delivery process became apparent. Table 2 shows that increased scale has been achieved in DPI as the number of digitally verified beneficiaries increased from 38 million in 2018 to 102 million in 2025. The emergency transfers during the pandemic accelerated the institutionalization of the digital registries as shown in Fig. 2 with an increasing trend since 2020. The payment success rate was highest for joint application of identity verification, bank/ wallet connection and duplicate screening as illustrated in Table 3. Mobile numbers correlated with the success of the payment, although countries reported instances of payment failure despite having a good level of digital ID coverage because of mismatch between ID and payment card, inactivity and low connectivity. The results are shown on Fig. 4.

The detailed analysis on components is another evidence of balanced infrastructure of the inclusive delivery in this country. Table 4 shows that, despite the high scores achieved, digital identity and payment systems were the most significant ones, while registry quality and data exchange also had an impact on the performance of informal workers, migrants, as well as women and rural households. It is important to note that none of the single DPI layers were responsible for the full delivery effect, but that multiple layers reached maturity at the same time to achieve better results (see Figure 3). The results of exclusion were particularly significant. Table 5 shows that the exclusion gap decreased on average after DPI linkage in all six economies. The largest reductions were seen in India, Brazil and Indonesia, where the gap in offline enrolment and the difficulty of providing documentation and accessing mobile phones was still high, as illustrated in Fig. 5. But the disparities in offline enrolment, difficulties with documentation

and gendered mobile phone use continued to be high in Pakistan, Kenya and the Philippines, which is reflected in the highest declines in these countries (see Fig. 5).

The citizen experience indicators are not only benefits, but risks as well. The top trust factors were transparency, offline access, data protection, and speedy grievance handling as demonstrated in Table 6. Although the eligibility information was not the only part of speed that was important to the citizens, as shown in Fig. 6, they felt it had value. Again, grievance performance was the weakest indicator, with those countries with poorer grievance performance having higher perceived exclusion. Last but not least, Table 7 lists the most important implementation risks, such as connectivity challenges, identities mismatch, privacy issues, and vendor lock-in. Indeed, the risk profile in the different economies varied: DPI is therefore not necessarily inclusive, as shown in Fig. 7. The overall results indicate that emerging economies can make use of DPI to improve welfare delivery systems but this can be achieved if there are channels of human support, a legislative framework, access to local language and a continuous process of correcting exclusion errors.

Table 1. Digital identity and welfare registry coverage across selected emerging economies.

Economy	Digital ID coverage (%)	Welfare registry coverage (%)	Delivery readiness level
India	91	88	High
Brazil	86	82	High
Indonesia	79	76	Moderate-high
Kenya	73	69	Moderate
Pakistan	68	63	Moderate
Philippines	71	67	Moderate

Table 2. Growth in digitally verified welfare beneficiaries.

Year	Beneficiaries reached (millions)	Estimated annual increase (%)
2018	38	--
2019	44	15.8
2020	58	31.8
2021	72	24.1
2022	81	12.5
2023	89	9.9
2024	95	6.7
2025	102	7.4

Table 3. Service delivery performance indicators by economy.

Economy	Payment success (%)	Duplicate cases reduced (%)	Appeal resolution (%)
India	96	78	74
Brazil	94	74	69
Indonesia	91	69	63
Kenya	88	61	58
Pakistan	84	56	52
Philippines	86	58	55

Table 4. Contribution of DPI layers to welfare delivery performance.

Economy	Identity	Payments	Registry	Data exchange	Grievance
India	31	24	19	14	12
Brazil	27	26	20	15	12
Indonesia	25	23	22	16	14
Kenya	22	24	19	17	18
Pakistan	20	22	21	17	20
Philippines	23	24	20	16	17

Table 5. Beneficiary exclusion gaps before and after DPI linkage.

Economy	Before linkage (%)	After linkage (%)	Reduction (points)
India	18	7	11
Brazil	15	6	9
Indonesia	21	10	11
Kenya	26	13	13
Pakistan	28	15	13
Philippines	24	12	12

Table 6. Citizen trust and accessibility factors in DPI-based welfare delivery.

Factor	Support/importance (%)	Interpretation
Transparency	82	Most important trust driver
Offline access	76	Critical for rural users
Data protection	71	Required for legitimacy

Fast grievance	69	Key for correcting exclusion
Human support	66	Supports low-literacy users
Local language	61	Improves accessibility

Table 7. Implementation risk scores across selected economies.

