

THE INNOVATION PARADOX IN DEVELOPING ECONOMIES: WHY DIGITAL TRANSFORMATION DOES NOT GUARANTEE SUSTAINABLE DEVELOPMENT



Economics

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Abstract

The role of digital transformation in driving economic development has become a central topic in current economic and policy discussions, particularly for developing countries. Digitalization is frequently seen as a route to greater efficiency, improved competitiveness and broader participation in economic activities. But such expectations are not always met in practice. Despite rapid growth of technology and investments in digital infrastructure, many developing economies are plagued with structural unemployment, inequality and uneven development. This discrepancy between expectations and results raises a fundamental question on the real contribution of digital transformation to economic development. This structured literature review examines the nexus between digital transformation and sustainable development, with a special focus on the economic and institutional factors affecting this relationship in developing countries. This review synthesizes academic literature and international development reports on digitalization, technological capacities, economic development, inequality, productivity, institutional capacity and environmental sustainability. The literature is analyzed through four interrelated analytical dimensions: technological and absorptive capabilities; digital inclusion and inequality; productivity and value capture; and the environmental and institutional dimensions of digital transformation. The analysis shows that technological progress, without inclusive economic policies, investments in human capital and effective institutions, is not a sufficient condition for sustainable development. In those contexts, digitalization will not lead to structural transformation but rather to a reproduction of existing constraints. Results show that the relationship between digital transformation and sustainability is not linear or automatic. The impact will depend on how digital processes are embedded in wider economic systems and policy-making as digital transformation could exacerbate existing inequalities rather than promote sustainable and inclusive economic growth.

1. Introduction

Digital transformation has fundamentally changed the structure of modern economies. The rapid expansion of broadband networks, mobile technologies, cloud computing, artificial intelligence, digital platforms, big-data analytics, and digital financial services has created new possibilities for economic growth and social development. For developing economies, these technologies are particularly attractive because they may facilitate access to global markets, improve public-service delivery, reduce transaction costs, and allow countries to overcome some traditional barriers to development. Nevertheless, the relationship between digital transformation and sustainable development is more complex than a simple assumption that more technology produces more development. *The World Bank's World Development Report 2016: Digital Dividends* found that digital technologies had been rapidly adopted across the world, but the wider development benefits had not lived up to expectations and were unevenly distributed. The report argues that digital adoption does not occur in a vacuum, and countries need complementary institutional and economic conditions, including appropriate regulation, human skills, competition and accountable institutions (World Bank, 2016). This observation is closely related to the notion of the *innovation paradox*. Cirera and Maloney (2017) argue that developing countries are often characterized by huge opportunities to improve productivity through technological upgrading, yet firms and governments often invest too little in innovation and technological capabilities. Their analysis highlights that innovation requires parallel investment in human and physical capital, managerial

capacity, organizational learning and institutions. This is also the case for digital transformation. But just having advanced digital infrastructure and platforms for artificial intelligence or digital government doesn't mean you will get the same advances in productivity or welfare. Technology needs to be paired with the capabilities to effectively use it. Therefore, digital transformation should not be considered an end in itself, but a tool whose developmental effects depend on the economic, institutional and social environment it is introduced to. This paper explores why digital transformation does not necessarily ensure sustainable development in developing economies. It focuses on four interrelated dimensions: the innovation paradox and technological capabilities, the digital divide and inequality, the digitalization and productivity nexus and the environmental implications of digital transformation. The paper then discusses policy measures that can help developing economies convert technological adoption into more inclusive and sustainable development.

2. Review Methodology

2.1 Review Design

This study adopts a structured literature review approach to examine the relationship between digital transformation and sustainable development in developing economies. The approach is designed to provide a transparent and organized synthesis of relevant academic literature and international development reports rather than to conduct a statistical meta-analysis. The review was designed to provide a transparent and organized synthesis of relevant academic literature and international development reports. The methodological framework was selected because the literature examined in this study encompasses conceptual contributions, economic-development research, institutional analysis, policy reports, and studies addressing technological and environmental dimensions of digitalization. The diversity of these sources makes a qualitative thematic synthesis more appropriate than a statistical meta-analysis.

