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Development of Digital Transformation Maturity Measurements: A Systematic Literature Review

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Abstract. Digital transformation is a phenomenon that provides the right demand and attitude for organizations in digital optimization. Digital transformation encourages organizations to adapt to technological developments as a strategic step to support organizational sustainability and win market competition. The purpose of this article is presenting a systematic literature review of the development of measuring the maturity of digital transformation. The methodology used in this article is systematic literature review approach with article collection strategy that discuss digital transformation and digital maturity measurement and is sourced from reputable journals indexed by Scopus and or the Web of Science. There are 1385 articles appear when searching for digital transformation, out of 1385 there are 30 articles relevant to the topic of digital transformation and digital maturity measurement with the range of 2018-2022. The findings of this systematic literature review have 6 levels and 4 dimensions in measuring the maturity of digital transformation in the industrial sector (large, medium, small), there are 8 levels and 7 dimensions in measuring the maturity of digital transformation in health sector, there are 6 levels and 6 dimensions in measuring the maturity of digital transformation in the banking sector, and there are 5 levels and 5 dimensions in measuring the maturity of digital transformation in the education sector. This article supplies valuable insights on the topic of measuring the maturity of digital transformation and can be an opportunity for further research such as evaluating, developing empirically testing in different sectors of the economy in different regions.

Key words: digital transformation, digital maturity index, systematic literature review

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INTRODUCTION

The rapid development of technology has a significant impact on many organizations. Adapting digital usage can help the organization to support the stability of organizational sustainability and to be able to win market competition. Digital transformation that becomes a trend in the world can provide benefits and strategic capabilities in organizational governance and organizational management (Barbosa et al., 2020). Lately digital applications are growing rapidly such as social media, cloud, internet of things (IoT), artificial intelligence, blockchain, automated vehicles, augmented reality as an organizational value creation (Pramanik et al., 2019). In the Covid-19pandemic, the digital gap has an impact on four primary services sectors such as: public administration services, education during the Covid-19 pandemic, health during the Covid-19 pandemic and economic recovery (Aissaoui, 2022).

According Antony et al., (2023) digital transformation is a sociocultural process of adapting old organizations to new organizational forms and the skill needed to stay afloat and relevant in the digital landscape. This is like changing the business process of previous organizations through reengineering business process through information technology (OECD, 2022). The change attempts to improve the previous business process. according to Vial (2019) digital transformation can be described as a process that aims to improve an entity by triggering significant changes in the organization through the combination of information, communication, and connectivity technologies. Digital transformation is defined as technological achievements that bring new breakthroughs and operating models in all sectors (Gökalp & Martinez, 2021).

Digital transformation research becomes very interesting because it continues to develop significantly in countries, regions and organizational sectors such as health, banking, education. The phenomenon of digital transformation becomes important for organizational success in facing the obstacles of globalization. Organizations must be prepared for digital transformation by creating industry 4.0 readiness models for organizational readiness evaluation before implementing digital transformation (Aissaoui, 2022). Digitalization plays a major role in contributing to the economy and the environment in the future (Bican & Brem, 2020). The importance of organizational sustainability in developing and transforming to digital requires organizations to make a variety of very complex efforts so that organizations can continue, maintain and create competitive-

ness value (Barbosa et al., 2020).

Digital transformation has recognizable impact on the growth of all sectors of the economy (Borovkov et al., 2021). Digital transformation also simultaneously exerts stakeholder influence in developing a strategic vision for the digital era (Berghaus & Back, 2018). The exploitation and integration of digital technologies has transformed business models in all industries in different sectors and provided increased innovation in value creation, sales, productivity, and service quality by improving system-based process and services (Gökalp & Martinez, 2021). Digital transformation has significantly attracted the interest of academics and industry, with more than 80% of CEOs reporting that their organizations have digital transformation programs that are expected by 2030 more than 70% of the economy's industries will rely on digital platforms and from new value creation (Gökalp & Martinez, 2021). Digital transformation knowledge becomes very important for organizations in many sectors to prepare for it appropriately in responding to the development of digital transformation. The maturity of digital transformation helps management and employees in developing self-assessment to increase maturity in conducting digital transformation activities effectively.

The term maturity refers to a state that is complete, perfect, or ready. It is the result of progress in the development of a system. Organizations that have a mature systems, are able to improve their organizations over time towards achievements from the present to the desired future (Teichert, 2019). Sometimes digital transformation and digital maturity are used interchangeably without considering differences, but digital maturity can be seen as a systematic way for an organization to transform digitally (Kiron et al., 2016; von Leipzig et al., 2017). Therefore, the term digital maturity specifically reflects the status of digital transformation in organizations (Chanias & Hess, 2016; Šimberová et al., 2022).