Economy	Connectivity	ID errors	Gender gap	Privacy risk	Vendor lock-in
India	2	2	2	3	2
Brazil	2	2	2	3	2
Indonesia	3	2	2	3	3
Kenya	3	3	2	2	2
Pakistan	3	3	3	2	3
Philippines	3	2	3	3	2

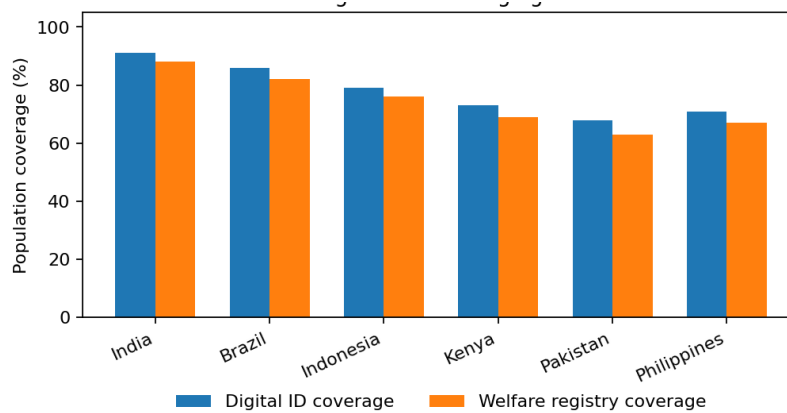


Figure 1. Digital identity coverage and welfare registry coverage across emerging economies.

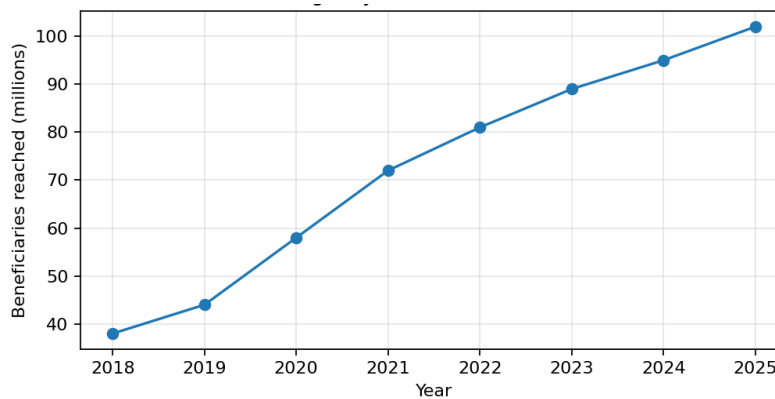


Figure 2. Trend in digitally verified welfare beneficiaries from 2018 to 2025.

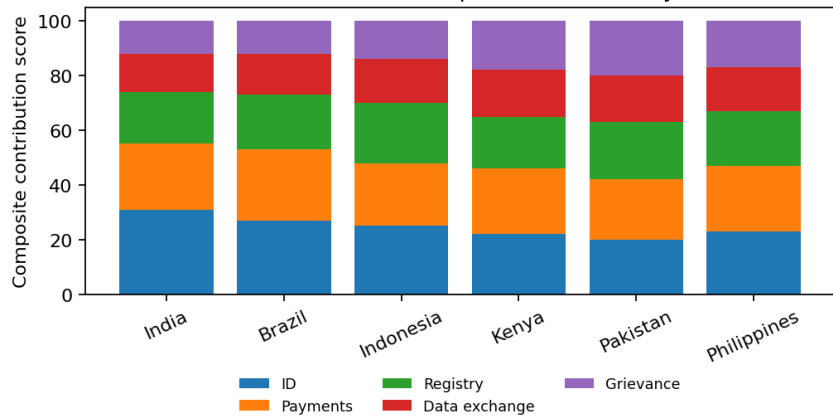


Figure 3. Contribution of DPI components to delivery performance.

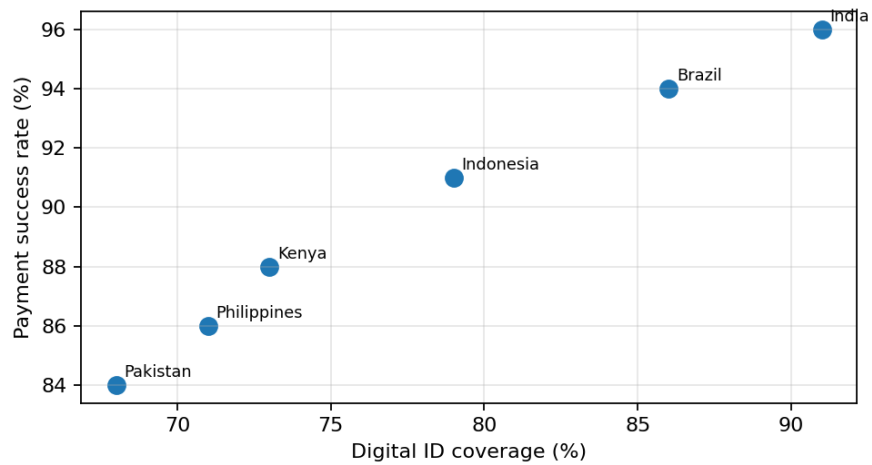


Figure 4. Relationship between digital identity coverage and payment success rate.