2.2 Research Focus and Review Questions

The review was organized around the following central question:

Why does digital transformation not necessarily translate into sustainable and inclusive economic development in developing economies?

The analysis was further guided by four subsidiary questions:

1. What technological and institutional capabilities determine whether developing economies can benefit from digital transformation?
2. How does digital transformation affect inequality and digital inclusion?
3. Under what conditions does digitalization contribute to productivity, innovation and domestic value creation?
4. What institutional and environmental conditions shape whether digital transformation contributes to sustainable development? These questions guided the organization and synthesis of the literature.

2.3 Search Strategy

Relevant literature was identified through academic and institutional sources addressing digital transformation, technological capabilities, innovation, economic development, inequality, productivity, institutions, and environmental sustainability. The academic search strategy focused on major scholarly databases and search platforms, including Scopus, Web of Science, and Google Scholar, while international development reports were identified through the publications of organizations such as the World Bank and United Nations Conference on Trade and Development (UNCTAD). The search strategy combined key concepts using Boolean operators.

Representative search terms included:

- “digital transformation” AND “developing economies”
- “digitalization” AND “economic development”
- “digital technologies” AND “sustainable development”
- “digital divide” AND inequality
- “digital transformation” AND productivity
- “technological capabilities” AND developing countries
- “absorptive capacity” AND innovation
- “digital economy” AND “developing countries”
- “digitalization” AND institutions
- “digital economy” AND environmental sustainability

Additional sources were identified through reference-list examination of relevant publications. Foundational theoretical contributions were retained where they provided an important conceptual basis for interpreting the more recent literature.

2.4 Inclusion Criteria

Sources were considered relevant when they met the following criteria:

1. They addressed digital transformation, digitalization, technological innovation, technological capabilities, or the digital economy.
2. They studied economic development, productivity, inequality, sustainable development, institutions or related development outcomes.
3. Their work either involved developing economies or offered theoretical insights that could be applied in developing country contexts.
4. They were published as peer-reviewed academic articles, scholarly books or reports, or authoritative international development reports.
5. Conceptual, empirical or policy-relevant evidence of the relationship between technology and development was presented.
6. Foundational works published prior to the main review period were retained when they were critical to the theoretical framework.

2.5 Exclusion Criteria

Sources were excluded if:

1. They addressed only the technical features of digital technologies with no reference to economic, social, institutional or developmental implications.
2. Did not provide substantive discussion of developing-country or development-related contexts.
3. Were primarily commercial, promotional, or non-evidence-based publications.
4. Duplicated evidence already represented by another source.
5. Did not contribute directly to the review questions.

2.6 Analytical and Synthesis Framework

The selected literature was organized through thematic synthesis. Rather than treating digital transformation as a single explanatory factor, the review examined the interaction between technological adoption and the complementary conditions required for development. Four major analytical themes were identified:

Theme 1: Technological and absorptive capabilities.

This theme relates to human capital, managerial capabilities, organizational learning, capacity to innovate, and capacity of firms and institutions to absorb and adapt external technologies.

Theme 2: Inclusion and inequality in the digital era.

This theme examines inequities in access, affordability, digital skills, productive use, job opportunities and the distribution of digital advantages.

Theme 3: Productivity, innovation and value capture.

This theme addresses the relationship between digitalization and productivity, firm capabilities, SMEs, domestic innovation and the ability of developing economies to capture value from digital economic activity.

Theme 4: Institutions, governance and environmental sustainability.

This theme looks at regulation and competition, data governance, institutional capacity, cybersecurity, resource use, energy consumption and electronic waste. The synthesis therefore treats sustainable development as an outcome produced by the interaction of technology, capabilities, institutions, economic structures, and environmental conditions rather than by technological adoption alone.

