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Digital Transformation in India's MSME Sector: Opportunities, Challenges, and Policy Pathways

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Abstract

This article examines the beneficial connection between the expansion of Micro, Small, and Medium-Sized Enterprises (MSMEs) in India and the nation's digital evolution. As digital technology is embraced across various sectors in India, MSMEs are leveraging these advancements to boost productivity, broaden their market presence, and optimize operations. This study employs pertinent literature reviews and empirical data analysis to assist MSMEs in comprehending the key factors driving the digital transformation of India's economy. It showcases how digitization reshapes MSMEs by offering examples of successful implementations and the resulting growth patterns. Furthermore, the paper outlines policy implications and strategic recommendations aimed at fostering inclusive and sustainable economic development in India by enhancing the positive impacts of digitalization on MSMEs.

Keywords: Goods and Services Tax (GST), MSMEs (Micro, Small and Medium Enterprises), Digital transformation, Technology adoption, Tax compliance, E-invoicing.

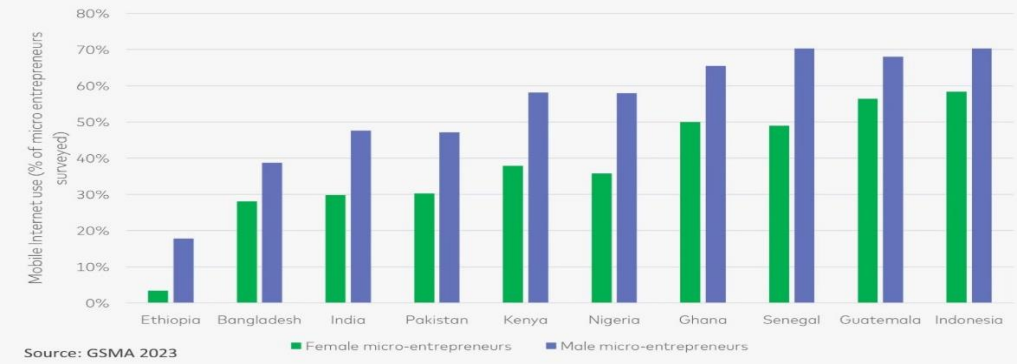
JEL Classification: H25, H26, O33, L26, L53 & O17

1. Introduction

In the current fast-paced business environment, driving growth and promoting innovation have become essential priorities for organizations in all sectors. Central to this shift is digitalization, which is transforming the way companies function, compete, and provide value to their clients. For manufacturing enterprises and micro, small, and medium sized businesses (MSMEs), digital transformation presents a distinct opportunity to bridge gaps, enhance operations, and create new revenue opportunities. By adopting technology and digital solutions for manufacturing, these businesses can't only endure but also prosper in a more competitive global market.

Digital manufacturing extends beyond mere automation to develop intelligent, interconnected systems that improve efficiency and lower costs. Smart manufacturing solutions, efficient workflows, robotics, IoT, and AI in manufacturing can streamline processes, reducing manual labor and optimizing resource usage. Access to real-time data insights enhances decision-making, increases productivity, and improves accuracy in production planning. AI-driven predictive maintenance helps avert expensive breakdowns by predicting failures, while sensor based monitoring safeguards equipment durability and operational continuity. Digital twins can replicate production processes to refine methods, enhance quality, and minimize defects. Sectors such as automotive, electronics, and pharmaceuticals are at the forefront of this transition, showcasing the transformative power of digital technologies in attaining operational excellence.

Figure1: Comparative Analysis of digital payments in MSMEs in different countries



Source: GSMA 2023

Generative AI is revolutionizing how companies utilize data for insights and innovation. AI-enhanced customer interactions, including chat, voice, and regional language options, improve engagement, while AI agents handle complex tasks to increase productivity. Advanced models that combine real-time data with specialized systems boost reliability, enhancing the effectiveness of AI applications. Decreasing hardware prices and the emergence of open-source models are facilitating adoption, further broadening AI's impact. In India, AI solutions designed for varied languages and sectors are promoting innovation in agriculture, healthcare, and governance. These developments leveraging Generative AI in business highlight the significance of data-driven decision-making across various industries.

