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Generating The Genealogy of Digital Transformation Documents Using Visualization Techniques

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ABSTRACT

This paper aims to generate a genealogy of Digital Transformation employing visualization techniques of scientific documents which will contribute theoretically to the research field and practically to the business. To reach the genealogy, three relations including ancestors, fathers, and descendants were defined. The ancestors and fathers were respectively determined by Reference Publication Year Spectroscopy (RPYS) and Citation analysis. Identification of the descendants was done through the bibliographic coupling of the documents published in the last two years. Visualization of the ancestors, fathers, and descendants was respectively done via fathers' reference co-citation analysis, citation analysis on documents, and clustering of the bibliographic couplings using VosViewer. The analysis of each cluster identifies the topics of each relation of the genealogy. The analysis of the ancestors showed that the ancestors have studied theoretical foundations in digital transformation to a great extent. according to the clusters obtained for the fathers, Business models, Strategy and Innovation, Industry 4.0, and Servitization were the dominant topics of this relation. The identified topical clusters of descendants contained Digital Transformation Nature, the Influence of Digitalization on Business, Industry 4.0 and Sustainability, Digital Twins, and other Technologies in Industry 4.0, Digital Transformation, and Medicine, and Digital Transformation, Smart City, and The Effect on Financial and Economic Services showing the focus of latest research in specific technologies and innovation. The generated genealogy can be used to anticipate future trends and measures to be taken by businesses to realize digital transformation.

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1. Introduction

The appearance of digital environments, the replacement of physical entities with digital alternatives, and facilitating messaging by removing physical barriers indicate that we have entered the digital era (Hassanzadeh, 2020). Digital Transformation refers to all the changes that occur in this era (HosseiniNasab, ShamiZanjani, & Gholipor, 2021). Business professionals and experts claimed that digital transformation should be an inseparable part of the business and that professional employees should be hired to pursue digital transformation strategies in business environments (Schallmo & Williams, 2018), but it seems that organizations and businesses are facing challenges in following this kind of transformation (Ghosh, 2019).

Being aware of the history, evolution, and effective research in the field of digital transformation can help managers and industry professionals deal with the possible challenges on the path to digital transformation. In this regard, the genealogy of digital transformation can help managers reach a general outline of the field, get a better understanding of the birth and death of specific topics, and get familiar with other disciplines contributing to the field (Dores, Benevenuto, & Laender, 2016). Bibliometric techniques can act as an appropriate tool in generating the genealogy since they are used for analysis based on citing and cited references which can determine the historical ancestors and future descendants of the papers in a specific field.

2. Literature Review

Looking back to the existing literature concerning genealogy research, it can be stated that most of them have focused on "Academic Genealogy" which highlights the relationships between students and their supervisors; Generally, Academic Genealogies research is done based on a specific scientist, journal, or discipline. Genealogy studies based on a specific scientist aim to determine the relationships of a scientist with their antecedent (e.g., Leisegang, Levin, & Kupsch, 2020). Journals can also be the base of a genealogy study; for instance, Mitchell (1992) extracted the information about the authors' supervisors, their graduation year, their degree, and their topics of interest whose papers have been published in the Journal of Training in Physical Education. As said before, academic genealogies can be generated based on a specific discipline or field as well. Mathematic genealogy (Gargiulo, Caen, Lambiotte, & Carletti, 2016), Sociology (Ni & Sugimoto, 2013), computer science (Anil, Kurian, Dey, Saha, & Sinha, 2018), Astronomy (Tenn, 2016), and fish farming genealogies (da Silva, Nunes, & Viegas, 2018) are some examples of genealogies done based on specific disciplines. In addition to the academic genealogies, few numbers of genealogy research can be found that have based their work on citation analysis; for example, Galvagno & Pisano (2021) tried to construct the genealogy of the Internationalization of Family Business based on the existing literature on the topic, not the academics. The current paper tried to follow the way that Galvagno & Pisano (2021) followed. Also, this paper wishes to fill the gap in understanding the historical roots, the most cited research, and the new research trends that have been opened up due to the novelty of the topic of Digital Transformation.

