



Mapping The Knowledge Domains of Digital Transformation Publications: A Bibliometric Analysis

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Abstract. This article identifies a scientific mapping on developing digital transformation publications in SMEs. Publications related to digital transformation in SMEs are still not popular enough. The trend of digital transformation publications has increased significantly starting in 2019, along with the emergence of the Covid-19 pandemic. It takes the development of scientific knowledge to explain, predict, and control the dynamic ability to adapt in the digital 4.0 era. Bibliometric analysis was used to analyse articles from Scopus, Emerald, Springer, ProQuest, Web of Science, and Science Direct databases. Through bibliometric analysis, the development of studies regarding digital transformation and the latest trends in this study is known. The search results using Publish or Perish from 2000 to 2022 found 529 articles. The co-occurrence analysis resulted in 3,011 keywords derived from titles and abstracts. After being limited to 3 occurrences of keywords and removing words that were considered irrelevant, 116 keywords were obtained, which were divided into 11 clusters. The results of the bibliometric analysis help develop the digital transformation research field for SMEs through trend visualisation. The results of the analysis provide variable recommendations for further research. The analysis results help find scientific mapping and future research directions related to digital transformation.

Keywords: Bibliometric, Digital Transformation, Scientific Mapping, SMEs.

1 INTRODUCTION

Digital transformation is a field of study that is very important to continue to develop. This condition increases demands for managers of large businesses or SMEs to have scientific knowledge in dealing with the digital era. Scientific knowledge and theory are starting to feel irrelevant in recognising the principles and laws of business management in today's digital era. It is necessary to develop scientific knowledge and theory so business management, especially SMEs, can transform digitally. For this reason, scientific mapping is needed to discover the development of digital transformation research.

Changes in the macro environment cause the demand for digital transformation. The macro-environment in question is the technological environment, the natural environ-

ment, the socio-cultural environment and the government environment that issues regulations. The technological environment has dramatically changed how people interact, transact and run a business. Conditions are getting more dramatic with the emergence of the COVID-19 pandemic as a natural environment. This existence triggers the necessity to carry out digital transformation.

Digital transformation is a very important field of study to research. This research emerged in line with the increasing demands for managers of large businesses or SMEs to have scientific knowledge in dealing with the digital era. These demands arose due to changes in the macro environment that changed. The macro-environment in question is the technological environment, the natural environment, the socio-cultural environment and the government environment that issues regulations. The technological environment has dramatically changed how people interact, transact and run a business. Conditions are getting more dramatic with the emergence of the COVID-19 pandemic as a natural environment. This existence triggers the necessity to carry out digital transformation.

The digital transformation carried out by SMEs will increase their competitive advantage and adaptability in the 4.0 era, which will soon welcome the 5.0 era (1,2). For this reason, it is very important to conduct research in producing concept formulations and generating insights about a systematic view of driving the digital transformation of SMEs.

Every organisation has to adapt to the changing environment. Likewise, with SMEs, they cannot stop adapting if they want to maintain their existence. The ability of SMEs to adapt is very important. Because SMEs have a strategic role and are very important for national economic development.

The existence of this digital transformation requires research and studies that provide thinking tools and produce scientific knowledge to encourage the transformation of SMEs into SMEs 4.0 or digital transformation of SMEs.

Scientific knowledge is knowledge that is processed using the scientific method. The knowledge is processed through scientific requirements that are carried out and disciplined. Until now, research on technology acceptance that leads to digital transformation is still being carried out. Experts and researchers have developed a theory of acceptance of digital technology to explain, predict, and control adaptation at the individual and organisational levels. Nevertheless, until now, no theory can be generally accepted.

For this reason, it is necessary to explore the extent to which research developments are related to digital transformation, especially the acceptance of this technology in the management of SMEs. Through this research, it is hoped that it can map the exploration of knowledge to increase understanding of digital technology acceptance at the organisational and business levels. This increased understanding will increase the ability to explain, predict, and control adaptation at the organisational level in accelerating the acceleration of SMEs transformation in the Digital Age.

1.1 Literature Review

Digital transformation is an organisational restructuring by adopting digital technology at the system level. How SMEs interact with customers, create value in the products offered, flexibility and integrate digital technology into their business processes [1], [2]. The need for transformation is triggered by complementary technologies today, namely, the Internet of Things (IoT), big data analytics, artificial intelligence, augmented reality, cloud computing, cyber-physical systems, virtual reality and additive manufacturing [3], [4], [5], [6]. Technology integration in the system, increasing the ability to interact with customers, creating value for its products, and flexibility in creating more effective and efficient economic value [1], [2], [3].

Researchers continue to research in order to advance scientific knowledge to increase the ability to explain, predict, and control the implementation of digital transformation [7], [8], [9], [10], [11]. Some of the researchers made studies related to models, tools that can improve the performance of SMEs [7], [8], [9], [12], and how strategies to encourage digital transformation of SMEs face the new era from various focuses [13], [14], [15].

There is no general acceptance from experts and researchers regarding the determinants of the success of digital transformation. However, the researchers believe that external stimulus factors and cognitive responses to technology acceptance models at the individual and organisational levels are sufficient to determine the transformation process. Based on substantial theoretical and empirical support, it has accumulated related external stimulus factors [8], [16], [17], [18], [19], [20], [21], at the organisational and business level experts and researchers use various factors in external stimulus (Table 1).

