



Strategic Intelligence and Digital Transformation in Energy Economics: Pathways to Renewable Energy Expansion and ESG-Aligned Sustainability

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ABSTRACT

The digital transformation is gradually transforming the energy systems by transforming the manner in which information is generated, processed and incorporated in strategic decision-making. In the third world, but where energy transformation is limited by institutional weakness, skills and capabilities, and governance issues, the degree to which digitalization positively contributes to renewable energy growth and plausible environmental, social, and governance (ESG) performance is lopsided. This is a review that incorporates interdisciplinary studies in the fields of energy economics, information systems, sustainability management, and human resource management to understand how the digital transformation affects the renewable energy consumption and the sustainability of ESG outcomes through the intermediation of strategic intelligence and human resource sustainability. The synthesis shows that the generation of transition value on the basis of digital technologies is not achieved by means of data accumulation but organizational capabilities that allow performing higher level analytics, future planning, and staff adaptation. It also demonstrates the existence of nonlinear impacts, gaps in governance, and risks of greenwashing that may deter the sustainability results without the devising supplementary human and institutional abilities. Elaborating on these insights, the paper constructs an integrative framework and a collection of propositions on the ways in which digital transformation, strategic intelligence and sustainable human resource management mutually contribute to the energy and ESG outcomes in developing economies. The review ends with the description of the managerial and policy implications and priority directions to be taken in further empirical research.

Keywords: Digital Transformation, Strategic Intelligence, Energy Economics, Sustainable HRM, Renewable Energy Consumption, ESG Performance, Developing Economies

JEL Classifications: Q40, Q42, Q56, M14, O33

1. INTRODUCTION

The world shift to the sphere of sustainable energy is more and more perceived as technological change and also as informational one. As renewable energy technologies constitute the physical foundation of decarbonization, digital transformation offers the informational infrastructure and provides the energy systems with the ability to operate effectively under the conditions of uncertainty, intermittency and regulatory complexity. Artificial intelligence, big data analytics, the internet of things (IoT) and digital platforms are transforming how the energy systems are

forecasted, their management, market coordination and investment decisions. At the same time, ESG frameworks have become core to the assessment of firm and policy performance related to energy market. The international institutions coupled with investors and regulators are demanding believable evidence of decarbonization process, social responsibility and quality of governance. Nevertheless, the digital innovation to renewable energy growth and ESG enhancements translation has yielded both positive and negative outcomes, especially in developing economies due to the diverse institutional capacity, digital maturity, and human capital (Khammad and Alzghoul, 2025; Sun et al., 2025).

The current studies have three significant limitations. To begin with, the existing studies on energy economics tend to concentrate on digitalization as a factor that makes work more efficient and under-theorize its contribution to strategic intelligence development in the matters of long-term transition decisions (Caferra et al., 2021; Mayer et al., 2021). Second, empirical research on the connection between digitalization and renewable energy use is based mostly on macro-level indicators and does not study organizational and workforce-level processes (Kuzmin et al., 2024). Third, the outcomes of ESG are often perceived as the external performance indicators instead of the internal capability arrangements that affect their validity (Buchetti et al., 2025; Ji et al., 2025). The identified gaps are filled in this paper by means of coherent literature review and development of the proposition. It looks at the role of digital transformation in influencing the energy outcomes based on strategic intelligence and sustainability of human resources, especially to developing economies. Developing a sound and logical structure of the paper by incorporating knowledge, insights, and intuitions in the study allows a future research and policy development.