The purpose of this article is to find out about the development of digital transformation maturity measurements models based on research trend between 2018-2022 and key factors such as digital transformation maturity measurement in different sector. This article contributes to the literature digital transformation measurements and addresses the problem of digital transformation. The data collected in this study is based on an objective screening and selection of thousands of research articles with systematic review protocols such as search sources in Scopus and or Web of Science database, search with terms/ keywords specific, inclusion criteria, exclusion criteria, and quality criteria.

METHOD

The study uses a systematic method. It explicitly aims to unify the empirical results of previous researchers by identifying, categorizing, visualizing and analyzing existing and relevant literature, objectively and thoroughly on the topic of digital transformation research (Belezas & Daniel, 2022; Zhu et al., 2021). The method of this article is presented in Figure 1.

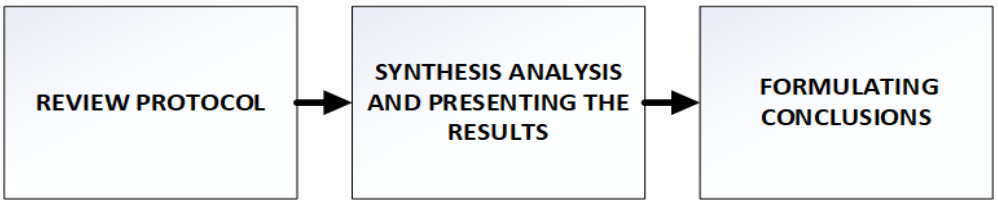

Figure 1. Steps Methodology a Systematic Literature Review

The method in this article uses a systematic literature review method. In this systematic literature review, identification carried out to determine the purpose, select, analyze, synthesize research literature with a specific topic and present it clearly 16. This systematic literature review approach covers three steps 18. The first is development of the review protocol. The second is conducting a synthesis analysis and presenting the results. And the third is formulating conclusions.

The systematic literature review protocol in this article is based on recommendations from 18, with the following scope: research questions, search sources, search terms/keywords, search strategy, inclusion criteria, exclusion criteria, and quality criteria.

In this first define the research question as the focus of the research digital transformation. The problem formulation in this article is:

- RQ1: How is the digital transformation in the industrial sector (small, medium, large), banking sector, health sector, education sector?
- RQ2: What are the dimensions of measuring the maturity of digital transformation in the industrial sector (small, medium, large), banking sector, health sector and education sector?

The search for studies in this article through the source of the Scopus database and or Web of Science database which is the main source of the search for relevant studies because it has a wide scope in various

fields. The study's search for articles about digital transformation published in Elsevier, Emerald Insight, IEEE Explore, ProQuest, Springer, IG Publishing, Wiley, EBSCO, Taylor and Francis, Sage Publishing.

The terms or keyword used in this article are as follows: (Digital Transformation OR Digital Devide) AND ("Digital Maturity" OR "Digital Maturity Measurement" OR "Dimensions" OR "Readiness") AND ("Industrial Sector" OR "Banking Sector" OR "Health Sector" OR "Education Sector") AND ("Qualitative" OR "Quantitative" OR "Mix-Methods" OR "Systematic Literature Review").

Searching the data in this article uses several search strategies including period, article type, publication title, subject areas. The explanation of each strategy is as follows:

- Period: 2018-2022.
- Article type: Reviews Article, Research Articles, Book Chapter, Thesis, Dissertation.
- Publication Title: All publication titles
- Subject Areas: Information Systems, Business Administration, Business management and Accounting.

The inclusion criteria in this article includes English. The title, abstract and content are relevant to the keywords. Empirical research methods such as qualitative, quantitative, mix-method and systematic literature review. Articles published by journals or proceedings or conferences. Exclusion criteria in this article include Duplicate. Paper irrelevant and object of research are irrelevant. The quality criteria in this article include A journal index of a minimum Q3 and a maximum of Q1. For paper proceedings and conferences indexed by Scopus or Web of Science. The paper must answer the following questions.

The literature review process was carried out in April 2022. The literature selection process is described in Figure 2.