This paper aims to build the genealogy of Digital Transformation based on the papers published on this topic. In doing so, it utilizes bibliometric indicators and visualization techniques to present a better image of the findings. The questions that will be addressed in this paper are as follow:

1. what are the most cited papers (the fathers in genealogy)?
2. what are the topical clusters of the most cited papers?
3. what are the historical roots of digital transformation research (the ancestors in the genealogy)?
4. What are the topical clusters of the digital transformation research ancestors?
5. What are the research trends of digital transformation research (the descendants in the genealogy)?

The remainder of the paper will first explain the methodology for answering the

above-mentioned questions, then will present the findings, and will ultimately discuss the obtained results.

3. Methodo

3.1 Data Gathering and search strategy

For the data collection, we searched the "Digital Transformation" keyword in the topic field of the Web of Science database which includes abstract, authors' keyword, and keyword plus from the beginning time to July 2022. the results were modified to include only the articles, Reviews, and Proceeding papers.

The early number of documents that were obtained was 4054. This number then was modified by excluding data reports and early access. Finally, 3693 records were retrieved. Full records and their cited references were exported in the range of 500 records as plain text and tab-delimited files.

3.2 Investigating the Genealogy

To investigate the genealogy, ancestors, fathers, and descendants must be identified. These three positions can be put in a hierarchy as shown in Figure 1.

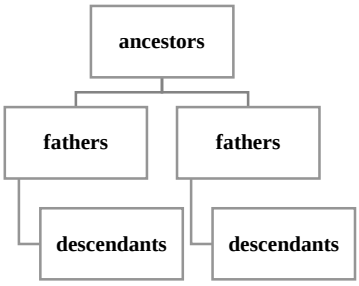

Figure 1. *The Hierarchy of a Genealogy*

The process of investigating genealogy starts with identifying the fathers. At this level, we utilized the citation analysis as it was already being used by previous studies (e.g. Galvagno & Pisano, 2021). We set the number of received citations as 50 or more. At the next level, we defined the ancestors as the roots and decided to use the reference published year spectroscopy (RPYS) to find the ancestors. In this way, the cited references are analyzed in different time windows. To extract the references for this purpose, we used a software called, CRexplorer which had a more user-friendly interface compared to similar software packages. In addition to RPYS, another complementary method was used in identifying the ancestors as well; by arguing that the references cited by the fathers are the fathers' fathers, we investigated these references as the ancestors. At the final level of the genealogy, descendants were identified by bibliographic coupling of the documents published within the recent two years. For determining the topical clusters of the ancestors, fathers, and descendants, VosViewer 1.6.17 was utilized.

4. Findings

4.1. The Fathers

We started to investigate the genealogy by finding the fathers standing in the middle of the genealogy hierarchy. 127 documents with 50 or more received citations were labeled as fathers. To get a better understanding of the nature of the documents in the father's position, they have been categorized according to the subject label they received in WoS. According to this categorization, most of the identified fathers are categorized under the Business & Economics subject. Engineering, Information Science & Library Science, and Computer Science were respectively the other subjects dedicated to fathers (Figure 2).

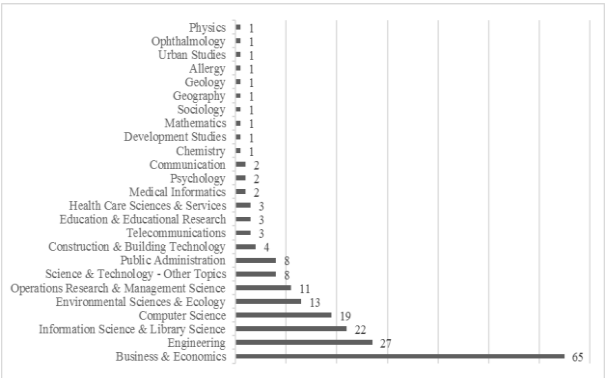

Figure 2*. The Subject Tags of the Fathers' Documents*

4.2. Fathers' Topical Clusters

to visualize the fathers, a co-citation analysis on the reference of fathers was done. All the cited references that had received at least 3 citations were chosen. Choosing this threshold was achieved by trial and error. 307 documents met this threshold. Those documents which did not have enough

bibliographic information were removed and finally, 303 documents were visualized (Figure 3). four clusters were identified. These clusters are Business Models, Industry 4.0, Strategy and Innovation, and Servitazion.