2. LITERATURE REVIEW AND PROPOSITION DEVELOPMENT

2.1. Digital Transformation in Energy Economics

The state of digital transformation of energy systems goes well beyond the process of digitization of operational processes, digitization of clearly defined technical functions; it is a reconstruction of organization structures, decision-making patterns, and governance that lie behind energy production, distribution, and market coordination (Awamleh et al., 2025; Karaki et al., 2023). In particular, energy systems are particularly vulnerable to digital innovation; energy systems are highly path dependent, very capital-intensive, requires real-time balancing, and are exposed to price volatility and regulatory uncertainty. As a result, the applicability of digital technologies in energy environments, as well as their relevance, is not only based on the adoption of a technical level but also the ability to incorporate digital potential into organizational and institutional forms. The empirical evidence is high rate of diffusion of digital technologies into energy value chain in fields of generation, transmission, distribution, and trading, where the improvement of efficiency, better reliability, predictive maintenance, and cost optimization are set as the primary objectives (Maroufkhani et al., 2022). System-level optimization is becoming more and more sustained by digital platforms, sophisticated analytics, and cyber-physical system optimization, which allow the constant monitoring of systems, forecasting decisions based on data, and automated control of the complex energy infrastructures. These functions are especially essential in dealing with intermittence of renewable energy and improving grid flexibility in the face of more and more variability energy sources (Li et al., 2021).

Among the changes, Industry 4.0 technologies are critical in facilitating real-time visibility of systems, predictive maintenance, decentralized coordination, and demand-side control (Ghobakhloo and Fathi, 2021). Recent literature demonstrates that these technologies can help asset utilization and operational risk decrease

considerably when incorporated across organisational borders and correlated with the decision authority (Shahzad et al., 2023). Digital control and forecast technologies have been demonstrated to be useful in the grid stability of renewable energy systems and enable greater proportions of renewables by enhancing responsiveness and coordination of actors (Al-Shetwi et al., 2025; Campana et al., 2025). Nonetheless, an increasing literature points to the fact that digital transformation performance benefits are incredibly dependent on the quality of governance and integrational aspects within an organization. The implementation is often fragmented, data structures are often siloed, and the institutional coordination weak, which often succeeds in defeating the potential benefits of digital investments, especially in developing economies where the regulatory framework and management capabilities are still unequal (Maroufkhani et al., 2022). As empirical research demonstrates, when no appropriate governance processes (such as the clear accountability systems, optimization of cross-functional operations, and data-driven decision-making procedures) are in place, digital technologies are either undercleaned or not strategic or sustainable at all (Vial, 2021).

Additionally, recent studies in the energy economics field also point to the fact that due to digitalization, unexpected consequences may arise, such as rebound effects and the fact that digital infrastructure can be used as an energy source itself, particularly at initial adoption stages (Bingxin et al., 2025). Such risks also highlight the need of institutionalizing the element of digital transformation in the governance structures that can support the alignment of the aspect of technological innovation with the long-term energy and sustainability goals. Collectively, the literature indicates that digital transformation is one of the factors in better performance of the energy system, not in the form of an independent technological intervention, but as an organizational ability that remakes coordination, decision-making, and responsibility in the energy system.

Proposition 1:

Digital transformation improves the performance of energy systems when it is embedded in organizational and governance structures that incorporate the use of digital capabilities into both strategic and operational decision-making as opposed to the implementation of digital adoption in isolation.

2.2. Strategic Intelligence as a Mediating Capability

Strategic intelligence is defined as the organizational ability to convert volumes of heterogeneous data into actionable information that can be used to make forecasts, perform investment appraisal, and long-term planning (Gitelman et al., 2021). This level of capability is especially important in energy economics since energy systems are being run in a situation of technological uncertainty, regulatory volatility, and growing vulnerability to climate and market risk. Decisions made concerning integration of renewable energy, expansion of infrastructure, flexibility of grids and risk hedging are based on accurate forecasting and scenario analysis which must utilize intelligence over the long term instead of operations over a short period. Digital transformation significantly increases the capacity to analyze due to complex modelling capabilities, real-time processing capabilities, as well as

algorithms to support the decision making process. With the spread of big data analytics, artificial intelligence, and machine learning, energy companies and operators of a system can enhance demand forecasting, optimize asset dispatch and estimate investment cases across numerous policy and price paths (Alrawahna et al., 2025; Alvarez et al., 2025). Nevertheless, the information systems research always points out that analytics can only deliver economic value when integrated into strategic decision-making process and governance practices (Chen et al., 2012; Vial, 2021). The availability of data in itself will not ensure better results unless it is combined with analytical insights in the capital budgeting process, policy planning, and organizational learning systems.

