Digital Transformation in Small Medium Enterprises: Mapping of the Knowledge Base

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Abstract
Small and medium-sized enterprises (SMEs) have an important role in the economic growth of a country. In global competition, SMEs need to have a digital transformation view to increase competitiveness in the industry 4.0 era. The purpose of this study is to present a comprehensive knowledge map of digital transformation in SMEs around the world based on the Scopus database. The analysis was carried out over a while of more than a decade, between 2005 – 2020, and obtained 219 academic documents. This research reveals an overview of article publications, author productivity, organization, country, sources of publications, maps of research themes, and collaborative relationships between researchers. This research contributes to the development of knowledge based on the mapping of digital transformation research themes in SMEs, namely Industry, Competition, Information, Digitalization, hereinafter referred to as ICID map.

Keywords
author network, bibliometric, digital transformation, research themes, small-medium enterprise

1. Introduction
The current digital era makes the world connected and there is no distance. The condition of digitization in each of these sectors also affects Small Medium Enterprises (Safari & Saleh, 2020). SMEs are increasingly benefiting from the speed of technology to reach the market faster and wider (Krammer, et al., 2018). SMEs are an industry grouping
based on its size based on several indicators, namely: company age, market share size, location, supply chain management, number of employees, asset value, sales capacity, to an innovative character (Sahoo & Yadav, 2017). Digitalization is very important for SMEs in facing global competition (Crupi, et al., 2020; Rashidirad & Salimian, 2020).

The digital paradigm provides opportunities for SMEs to adopt technologies such as additive manufacturing, artificial intelligence, internet of things, big data, cloud computing, augmented and virtual reality (Rindfleisch et al., 2017; Nambisan, 2017). Technology and automation are the beginning of the mention of the industry 4.0 era that is currently happening (Frank et al., 2019).

In intense competition and full of innovation, SMEs require highly adaptive survival strategies (Ko & Liu, 2017ko; Putra, et al., 2020). Digital transformation is proven to be able to provide innovation value and strengthen the competitiveness of SMEs (Pelletier & Cloutier, 2019). Digital transformation in SMEs is very important to implement for businesses to survive (Cha et al., 2015: Li et al., 2018). If done properly, digital transformation becomes an accelerator for business growth and development (Alcacer et al., 2016; Urbinati et al., 2018). The implementation of digital transformation makes business processes more effective; innovation develops and improves business performance (Chen, et al., 2014; Tan, et al., 2015).

Research on digital transformation in SMEs has been carried out and developed at the international level. However, no one has yet provided a large-picture map that is visualized on a global scale using data from many published studies. Until now, there are still no publications that directly discuss the impact of scientific research and mutually beneficial interactions between researchers on the topic of digital transformation research on SME’s in various parts of the world. The bibliometric method is used to see the relationship of the research. Where is a method for measuring and analyzing scientific references with a combination of statistical and mathematical methods (Purnomo, et al., 2020). Bibliometrics is a statistical technique used to analyze bibliometric publication data such as reports, reviews, books, peer-reviewed articles, magazines, conference proceedings, and publications. Bibliometric methods are used to present the relationship between quantitative methods and research domains (IGI Global, 2021).

The question in this study is how to map and research trends in digital transformation on SMEs globally? Based on a bibliometric approach, this study aims to study mapping visually and show trends in digital transformation research on SME’s globally in the last decade, namely 2005 – 2020.

This scientific article is organized into several parts, namely: the first part is an introduction that discusses the background of the research, questions, and research objectives, the second part is a research method that explains the scientific approach used in research, the third part is the results and discussion that explains the research findings, and the fourth section summarizes the essence and implications of the research. At the end of the article accompanied by an acknowledgment and reference

1.1 Objectives
Based on a bibliometric approach, this study aims to study mapping visually and show trends in digital transformation research on SME’s globally in the last decade, namely 2005 – 2020.