3. The Innovation Paradox and Technological Capabilities

Innovation is commonly associated with the creation of new technologies, products, and processes. But in emerging economies innovation also means the adoption, adaptation and effective use of technologies that have already been developed elsewhere. This distinction is important because technological catch-up can potentially allow developing countries to increase productivity without reproducing every stage of technological development experienced by advanced economies. Cirera and Maloney (2017) identify a paradox: developing countries can potentially obtain large productivity gains from technological upgrading, but firms and governments frequently invest too little in the capabilities required to achieve those gains. Their explanation focuses on complementary factors such as managerial quality, worker skills, organizational capabilities, finance, and institutions.

The problem we are discussing is well grounded theoretically in the concept of *absorptive capacity* developed by Cohen and Levinthal (1990). They argue that firms need the ability to recognize the value of external knowledge, assimilate it and apply it commercially. Thus, having access to knowledge does not guaranty the capacity to use that knowledge productively (Cohen & Levinthal, 1990). This principle is highly relevant to digital transformation. Consider a small manufacturing firm that buys sophisticated enterprise software. The software itself may be technologically advanced, but the firm may lack employees with the abilities needed to run it; managers who are capable of restructuring production processes or financial resources to maintain and upgrade the system. In such circumstances, the technology exists, but its economic potential is underutilized. The same problem occurs at the national level. Governments can invest in digital public services, electronic identification or artificial intelligence. But the impact of such initiatives can be limited if public institutions lack trained personnel, interoperable databases, cybersecurity capabilities or effective governance structures. The innovation paradox thus suggests that digital transformation should be assessed not simply by the amount of technology a country has, but by its capacity to absorb and transform technology into productive knowledge. The World Bank also highlights that digital technologies need what it calls “analog complements”. These include effective regulation, worker skills, competitive markets and accountable institutions. Without such complementary conditions, the expected benefits of digital investments might not come to bear fully. This helps explain why similar technologies may generate very different outcomes in different countries. A digital platform introduced in a highly skilled, competitive and institutionally capable economy may enhance productivity and innovation. However, in a weak institutional environment, with low skills, poor connectivity and limited access to finance, the benefits from the same platform may be much lower.

4. Digital Transformation and The Digital Divide

One of the major challenges for developing economies is the persistence of the digital divide. Traditionally, the digital divide was understood in terms of disparities in access to computers and internet connections. Today, however, the concept is broader. It includes differences in affordability, connection quality, digital skills, patterns of use, and the ability to convert digital access into economic and social benefits. The World Bank has demonstrated that digital technologies can create substantial opportunities for poor populations. For example, mobile phones can reduce information and transaction costs and improve access to markets and services. However, the benefits at large remain uneven as disadvantaged populations often lack the complementary capabilities to use digital technologies productively. This creates a distinction between digital access and meaningful digital inclusion. Connecting an individual to the internet does not automatically improve his or her income, education, employment opportunities or quality of life. The individual needs relevant skills, affordable services, reliable electricity, access to financial services, and opportunities to participate in productive economic activities. The digital divide is also especially pertinent in rural areas and for low-income households. Rural populations may be confronted with weaker broadband infrastructure and higher costs for connectivity. In parallel, women, older workers, low-skilled workers and people with limited opportunities for education may encounter additional barriers to digital participation. Digital transformation can therefore have contradictory effects on inequality. On one hand, it can expand access to financial services, education, employment and markets. Conversely, those individuals and firms with better skills and resources may take an outsized share of the benefits. This has particular relevance in labor markets. Digital technologies can complement workers with advanced analytical, technical and managerial skills, while substituting some routine tasks. Thus, digital transformation may increase productivity, while at the same time also increase income differences between workers with different levels of human capital. The challenge is not technology per se, but the unequal distribution of the capabilities to take advantage of it. A country that builds out digital infrastructure without simultaneously improving education and digital skills may see the number of people connected rise, but not the same proportionate increases in productivity or social welfare.