In the energy markets, sophisticated forecasting and intelligence systems have been demonstrated to enhance the bidding strategy, unpredictability caused by renewable intermittency, and more efficient capital allocation through efficient assessment of the risk-return trade-offs (Lago et al., 2021). Recent findings show that decision-making based on analytics can enhance the timing and magnitude of an investment in a renewable project by reducing informational asymmetry and enhancing the future system condition expectations (He et al., 2025). The strategic intelligence is, therefore, a pathway between cyber infrastructure and the ultimate results of energy transition. However, empirical research points to the high level of dissonance between analytical possibilities and strategic exploitation and thus, especially in developing economies. Most organizations are not equipped with the institutional processes to transform analytical outputs into strategic action, including cross-functional integration, decision authority correspondence and governance frameworks that are more focused on long-term sustainability than operational short-term benefits (Maroufkhani et al., 2022). Consequently, the digital means are usually limited to operational streamlining, e.g. load balancing in the short term or cost savings, but the possible role in long-term renewable investments and system transformation is not fully utilized. Strategic intelligence as an intervening capacity to turn digital transformation into an increase in renewable energy is highlighted in energy economics studies as a crucial factor that dictates whether a company will thrive in the digital transformation process or not. Lack of intelligence systems that could unify technical, economic, and regulatory information into consistent investment stories can mean that digitalization does not affect the decisions made on capital allocation to determine the energy mix. This is especially relevant to the context of developing economies, where the persistence of uncertainty, lack of financing facilities, and fragmentation of institutions increases the significance of viable, information-driven strategic planning.

Proposition 2:

Strategic intelligence can play a role of bridging the gap between digital transformation and renewable energy results by emerging results of converting digital competencies into informed decisions on long-term investments, planning, and managing risks.

2.3. Human Resource Sustainability and Capability Absorption

Human resource sustainability is a micro foundation of critical significance to digital transformation and strategic intelligence development in the energy systems. Sustainable human resource

management (HRM) is not just the extension of the efficiency-based HR practices but focuses more on the long-term skill regeneration, employees and the efficiency of working force to produce the capabilities related to sustainability of the environment and society (Kramar, 2014). This point of view is especially applicable to the energy transitions, where the organizations have to both implement the most innovative digital technologies and redesign the operating patterns, and meet the growing stricter safety and environmental requirements. With digitalized energy systems, employees are not passive consumers of technology since they are active agents of data interpretation, management of complex infrastructures, and transformation of analytical results into operational and strategic judgments. The digital transformation, in turn, creates pressure on the demands of data literacy, cross-functional cooperation, and lifelong learning. That is why, unless companies have sustainable HRM systems which enable reskilling, knowledge sharing, and psychological safety, digital technologies will not contribute to strategic intelligence as much as they potentially could (Vial, 2019; Maroufkhani et al., 2022).

Empirical research on the topic of Green HRM gives us a solid data on the effectiveness of such business practices like environmental training, employee participation, incentives which are linked to sustainability, and green performance appraisal to improve the individual pro-environmental behaviour and organizational environmental performance (Paille et al., 2020; Sabokro et al., 2021). The mentioned practices are especially relevant to the energy companies that implement digital monitoring and control systems since the employees should be able to interpret sustainability-related data and act accordingly in the framework of operations and strategies. According to recent research, sustainable HRM, in turn, leads to the development of organizational learning and innovation capability, which is necessary to adapt digital tools to the changing energy transition issues (Renwick et al., 2016; Bai et al., 2023). Notably, the indicators of emerging energy economics show that human capital preconditions the usefulness of digitalization in encouraging the use of renewable energy. The cross-country comparison indicates that due to its digitalization, economies have greater benefits in terms of renewable energy, with higher human capital levels, which highlights the power of workforce capability in adopting and taking advantage of digital technologies (Bingxin et al., 2025). In less developed economies, where skills deficiency and institutionalized constraints are more acute, the moderating aspect of sustainable HRM is how digital transformation will increase strategic intelligence or how it would stay trapped in short-term operation optimization.

With regards to strategic intelligence, sustainable HRM adds to the quality and credibility of decision-making through the assistance in critical analysis of analytical deliverables, ethical use of data, and long-term orientation. The inclusion of contextual knowledge and the congruence of digital insights with sustainability goals are also more probable with the assistance of the inclusion of HR practices and the skills relevant to the employees (Afaishat et al., 2025; Alzghoul et al., 2024). On the other hand, dysfunctional HR systems can lead to the development of algorithm dependency, lower transparency, and devalue the strategic worth of digital intelligence. All the literature points to the idea of human resource sustainability as an amplifier of the effect of digital transformation

on strategic intelligence in the way of enabling organizations to absorb, digest, and strategize the use of digital capabilities, particularly in complex and unpredictable energy transition settings.