Table 1. External Stimulus Factors.

<i>Factors</i>	<i>Description</i>	<i>Resources</i>
<i>Company Size</i>	<i>Company size is measured based on the number of employees, annual income, and production volume.</i>	[18] [22], [23]
<i>Organisational complexity</i>	Industry, production methods, and product mix measure organisational complexity.	[24]
<i>Attitude towards Industry 4.0.</i>	Industry environmental behaviour that shows views, efforts to implement, and awareness.	[11]
<i>Environmental factor</i>	Forces that exist outside that affect the organisation.	[8], [16], [19]
<i>Organisational Factors</i>	Strength from within the organisation that has an impact on organisational management.	[8], [16] [19]
<i>Specific Technology Factors</i>	<i>The suitability factor of existing technology with the needs of the organisation.</i>	[8], [16] [19]

External stimulus and cognitive response are used as keywords in bibliometric analysis. The factors often used by researchers to express cognitive responses are Benefits, Drivers, Barriers and Challenges. Meanwhile, researchers often use factors to express cognitive responses such as Benefits, Drivers, Barriers and Challenges as seen in Table 2.

Table 2. Cognitive Response Factors.

Factors	Description	Resources
<i>Benefit</i>	The degree of knowledge or confidence in using digital technology in SMEs will maintain and enhance competitiveness.	[25], [26], [27]
<i>Driver</i>	The benefits that will be obtained by SMEs in the application of digital technology.	[28], [29], [30], [31], [32], [33], [34]
<i>Barriers</i>	Knowledge and feeling of the constraints faced in applying technology to business activities.	[9], [35], [36]
<i>Challenge</i>	Challenges faced in the application of digital technology for SMEs.	[6], [9], [28], [37], [38]

2 METHODS

This article uses a qualitative research method with a historical approach. This approach is taken to discover developments, trends or research mapping regarding digital transformation. This research was conducted through two stages. The first stage is systematic data collection. The data from this study are articles that have been published in reputable international journals.

The second stage is to analyse the collected articles with bibliometric analysis. Bibliometric analysis analyses and systematises data in words or wordings derived from titles and abstracts of published articles. This analysis helps the development, trends or mapping of current digital transformation research so that the research results also help provide recommendations for themes or research variables for future researchers.

2.1 Collecting Data Method

Data collection consisted of research articles taken from reputable journal publishing groups: 1) Scopus, 2) Emerald, 3) Springer, 4) ProQuest, 5) Web of Science, and 6) Science Direct. Articles are collected from a database that can be accessed from the six groups of journal publishers.

Search for articles using Publish or Perish (PoP). This software helps find articles with relevant research topics. The stages of data collection are as follows:

1. Search is limited to the years 2000-2022.
2. The title words used as search criteria are ["Digital Transformation"] and "Small and Medium Enterprise".

3. The combination of keywords used as search criteria consists of two combinations. The first combination ["company size, organisational complexity; attitude towards industry 4.0; general technological factors; environmental factors; organisational factors; Specific technological factors"]. The second combination ["SMEs", "Barriers", "drivers", "opportunities", "challenges", "benefits"].
4. Furthermore, research collected by the software is reduced based on journals written in English. Source articles from reputable journals.
5. Search is limited to journal articles in the scientific fields of management, business, economics, social, information and entrepreneurship. In this study, the data collected did not include conference results, meeting results or books.
6. The articles to be analysed are examined for the completeness of the research related to the existence of "title", "Abstract", and "keywords".
7. Completeness to be considered in selecting articles to be processed are DOI, publishing journal, publisher, article URL, Number of citations, GS Ranking, CitesPerYear, CitesPerAuthor, and AuthorCount.

Articles collected from searches using Publish or Perish from 2000 to 2022 have 529 articles. With a combination of search titles and keywords, as shown in Table 3.

Table 3. Search Combinations and Number of Articles Generated.

Titles	Keywords	Amount
["Digital Transformation"]	SMEs, company size, organisational complexity, environmental factors, organisational factors, Specific technology factors	197 Article
["Digital Transformation"]	SMEs, Barriers, drivers, opportunity, challenge, benefit.	104 Article
["Small and Medium Enterprise"],	Digital Transformation, Technology Acceptance	228 Article

2.2 Analysis Data Method

Bibliometric analysis using the VOSviewer application. The findings from the analysis show a digital transformation bibliographic map. The resulting bibliometric analysis is in the form of bibliographic data maps and text data extracted from titles and abstracts of selected articles [39], [40].

The analysis results are used to map and develop reference fields of study [39]. Scientific mapping analyses trends and patterns from the development of scientific research related to the results of research studies on digital transformation.

VOSviewer analyses published scientific articles. VOSviewer visualises knowledge development through network visualisation and provides cluster labelling. In other words, VOSviewer provides information on research updates and how much research related to this field has been carried out.

The output of VOSviewer displays maps and networks based on co-citation data or keyword maps based on very detailed co-occurrence and keyword relevance data. The

map and keyword network visualisations have different colours for each data cluster [41], [42], [43], [44]. The VOSviewer application displays an overlay network that shows the development of articles from time to time. An overlay network presents the time span (years) in which the linkages of each keyword are presented in the form of a network. Based on the visualisation of the overlay network, it is known how far the progress of studies related to digital transformation and SMEs has been. Furthermore, there is density visualisation. The density visualisation display shows the high or low frequency of the concept or constructs used as research.