5. Digital Transformation, Productivity and Economic Development

The potential of digital technologies to raise productivity is enormous. Firms can reach new markets through digital platforms, cut information-technology costs by using cloud computing, make better decisions through data analysis and raise production efficiency by using automated systems. Governments can use digital technologies to improve tax collection, public administration, healthcare, education and social-protection systems. But productivity gains do not come automatically. They demand organizational change and complementary investments. You can't buy your way to higher productivity by buying new software or hardware. It may have to redesign production processes, train workers, upgrade management practices and institute new systems for communication and coordination. This argument is in line with the innovation literature. Cohen and Levinthal (1990) stress the importance of organizational knowledge and prior capabilities in

determining the ability to exploit external technological knowledge. Similarly, Cirera and Maloney (2017) argue that developing countries need to build firm-level capabilities rather than rely solely on investment in research and development or technology acquisition. This is of great significance for small and medium-sized enterprises (SMEs). SMEs represent a significant part of employment and economic activity in many developing countries but often face constraints in accessing finance, skilled labor, management expertise and advanced technologies. Consequently, large firms may benefit more rapidly from digital transformation than smaller firms. There is also a question of value capture. Digital transformation can generate substantial economic value but this value does not flow automatically to the developing country. Global digital platforms can operate beyond national borders, extract data from users in developing countries and generate large economic rents through international business models. Developing countries may therefore become consumers of digital services, without developing equivalent domestic technological capabilities. The UNCTAD's *Digital Economy Report 2021* stresses that the ability to create and capture value in the digital economy is unevenly distributed across countries. This creates an important development challenge: countries need not only access to digital technologies, but also the productive and institutional capabilities required to participate in digital value creation. The policy objective should therefore be to move from digital consumption toward digital capability development. This includes support to domestic companies, universities, entrepreneurs, research bodies and technology ecosystems that have the potential to adapt and to develop digital solutions.

6. The Environmental Paradox of Digital Transformation

Sustainable development cannot be defined in terms of economic growth alone. Environmental sustainability and social inclusion are important too. Digital technologies can facilitate environmental goals, but digitalization as such has a large environmental footprint. Digital technologies can help positively in terms of environmental sustainability, for example, through smart electricity grids, intelligent transport systems, precision agriculture, digital monitoring of ecosystems, remote sensing and better supply chains. Digital instruments can help governments and business measure their use of resources and make better decisions for the environment. But digitalization itself depends on physical infrastructure and natural resources. Digital devices, servers, data centers, telecommunications networks and electronic components all require minerals, energy, water and manufacturing processes. But when electronic devices reach the end of their useful life, they generate waste that can be environmentally and health hazardous if not well managed. The environmental dimension is explicitly addressed in the UNCTAD's *Digital Economy Report 2024*. It points out that the digital economy is highly dependent on raw materials and the increased production and disposal of digital devices, and increased energy and water requirements, are placing major pressure on the environment. This also brings out a second paradox: that developing countries tend to bear a disproportionate share of the environmental costs while reaping less of the economic benefits of digitalization. This creates a second paradox. Digital technologies can help economies to become more resource-efficient but also increase overall resource consumption. The sustainability of digital transformation therefore depends on how technologies are produced, powered, used, and discarded. Policies on renewable energy, energy efficiency,

circular economy principles, sustainable electronics and responsible e-waste management are all a must. This is especially a problem for developing countries that may be heavily dependent on imported electronic equipment and digital infrastructure. Without effective environmental regulation, they may face increasing waste and resource pressures but capture relatively little economic value. Digital transformation needs to be evaluated therefore in terms of its entire life cycle and not just its immediate economic benefits.