2. Methods
This study visually maps the status of digital transformation research on SMEs at the international level indexed by Scopus in the last 1 decade, namely 2005 – 2020. Research with a bibliometric approach was carried out with data from the document search service feature on Scopus (Purnomo, et al., 2020).

This study took data on the Scopus website with the identification of SMEs strategy keywords starting from January 2005 – December 2020. There were 219 published academic documents. The command that is applied when mining data on Scopus is (TITLE-ABS-KEY ("Small medium enterprise*" OR "Small and medium-sized enterprise*" OR "Small and Medium Enterprise*" OR "small and medium-sized business" OR "Small and Mid-size Enterprise" OR "SMEs") AND TITLED-ABS-KEY ("digital transformation" OR "transformation of digital") AND PUBYEAR < 2021. Analysis services retrieved from the Scopus web visualize article information publications, author productivity, organization, country, and sources of publications
Furthermore, scientific literature analysis was carried out using the scientometric method using the VOSviewer application version 1.6.16 in the analysis of co-occurrence and co-authorship (Van & Waltman, 2010). Co-authorship analysis was conducted to obtain information on international collaborative research networks on the topic of digital transformation research in SMEs. This study also carried out an in-depth co-occurrence analysis on keyword relationships to generate a research theme network.

3. Results and Discussion

This section describes the search results and data processing consisting of article publications, author productivity, organization, country, sources of publications, maps of research themes, and collaborative relationships between researchers.

3.1 Annual Publication in Digital Transformation Research On SME’s

![Diagram of Annual Publication in Digital Transformation Research](image)

The trend of publications on SMEs strategy in various countries is always growing from year to year which can be seen in Figure 1. The digital transformation of SMEs has become interesting to study because this is the era of digital competition. Publication data for the last 5 years for digital transformation research at SMEs is 2016 with 6 documents, 2017 with 7 documents, 2018 with 30 documents, 2019 with 55 documents, and 2020 as the peak with 119 publication documents on the Scopus database.

3.2 The Most Productive Individual Researchers in Digital Transformation Research in SME’s

From 219 documents on SMEs strategy, data were obtained for 159 authors and ranked in the top 10 for the most active authors with the scope of digital transformation research at SMEs, which can be seen in Figure 2. The most productive researcher is Schuh, G with 5 documents from Rheinisch-Westfälische Technische Hochschule Aachen, Aachen, Germany. Next in second and third place are Ays, Julian L from WZL, Germany, and Muhlbradt, Thomas, both of whom are balanced with 4 documents.

![Diagram of The Most Productive Individual Researchers in Digital Transformation Research for SME’s](image)
Complete data on the 10 most productive authors with the theme of digital transformation research on SMEs for the last 15 years are presented in table 1.

Table 1. Top 10 Productive Individual Researcher in Digital Transformation Research for SME’s

<table>
<thead>
<tr>
<th>No</th>
<th>Author</th>
<th>Documents</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Schuh, G.</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>Ays, J.</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>Mühlbradt, T.</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>Charalabidis, Y.</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>Dmytrotsa, L.</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>Gamache, S.</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>Gützlaff, A.</td>
<td>3</td>
</tr>
<tr>
<td>8</td>
<td>Kozbur, H.</td>
<td>3</td>
</tr>
<tr>
<td>9</td>
<td>Nasiri, M.</td>
<td>3</td>
</tr>
<tr>
<td>10</td>
<td>Pelletier, C.</td>
<td>3</td>
</tr>
</tbody>
</table>

3.3 The Most Productive Affiliation/ Organization in Digital Transformation Research on SME’s

From 219 published documents, data were obtained as many as 160 affiliates in digital transformation research on SMEs. The affiliate with the most documents with digital transformation research on SMEs in the Scopus database is Université du Québec Trois-Rivières with 7 documents, then second and third are Rheinisch-Westfälische Technische Hochschule Aachen with 6 documents, and the Fraunhofer Institute for Manufacturing Engineering and Automation IPA with 6 documents.