3 RESULTS AND DISCUSSION

3.1 Numbers of Publication Years

The early 2000s saw the evolution of e-marketplaces with the increasing use of social media, which became a potential ecosystem for e-marketplaces. This number continues to increase with the emergence of smartphones as a public access channel to connect to the internet. Changes in the technological environment that dramatically change other macro environments change the business management landscape. This condition has made many researchers research related to digital transformation, both as article titles and as keywords in articles. The search results for 529 articles from 2000 to 2022 are as shown in Table 4.

Table 4. Numbers of Publication Years from 2000-2022.

Year	Publication Years	Year	Publication Years
2000	7	2012	4
2001	1	2013	7
2002	7	2014	11
2003	6	2015	11
2004	8	2016	13
2005	8	2017	21
2006	11	2018	19
2007	6	2019	32
2008	7	2020	56
2009	17	2021	113
2010	12	2022	132
2011	14	Total	523

Its value continues to increase from 2019 to 2020. This year, a pandemic occurred, which is considered a natural environment. All business managers, both large companies and SMEs, must be able to optimise digital technology. More and more problems are found with increasingly dramatic changes in the business environment. There is no

other choice other than digital transformation. For this reason, experts and researchers worldwide are trying to research so that they can explain, predict, and control activities in adapting to the digital environment.

3.2 Author Analysis

Author analysis uses Google Scholar (GS) ranking. Basically, GS has the same function as Thomson ISI Web of Knowledge, which produces Journal Impact Factors (JIF). JIF assesses the article's impact factor [45]. GS has an advantage in ranking through access to free articles. Free article access provides an opportunity for researchers to make the article a reference, regardless of the financial capacity of the institution of the researcher.

Table 5. Active Publication per Year from 2000-2022.

Author's Name	Title	GS Rank
P C. Verhoef, T Broekhuizen, Y et. al (2021)	Digital transformation: A multidisciplinary reflection and research agenda	14
K Zhu, S Dong, SX Xu, KL Kraemer (2006)	Innovation diffusion in global contexts: determinants of post-adoption digital transformation of European companies	93
F Li (2020)	The digital transformation of business models in the creative industries: A holistic framework and emerging trends	52
S Nadkarni, R Prügl (2021)	Digital transformation: A review, synthesis and opportunities for future research	64
D Ulas (2019)	Digital Transformation Process and SMEs	7
YYK Chen, YL Jaw, BL Wu (2016)	Effect of digital transformation on organisational performance of SMEs: Evidence from the Taiwanese textile industry's web portal	200
A Garzoni, I De Turi, et. al (2020)	Fostering digital transformation of SMEs: a four levels approach	191
V Jafari-Sadeghi, A Garcia-Perez, E Candelo, and J Couturier (2021)	Exploring the impact of digital transformation on technology entrepreneurship and technological market expansion: The role of technology readiness, exploration and exploitation	15
A Crupi, N Del Sarto, et. al (2020)	The digital transformation of SMEs—a new knowledge broker called the digital innovation hub	199
G Dutta, R Kumar, R Sindhvani, RK Singh (2020)	Digital transformation priorities of India's discrete manufacturing SMEs—a conceptual study in perspective of Industry 4.0	192
B Melović, M Jocović, M Dabić, TB Vulić, B Dudic (2020)	The impact of digital transformation and digital marketing on brand promotion, positioning and electronic business in Montenegro	44

Author's Name	Title	GS Rank
L Quinn, S Dibb, L Simkin, et. al (2016)	Troubled waters: The transformation of marketing in a digital world	238
MK Peter, C Kraft, J Lindeque (2020)	Strategic action fields of digital transformation: An exploration of the strategic action fields of Swiss SMEs and large enterprises	194
CF Breidbach, BW Keating, C Lim (2020)	Fintech: research directions to explore the digital transformation of financial service systems	204
F Brunetti, DT Matt, et. al (2020)	Digital transformation challenges: Strategies emerging from a multi-stakeholder approach	190
MD Jones, S Hutcheson, JD Camba (2021)	Past, present, and future barriers to digital transformation in manufacturing: A review	2
G Gupta, I Bose (2019)	Digital transformation in entrepreneurial firms through information exchange with the operating environment	36
G Gupta, I Bose (2019)	Strategic learning for digital market pioneering: Examining the transformation of Wishberry's crowdfunding model	49
HS Pramanik, M Kirtania, AK Pani (2019)	Essence of digital transformation—Manifestations at large financial institutions from North America	20
S Kraus, S Durst, JJ Ferreira, et. al (2022)	Digital transformation in business and management research: An overview of the current status quo	8
M Ghobakhloo, M Iranmanesh (2021)	Digital transformation success under Industry 4.0: A strategic guideline for manufacturing SMEs	189
V Nissen (2018)	Digital transformation of the consulting industry—introduction and overview	97
W El Hilali, A El Manouar, MAJ Idrissi (2020)	Reaching sustainability during a digital transformation: a PLS approach	198
H Wang, J Feng, H Zhang, X Li (2020)	The effect of digital transformation strategy on performance: The moderating role of cognitive conflict	237
V Scuotto, M Nicotra, et. al (2021)	A Micro foundational Perspective on SMEs' Growth in the Digital Transformation Era	13
M Wolf, A Semm, C Erfurth (2018)	Digital transformation in companies—challenges and success factors	59
WW Baber, A Ojala, R Martinez (2019)	Effectuation logic in digital business model transformation: Insights from Japanese high-tech innovators	236
Z Yang, J Chang, L Huang, A Mardani (2021)	Digital transformation solutions of entrepreneurial SMEs based on an information error-driven T-spherical fuzzy cloud algorithm	4
L Moi, F Cabiddu (2021)	Leading digital transformation through an Agile	108