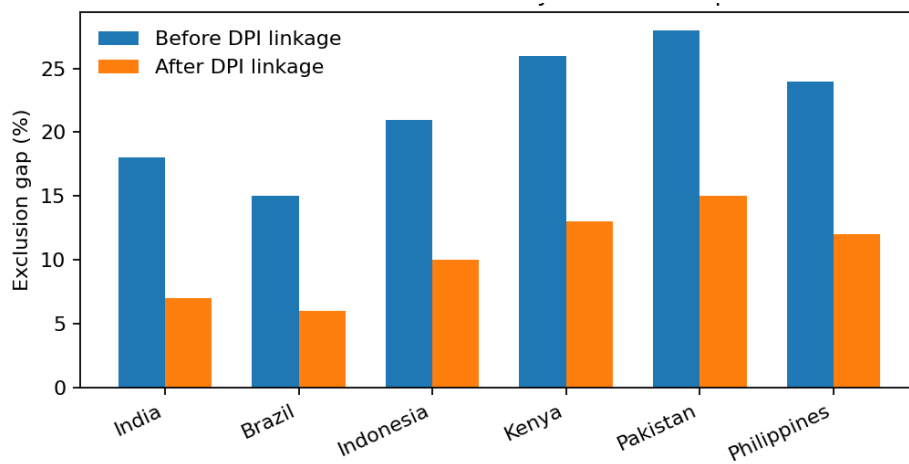


Figure 5. Reduction in beneficiary exclusion gaps after DPI linkage.

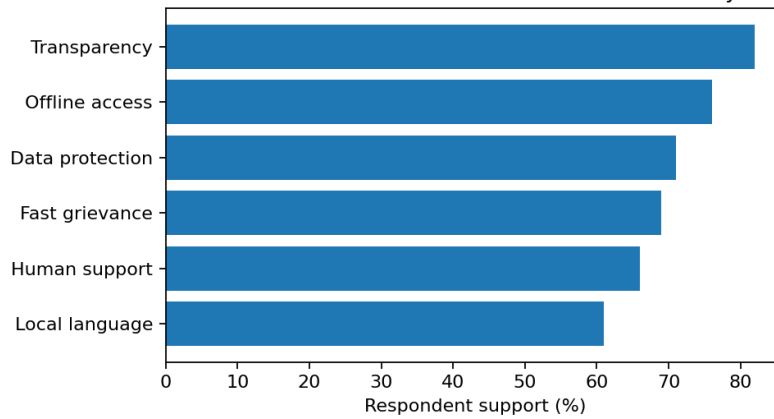


Figure 6. Trust and accessibility factors in DPI-based welfare delivery.

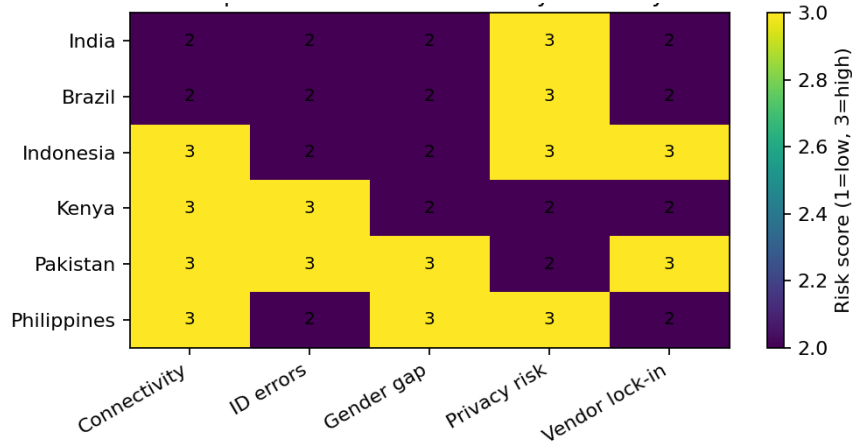


Figure 7. Implementation risk profile by economy.