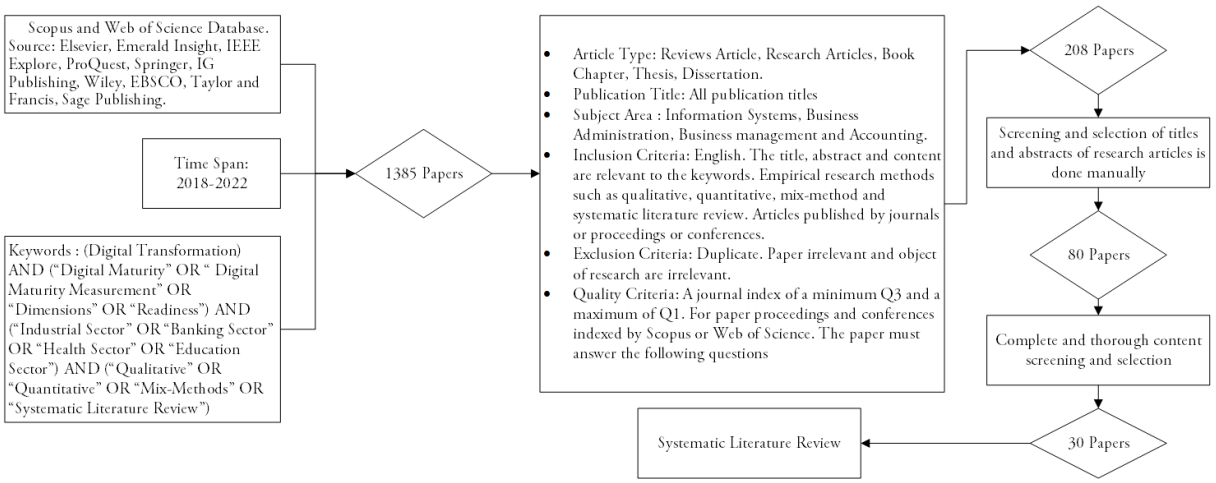

Figure 1. Systematic Literature Review Proses

From 1385 articles that appeared based on keywords, we conducted a sorting process with time criteria from 2018 – 2022, removed the duplication of articles that appeared, and focused on the discipline of information systems. From this process, 208 articles were found. Furthermore, from 208 articles, the search process was conducted by extracting the article into an electronic spreadsheet by selecting a title, reading the abstract content and reviewing keywords. We obtained 80 articles. After that we read and analyzed the content of 80 articles as a whole digital transformation content and digital maturity measurement. Articles that did not fit the criteria and eligibility to answer our questions were excluded from the screening.

Screening involved measuring the maturity of digital transformation, which included the dimensions and levels conducted in the industrial sectors (small, medium, large), health, banking, and education. The criteria in the publication data were analyzed based on the timeliness of publication between 2018 – 2022. The criteria in the method and research design were adopted with a qualitative, quantitative, mix–method, systematic literature review approach. So that the results of the screening found that there were 30 relevant articles to be processed.

RESULTS AND DISCUSSION

After the selection process the results of the data synthesis extract based on the methodology and quality criteria are presented in the Table 1 and Table 2.

Table 1. Distribution of Research Methodology

Research Method	Author	Total	Percentage
References Theory and Object			
Digital Transformation Maturity in Industrial Sector	(Antony et al., 2023; Bican & Brem, 2020; Borovkov et al., 2021; Gökalp & Martinez, 2021; Teichert, 2019; Zhu et al., 2021; Kıyıklık et al., 2022; Tripathi & Gupta, 2021; Wagire et al., 2021; Rafael et al., 2020; Narula et al., 2020)	24	80%
Digital Transformation Maturity in Banking Sector	(Bandara et al., 2019; Goumeh & Barforoush, 2021)	2	7%
Digital Transformation Maturity in Health Sector	(Duncan et al., 2022; Williams et al., 2019)	2	7%
Digital Transformation Maturity in Education Sector	(Marks et al., 2020; Büyüközkan et al., 2021)	2	7%
Reference Approach			
Empirical Qualitative	(Bican & Brem, 2020; Borovkov et al., 2021; Gökalp & Martinez, 2021; Rafael et al., 2020; Ghosh et al., 2022; Kraft et al., 2022; Machado et al., 2021; Ostmeier & Strobel, 2022; Pirola et al., 2020; Reuschl et al., 2022; Rossini et al., 2021; Yu et al., 2022; Sousa-Zomer et al., 2020; Williams et al., 2019; Marks et al., 2020; Begicevic Redjep et al., 2021)	16	53%
Empirical Quantitative	(Narula et al., 2020; Sousa-Zomer et al., 2020; Li et al., 2021)	3	10%
Empirical Mix-Method	(Antony et al., 2023; Gökalp & Martinez, 2021; Šimberová et al., 2022; Wagire et al., 2021; Yu et al., 2022)	5	17%
Systematic Literature Review	(Zhu et al., 2021; Tripathi & Gupta, 2021; O. Bandara & Wickramarachchi, 2020; Goumeh & Barforoush, 2021; Duncan et al., 2022; Tekic & Koroteev, 2019)	6	20%

Table 1 shows the results of the research methods from the authors with several categories including theory and research objects. The research theory is taken on the topic of digital transformation maturity with a focus on the object of the industrial sector, the banking sector, the health sector, and the education sector. second, the category of research approach which includes qualitative empirical research, quantitative empirical research, mixed methods empirical research, and literature systematic review methods.

In the theory and object categories studied, it was found that there was a gap that many researchers discussed and empirically tested digital transformation maturity in the industrial sector with a percentage of 80%, but there were still few who discussed and tested digital transformation maturity empirically in the banking sector, health sector and education sector. Research approach with the topic of digital transformation, researchers prefer a qualitative approach with a percentage of 53%. but there are also researchers who test with a quantitative approach, mixed methods and a systematic review of the literature. The journals used in this article are based on journals published in 2018-2022. As for the results obtained from that time span, they are presented in the Figure 3.