1.1 Digital Payment policies promoted by the Government of India

The Government of India is actively working to encourage a cashless economy and to provide all citizens with access to seamless digital payment options in a user-friendly manner. Prioritizing the promotion of digital payments, the Government of India aims to include every segment of society within the formal framework of digital payment services. The goal is to ensure that all citizens of India can engage in digital payments that are convenient, straightforward, affordable, rapid, and secure. As part of this initiative, the Ministry of MSME has launched several initiatives to digitally empower the entire MSME ecosystem. Following the recommendations from the Committee of Secretaries (CoS) and the directives of MeitY, a committee focused on Digital Payments has been established within the Ministry, led by the Secretary (MSME).

Table 1: Government Digitalization Support Schemes for MSMEs

Scheme	Year	Type of Support
Digital MSME Scheme	2017	ICT & cloud adoption
MSME Champions (Industry4.0)	2021	Digital tech(AI/IoT) grant
Lean Manufacturing ERP Cluster	2020	Digital ERP tools
PSB Loans In 59 Minutes	2018	Digital credit access
Payments Infra Development Fund (PIDF)	2021	QR/PoS installation

Source: Ministry of MSME, Government of India.

During the 2023–24 period, the Ministry of MSME and its affiliates executed more than 16.62 million transactions totaling Rs.98,396.45 crore, with a remarkable 87.16% conducted through digital means. The majority of these transactions were attributed to KVIC and the DC Office, while NSIC registered the highest average value per transaction. Both COIR BOARD and NI-MSME reached an impressive digitization rate of Over 99 % by value, indicating a nearly complete transition to cashless transactions. Conversely, MGIRI recorded the lowest percentage of digital transactions at 84.01 % In total, Rs. 84,046.98 crore (85.42% of the overall value) was processed digitally, illustrating significant advancements in digital adoption throughout MSME organizations, although discrepancies in adoption rates persist among different bodies.

The Government operates several programs and schemes to enhance the business capabilities of MSMEs and enable them to compete with larger e-commerce entities through various digitalization efforts, including the Udyam portal, the MSME Champions Portal, the Government e-Marketplace (GeM), the Trade Receivables Discounting System (TReDS), and msmemart.com. Furthermore, the MSME SAMBANDH platform enables the monitoring of procurement activities by Central Public Sector Enterprises (CPSEs) from Micro and Small Enterprises (MSEs), while the MSME SAMADHAAN portal allows for the submission of applications concerning delayed payments. Currently, there are 1.24 crore MSMEs registered on the Udyam Registration portal.

Table 2: Digital Transactions of MoMSME and Its Organisations (2023–24)

Organisation	Total Trans-actions	Total Value (Crore)	Digital Trans-actions	Digital Value (Crore)	Digital Trans-actions (%)	Digital Value (%)
KVIC	80,61,470	8,449.23	70,72,898	8,310.55	87.74	98.36
NSIC	1,44,353	31,223.00	1,40,502	30,602.00	97.33	98.01
DC Office (ToolRoom+DFO+HQ)	83,81,139	45,890.12	73,80,637	44,766.06	88.06	97.55
COIRBOARD	23,467	299.769	23,264	298.195	99.13	99.47
NI-MSME	7,832	58.33	7,732	58.27	98.72	99.78
MGIRI	1,857	12.449	1,560	11.909	84.01	95.66
TOTAL	1,66,20,118	98,396.45	1,44,86,733	84,046.98	87.16	85.42

Source: MoMSME, Government of India

1.2 A game theoretic approach to MSMEs and digitization

In this study, we conceptualize the digitization of MSMEs as a strategic coordination game utilizing classical game theory concepts. Two representative MSMEs, referred to as "firms," choose between two options: Digitize (D) by implementing digital technologies (such as online payments, invoicing, and e-commerce) or Not Digitize (N), with their payoffs determined by: (i) a personal advantage of digitization, (ii) an initial cost of implementation, (iii) a network effect that occurs when both firms digitize, since the value of digitization increases with widespread adoption, and (iv) a potential reduction in profits due to competitive pressures when both firms digitize. This situation leads to a 2×2 normal-form payoff matrix, where the Nash equilibrium on the relative magnitudes of these variables. If the net private benefit is positive even on its own, digitization emerges as a dominant strategy, resulting in both firms adopting it.