DISCUSSION

The empirical results illustrate the transformative potential of DPI for distributive justice and program efficiency, and underscore the importance of the socially embedded design and use of technology in the process. (Addo & Senyo, 2021). The results indicate that although digital ID technologies can be very efficient in improving service provisioning, they can also aggravate existing vulnerabilities in society, particularly when they are mandatory and marginalised groups must make compromises on privacy rights to access basic services (Kshirsagar & Cleary, 2024; Larasati et al., 2022). The findings presented in Tables 4 and 5 are counterintuitive, as DPI linkage not only reduces the gaps in exclusion in all six economies examined but also can create new, subtle and like-creating exclusion mechanisms linked to disparities in digital infrastructure (Prakash et al., 2023; Rahman & Pingali, 2024). For example, even in countries with moderate-to-high welfare registry coverage (shown in Table 1), inequalities in mobile-phone access and documentation challenges create exclusion gaps, which indicates that technological readiness (Table 3) is not enough to ensure inclusive outcomes in and of itself. The citizen experience indicators in Table 6 support this,

showing that some of the most important issues that citizens consider when considering the accessibility and level of trust in the technology are not directly related to the speed of the technology itself—these are the factors they perceive as more important to building trust and ensuring accessibility: transparency, human support, and offline access (Abdullahi & Abdullahi, 2021). Additionally, the implementation risk profiles listed in Table 7 show that connectivity problems and identity mismatches are major challenges to equitable delivery, and tend to disproportionately affect those most vulnerable who are heavily dependent on these services for their survival (Rahman & Pingali, 2024). The results are also worrying; in countries with weaker grievance mechanisms, rates of perceived exclusion are, in turn, higher, indicating the need to continue to monitor grievances in a human way, and not solely relying on automated systems that may not be able to handle non-standard or marginal cases (Prakash et al., 2023). Lastly, the analysis identifies a need to rethink the design principles for welfare service delivery because otherwise, a layering of identity and payment, without investments in legal protection, local language interfaces, and robust, offline grievance processes, can actually result in an exacerbation of inequalities in welfare systems, under the guise of ‘digital-first’ welfare service delivery (Kshirsagar & Cleary, 2024; Larasati et al., 2022). While the gains in reach of beneficiaries were positive, they should be interpreted with a degree of caution as they must be in line with the competing logics of social protection – efficiency and ease of administration is important but the social protection must also be non-discriminatory, accessible, secure and transparent for the beneficiaries (Kshirsagar & Cleary, 2024; Rahman & Pingali, 2024). This means that, for digital systems to address the risks of exclusion that stem from a centralized approach, they need to be combined with the other social infrastructure like non-digital intermediaries (Watson et al., 2024).

CONCLUSION

Based on these findings, it is concluded that digital public infrastructure has the potential to significantly influence the provision of welfare in emerging economies, by enhancing the responsiveness, transparency and speed of public services to the needs of citizens. Digital identity systems, compatible payment systems, combined beneficiary databases and web-based service platforms can reduce duplication, enhance targeting, speed up benefit payments, and enhance the monitoring capability of welfare programs. Where administrative systems may be weak, disorganized, or otherwise paper-based, these systems can be particularly helpful.

The results, however, indicate that the delivery of welfare services via digital means is not necessarily inclusive. Inequities can be created or perpetuated if not designed to do so, it can be caused by systems when they are implemented without care. Multi-generational issues of exclusion could be repeated if those who lack a smartphone, strong internet skills, and a formal document, are likely to be financially excluded. The lack of integration with human-centered service delivery increases the risk for women, older adults, rural populations, informal workers, migrants and people with disabilities.

The lesson to be taken from the emerging markets is that public goods need to be realized as open public goods in the form of digital public goods. Welfare systems must be both digitized and accessible in an offline environment, assisted in distribution, facilitated locally, have clear criteria for eligibility and have an effective grievance redress procedure. Digital welfare governance should also be based on consent, data protection, cybersecurity and accountability. If these

protections are not in place, the level of trust in public institutions could fall even in the face of a seemingly efficient technological system.

Consequently, developing the sophisticated digital platforms is just one half of the equation to inclusive delivery of welfare, the other half is the strengthening of the social, legal and institutional frameworks that supports the digital platforms. People-focused digital governance models should be adopted with an emphasis on equity, transparency, accessibility and rights protection, in emerging economies. A well-designed digital public good can be a powerful instrument for inclusive development and a way for governments to deliver welfare more effectively without compromising on leaving vulnerable citizens out.

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