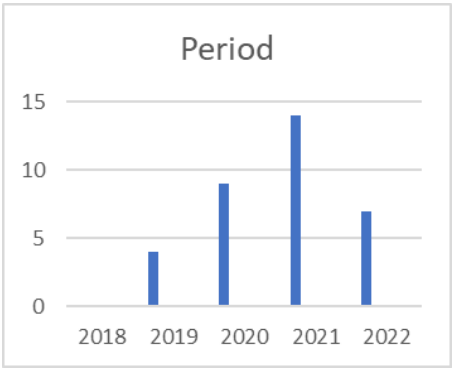

Figure 2. Total per Period of Publication

Articles published on the topic of digital transformation maturity in the industrial sector (small, medium, large), health, banking and education in 2019 were found 4 publication articles. In 2020 were found 9 articles. In 2021 were found 14 articles. In 2022 were found 7 articles.

Table 2. Quality Criteria

Journal	Quartile	Total
TQM Journal	Q2	1
Technology, Pedagogy and Education	Q1	1
Sustainability	Q1	3
Journal of Medical Internet Research	Q1	1
Technovation	Q1	4
Computers In Industry	Q1	1
International Journal of Production Economics	Q1	1
Decision Analytics Journal	Q1	1
Journal of Strategy and Management	Q2	1
Journal of Manufacturing Technology Management	Q1	3
International Journal of Advanced Computer Science and Applications	Q3	1
Journal Advances in Management Research	Q2	1
Journal of Business Research	Q1	3
Journal of Manufacturing Technology Management	Q1	3
Technological Forecasting & Social Change	Q1	1
Benchmarking: An International Journal	Q3	1
Production Planning & Control	Q1	1
Jmir Medical Informatics	Q2	1
Business Horizons	Q1	1
Computer and Industrial Engineering	Q1	1
System Engineering	Q2	1
Proceedings of the IEEE Computer Society Conference on Computer Vision and Pattern Recognition	-	1

The findings on publishing sources are based on the selected subject area, all papers are obtained from scientific journal publishers indexed on Scopus and the Web of Science with a minimum quartile of Q3 and a maximum of Q1. We conducted a bibliographic analysis using a vosviewer analysis tool to decide research trends and the relationship between visual research discussions on the topic of digital transformation and measuring the maturity of digital transformation. Given the topics presented on each article with a set of words, the vosviewer tool helped in organizing and offering an instructive data structure to understand the interconnected set of words. It was to identify the topic or structure of data collection in the literature review to assume that the documents collected for a particular problem included a homogeneous list of topics (Lee et al., 2021). We did bibliographic analysis by extracting journal files stored on reference tools into .RIS. Next, we conducted a bibliographic analysis based on the data of the title text and abstract. The visual results of the bibliographic analysis are presented in Figure 4.