Author's Name	Title	GS Rank
	Marketing Capability: The case of Spohome	
MY Veselovsky, MA Izmailova, et al (2019)	Quality of digital transformation management on the way of formation of innovative economy of Russia	368
M Deja, D Rak, B Bell (2021)	Digital transformation Readiness: perspectives on Academia and library outcomes in information Literacy	33
C Favoretto, GH de Sousa Mendes, MG Filho, et. al (2021)	Digital transformation of business model in manufacturing companies: challenges and research agenda	195

The GS rating can be seen from the author's contribution to producing articles every year. Based on the data collected, there are 36 active writers. Table 5 discusses the authors who contribute articles every year by looking at the GS rating. Table 5 shows how the authors contribute articles annually [40].

3.3 Citation Analysis

Citation analysis shows how many articles are cited or used as references for other researchers. Researchers related to digital transformation continue to increase, especially from 2019 to 2022.

Changes in the macro environment raise problems in business management. Business managers, both large companies and SMEs, must be able to adapt to the challenges of these changes. Efforts to increase this adaptation encourage the high commitment of researchers to continue to develop scientific knowledge to answer digital-based business management problems. The journal with the most digital transformation publications is the Journal of Information & Management as shown in Table 6.

Table 6. Top 25 Authors and Articles Cited in Digital Transformation Publication.

Author's Name	Publisher	Cited Frequency
V Venkatesh, FD Davis (2000)	Management Science	26.812
V Venkatesh (2000)	Information systems research	8.268
V Venkatesh, MG Morris (2000)	MIS Quarterly	6.039
YY Mun, JD Jackson, JS Park, JC Probst (2006)	Information & management	1.597
K Amoako-Gyampah, AF Salam (2004)	Information & management	1.441
PJH Hu, THK Clark, WW Ma (2003)	Information & management	894
K Zhu, S Dong, SX Xu, KL	European Journal of Information Systems	869

Author's Name	Publisher	Cited Frequency
Kraemer (2006)		
VS Lai, H Li (2005)	Information & Management	779
R Walczuch, J Lemmink, S Streukens (2007)	Information & Management	754
GJ Avlonitis, NG Panagopoulos (2005)	Industrial marketing management	394
M Zain, RC Rose, I Abdullah, M Masrom (2005)	Information & Management	386
JSC Lin, HC Chang (2011)	Managing Service Quality: An International Journal	380
LG Wallace, SD Sheetz (2014)	Information & Management	379
HH Lee, AM Fiore, J Kim (2006)	International Journal of Retail & Distribution Management	358
CH Hsiao, C Yang (2011)	International Journal of Information Management	349
S Nadkarni, R Prügl (2021)	Management Review Quarterly	234
Antonello Garzoni and Ivano De Turi, Giustina Secundo and Pasquale Del Vecchio (2020)	Management Decision	115
A Pontiggia, F Virili (2010)	International Journal of Information Management	92
D MK Peter, C Kraft, J Lindeque (2020)	Journal of Strategy and Management	85
S Singh, MM Sahni, RK Kovid (2020)	Management Decision	70
CiroTroisea Vincenzo Corvellob Abby Ghobadianc Nicholas O'Regand (2022)	Technological Forecasting and Social Change	63
Mohamed Ashmel Mohamed Hashim, Issam Tlemsani & Robin Matthews. (2022)	Education and Information Technologies	39
S Ghosh, M Hughes, I Hodgkinson, P Hughes (2022)	Technovation	31
Bader K. AlNuaimi, Sanjay Kumar Singh, Shuang Ren, Pawan Budhwar, Dmitriy Vorobyev (2022)	Journal of Business Research	30
L Li (2022)	Industrial Marketing Management	17

3.4 Bibliometric Analysis

Bibliometric analysis helps researchers map and determine the extent to which research developments are related to digital transformation. So that research results can identify relevant and up-to-date research themes or variables, thus clarifying the potential impact of research if it is developed.

Co-authorship Analysis.

In the Co-authorship analysis, there are authors who are linked to other authors' names. The results of this analysis show that the authors collaborate in conducting research related to digital transformation as shown in Figure 1. Ghobadian performs collaborations with other authors. The two articles published by Ghobadian were carried out by two research teams. Likewise, Troise and Corvello have produced two articles published by different writing teams.