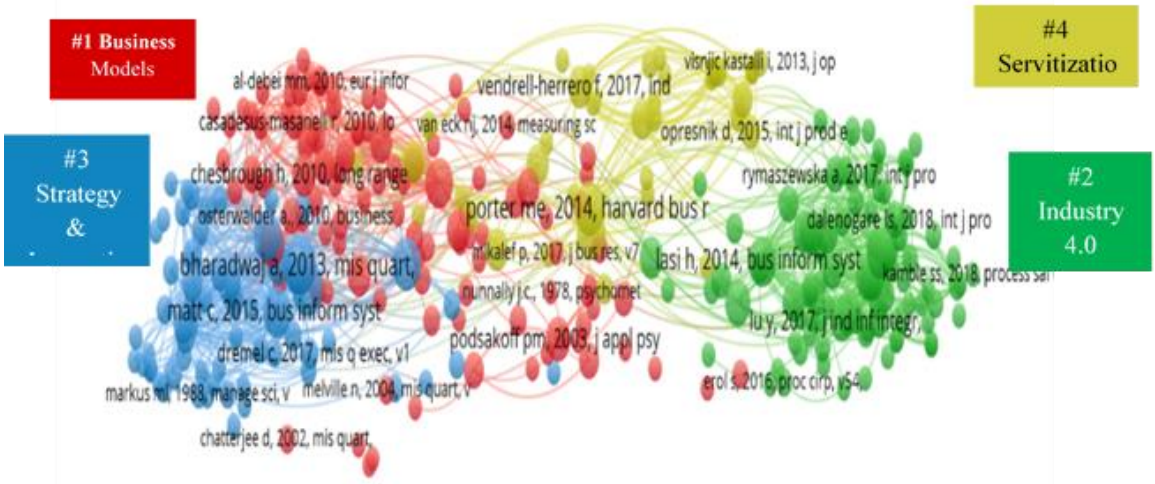

***Figure 3**. The Fathers' Research Clusters*

Cluster 1: Business Models; This cluster contains 107 documents which are more than other clusters. The documents in this cluster mainly discussed business models and the necessity of innovation in the models which is caused by the emergence of Digital Transformation. A point that has been emphasized in this cluster is the lack of theoretical bases for business models. As a result, some documents have tried to reach a theoretical framework of a business model (e.g. Al-Debei & Avison, 2010). Teece (2010) asserted that a business model should be developed before starting a business enterprise and stressed that value creation and its delivery to customers is the essence of business models. Also, some documents in this cluster highlighted value creation in business models (Berman, 2012; Zott, Amit, & Massa, 2011).

Cluster 2: Industry 4.0; This cluster contains documents that focus on topics such as the previous and current state of industry 4.0 (e.g., Ghobakhloo, 2018; Hofmann & Rüsch, 2017; Xu, Xu, & Li, 2018), the effect of industry 4.0 on some specific industries (Oesterreich & Teuteberg, 2016; Tortorella & Buliga, 2018), or enterprises (Julian Marius Müller, Buliga, & Voigt, 2018). The general impact of industry 4.0 on organizations and changes subjected to traditional industries has also been investigated by another research in this cluster (Lasi, Fettke, Kemper, Feld, & Hoffmann, 2014).