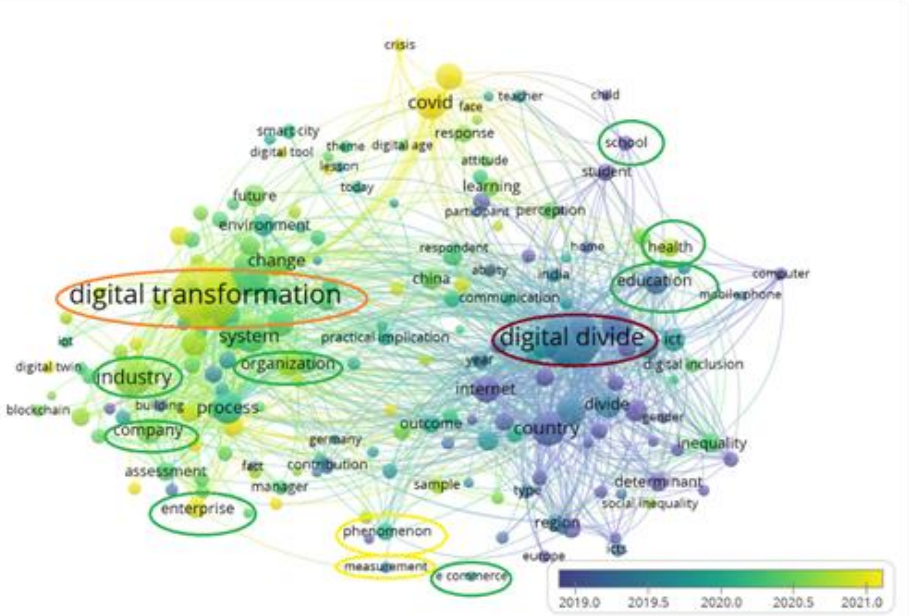

Figure 3. Keyword and abstract network visualization

The mapping study analyzed in Figure 4. supplies an overview of the close relationship between digital transformation and the digital divide. Earlier researchers conducted research by creating a model measuring the maturity of digital transformation using qualitative methods based on phenomenology that occurs in various sectors, especially in the industrial, health, education, and financial sectors in their countries. The digital transformation is the focus of researchers to evolve and develop at the level of measurement of its maturity and dimensions created and developed with the aim of helping, taking, clarifying the strategic position of the organization in terms of maturity level and also as a theory of development about the relationship between structure, performance, and dynamic environment. Here is the collection of data or data excavation derived from the main article research results that relevance to answer the research question of digital transformation model, the level of digital maturity of transformation and the digital dimension of transformation in four sectors: big industry, medium and small enterprise, health, banking, and education . It is presented in Table 3.

Table 3. Model Digital Transformation

Sector	Digital Transformation Maturity Level	Dimensions of Digital Transformation	Author
Big Industry, Medium Industry, Small Enterprises	0. Incomplete 1. Realized 2. Managed 3. Established 4. Predictable 5. Innovative	1) Strategic Governance 2) Information and Technology 3) Digital Process Transformation 4) Workforce Management	4,6,8,24,27,31,44
Health	0. Administrative 1. Tactical 2. Fixed 3. Mobile 4. Externalized 5. Integrated 6. Contextualized 7. Orchestrated	1) Strategy 2) IT Capability 3) Interoperability 4) Governance and Management 5) Patient-Centered Care 6) People, Skill, and Behavior 7) Data Analytics	36,37
Banking	1. Not started 2. Digital beginner 3. Enabling 4. Integrating 5. Optimizing 6. Digital Champion	1) Governance 2) Products and Services 3) Technology and Human Resources 4) Organizational strategy 5) Operational 6) Customer	34,35
Education	1) Basic 2) First 3) e-Enabled 4) e-Confident 5) e-Mature	1) Planning, Management, and Leadership 2) IS in Learning and Teaching 3) Digital Skills Development 4) IS Culture 5) IS Infrastructure	38,40

The digital transformation in big industry, medium industry, small enterprises has six levels of maturity. Level 0 incomplete has not started initiatives on digital transformation. Level 1 realized; digital transformation starts digital transformation initiatives. Level 2 managed, digital transformation begins physically. Level 3 established, digital transformation strongly consistent and by standardization. Level 4 predictable, digital transformation has to products, services, or processes with real-time data. Level 5 Innovating, the Organization uses the data collected for continuous evaluation and improvement, an innovative culture, dynamic cooperation and increased transparency to expand operational visibility with the effective and efficient exchange of information (Gökalp & Martinez, 2021).

The dimensions and indicators in the digital transformation capability model are as follows: Strategic Governance (digital transformation development, portfolio management, project management, financial and supplier management), Information and Technology (IT strategy management, requirement definition, enterprise architecture development, infrastructure management, data governance, agile software development, security management, enterprise architecture integration, data analytics, enterprise architecture maintenance), Digital Process Transformation (Business process digitalization, business process vertical integration, business process horizontal integration, data driven decision management, quantitative performance management, business process integration toward life cycle, quantitative process improvement, Workforce Management (HR skill development, organizational structure management, organizational change management, sustainable learning management) (Gökalp & Martinez, 2021).

The maturity level of digital transformation in health sector uses eight levels : Level 0: Administrative, at this level the hospital does not use information technology in best clinical use. Level 1: Tactical, at this level hospitals began to use information technology for clinical purposes. Level 2: Fixed, at this level hospitals already have the availability of digital clinical data. Level 3: Mobile, at this level hospitals are already able to have clinical data available on mobile devices such as online consultations. Level 4: Externalized, at this level the hospital is able to perform services without having to come to the location. Level 5: Integrated, at this level the hospital has integrated the entire clinical process from simple to complex. Level 6: Contextualized, at this level information to plays a specific role with a high degree of data interoperability between clinical systems, physicians and patients. Level 7: Orchestrated, at this level clinician and patient experience meets clinical needs that can be automatically done. The dimensions used in hospitals are as follows: Transport, Collaboration, Security, Mobility, Data Center (Williams et al., 2019). The dimensions in health are: Strategy. IT Capability. Interoperability. Governance and Management. Patient-Centered Care. People Skill, and Behavior. Data Analytic (Duncan et al., 2022).