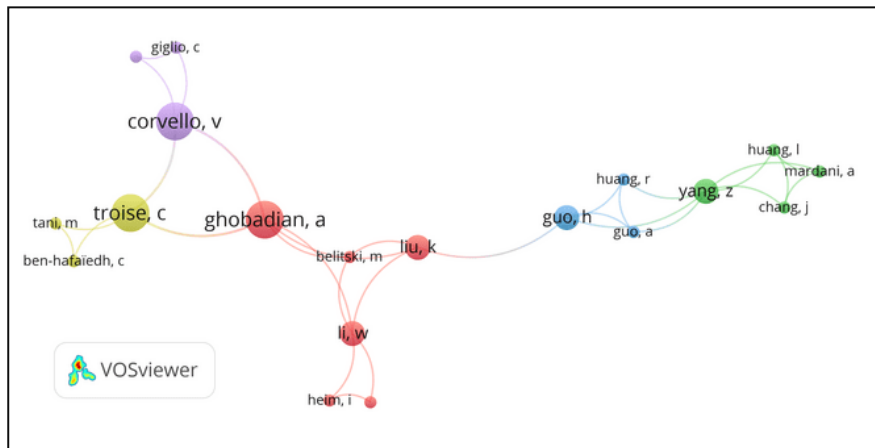


Fig. 1. Author Network.

The collaboration carried out by the authors shows a high commitment to continue conducting research related to digital transformation. Table 7 shows the research titles of the authors who conducted the research.

Table 7. Author Collaboration.

AUTHOR	TITLE
C Troise, V Corvello, A Ghobadian et. al (2022)	How can SMEs successfully navigate the VUCA environment: The role of agility in the digital transformation era
C Troise, C Ben-Hafaïedh, M Tani, et. al (2022)	Guest editorial: New technologies and entrepreneurship: Exploring entrepreneurial behaviour in the digital transformation era

AUTHOR	TITLE
V Corvello, S Verteramo, C Giglio (2022)	Turning crises into opportunities in the service sector: How to build antifragility in small and medium service enterprises
W Li, K Liu, M Belitski, A Ghobadian, et al. (2016)	e-Leadership through strategic alignment: An empirical study of small and medium-sized enterprises in the digital age
I Heim, Y Kalyuzhnova, W Li, et. al (2019)	Value co-creation between foreign firms and indigenous small and medium-sized enterprises (SMEs) in Kazakhstan's oil and gas industry: The role of information technology spillovers
K Liu, H Guo (2020)	Digital innovation and transformation to business ecosystems
H Guo, Z Yang, R Huang, A Guo (2020)	The digitalisation and public crisis responses of small and medium enterprises: Implications from a COVID-19 survey
Z Yang, J Chang, L Huang, A Mardani (2021)	Digital transformation solutions of entrepreneurial SMEs based on an information error-driven T-spherical fuzzy cloud algorithm

Network Visualisation Analysis Bibliometric.

The results of the analysis with VOSviewer conducting a co-occurrence analysis found 3,011 keywords related to digital transformation. To produce more specific keywords in the keyword analysis of titles and abstracts, keyword occurrences are limited to 3. From the limitation of nine occurrences, 116 keywords were obtained which were divided into 11 clusters as shown in Table 8.

Table 8. Keywords Clustering.

Cluster	Keyword
cluster 1	blockchain technology, complex nature, culture, digital supply chain transformation, environmental factor, high complexity, human resource, influencing factor, internal factor, interplay, network, scm, significant barrier, supply chain, supply chain management, sustainable development, technology readiness, Variety
cluster 2	business model innovation, critical success factor, digital innovation, digital tool, digital transformation initiative, driving factor, investment, large company, main barrier, manager, manufacturing sector, maturity, a new challenge, post-adoption digital transformation, small business
cluster 3	artificial intelligence, competency, competition, digital skill, digital transformation strategies, disruptive change, external factor, financial service, fintech, full advantage, critical success factor, new digital technology, organisations
cluster 4	alignment, business environment, business performance, business strategy, en-

Cluster	Keyword
	trepreneurial orientation, environmental performance, firm performance, influence, internationalisation, medium-sized enterprise, small firm, small and medium-sized enterprise, strategic orientation
cluster 5	crisis, digital barrier, e-commerce, economic benefit, organisational culture, service sector, social medium, sustainable performance, tam, technology acceptance model, user acceptance
cluster 6	agility, connectivity, digital age, digital transformation era, force, manufacturer, medium-sized company, micro foundational perspective, organisational capability, organisational factor, smes growth, successful digital transformation
cluster 7	circular economy, cloud computing, complex system, eco-innovation, innovative growth, internet, IoT, key driver, knowledge management, main factor, technology development
cluster 8	communication technology, digital platform, digitalisation, ICT, main driver, organisational performance, pandemic, platform
cluster 9	e-commerce adoption, investigation, medium enterprises, small, technology acceptance, unified theory, utaut, willingness
cluster 10	enterprise digital transformation, enterprise resource planning, it strategy, sized enterprise, software, antecedent, corporate social responsibility, CSR
cluster 11	antecedent, corporate social responsibility, CSR, term

The results of the Network Visualization Analysis show that there are many small nodes that represent the keywords generated from the analysis as shown in Figure 2. This visualisation shows that there are still many research gaps that exist today. Much research related to digital transformation is needed to fill this research gap. For example, the "Supply Chain Transformation" digital nodes are not yet connected to the "Strategy" or "IT strategy" digital model nodes. It takes much research to explain the causality of each node. The explanation of causal linkages produced by this research will produce scientific knowledge that can understand, explain and control digital transformation.