Cluster 3: Strategy and Innovation; Adopting a digital transformation strategy is the main focus of this cluster. This strategy is considered important because it coordinates, prioritizes, and implements the strategy within a company and helps companies to manage the difficulties caused by digital transformation (Matt, Hess, & Benlian, 2015). One study (Hess, Matt, Benlian, & Wiesböck, 2013) claims that business leaders are facing challenges in digital transformation and the solution to the challenges is the adoption of a digital transformation strategy .

Cluster 4: Servitizaion; Servitization of manufacturers is the main concern of this cluster. A study (Baines & W. Lightfoot, 2013) has investigated manufacturers moving toward servitization and analyzed the techniques and technologies they employed in this way. In general, digital technologies played an important role in service transformation and the servitization of manufacturers. For example, the Internet of Things (IoT), Cloud Computing, and Predictive Analysis are essential respectively in service transformation, moving to the provider's performance profile, and implementing an industrialization strategy (Ardolino et al., 2018). Coreynen, Matthyssens & Bockhaven (2017) believe that digitization results in value servitization, industrial servitization, and commercial servitization. Generally speaking, the servitization of products and using digital

technologies by manufacturers in the realization of servitization was the main issue examined in this cluster.

4.3. The Roots (Ancestors)

In defining the roots in RPYS, we first determined three time-windows based on all the years and the number of published references. The first time-range was from 1971 to 2017 (Figure 4.). In this window, the number of documents concerning digital transformation was less than 100. 2018 to 2020 which contained less than 1000 documents composed the second period.

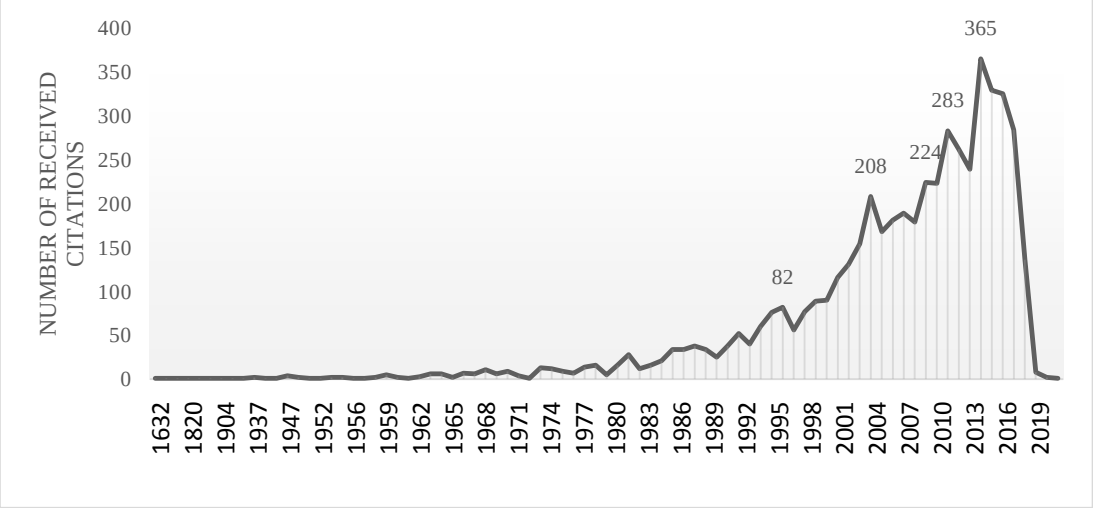

Fig. 4*. RPYS analysis of the first period*

Documents of the recent two years formed the third period. The data for every period were imported into CRexplorer and the chart was drawn.