In the digital maturity of banking sector, there are five levels. Level 1: Initial, at this level the process is not well controlled. The management process is reactive. Level 2: Managed, at this level the transformation process has begun to be planned and implemented. Level 3: Defined, at this level the process that implemented are good enough in the organizational management. Level 4: Set up, digital transformation supplies added value in each operational process and follow organizational standardization. Level 5: Digital Oriented, at this level the organizational process is already digitally oriented so that the technology infrastructure targets organizations grow significantly. Dimensions and indicators used as follows: Products and Services (Customized products, Digitalized products, Data-driven services, Digital marketing approaches). Technology and Resources (Use of advance technologies, use of mobile devices, cloud technologies). Strategy Organization (Available resources for realization, Adaption of business models, organization culture for innovation), Operations (decentralization of processes, interdisciplinary, interdepartmental collaboration, data driven excellence, new digital business models), Customers (personalized services, use of customer data, digitalization of services, customer's digital media competence, customized apps). Governance (labor regulations, technology standards, real time decision making, data governance, information security). Employees (knowledge, ability and competences of employees to modern technologies, user training, ensure service accuracy) (O. Bandara & Wickramarachchi, 2020).

The digital maturity model of education has five levels of digital transformation maturity. Level 1 Basic, schools still do not realize the importance of technology as a learning medium or as a tool in the management process so that schools do not consider and plan for the growth and development of technology. Level 2 Initial, the school begin to have awareness of the possible use of information technology in the learning, teaching and

management processes, but it has not implemented. Level 3 e-Enabled, the school begin to realize the possibility of using information technology in all activities, contributing and taking part in small projects focused on information technology, guiding the development of strategic and integrated documents. Level 4 e-Confident, the school clearly recognizes the advantages of information technology in its use by integrating all activities and implemented into strategic documents and applied to daily activities. Level 5 e-Mature, the school is clear, clearly recognizes, and requires the use of information technology throughout the activities poured in strategic documents and work programs in its development. The entire management of the school depends on the integration of technology, data collection, and data acquisition obtained entirely from the school information system (Begicevic Redjep et al., 2021).

Dimensions and indicators of the digital maturity model in the education sector include: planning, management, and leadership with indicators such as vision, strategic plan and objectives of information system integration, school development program plans from an information system perspective, managing information system integration in the learning and teaching process, managing information system integration in all school activities including business in schools, learning analytics data, organized access to information system resources, the use of information systems when teaching students with specialized education. The second dimension is information systems in learning and teaching, with indicators such as the use of information systems in learning and teaching activities, digital content, student evaluation, student experience. The third dimension is culture, with indicators such as access to information system resources by educational staff and teachers, access to all student data and business processes using information system resources, networks, communications, information and reporting, copyright and intellectual property. The fourth dimension is information system infrastructure, with indicators, planning and procurement of information system infrastructure, information system equipment in supporting, maintaining, storing digital documents and educational content with a controlled information security system and permits (Begicevic Redjep et al., 2021).

CONCLUSION

This systematic literature review aims to answer questions about the development of the latest model to assess the maturity of digital transformation in four sectors, the industrial sector both large, medium and small, health sector, education sector, banking sector. The model developed by the researchers evaluated with a wide variety of methodologies including systematic, qualitative, quantitative, mix method reviews for empirical validation. The approach in this article is to review the systematic literature by reading, analyzing and collecting dimensions and deciding the maturity level of digital transformation in four sectors namely in the sectors of industry, finance, education and health.

Based on the findings of the digital transformation maturity model, the most researched by earlier researchers, is the manufacturing industry sector. This can be a research activity in the future with strategic steps in testing existing models or creating and bringing up new dimensions and maturity levels in digital transformation in the health sector, education sector, banking sector in various countries and regions. Furthermore, it becomes a roadmap to increase the maturity of certain items and related dimensions that will be developed as a determination of strategic programs and projects.

REFERENCES

Aissaoui, N. (2022). The digital divide: a literature review and some directions for future research in light of COVID-19. *Global Knowledge, Memory and Communication*, *71*(8–9), 686–708. https://doi.org/10.1108/GKMC-06-2020-0075

Antony, J., Sony, M., & McDermott, O. (2023). Conceptualizing Industry 4.0 readiness model dimensions: an exploratory sequential mixed-method study. *TQM Journal*, *35*(2), 577–596. https://doi.org/10.1108/TQM-06-2021-0180

Bandara, O. K. K., Tharaka, V. K., & Wickramarachchi, A. P. R. (2019). Industry 4.0 maturity assessment of the Banking Sector of Sri Lanka. *Proceedings - IEEE International Research Conference on Smart Computing and Systems Engineering, SCSE 2019, March*, 190–195. https://doi.org/10.23919/SCSE.2019.8842818

Bandara, O., & Wickramarachchi, R. (2020). A Model for Assessing Maturity of Industry 4 . 0 in the Banking Sector. *Proceedings of the International Conference on Industrial Engineering and Operations Management Bangkok, Thailand, March*, *May*, 1141–1150.