Table 3: Game-theoretic parameters for MSME digitization

Parameter	Symbol	Example Value
Private benefit of digitizing	b	10
Cost of adoption	c	12
Network benefit when both digitize	α	5
Competition loss	δ	1
Payoff (Digitize, Digitize)	π(D, D)	$10 + 5 - 1 - 12 = 2$
Payoff (Digitize, Not Digitize)	π(D, N)	$10 - 12 = -2$
Equilibrium outcome (if $b<c$ and $b+\alpha>c$)		Coordination game

Source: Author's analysis

However, if individual adoption is not profitable but can be profitable with joint coordination, then digitization represents a Pareto-superior equilibrium, provided both firms opt for it simultaneously. On the other hand, the option of remaining offline (N, N) also stands as a Nash equilibrium, leading to a coordination failure or a multiple-equilibrium dilemma akin to stag-hunt and threshold public-good scenarios in game theory. This framework enables an analysis of how government policy instruments—like subsidies, shared infrastructure, or compulsory e-invoicing—can facilitate the transition of firms from the inefficient "offline" equilibrium to the effective "digitized" equilibrium. In conclusion, the game-theoretic model reveals that the digitization of MSMEs is not simply a technological selection but rather a strategic choice influenced by expectations regarding the actions of other firms, highlighting the necessity of policy coordination for achieving extensive digital adoption and growth within the sector.

Table 4: Payoff Matrix of Game-theoretic Model

A\B	Digitize (D)	Not Digitize (N)
Digitize (D)	$(b + \alpha - \delta - c, b + \alpha - \delta - c)$	$(b - c, \alpha')$
Not Digitize (N)	$(\alpha', b - c)$	(0, 0)

Source: Author's analysis

2. Literature Review

Even though digitalization and digital transformation are frequently regarded as synonymous (Reis et al., 2018), distinguishing between the two is important since some scholars view digital transformation as a more advanced phase of digitalization (Busulwa etal.,2022). Digitalization refers to the creation and application of IT-based solutions by individuals, organizations, and society aimed at enhancing user experience, efficiency, and effectiveness (Alt, 2018). As noted by Plotnikov (2018), digitalization involves the predominant application of digital technologies for the generation, processing, transmission, storage, and visualization of information due to the emergence and spread of new hardware and software solutions. Therefore, digitalization is manifested in the movement of information via technology and tasks executed on computers.

According to Obukhova et al.(2020), the digital transformation of businesses necessitates categorizing digital technologies into three groups based on their accessibility and convenience: Basic technologies, which encompass cloud, wireless, and paperless technologies, are essential for enabling the digital transformation of a company; Critical technologies such as big data, cloud computing, and unmanned technologies facilitate a comprehensive digital transformation; and Innovative technologies including artificial intelligence, neural networks, distributed data logging, and machine learning empower a company to move from analog to digital.

These categories of technology—basic, critical, and innovative—enable organizations to progress from digitalization to digital transformation, ultimately becoming digital enterprises that support their nations' shift toward a digital economy (Obukhova et al., 2020). From this perspective, digital transformation indicates an organizational change that is initiated and shaped by the widespread adoption of digital technologies (Hanelt et al.,2021) and the use of cutting-edge technology.

The idea of digital transformation in micro, small, and medium enterprises (MSMEs) is crucial for grasping the changing dynamics of how businesses operate. As pointed out by Sharma et al. (2020), this transformation entails the strategic adoption of digital resources like cloud services, e-commerce platforms, and data analytics. This adoption is seen as a way to improve operational efficiency, encourage innovation, and enhance competitiveness. Improving operational efficiency through digitization is a common theme in the existing research. Bala and Verma (2019) contend that the uptake of digital technologies in MSMEs results in more streamlined operations, decreased manual efforts, and heightened productivity. For MSMEs striving to succeed in a technology-driven market, the integration of digital tools is considered a strategic necessity. The pursuit of digital technologies has allowed Indian MSMEs to go beyond geographical limits and tap into global markets. Pareek et al. (2021) maintain that digital platforms, especially e- commerce and online market places, act as significant instruments for MSMEs to present their products and services to a wider audience. This globalization effect has the capacity to transform the competitive landscape for MSMEs. Dwivedi et al. (2020) emphasize the difficulties MSMEs encounter in their journey towards digitization, which include gaps in skills, accessibility to technology, and concerns regarding cyber security.

A study conducted by Bansal and Zahra (2021) examines how digital technologies assist MSMEs in incorporating social and environmental responsibility into their business frameworks. The research highlights the ability of digitalization to foster sustainable practices

and enhance corporate social responsibility. As MSMEs adopt digital solutions, they also expose themselves to potential cyber security threats. The work of Choudhary et al. (2022) delves into the cyber security issues encountered by MSMEs in India and suggests strategies for risk mitigation. It is essential to understand and tackle cyber security challenges to secure the long-term sustainability of MSMEs in the digital world. The COVID-19 pandemic has hastened the shift towards digital technologies across various sectors. Research by Sivarajah et al. (2020) examines how the pandemic has served as a driving force for the digital transformation of MSMEs, influencing their resilience approaches in the face of unique challenges. The increasing dependency on data-driven technologies raises significant concerns regarding data privacy and ethics.