The first timespan had five peaks which happened in 1995, 2003, 2008, 2010, and 2013. In these years, more documents have received citations. To identify the roots or the ancestors in this period, we find the most cited documents in the peak years and put them in the ancestor's position. After finding these documents, we found that although some of the documents have received a notable number of citations, they have failed to obtain a remarkable percentage of the whole citation of the publication year. So, we decided to ignore them in our genealogy. Out of the five peaks in the first period, documents belonging to three peaks were identified as ancestors (Table 1). One of these documents seeks to analyze information technology as a resource for sustainable competitive advantage. Another study at this peak has focused on Common method biases. An investigation of the papers citing this document shows that this paper has been mainly cited in the methodology section. It means that this paper may not be helpful in digital transformation genealogy, since it would not contribute to the topic. The third document in this period is amongst the studies focused on digital transformation strategy. This study can be seen in the fathers as well. As we go closer to the recent years, the fathers will appear among the ancestors because they will naturally receive more citations.

Table 1. *The fathers of the first window*

The first window (2017-1971)			
Title	**Peak year**	**Number of received citations**	**Percentage of received cation compared to the total citation of the peak year**
Anandhi Bharadwaj, Omar A. El Sawy, Paul A. Pavlou, and N. Venkatraman. 2013. Digital business strategy: toward the next generation of insights. MIS Q. 37, 2 (June 2013), 471–482.	2013	6	2%
Podsakoff PM, MacKenzie SB, Lee JY, Podsakoff NP. Common method biases in behavioral research: a critical review of the literature and recommended remedies. J Appl Psychol. 2003 Oct;88(5):879-903	2003	5	2%
Mata, F. J., Fuerst, W. L., & Barney, J. B. (1995). Information technology and sustained competitive advantage: A resource-based analysis. MIS Quarterly, 19(4), 487–505.	1995	3	4%

In the second window, six peaks were found (1989, 2003, 2007, 2010, 2013, 2015, and 2017) (Figure 5). Like the previous time window, the documents chosen to represent the ancestors in this window were those that have received a higher citation percentage compared to the total received citations of the peak year. The three documents chosen in this window are listed in Table 2.