Barbosa, M., Castañeda -Ayarza, J. A., & Lombardo Ferreira, D. H. (2020). Sustainable Strategic Management (GES): Sustainability in small

business. *Journal of Cleaner Production*, *258*, 120880. https://doi.org/10.1016/j.jclepro.2020.120880

Begicevic Redjep, N., Balaban, I., & Zugec, B. (2021). Assessing digital maturity of schools: framework and instrument. *Technology, Pedagogy and Education*, *30*(5), 643–658. https://doi.org/10.1080/1475939X.2021.1944291

Belezas, F., & Daniel, A. D. (2022). Innovation in the sharing economy: A systematic literature review and research framework. *Technovation*, 102509. https://doi.org/https://doi.org/10.1016/j.technovation.2022.102509

Berghaus, S., & Back, A. (2018). Disentangling the Fuzzy Front End of Digital Transformation: Activities and Approaches. *ICIS 2017: Transforming Society with Digital Innovation*, 0–17.

Bican, P. M., & Brem, A. (2020). Digital Business Model, Digital Transformation, Digital Entrepreneurship: Is There A Sustainable "Digital"? *Sustainability*, *12*(13), 5239. https://doi.org/10.3390/su12135239

Borovkov, A., Rozhdestvenskiy, O., Pavlova, E., Glazunov, A., & Savichev, K. (2021). Key barriers of digital transformation of the high-technology manufacturing: An evaluation method. *Sustainability (Switzerland)*, *13*(20), 1–13. https://doi.org/10.3390/su132011153

Büyüközkan, G., Güler, M., & Mukul, E. (2021). Assessing the Maturity for Digital Education with HFL DEMATEL-HFL ARAS Techniques. *Proceedings of the Central European Conference on Information and Intelligent Systems*, *2020*, 303–308.

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.

Duncan, R., Eden, R., Woods, L., Wong, I., & Sullivan, C. (2022). Synthesizing Dimensions of Digital Maturity in Hospitals: Systematic Review. *Journal of Medical Internet Research*, *24*(3), e32994. https://doi.org/10.2196/32994

Ghosh, S., Hughes, M., Hodgkinson, I., & Hughes, P. (2022). Digital transformation of industrial businesses: A dynamic capability approach. *Technovation*, *113*, 102414. https://doi.org/https://doi.org/10.1016/j.technovation.2021.102414

Gökalp, E., & Martinez, V. (2021). Digital transformation capability maturity model enabling the assessment of industrial manufacturers. *Computers in Industry*, *132*, 103522. https://doi.org/10.1016/j.compind.2021.103522

Goumeh, F., & Barforoush, A. A. (2021). A Digital Maturity Model for digital banking revolution for Iranian banks. *2021 26th International Computer Conference, Computer Society of Iran (CSICC)*, 1–6. https://doi.org/10.1109/CSICC52343.2021.9420566

Kiron, D., Kane, G. C., Palmer, D., Phillips, A. N., & Buckley, N. (2016). Aligning the Organization for Its Digital Future. *MITSloan Management Review*, *58180*, 1–29.

Kıyıklık, A., Kuşakcı, A. O., & Mbowe, B. (2022). A digital transformation maturity model for the airline industry with a self-assessment tool. *Decision Analytics Journal*, *3*, 100055. https://doi.org/https://doi.org/10.1016/j.dajour.2022.100055

Kraft, C., Lindeque, J. P., & Peter, M. K. (2022). The digital transformation of Swiss small and medium-sized enterprises: insights from digital tool adoption. *Journal of Strategy and Management*, *15*(3), 468–494. https://doi.org/10.1108/JSMA-02-2021-0063

Lee, C.-H., Liu, C.-L., Trappey, A. J. C., Mo, J. P. T., & Desouza, K. C. (2021). Understanding digital transformation in advanced manufacturing and engineering: A bibliometric analysis, topic modeling and research trend discovery. *Advanced Engineering Informatics*, *50*, 101428. https://doi.org/https://doi.org/10.1016/j.aei.2021.101428

Li, H., Wu, Y., Cao, D., & Wang, Y. (2021). Organizational mindfulness towards digital transformation as a prerequisite of information processing capability to achieve market agility. *Journal of Business Research*, *122*, 700–712. https://doi.org/10.1016/j.jbusres.2019.10.036

Machado, C. G., Winroth, M., Almström, P., Ericson Öberg, A., Kurdve, M., & AlMashalah, S. (2021). Digital organisational readiness: experiences from manufacturing companies. *Journal of Manufacturing Technology Management*, *32*(9), 167–182. https://doi.org/10.1108/JMTM-05-2019-0188

Marks, A., AL-Ali, M., Atassi, R., Abualkishik, A. Z., & Rezgui, Y. (2020). Digital transformation in higher education: a framework for maturity assessment. *International Journal of Advanced Computer Science and Applications*, *11*(12),

504–513. https://doi.org/10.14569/IJACSA.2020.0111261

Narula, S., Prakash, S., Dwivedy, M., Talwar, V., & Tiwari, S. P. (2020). Industry 4.0 adoption key factors: an empirical study on manufacturing industry. *Journal of Advances in Management Research*, *17*(5), 697–725. https://doi.org/10.1108/JAMR-03-2020-0039