3. Research Methodology- Cronbach's Alpha

Cronbach's alpha coefficient assesses the internal consistency or reliability of a group of survey items. This statistic helps evaluate whether a set of items reliably measures the same attribute. Cronbach's alpha expresses the level of agreement on a standardized scale from 0 to 1. Higher values reflect greater agreement among the items. Typically, this statistics derived from survey responses, assessment tools, and test scores. The data can be continuous but is often in the form of Likert scale and binary values. The calculations are based on the assumption that all items gauge the same trait using an identical scale, a concept referred to by statisticians as a tau equivalent model. The formula for Cronbach Alpha can be expressed as:

$$\alpha = \frac{k}{k-1}\left[1 - \frac{\sum_{i=1}^{k} \sigma_{y_i}^2}{\sigma_y^2}\right]$$

In this equation, :

- k shows the number of items in the measure
- $\sigma_{y_i}^2$ shows the variance associated to each item i
- σ_y^2 shows the variance associated to the total scores, $y = \sum_{i=1}^{k} y_i$

It can also be calculated through the following formula:

$$\alpha = \frac{k\bar{c}}{\bar{v} + (k-1)\bar{c}}$$

Where:

- $\bar{v}$ shows the average variance
- $\bar{c}$ shows the average inter-item covariance.

In order to study the impact of digitization on growth of MSMEs, this research analyses likert scale responses from 533 MSMEs of Northern Delhi in sectors like Textile, electronics, printing and packaging, autoparts, and plastics. Cronbach's alpha test will help us to measure the internal consistency of the tests.

4. Results and Discussions

Table 5 presents the reliability statistics for the various constructs utilized to assess the influence of digitization on MSMEs. The overall scale, consisting of 22 items, achieves a Cronbach's Alpha of 0.87 — indicating an excellent level of internal consistency. This suggests that MSMEs that report a positive impact of digitization in one domain are statistically very likely to notice enhancements in other areas as well, indicating that the effects of digitization are widespread and mutually enhancing.

When broken down, results indicate that the Operational Impact construct (Alpha Value =

0.85) is highly dependable, meaning respondents consistently link digitization to improved workflow, time efficiency, and lower daily operating expenses. The Financial and Cashflow Improvement construct also shows strong performance (Alpha Value = 0.81), suggesting that digital tools facilitate faster payments, improved working-capital cycles, and greater transparency regarding receivables. The Market Expansion construct, which encompasses entrance into new markets, online reach, and a broader customer base, demonstrates acceptable reliability (Alpha value= 0.78), indicating that firms view digitization as a means to create opportunities outside of their traditional geographic limits. The MSME Growth Outcome Scale — which assesses sales increase, job growth, and profitability — exhibits the highest reliability (Alpha = 0.88), reaffirming that the larger growth metrics of MSMEs are consistently connected to their level of digital engagement.

Collectively, the elevated Cronbach's Alpha values reinforce the notion that digitization serves as a comprehensive growth driver for MSMEs. Instead of merely enhancing a singular function, digital adoption improves the entire value chain — spanning procurement, production, sales, customer service, and financial management. These findings imply that policy measures such as subsidized QR/UPI integration, GST-linked e-invoicing tools, and platforms for online market access can greatly boost MSME growth. Future strategies for MSME development should view digitization not as an ancillary technology enhancement but as a core component of competitiveness, scalability, and resilience.