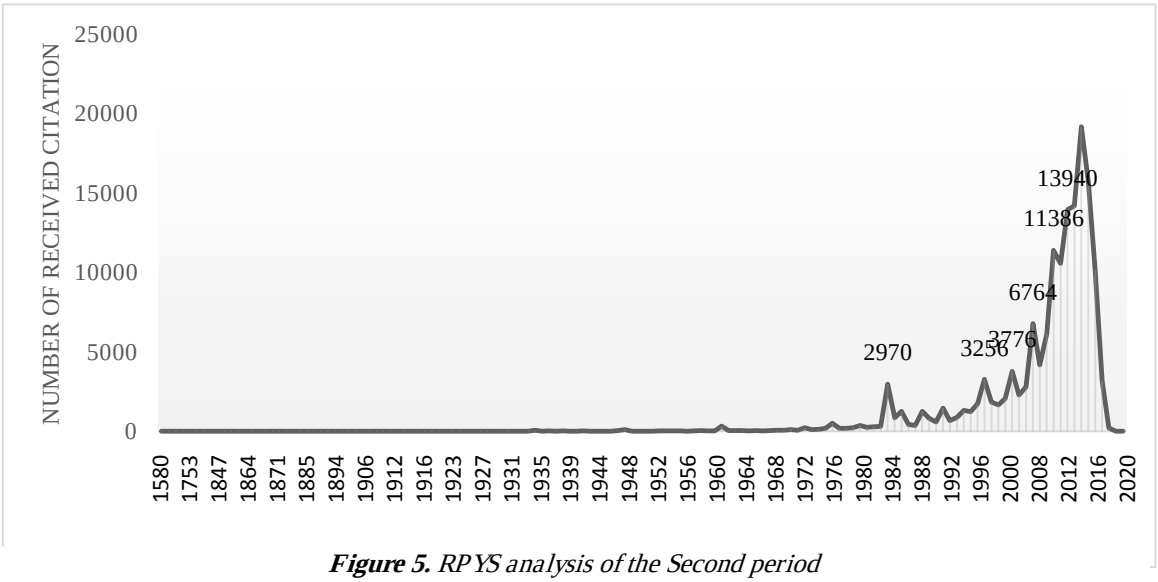

Figure 5. *RPYS analysis of the Second period*

Table 2. *The Fathers of the Second Window*

The Second window (2018-2020)			
Title	**Peak year**	**Number of received citations**	**Percentage of received cation compared to the total citation of the peak year**
Everett M. Rogers, Diffusion of Innovations, 5th Edition: Simon and Schuster, 2003.	2003	22	1%
Eisenhardt, K.M., Graebner, M.E., 2007. Theory building from cases: opportunities and challenges. Academy of Management Journal, 50(1), 25-32.	2007	35	2%
Eisenhardt, K.M. Building theories from case studies. Acad. Manag. Rev. 1989, 14, 532–550.	1989	47	1%

Two documents in this window do not directly discuss digital transformation. These two documents are famous for theories in multiple case studies. Another study that has received more citations is a book that has proposed "Diffusion of Innovation" for the first time.

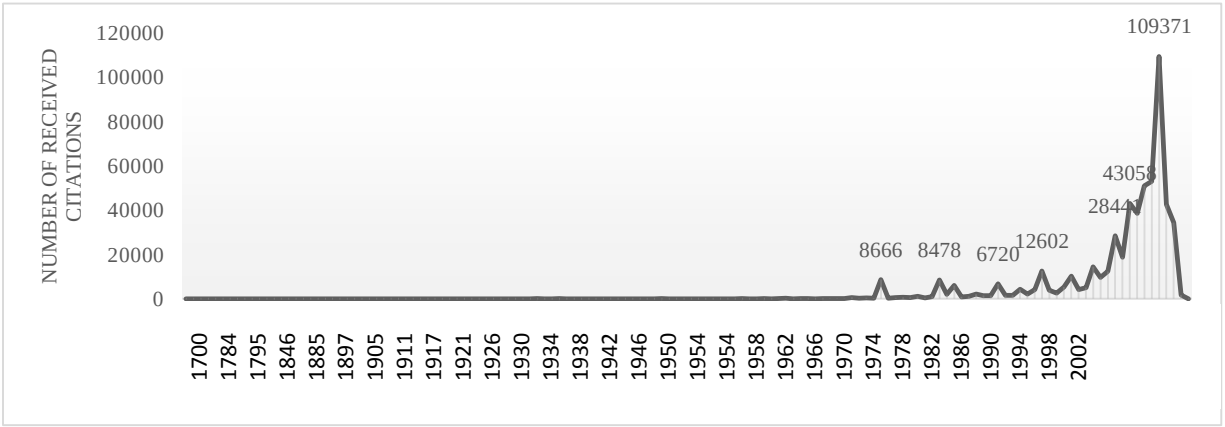

Figure 6. *RPYS Analysis of the Third Period*

In the third window, 10 peaks were found (1997, 1991, 1981, 2003, 2007, 2010, 2013, 2015, and 2019) (Figure 6). The number of received citations of the documents in this window is high but it is still not so remarkable compared to the percentage of total citations of the peak year. As a result, only one document was chosen as the ancestor (Table 3).

The paper included in the third window studied the microfoundations of dynamic capabilities. This study helps managers in understanding the foundations of development. the framework put out by this study can assist managers in defining pertinent strategic considerations and the priorities they should embrace to improve firm performance.

4.4. The Topical Clusters of the Ancestors

Identifying the ancestors with the RPYS method, cannot give a visualization of the documents' topics. Besides, the identified ancestors, may not be reliable due to the low percentage of the total received citations. Therefore, the ancestors were re-identified with co-citation analysis.

Table 3. The Fathers of the Third Window

The Third window (2018-2020)			
Title	**Peak year**	**Number of received citations**	**Percentage of received cation compared to the total citation of the peak year**
Teece, D.J. (2007), "Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance", Strategic Management Journal, Vol. 28 No. 13, pp. 1319-1350.	2007	63	1%

For identifying the ancestors with co-citation analysis, documents identified as fathers were classified according to their published year. The fathers' publication year and the number of documents from each year have been displayed in Table 4.