Proposition 3:

Human resource sustainability moderates the effect of digital transformation on strategic intelligence building in energy organizations in a positive way.

2.4. Digitalization and Renewable Energy Consumption

The study of energy economics also shows an increased association of digitalization with renewable energy use due to the increasing acknowledgment that information infrastructures influence the organization of energy systems, the distribution of resources, and (most importantly) the response to unpredictability. The information and communication technologies (ICT) development help to integrate renewable energy in terms of system coordination, lower transaction and information costs, and grid management and flexibility (Lee et al., 2023). Through digital platforms and smart-grids, better matching between supply and demand is possible, decentralized generation can be supported, and it is easier to integrate renewable energy sources that are variable and volatile into existing energy systems. Yet, recent empirical data does indicate the lack of linearity between digital transformation and renewable energy consumption. According to the early phases of digitalization, the growth of ICT infrastructure (including data centres, communication networks and digital devices) can augment the total electricity demand that may cancel out the efficiency benefits and slow the development of renewable energy (Bingxin et al., 2025; Tawalbeh et al., 2025). At this stage, digitalization can even be used to support rather than hasten the shift to renewables in economies whose electricity provision is still based on fossil fuels.

The balance could change as the level of digital maturity grows. High-tech digital systems can make more efficient energy forecasting, real-time optimization of a grid, and investment planning, which can facilitate increased presence of renewable energy sources. Energy economics research is starting to recognize threshold effects, that is, the point where digitalization starts to have a positive impact on renewable energy consumption is only after reaching some degree of technological integration and institutional preparedness (Lee et al., 2023; Bingxin et al., 2025). This nonlinearity is useful in the explanation of the heterogeneous empirical results found in countries and regions. The quality of institutions and the capability of workforce have decisive impacts on the pace of shifting economy between the negative to the positive outcomes of digitalization. Well-developed regulatory frameworks, good governance, and qualified human resources can facilitate strategic utilization of the digital technologies to long-term energy planning, as opposed to short-term optimization of operations (Maroufkhani et al., 2022). The strategic intelligence capabilities enable the organization and policy makers to foresee the system level effects, handle the effects of the rebound effect as well as aligning digital investments with renewable energy goals (Pfenninger et al., 2014). In like manner, human resource sustainability will help absorb digital technologies as the latter

will see employees have skills as well as motivation needed to convert digital technologies into efficient renewable integration practices (Mikalef et al., 2021). In less developed countries where institutional barriers and skills are worse, no strategic intelligence or sustainable HRM may increase the negative digitization period (Al-Jaber et al., 2025). On the other hand, jointly investing in digital capability, governance and human capital has the potential to speed up the shift towards a stage where digital transformation promotes renewable energy growth and system resilience.

Proposition 4:

The digital transformation regarding the consumption of renewable energy is non-linear and does not rely on the availability of strategic intelligence and human resource sustainability.

2.5. Digital Transformation and ESG Outcomes

The main impact of digital transformation on ESG outcomes is providing the better accuracy of measurements, transparency of the information, and control over the activities in organizations. High-tech tools can help companies to gather, process, and share small-scale sustainability data on a real-time basis. Empirical evidence seems to reveal a growing positive relationship between digital capabilities and ESG performance as well as firm value, indicating that digital transformation can reinforce sustainability performance and market value provided that it is managed in an adequate way (Wang and Esperanca, 2023; Cai et al., 2024). The digital transformation has the most pronounced relevance of ESG in energy sectors. Digital monitoring systems enhance the measurement of emissions, contribute to predictive safety management, and increase the ability to comply with the environmental and occupational standards. Smart sensors, automated reporting tools and data analytics ease the burden on carbon emissions, energy efficiency, and safety incidents and reduce information asymmetry between companies, regulating bodies and investors (Maroufkhani et al., 2022). These are crucial to the energy firms that struggle with the increasing regulatory pressure and climate-related financial reporting requirements. Nonetheless, another crucial tension that the literature points out is that increased reporting capability does not necessarily result in a significant improvement of ESG. Symbolic compliance or greenwashing It can easily occur when digital tools are employed accidentally in institutional settings that have weak enforcement, limited oversight, or misaligned incentives conditions very common in the developing economies (Christensen et al., 2021; Marquis et al., 2014). Selective disclosure, narrative management, or overweighting on easily quantifiable indicators at the cost of the material environmental and social impacts can be facilitated by the capacity to produce a high amount of ESG data.