Figure 3. The Most Productive Affiliation in Digital Transformation Research on SME’s

Complete data on the 10 most productive affiliates within the scope of digital transformation research at SMEs is presented in table 2 below.

Table 2. Top 10 Productive Affiliation/ Organization – Digital Transformation on SME’s

<table>
<thead>
<tr>
<th>No</th>
<th>AFFILIATION</th>
<th>Documents</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Université du Québec à Trois-Rivières</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td>Rheinisch-Westfälische Technische Hochschule Aachen</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>Fraunhofer Institute for Manufacturing Engineering and Automation IPA</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>Fachhochschule Nordwestschweiz FHNW</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>Friedrich-Alexander-Universität Erlangen-Nürnberg</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>Hochschule Karlsruhe - Technik und Wirtschaft</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>Tecnologico de Monterrey</td>
<td>3</td>
</tr>
</tbody>
</table>
3.4 The Most Productive Country in Digital Transformation Research on SME’s

From 219 publication documents, data were obtained from 56 countries/territories that are the most productive in digital transformation research on SMEs. The most productive country is Germany with 56 documents, the second place is Italy with 26 documents and the third is Spain with 12 documents. The graph of the 10 most productive countries in digital transformation research on SMEs is presented in Figure 4.

![Figure 4. The Most Productive Country – Digital Transformation on SME’s](image)

Data on the number of documents in the 10 most productive countries around the world in digital transformation research on SMEs is presented in table 3 below.

<table>
<thead>
<tr>
<th>No</th>
<th>COUNTRY/TERRITORY</th>
<th>Documents</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Germany</td>
<td>56</td>
</tr>
<tr>
<td>2</td>
<td>Italy</td>
<td>26</td>
</tr>
<tr>
<td>3</td>
<td>Spain</td>
<td>12</td>
</tr>
<tr>
<td>4</td>
<td>Finland</td>
<td>9</td>
</tr>
<tr>
<td>5</td>
<td>Portugal</td>
<td>9</td>
</tr>
<tr>
<td>6</td>
<td>United Kingdom</td>
<td>8</td>
</tr>
<tr>
<td>7</td>
<td>United States</td>
<td>8</td>
</tr>
<tr>
<td>8</td>
<td>Austria</td>
<td>7</td>
</tr>
<tr>
<td>9</td>
<td>France</td>
<td>7</td>
</tr>
<tr>
<td>10</td>
<td>Greece</td>
<td>7</td>
</tr>
</tbody>
</table>

3.5 Digital Transformation Research On Smes By Sources

The Scopus database shows that there are 77 publishers in 219 analysis documents. The most productive source of documents is Procedia CIRP with 10 documents. Then the second position is IFIP Advances In Information And Communication Technology with 9 documents. Sustainability Switzerland with 7 documents. Advances In Intelligent Systems And Computing with 6 documents. The fifth place is the ACM International Conference Proceeding Series with 5 documents. The graph of the most productive publication sources for digital transformation research on SMEs is presented in Figure 5.
3.6 The Subject Area That Most Researches Digital Transformation in SME’s

The Scopus database shows 17 subject areas in 219 Digital Transformation on SME’s research documents. The most productive subject area is Computer Science 24.9% or 110 documents. The second one is Business, Management, and Accounting with 87 documents or 19.7%. Engineering is third with 86 documents or 19.5%. The pie chart subject area in Digital Transformation on SME’s research for the last 1.5 decades is presented in Figure 6 and Table 4.