Table 4. *Publication Year and the Number of Father's Documents*

Publication Year	**Number of documents**
2003	1
2006	2
2010	1
2011	2
2015	3
2016	3
2017	12
2018	17
2019	25
2020	40
2021	20
2022	1

According to the distribution of the fathers' documents, two ranges of time were defined. The first range was from 2003 to 2019 and the second was from 2020 to 2022. The selection of these two ranges was based on the number of documents. In other words, the first range included 66 while the second range had 61 documents which are relatively close. In the next step, the cited references of the fathers' document in each time range were analyzed. The threshold of the number of citations was set to at least 5 citations and the ancestors of the two ranges were mapped.

In the first map (Figure 7), three clusters can be seen. The red cluster has covered six documents. The topics discussed in this document are the effect of new technology and the necessity of adopting a new strategy for gaining competitive advantage (Porter & Heppelmann, 2014), the approval or rejection of managers toward it (Brettel, Friederichsen, Keller, & Rosenberg, 2014), and the fourth industrial revolution and its capabilities in some specific territorial context (i.e., Germany) (Kagermann, Wahlster, & Helbig, 2013). Two documents in the cluster which are placed close together see digital strategy as essential for an organization's change management (Matt et al., 2015) and have guided managers in adopting a digital strategy (Hess et al., 2013). The other study (Yoo, Boland, Lyytinen, & Majchrzak, 2012), which also acts as a connector of this cluster to other clusters, believes that understanding the influence of digital technologies, products, and services is the basis for understanding the potential effect of digital technologies on organizations' science and innovation.

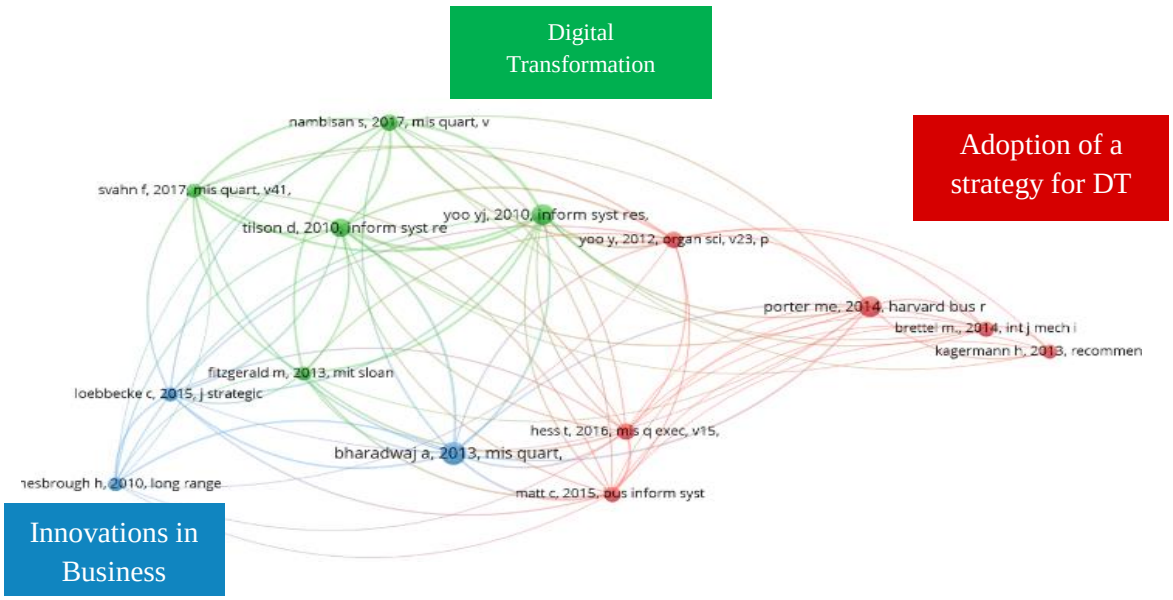

Figure7. *Mapping the Ancestors of the First Period*

The second cluster, colored blue, generally discussed the theoretical and practical bases for digital transformation. For example, Nambisan et al (2017) stated that new theories are required for digital innovation. This need for theorizing has also been emphasized by other studies in this cluster as well. Tilson, Lyytinen, & Sørensen (2010) and Fitzgerald, Kruschwitz, Bonnet, & Welch (2014) have respectively highlighted strengthening the theoretical foundations of digital transformation and adopting new methods and strategies.