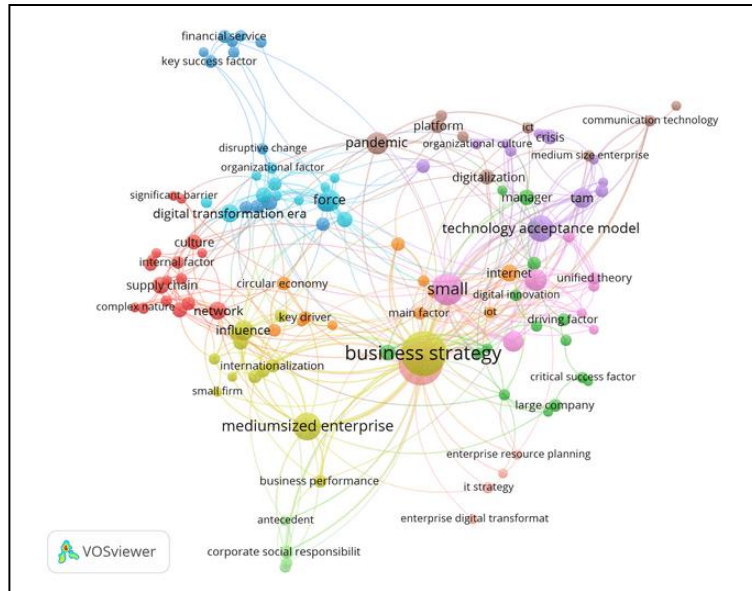


Fig. 2. Network Visualisation in Digital Transformation Publications.

Overlay Visualisation Analysis.

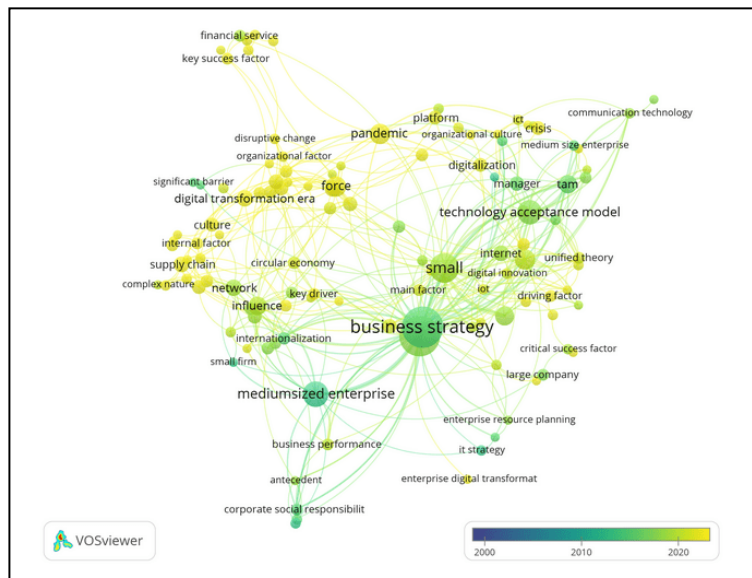


Fig. 3. Overlay Visualisation in Digital Transformation Publications.

Figure 3 shows that most themes have a bright yellow node colour. The yellow indicates that most published articles range from 2020 to 2022. Based on the results of this analysis, it can be the basis for the assumption that the themes related to digital transformation are the most recent.

Based on Overlay Visualization, the theme related to digital transformation is the latest study. In accordance with previous data, research related to digital transformation in general has increased significantly since 2019.

Density Visualisation Analysis.

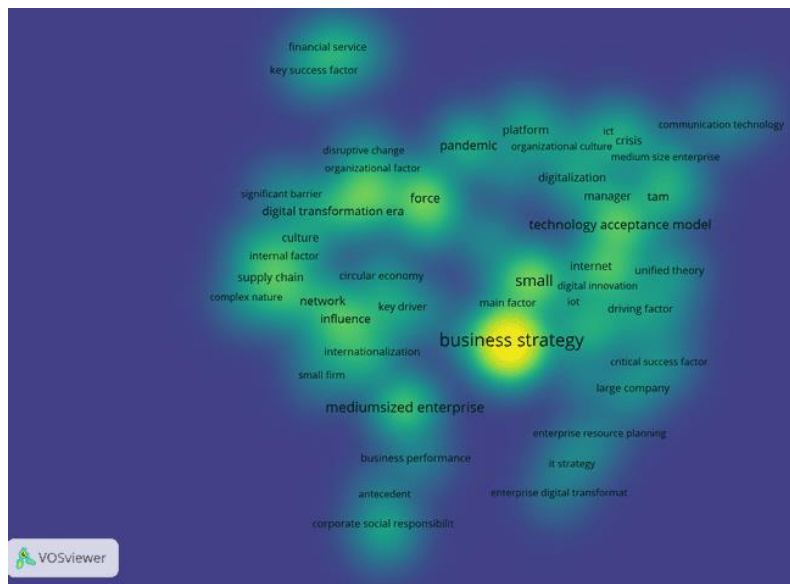


Fig. 4. Density Visualisation in Digital Transformation Publications.

Figure 4 shows research related to Digital Transformation, mostly related to Business Strategy. This condition can be seen from the yellow focus on the output Density visualisation. The colours that appear from each theme or variable tend to be darker. This means that there are not too many publications that examine this sub-theme. This condition strengthens the results of the analysis on Network Visualization Analysis, and Overlay Visualization. This visualisation shows the importance of conducting research related to digital transformation, especially in SMEs. Through the research conducted, it will help scientific preparation and development of scientific knowledge related to digital transformation.