Table 5: Reliability Analysis for Various Constructs

Construct/ Scale	No. of Items	Cronbach's Alpha( )	Interpretation
Operational Impact (efficiency, costs)	6	0.85	Highly reliable
Financial & Cashflow Improvement	5	0.81	Strong internal consistency
Market Expansion (reach, customer base)	4	0.78	Acceptable consistency
MSME Growth Outcome (sales, employment)	7	0.88	Highly reliable
Overall Digitization Impact Scale	**22**	**0.87**	**Highly Reliable**

Source: Author's analysis

Table 6: Impact of Digitization across Different Constructs

Construct/ Scale	Mean Score	Standard Deviation	Minimum	Maximum
Operational Impact (efficiency, costs)	4.11	0.63	2.2	5.0
Financial & Cashflow Improvement	4.05	0.71	2.0	5.0
Market Expansion (reach, customer base)	3.88	0.68	1.8	5.0
MSME Growth Outcome (sales, employment)	4.03	0.65	2.1	5.0
Overall Digitization Impact Scale	4.02	0.59	2.4	5.0

Source: Author's analysis

5. Conclusion

The results of this research strongly support that digitization positively influences the growth and performance of MSMEs in North Delhi. By examining feedback from 533 MSMEs and creating reliable multi-item scales, the research shows that adopting digital

technologies goes beyond merely implementing new tools; it significantly leads to improved operational efficiency, seamless financial transactions, better access to markets, and tangible business growth. High Cronbach's Alpha scores (Alpha value = 0.87 for the overall scale) suggest that these advantages are interrelated — MSMEs that utilize digital tools are much more likely to excel across various business areas simultaneously, including sales, profitability, and job creation.

The findings indicate that digitization serves as a strategic catalyst for growth rather than just an auxiliary technological addition. Companies that have transitioned to digital payment methods (UPI/QR), e-invoicing, GST-based documentation, and online customer interactions experience substantial competitive benefits such as reduced costs, quicker working-capital cycles, and access to new markets beyond their immediate vicinity. Hence, digitization stands out as a crucial enabler of both resilience and scalability within the fiercely competitive urban MSME environment of North Delhi.

In light of these findings, policymakers and financial institutions should strengthen their efforts toward facilitating digital onboarding, conducting awareness initiatives, providing subsidized access to digital resources, and offering training for MSMEs. Targeted campaigns in densely populated areas such as Sadar Bazaar, Bawana, Narela, Rohini, and Karawal Nagar can help accelerate the digital transition for underperforming units. In summary, this study asserts that digitization is an effective tool for promoting inclusive and sustainable growth of MSMEs in urban regions, and should be central to future MSME development strategies in Delhi.

6. References

1. Shah, Jainam Sardar, Kashan. (2024). A Study on The Impact of Digitization in India: A Shifting Paradigm From Traditional to Modern MSMES. 10.13140/RG.2.2.29770.58567.
2. Ayyagari, M., Demirgüç-Kunt, A.,Maksimovic, V. (2017). SME financing and growth: Evidence from India.Small Business Economics, 48(3), 485–512.
3. Beck, T., Pamuk, H., Ramrattan, R., Uras, B. (2022). Digitalization and small business resilience. Journal of Financial Intermediation, 50, 100954.
4. Brynjolfsson, E., McAfee, A. (2014). The Second Machine Age. New York: W.W. Norton.
5. Chhibber, A. (2023). Digital transformation and MSME competitiveness in India. Economic and Political Weekly, 58(30), 47–55.
6. DeStefano, T., Kneller, R., Timmis, J. (2019). Cloud computing and firm growth: Evidence from UK microdata. The Economic Journal, 129(623), 1344–1370.
7. Deloitte (2020). India's MSME digital readiness survey. Deloitte Consulting Report.
8. Government of India. (2023). Annual Report 2022–23, Ministry of Micro, Small and Medium Enterprises. New Delhi: MSME Publications.
9. International Finance Corporation. (2019). MSME Finance Gap: Assessment of the shortfalls in financing MSMEs. Washington, DC: World Bank Group.
10. McKinsey Global Institute. (2021).The future of Indian MSMEs in a digital world. McKinsey Report.
11. NPCI. (2022). Growth of UPI merchant ecosystem. Mumbai: National Payments Corporation of India.
12. OECD. (2021). The Digital Transformation of SMEs. Paris: OECD Publishing.
13. Prasad, S., Kant, S. (2021). Digital adoption and SME productivity in India. Journal of Development Policy and Practice, 6(2), 222–238.
14. Reserve Bank of India. (2023). Handbook of Statistics on Indian Economy. Mumbai: RBI.
15. Sengupta, R., Sharma, A. (2020). COVID-19, digitization and the urban MSME sector. IIMB Management Review, 32(4), 323–340.
16. Shah, H., Natarajan, V. (2019). Barriers to digital adoption by small businesses in India. Global Journal of Flexible Systems Management, 20(1), 91–105.
17. Sharma, P. Mittal, N. (2022). E-payments and MSME growth: Evidence from Delhi. NCR. International Journal of Emerging Markets, 17(6), 1578–1596.
18. TRAI. (2022). Telecom Sector Performance Indicators Report. New Delhi: Telecom