The research on energy economics and sustainability started to pay more attention to the fact that ESG performance is defined not only by the availability of the data but also by governance incentives and ethical standards possessed by the organization. Lacking accountability systems, independent verification and ethical leadership, digital ESG systems are liable to place more emphasis on appearance than substance (Christensen et al., 2021). This is one of the risks especially in energy markets as the complicated supply chains and technical obscurity may blur actual environmental

performance. Sustainable HRM is very critical in the elimination of these dangers and the credibility of ESG. Internal governance of digital reporting systems is reinforced by HR practices that facilitate ethical conducts, employee voice, sustainability-based training, and correspondence between performance evaluation and ESG goals (Mousa and Othman, 2020). When employees have the appropriate skills and are guided by ethical standards, they have a higher chance of noticing gaps, questioning deceptive behavior, and making sure that digital ESG data do not reflect a symbolic adherence to standards, but rather reflect the actual performance in the operations (Morrison, 2023; Poon and Law, 2022). Sustainable HRM, therefore, is an additive of digital transformation since it introduces the integrity of ESG into the organizational practices. Combined, the literature implies that digital transformation can improve the ESG results only when integrated into the governance systems and HR frameworks that relate the technological potential to the ethical standards and accountability processes.

Proposition 5:

Digital transformation enhances the performance of ESGs in case it is underpinned by a sustainable human resource management and governance mechanisms that lead to transparency, accountability, and credibility of disclosure.

2.6. Integrated Capability Configuration

The aggregate amount of evidence provided by energy economics, information systems, and sustainability research studies point to a single conclusion: digital transformation alone cannot produce long-term changes in the uptake of renewable energy and sustainability performance. Despite the crucial increase in the availability of digital technologies and their analytical potential, its efficiency relies on the additional organizational power enabling the interpretation, coordination, and strategic implementation of information. An emerging literature shows that the application of standalone investments of digital infrastructure can often lead to short-term or minimal benefits without a strong strategic intelligence and sustainable human resource culture (Vial, 2019; Maroufkhani et al., 2022). Digitally, based on capability, digital transformation offers the technological basis of change in an organization, yet strategic intelligence defines how digital inputs can become forward-thinking investment choices, system-wide optimization, and successful risk management. The technical, economic, and regulatory data analytics and forecasting solutions are required to propel the long-term energy transition direction rather than support operational efficiency at a short-term level (Chen et al., 2012; Lago et al., 2021). It is particularly crucial in emerging markets, where the fact that the overall uncertainty is enormous, the regulatory uncertainty is significant, and the institutional fragmentation contributes to the fact that coherent and data-driven strategic planning is greatly needed.

The effectiveness of digital transformation and strategic intelligence is also predisposed by human resource sustainability. Sustainable HRM makes sure that organizations have the capabilities, learning ability, and ethical standards that are necessary to assimilate digital technologies and analytically interact with analytical outputs (Kramar, 2014; Poon and Law, 2022). Empirical results suggest that human capital increases the benefits of digitalization and the