4 CONCLUSIONS

The bibliometric analysis shows that scientific mapping related to the development of SMEs digital transformation research still has many research gaps. This research gap is an indication for future researchers to conduct future research related to digital transformation in SMEs. There are several themes or themes that are recommended for research related to digital transformation in SMEs.

References

1. Li, G., Hou, Y. & Wu, A. Fourth Industrial Revolution: technological drivers, impacts and coping methods. *Chinese Geogr. Sci.* (2017). doi:10.1007/s11769-017-0890-x
2. Thoben, K. D., Wiesner, S. A. & Wuest, T. "Industrie 4.0" and smart manufacturing-a review of research issues and application examples. *International Journal of Automation Technology* (2017). doi:10.20965/ijat.2017.p0004
3. Reddy, S. K. & Reinartz, W. Digital Transformation and Value Creation: Sea Change Ahead. *NIM Mark. Intell. Rev.* (2017). doi:10.1515/gfkmir-2017-0002
4. Frank, A. G., Dalenogare, L. S. & Ayala, N. F. Industry 4.0 technologies: Implementation patterns in manufacturing companies. *Int. J. Prod. Econ.* (2019). doi:10.1016/j.ijpe.2019.01.004
5. Culot, G., Nassimbeni, G., Orzes, G. & Sartor, M. Behind the definition of Industry 4.0: Analysis and open questions. *Int. J. Prod. Econ.* (2020). doi:10.1016/j.ijpe.2020.107617
6. Moeuf, A. *et al.* Identification of critical success factors, risks and opportunities of Industry 4.0 in SMEs. *Int. J. Prod. Res.* (2020). doi:10.1080/00207543.2019.1636323
7. Bär, K., Herbert-Hansen, Z. N. L. & Khalid, W. Considering Industry 4.0 aspects in the supply chain for an SME. *Prod. Eng.* (2018). doi:10.1007/s11740-018-0851-y
8. Mittal, S., Khan, M. A., Romero, D. & Wuest, T. A critical review of smart manufacturing & Industry 4.0 maturity models: Implications for small and medium-sized enterprises (SMEs). *Journal of Manufacturing Systems* (2018). doi:10.1016/j.jmsy.2018.10.005
9. Moeuf, A., Pellerin, R., Lamouri, S., Tamayo-Giraldo, S. & Barbaray, R. The industrial management of SMEs in the era of Industry 4.0. *Int. J. Prod. Res.* (2018). doi:10.1080/00207543.2017.1372647
10. Rauch, E. *et al.* Transfer of industry 4.0 to small and medium sized enterprises. in *Advances in Transdisciplinary Engineering* (2018). doi:10.3233/978-1-61499-898-3-63
11. Türkeş, M. C. *et al.* Drivers and barriers in using industry 4.0: A perspective of SMEs in Romania. *Processes* (2019). doi:10.3390/pr7030153
12. Sevinç, A., Gür, Ş. & Eren, T. Analysis of the difficulties of SMEs in industry 4.0 applications by analytical hierarchy process and analytical network process. *Processes* (2018). doi:10.3390/pr6120264
13. Wang, Y., Wang, G. & Anderl, R. Generic Procedure Model to introduce Industrie 4.0 In Small and Medium-sized Enterprises. in *Lecture Notes in Engineering and Computer Science* (2016).
14. Wank, A. *et al.* Using a Learning Factory Approach to Transfer Industrie 4.0 Approaches to Small- and Medium-sized Enterprises. in *Procedia CIRP* (2016). doi:10.1016/j.procir.2016.05.068
15. Jordan, F., Bernardy, A., Stroh, M., Horeis, J. & Stich, V. Requirements-Based matching approach to configurate cyber-physical systems for SMEs. in *PICMET 2017 - Portland*