7. Institutions and Governance as Critical Conditions

Institutional capacity is one of the most important determinants of the extent to which digital transformation contributes to sustainable development. Technology does not operate independently of institutions. Governments establish rules governing competition, taxation, data protection, cybersecurity, labor rights, intellectual property and environmental standards that influence how digital technologies affect firms, workers, consumers and society. The World Bank states that digital technologies can reinforce existing institutional conditions. Effective institutions allow digital technologies to enhance service delivery, transparency, competition, and access to opportunities. When institutions are weak, technology can entrench market concentration, exclusion, and inequality of access to resources. For this reason, digital transformation should be accompanied by effective competition policy. Digital markets are characterized by network effects, economies of scale and the strategic value of data. These characteristics can enable dominant firms to rapidly accumulate advantages. We also need strong institutions to protect privacy and ensure good data governance. As governments and businesses become more dependent on big data sets and artificial intelligence, questions of data ownership, surveillance, algorithmic discrimination and cyber security become more prominent. The institutional dimension is especially important in developing countries where poor administrative capacity can make it difficult to implement sophisticated digital regulations. Hence, building institutional capacity should be considered part of digital transformation itself, rather than a separate policy objective. In this context, the main question is not how to digitize, but how to govern digitalization well.

8. Policy Implications

The analysis underscores the need for a comprehensive policy approach rather than a piecemeal approach to investments in digital infrastructure in the developing economies.

8.1 Investment in Human Capital

The first step is to invest in education and digital skills. Basic technological literacy is a prerequisite, but developing economies also need high-level skills such as programming, data analysis, cybersecurity, artificial intelligence, engineering and digital management.

8.2 Building Firm Capabilities

Governments should assist SMEs to effectively adopt and utilize digital technologies. Training programs, innovation vouchers, technology transfer initiatives, management development and access to finance can assist firms to develop the capabilities they need for digital transformation.

8.3 Universal and Affordable Connectivity

Digital infrastructure must be reliable, affordable, and accessible. Policies must address rural connectivity and affordability, not only national internet-penetration statistics.

8.4 Strong Institutions and Competition

Competition policy, data governance, cybersecurity, consumer protection and accountable public institutions are all important. Digital markets should be open enough to enable new firms and innovators to enter.

8.5 Domestic Innovation Ecosystems

Developing countries should strengthen links among universities, research institutions, firms, governments and entrepreneurs. The aim should be to develop domestic capabilities for adaptation and innovation rather than permanent dependence on imported technologies.

8.6 Environmental Sustainability

Environmental sustainability needs to be considered from the beginning of digital strategies. Renewable energy, energy-efficient infrastructure, circular-economy practices, repair and reuse systems, and responsible electronic-waste management should become components of national digital strategies. These policy priorities reflect the central lesson of the innovation paradox: technological investment produces greater returns when it is supported by complementary capabilities and institutions.

9. Conclusion

The digital transformation represents a major opportunity for developing economies, but it is not a guarantee of sustainable development. The innovation paradox points out that countries can miss out on the potential gains from technological upgrading if they do not have the complementary capabilities needed to absorb and exploit new technologies. Digital technologies can increase productivity, improve public services, increase financial inclusion, and generate new economic opportunities. But they can also reinforce existing inequalities when access to skills, infrastructure, finance and productive opportunities is uneven. They can contribute to labour-market polarization and market concentration while their production and use can result in substantial environmental costs. The key conclusion is therefore that technology adoption and sustainable development are not synonymous. The developmental effects of digital transformation depend on the institutional, economic, social and environmental context in which technology is introduced. Developing economies should consequently move beyond a narrow focus on purchasing technologies or increasing internet penetration. Their long-term objective should be the creation of digital capabilities: educated workers, capable firms, innovative institutions, competitive markets, effective governance, and sustainable infrastructure. The most successful digital transformation strategies will therefore be those that combine technological investment with human capital, institutional development, innovation policy, social inclusion, and environmental responsibility. Digitalization should not be treated as a substitute for development policy. Rather, it should be integrated into a

broader development strategy designed to ensure that technological progress produces lasting and broadly shared economic, social, and environmental benefits.

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