Regulatory Authority of India.
19. UNCTAD. (2019). Digital Economy Report. Geneva: United Nations.
20. World Bank. (2020). World Development Report 2020 – Trading for Development in the Age of Global Value Chains. Washington, DC: World Bank.
21. Yadav, M., Goyal, P. (2022). Impact of digital platforms on micro-entrepreneurial performance: Evidence from India. Journal of Small Business and Enterprise Development, 29(7), 1061–1080.
22. Gutiérrez Navas, E. B., Sarmiento Suarez, J. E., Ram´ırez Montañez, J.,Rincón Quintero, Y. A. (2024). Determining factors for the digitization of micro, small, and medium-sized enterprises (MSMEs) in Ibero-America. Journal of Innovation Knowledge, 10, 100631.
23. (Reis et al., 2018) Reis, J., Amorim, M., Melão, N., Matos, P. (2018). Digital transformation: A literature review and guidelines for future research. World Conference on Information Systems and Technologies, 411–421.
24. (Busulwa et al., 2022) Busulwa, R., Pickering, M., Mao, I. (2022). Digital transformation and hospitality management competencies: Toward an integrative framework. International Journal of Hospitality Management, 102, Article 103132.
25. (Alt, 2018) Alt, R. (2018). Electronic markets on digitalization. Electronic Markets, 29, 397–402.
26. (Plotnikov, 2018) Plotnikov, V. (2018). Digitalization of the economy and the development of the digital economy. Economic and Social Changes: Facts, Trends, Forecast, 11(6), 63–73.
27. (Feliciano et al., 2023) Feliciano, G., Villanueva, M., Soler, M. (2023). Digital transformation strategies for SMEs: A multiple case study. Journal of Small Business and Enterprise Development, 30(3), 457–475.
28. (Gebauer et al., 2020) Gebauer, H., Fleisch, E., Lamprecht, C., Wortmann, F. (2020). Growth paths for overcoming the digitalization paradox. Business Horizons, 63(3), 313–323.
29. (Ulas, 2019) Ulas, D. (2019). Digital transformation process and SMEs. Procedia Computer Science, 158, 662–671.
30. (Chanias Hess, 2016) Chanias, S., Hess, T. (2016). How digital are we? Maturity models for the assessment of a company's status in the digital transformation. Management Report/Institut Für Wirtschaftsinformatik Und Neue Medien, 2, 1–14.
31. (Verhoef et al., 2021) Verhoef, P., Broekhuizen, T., Bart, Y., Bhattacharya, A., Dong, J., Fabian, N., Haenlein, M. (2021). Digital transformation: A multidisciplinary reflection and research agenda. Journal of Business Research, 122, 889–901.
32. Sharma, R., Mithas, S., Kankanhalli, A. (2020). Transforming with digital innovation: An empirical investigation of information technology and firm performance. Information Systems Research, 31(4), 1080–1103. https://doi.org/10.1287/isre.2019.0899
33. Bala, R., Verma, S. (2019). Digitalization and performance of small and medium enterprises in India: A structural equation modeling approach. Journal of Advances in Management Research, 16(2), 186–203.
34. Pareek, A., Bansal, M., Sharma, S. (2021). Digital transformation for SMEs: A strategy framework for Industry 4.0. Journal of Manufacturing Technology Management, 32(2), 416–439. https://doi.org/10.1108/JMTM-10-2019-0465
35. Dwivedi, Y.K., Hughes, D.L., Coombs, C., Constantiou, I., Duan,Y., Edwards, J. S., ... Upadhyay, N. (2020). Impact of COVID-19 pandemic on information management research and practice: Transforming education, work and life. International Journal of Information Management, 55, 102211.
36. Bansal, P., Zahra, S.A. (2021). Sustainability as a strategy. Harvard Business Review, 99(1), 112–121.
37. Choudhary, S., Kumar, A., Gupta, M. P. (2022). Cyber security challenges and risk mitigation strategies for MSMEs in India. Information Systems Frontiers, 1–21.
38. Sivarajah, U., Kamal, M. M., Irani, Z., Weerakkody, V. (2020). Critical analysis of Big Data challenges and analytical methods in COVID-19 (Coronavirus) pandemic. Journal of King Saud University Computer and Information Sciences.