- International Conference on Management of Engineering and Technology: Technology Management for the Interconnected World, Proceedings* (2017). doi:10.23919/PICMET.2017.8125442
16. Alomary, A. & Woollard, J. How Is Technology Accepted by Users? A Review of Technology Acceptance Models and Theories. *IRES 17th Int. Conf.* (2015).
 17. Setiawan, A. & Sulistiowati, L. H. Penerapan Modifikasi Technology Acceptance Model (TAM) dalam E-Business. *J. Manaj. dan Pemasar. Jasa* (2018). doi:10.25105/jmpj.v10i2.2277
 18. Masood, T. & Sonntag, P. Industry 4.0: Adoption challenges and benefits for SMEs. *Comput. Ind.* (2020). doi:10.1016/j.compind.2020.103261
 19. Stentoft, J. & Rajkumar, C. The relevance of Industry 4.0 and its relationship with moving manufacturing out, back and staying at home. *Int. J. Prod. Res.* (2020). doi:10.1080/00207543.2019.1660823
 20. Ricci, R., Battaglia, D. & Neirotti, P. External knowledge search, opportunity recognition and industry 4.0 adoption in SMEs. *Int. J. Prod. Econ.* (2021). doi:10.1016/j.ijpe.2021.108234
 21. Stentoft, J., Adsbøll Wickstrøm, K., Philipsen, K. & Haug, A. Drivers and barriers for Industry 4.0 readiness and practice: empirical evidence from small and medium-sized manufacturers. *Prod. Plan. Control* (2021). doi:10.1080/09537287.2020.1768318
 22. Weiß, M., Tilebein, M., Gebhardt, R. & Barteld, M. Smart Factory Modelling for SME: Modelling the Textile Factory of the Future. in *Lecture Notes in Business Information Processing* (2018). doi:10.1007/978-3-319-94214-8_24
 23. Orzes, G., Rauch, E., Bednar, S. & Poklemba, R. Industry 4.0 Implementation Barriers in Small and Medium Sized Enterprises: A Focus Group Study. in *IEEE International Conference on Industrial Engineering and Engineering Management* (2018). doi:10.1109/IEEM.2018.8607477
 24. Taherdoost, H. A review of technology acceptance and adoption models and theories. in *Procedia Manufacturing* (2018). doi:10.1016/j.promfg.2018.03.137
 25. Pagani, M. Digital business strategy and value creation: Framing the dynamic cycle of control points. *MIS Q. Manag. Inf. Syst.* (2013). doi:10.25300/MISQ/2013/37.2.13
 26. Kane, G. C., Palmer, D., Philips Nguyen, A., Kiron, D. & Buckley, N. Strategy, Not Technology, Drives Digital Transformation. *MIT Sloan Manag. Rev. Deloitte* (2015).
 27. Sony, M. & Naik, S. Critical factors for the successful implementation of Industry 4.0: a review and future research direction. *Prod. Plan. Control* (2020). doi:10.1080/09537287.2019.1691278
 28. Adolph, S., Tisch, M. & Metternich, J. Challenges and Approaches To Competency Development for Future Production. *J. Int. Sci. Publ.* (2014).
 29. Karre, H., Hammer, M., Kleindienst, M. & Ramsauer, C. Transition towards an Industry 4.0 State of the LeanLab at Graz University of Technology. *Procedia Manuf.* (2017). doi:10.1016/j.promfg.2017.04.006
 30. Müller, J., Dotzauer, V. & Voigt, K. Industry 4.0 and its Impact on Reshoring Decisions of German Manufacturing Enterprises. in *Supply Management Research* (2017). doi:10.1007/978-3-658-18632-6_8
 31. Paritala, P. K., Manchikatla, S. & Yarlagadda, P. K. D. V. Digital Manufacturing-Applications Past, Current, and Future Trends. in *Procedia Engineering* (2017). doi:10.1016/j.proeng.2017.01.250
 32. de Sousa Jabbour, A. B. L., Jabbour, C. J. C., Foropon, C. & Filho, M. G. When titans meet – Can industry 4.0 revolutionise the environmentally-sustainable manufacturing wave? The

- role of critical success factors. *Technol. Forecast. Soc. Change* (2018). doi:10.1016/j.techfore.2018.01.017
33. Geissdoerfer, M., Vladimirova, D. & Evans, S. Sustainable business model innovation: A review. *Journal of Cleaner Production* (2018). doi:10.1016/j.jclepro.2018.06.240
 34. Şchiopu, R. Business Digitization in the European Union. *Proc. Int. Conf. Bus. Excell.* (2020). doi:10.2478/picbe-2020-0037
 35. Colotla, I. *et al.* Winning the Industry 4.0 Race - How ready are danish manufacturers? *Bost. Consult. Gr.* (2016).
 36. Calabrese, A., Levaldi Ghiron, N. & Tiburzi, L. 'Evolutions' and 'revolutions' in manufacturers' implementation of industry 4.0: a literature review, a multiple case study, and a conceptual framework. *Prod. Plan. Control* (2021). doi:10.1080/09537287.2020.1719715
 37. Geisbauer, R., Vedso, J. & Schrauf, S. Industry 4.0: Building the digital enterprise. *2016 Glob. Ind. 4.0 Surv.* (2016).
 38. Fatorachian, H. & Kazemi, H. Impact of Industry 4.0 on supply chain performance. *Prod. Plan. Control* (2021). doi:10.1080/09537287.2020.1712487
 39. Li, X., Wu, P., Shen, G. Q., Wang, X. & Teng, Y. Mapping the knowledge domains of Building Information Modeling (BIM): A bibliometric approach. *Automation in Construction* (2017). doi:10.1016/j.autcon.2017.09.011
 40. Shi, Y. & Li, X. A bibliometric study on intelligent techniques of bankruptcy prediction for corporate firms. *Heliyon* (2019). doi:10.1016/j.heliyon.2019.e02997
 41. Fusco, F. & Ricci, P. What is the stock of the situation? A bibliometric analysis on social and environmental accounting research in public sector. *International Journal of Public Sector Management* (2019). doi:10.1108/IJPSM-05-2017-0134
 42. Di Vaio, A., Syriopoulos, T., Alvino, F. & Palladino, R. "Integrated thinking and reporting" towards sustainable business models: a concise bibliometric analysis. *Meditari Accountancy Research* (2020). doi:10.1108/MEDAR-12-2019-0641
 43. Lafont, J., Ruiz, F., Gil-Gómez, H. & Oltra-Badenes, R. Value creation in listed companies: A bibliometric approach. *J. Bus. Res.* (2020). doi:10.1016/j.jbusres.2020.01.012
 44. Prashar, A. & Sunder M, V. A bibliometric and content analysis of sustainable development in small and medium-sized enterprises. *Journal of Cleaner Production* (2020). doi:10.1016/j.jclepro.2019.118665
 45. Harzing, A. W. K. & van der Wal, R. Google Scholar as a new source for citation analysis. *Ethics Sci. Environ. Polit.* (2008). doi:10.3354/esep00076

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