benefits of renewable energy by coexisting with the possibility of organizations adjusting digital solutions to local conditions and changing system needs (Bingxin et al., 2025). Conversely, the HR systems that are weak add value to the threats of the existence of algorithmic dependence, non-coordinated coordination, and the superficiality of ESG compliance. Recent studies of sustainability and energy are starting to take a configurational viewpoint and are beginning to think that high performance results not from one-factor investments but from coherent groups of complementary capabilities (Cai et al., 2024; Li and Li, 2025). In this paradigm, digital transformation, strategic intelligence, and human resource sustainability are similarly capability layers that are mutually reinforcing. It is through their interaction that organizations are able to deal with nonlinear dynamics of transitions, reduce the risk of rebound and greenwashing, as well as match technological innovation with plausible environmental and social performance. Such complementarities in capability are particularly relevant in energy systems that are highly complex, have long payback periods and whose structure is subject to uncertainty. Organizations that do not build these capabilities in a holistic fashion will find it difficult to make use of digital technologies, they will allocate capital in a manner that lacks substance, and they will generate symbolic improvements to ESG that lack any tangible effect (Grubb et al., 2014; Vial, 2021). In comparison, those organizations that integrate digital infrastructure and intelligence-based decision-making and sustainable workforce policies are more likely to realize sustainable renewable energy growth and plausible ESG results.

Proposition 6:

Organizations that simultaneously develop digital transformation, strategic intelligence, and human resource sustainability achieve superior renewable energy and ESG outcomes compared to organizations pursuing isolated or uncoordinated capability investments.

3. DISCUSSION AND IMPLICATIONS

The synopsis of the literature highlights that digital transformation is changing the economics of energy using informational and organizational channels to a larger extent than technological substitution. Although digital technologies improve the accessibility of the data and its computational power, the economic and sustainability effects appear only when the organizations have corresponding skills needed to comprehend, synthesize, and implement the information strategically. Strategic intelligence and sustainable HRM can therefore be considered the key explanatory variables that explain the varying impacts of digitalization in the adoption of renewable energy and ESG performance evident in the developing economies. One main finding of this synthesis tool is that digital transformation changes the informational pillars of the energy markets by minimizing uncertainty, enhancing coordination, and providing forward-looking decision-making. There is however an unequal distribution of these benefits. When digitalization is deployed in the absence of proper governance institutions, analytical integration, and labor potential, digital investments may remain limited to the operational optimization aspects in the short term, with minimal contribution to long term energy transition goals. This trend explains the presence of

significantly dissimilar renewable energy and ESG performance in countries, as well as firms, with similar amounts of digital infrastructure.

Regarding management, the results suggest that digital transformation in energy organizations must be viewed as a capability-forming process instead of an undertaking of acquiring technology. Managers need to understand that to achieve sustainable value, investments in digital infrastructure, including analytics systems, smart-grid systems, and monitoring systems, must be accompanied by investments in strategic intelligence and human resource development. A strategic intelligence that is institutionalized involves institutionalizing processes that span the entire capital budget and risk management processes with analytical outputs, cross-functional coordination between technical, financial, and regulatory departments. Otherwise digital tools might undermine long-run transition planning and augment short-term efficiency indicators. Digital technologies absorption and adaptation is a key part of the process that is made possible by sustainable HRM. Reskilling of workforce, lifelong learning and engagement of the employees are not an incidental aspect of successful digital transformation, but a pillar of it. Employees in energy systems with high levels of technological complexity and sensitivity to safety need to be able to interpret the results of the analysis, make judgments in uncertain conditions, and match the operational decisions with the sustainability goals. Also, HR practices that facilitate ethical conduct and employee voice are critical to support the plausibility of ESG data and reducing risks of greenwashing and symbolic compliance.

Significant implications to policymakers in developing economies are also derived out of the synthesis. To start with, digital infrastructure and energy transition policies should not be developed independently by the policymakers. The infrastructure modernization and efforts of grid modernization, decarbonization, and the creation of renewable energy should go hand in hand with broadband connectivity, investment in data platforms, and smart infrastructure. Second, the development of the human capital must be regarded as the pillar of the digital energy policy. To hasten the phase of digitalization between the negative and the positive phase of digitalization that was found in the recent research in the energy economics field, public investments in education, vocational training and digital skills are required. Moreover, the quality of governance and institutions turns out to be a determining factor that will influence the efficiency of digital transformation. Policy makers should intensify regulatory systems that enhance transparency, accountability, and interoperability in the systems of energy. Good criteria on ESG reporting, third-party checks and balances, and alignment of rewards to long-term sustainability objectives are of paramount importance in order to make certain that the digital reporting functions make a difference in terms of material environmental and social change. Without the implementation of these types of governance structures, digitalization is likely to increase information asymmetries and weaken ESG credibility instead of strengthening it.