OECD. (2022). Digital Transformation Maturity Model. *Studies on Entrepreneurship, Structural Change and Industrial Dynamics*, 221–235. https://doi.org/10.1007/978-3-030-89832-8_12

Ostmeier, E., & Strobel, M. (2022). Building skills in the context of digital transformation: How industry digital maturity drives proactive skill development. *Journal of Business Research*, *139*, 718–730. https://doi.org/https://doi.org/10.1016/j.jbusres.2021.09.020

Pirola, F., Cimini, C., & Pinto, R. (2020). Digital readiness assessment of Italian SMEs: a case-study research. *Journal of Manufacturing Technology Management*, *31*(5), 1045–1083. https://doi.org/10.1108/JMTM-09-2018-0305

Pramanik, H. S., Kirtania, M., & Pani, A. K. (2019). Essence of digital transformation—Manifestations at large financial institutions from North America. *Future Generation Computer Systems*, *95*, 323–343. https://doi.org/10.1016/j.future.2018.12.003

Rafael, L. D., Jaione, G. E., Cristina, L., & Ibon, S. L. (2020). An Industry 4.0 maturity model for machine tool companies. *Technological Forecasting and Social Change*, *159*, 120203. https://doi.org/https://doi.org/10.1016/j.techfore.2020.120203

Reuschl, A. J., Deist, M. K., & Maalaoui, A. (2022). Digital transformation during a pandemic: Stretching the organizational elasticity. *Journal of Business Research*, *144*, 1320–1332. https://doi.org/https://doi.org/10.1016/j.jbusres.2022.01.088

Rossini, M., Cifone, F. D., Kassem, B., Costa, F., & Portioli-Staudacher, A. (2021). Being lean: how to shape digital transformation in the manufacturing sector. *Journal of Manufacturing Technology Management*, *32*(9), 239–259. https://doi.org/10.1108/JMTM-12-2020-0467

Šimberová, I., Korauš, A., Schüller, D., Smolíkova, L., Straková, J., & Váchal, J. (2022). Threats and Opportunities in Digital Transformation in SMEs from the Perspective of Sustainability: A Case Study in the Czech Republic. *Sustainability (Switzerland)*, *14*(6). https://doi.org/10.3390/su14063628

Sousa-Zomer, T. T., Neely, A., & Martinez, V. (2020). Digital transforming capability and performance: a microfoundational perspective. *International Journal of Operations and Production Management*, *40*(7–8), 1095–1128. https://doi.org/10.1108/IJOPM-06-2019-0444

Teichert, R. (2019). Digital transformation maturity: A systematic review of literature. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, *67*(6), 1673–1687. https://doi.org/10.11118/actaun201967061673

Tekic, Z., & Koroteev, D. (2019). From disruptively digital to proudly analog: A holistic typology of digital transformation strategies. *Business Horizons*, *62*(6), 683–693. https://doi.org/https://doi.org/10.1016/j.bushor.2019.07.002

Tripathi, S., & Gupta, M. (2021). A holistic model for Global Industry 4.0 readiness assessment. *Benchmarking*, *28*(10), 3006–3039. https://doi.org/10.1108/BIJ-07-2020-0354

Vial, G. (2019). Understanding digital transformation: A review and a research agenda. *The Journal of Strategic Information Systems*, *28*(2), 118–144. https://doi.org/https://doi.org/10.1016/j.jsis.2019.01.003

von Leipzig, T., Gamp, M., Manz, D., Schöttle, K., Ohlhausen, P., Oosthuizen, G., Palm, D., & von Leipzig, K. (2017). Initialising Customer-orientated Digital Transformation in Enterprises. *Procedia Manufacturing*, *8*(October 2016), 517–524. https://doi.org/10.1016/j.promfg.2017.02.066

Wagire, A. A., Joshi, R., Rathore, A. P. S., & Jain, R. (2021). Development of maturity model for assessing the implementation of Industry 4.0: learning from theory and practice. *Production Planning and Control*, *32*(8), 603–622. https://doi.org/10.1080/09537287.2020.1744763

Williams, P. A., Lovelock, B., Cabarrus, T., & Harvey, M. (2019). Improving Digital Hospital Transformation: Development of an Outcomes-Based Infrastructure Maturity Assessment Framework. *JMIR Medical Informatics*, *7*(1), e12465. https://doi.org/10.2196/12465

Yu, H., Fletcher, M., & Buck, T. (2022). Managing digital transformation during re-internationalization: Trajectories and implications for performance. *Journal of International Management*, *28*(4), 100947. https://doi.org/https://doi.org/10.1016/j.intman.

2022.100947

Zhu, X., Ge, S., & Wang, N. (2021). Digital transformation: A systematic literature review. *Computers & Industrial Engineering*, *162*, 107774. https://doi.org/https://doi.org/10.1016/j.cie.2021.107774