Table 4. Top 5 Subject Area that Most Researches SMEs Strategy Research

<table>
<thead>
<tr>
<th>No</th>
<th>SUBJECT AREA</th>
<th>Documents</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Computer Science</td>
<td>110</td>
</tr>
<tr>
<td>2</td>
<td>Business, Management and Accounting</td>
<td>87</td>
</tr>
<tr>
<td>3</td>
<td>Engineering</td>
<td>86</td>
</tr>
<tr>
<td>4</td>
<td>Decision Sciences</td>
<td>58</td>
</tr>
<tr>
<td>5</td>
<td>Social Sciences</td>
<td>29</td>
</tr>
</tbody>
</table>
3.7 Global Research Theme Map on digital transformation research in SME’s

The evaluation and visualization process related to the Digital Transformation on SME’s research theme map was constructed using the VOS Viewer software. A review of the SMEs Strategy research theme map was identified by keyword linkages between publications. The criteria for the number of keywords in a published document is 8 repetitions so that a threshold of 24 interrelated keywords is found in 219 publication documents. A map of the SMEs strategy research network for a quarter of a century is presented in Figure 7.

From Figure 7, there are four clusters in Digital Transformation on SME's research, grouping themes focusing on keyword studies. The theme map was then simplified and shortened to ICID.

1. Industry Cluster (Red): The keywords in this cluster are industrial research, industry, industry 4.0, manufacture, and manufacturing.
2. Competition (Blue) Cluster: The keywords in this cluster are competition, innovation, small medium enterprise, and industrial management.
3. Cluster Information (Yellow): The keywords in this cluster are information systems, information use, and service industry.
4. Cluster Digitalization (Green): The keywords in this cluster are digital technologies, metadata, digital transformation, surveys, and decision making.

3.8 Global Network Of Digital Transformation Researchers on SME’s

The topic of digital transformation in SMEs has been investigated by several research groups. This research forms the author's network map with VOSviewer software. The criteria used for the formation of the network is a minimum of 4 documents publication. From 218 documents, the results of a network formed by 3 researchers, namely Ays, Julian L, Muhlbradt, Thomas., and Schuh, Gunther, were obtained. The three researchers are from Germany and one of their collaborative works is “SME 4.0 – Companies and Employees design the Digital Transformation.” The map of the most productive research network with the theme Digital Transformation on SMEs is presented in Figure 8.
4. Conclusion
This study shows the visualization of maps and patterns on Digital Transformation on SME's research around the world obtained from the Scopus database. The results of the database analysis show that the trend of publications on Digital Transformation on SME's always increases every year where the peak is in 2020 with 119 documents. Research on digital transformation is becoming more and more interesting because today is the era of digital competition. The most productive researcher on the theme of digital transformation on SME's is Schuh, G with 5 documents from Rheinisch-Westfälische Technische Hochschule Aachen, Aachen, Germany. Furthermore, Université du Québec Trois-Rivières is the most prolific affiliation with the theme of digital transformation research on SME's with 7 documents. Germany with 56 documents became the most productive country on the theme of this research. Procedia CIRP became the most productive publication source with 10 documents in digital transformation research on SME's. Computer science is the most productive subject area in this research theme with 110 documents or 24.9%. The research theme map for the last 15 years has formed the linkage of keywords into 4 clusters, namely: Industry, Competition, Information, and Digitalization, which was then abbreviated as ICID. A collaborative network of researchers was formed with a threshold qualification of 3 research documents and found 3 interrelated researchers, namely Ays, Julian L, Muhlbradt, Thomas., and Schuh, Gunther.

The implications of this research are in the form of theoretical and practical contributions. In theory, this study shows the visualization of ICID as a map of research themes formed from published data over the last 1.5 decades (2005-2020). Practically, the results of this research theme map can be used as a basis for reference for knowledge in carrying out digital transformation for SME actors. Further researchers can explore, develop, and collaborate on research on digital transformation in SMEs based on the findings of the research theme map.

Acknowledgments
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IGI Global. (2021). What is Bibliometric Analysis? IGI Global. https://www.igi-global.com/dictionary/educationliterature-development-responsibility/2406#:~:text=Bibliometric is defined as the percentage reports%


**Biography**

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