The combined discussion supports a configurational approach to the issue of digital transformation in energy economics. Best

renewable energy and ESG performance are not the result of individual investment in technologies, analytics, or human capital, but of synchronized packages of complementary capabilities which together support learning, coordination and strategic alignment. Such an attitude is especially relevant to the developing economies in which the risk of uncoordinated digitalization can be more significant due to resource limitations and institutional disjuncture. Lastly, the synthesis gives some vital directions towards future research and experimentation of policies. Empirical research needs to go beyond a linear model to investigate interaction and threshold effects between the digital transformation, strategic intelligence, and human resource sustainability. Evaluation of policy initiatives must be determined with reference to not only the aspect of technological implementation but also the aspect of developing sustainable organizational and institutional strengths. Through this integrated method, not only scholars but also practitioners will gain a greater insight into how digital transformation can be used as an impetus in the chase of sustainable energy systems and plausible ESG performance.

4. CONCLUSION

This review shows that digital transformation can contribute to the meaningful contribution to the further development of renewable energy and the enhancement of ESG performance in developing economies, yet the effectiveness of this factor is inherently conditional. Digital technologies have an ability to increase informational ability and analytical complexity; but on their own, they do not ensure sustainable energy or plausible ESG results. The synthesized evidence of this review demonstrates that the digitalization transition value relies upon the availability of complementary organizational competencies that allow the digital tools to be interpreted, managed, and strategically implemented in complex and uncertain energy systems. Strategic intelligence and human resource sustainability become the key competence that will define whether the digital transformation yields significant sustainability benefits or whether it is associated with the symbolic compliance. Strategic intelligence makes organizations and policymakers able to transform digital data into future investment decisions, optimization on the system level, and plausible risk management in the circumstances of regulatory, technological, and even market uncertainty. In its turn, human resource sustainability will allow energy organizations to have the necessary skills, learning capacity, and ethical norms that will allow absorbing digital technologies and critically interact with analytical outputs. In areas where such capacities are limited or lacking, digitalization is likely to support short-term operational effectiveness, postpone renewable energy changes, and augment the threat of superficial environmental and social accounts, instead of providing lasting environmental and social benefits.

The review improves the economics of energy through the change of the analytical focus of the explanations on technology to the capability-based and configurational framing of the digital transformation. Instead of considering the digitalization process as an external force that influences energy outcomes, the synthesis shows that the use of renewable energy and overall ESG performance are the products of the interaction between

digital infrastructure, strategic intelligence, and sustainable human resource management. This view can be used to support the existence of this heterogeneous empirical evidence in relation to the developing economies and explain why, at the same stage of digital uptake, it is often the case that transition trajectories are observed to diverge. Implications of the findings to further research are also significant. The current reports are more of correlational studies that do not allow causality to be concluded. Further studies must thus capitalize on natural experiments, policy changes, rolling out digital infrastructure staggered, and regulatory breaks to establish the causal effect of digital transformation on renewable energy use and ESG performance. At the same time, digital transformation and sustainability performance should be more accurately measured. Researchers need to not only leave behind aggregate ICT indicators and ESG ratings but also add firm-level digital maturity, analytics integration, quality of governance, and outcome-based performance measures in the environment and social contexts.

Additional development needs cross-level empirical designs that would bridge organizational capabilities and system-level energy outcomes. Changes in energy flow are happening simultaneously on firm, worker, market, and institution level, and multi-level modelling promises to be one of the directions towards uniting these views. Moreover, nonlinear and threshold effects should also be explicitly considered in future research because current evidence indicates that digitalization might lead to a rise in energy demand prior to facilitating the growth in renewable sources once the human capital and the capacity of governance is adequately established. Lastly, the governmental and moral aspects of digital transformation should be given more focus. Although digital tools can improve the level of measurement and transparency, they also pose new possibilities of greenwashing, selective reporting and algorithms obscurity. Understanding the role of institutional quality, regulatory enforcement and ethical human resource practices on credibility of digitally enabled ESG reporting is an important area of research, particularly in developing economies. The focus on these challenges is critical in ensuring that digital transformation is an accelerating, but not a distracting force in the quest to have a sustainable system of energy and reliable performance of ESG.

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