The third cluster which is shown in green includes three documents. Two of them (Chesbrough, 2010; Loebbecke & Picot, 2015) directly addressed innovative business models, which is partly a result of the incorporation of new technologies into businesses .

On the whole, ancestors identified in the first period have covered topics such as digital transformation strategy as an essential strategy, welcoming new technologies, and planning to change business models and strategies in organizations.

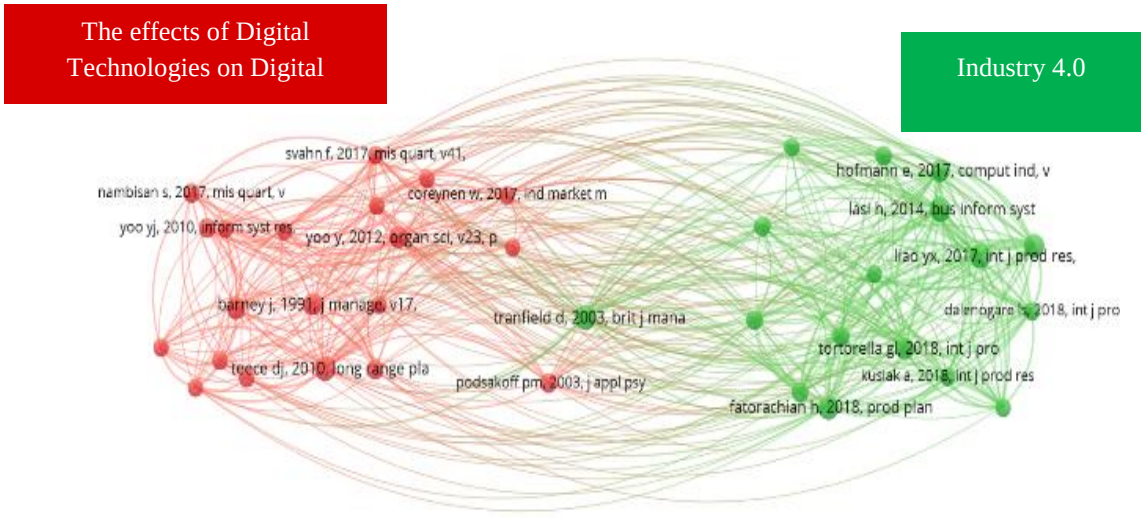

Figure 8. Mapping The Ancestors of the Second Period

In mapping the ancestors' second time-window, two clusters were identified (Figure 8). The left cluster contains 20 documents and explored the topics such as innovative business models and value creation (Teece, Pisano, & Shuen, 1997), changing the models due to the introduction of new technologies (Berman, 2012) and the role of models in macro management (Foss & Saebi, 2017). Some items in this cluster dealt with the impact of new technologies on other industrial processes such as servitization (Vendrell-Herrero, Bustinza, Parry, & Georgantzis, 2017). Moreover, requirements needed due to the application of digital technologies were the subject of a series of other documents. It has been believed that following the application of technologies, utilizing theoretical frameworks (Nambisan et al., 2017; Yoo et al., 2012), strategy (Matt et al., 2015), digital platforms (Yoo, Henfridsson, & Lyytinen, 2010), and gaining acceptance among managers (Hinings, Gegenhuber, & Greenwood, 2018) is essential.

Most of the documents in the green cluster focused on industry 4.0 defining the fourth industrial revolution, its current status and future perspective, and its domain (Lu, 2017). Other series in the cluster analyzed industry 4.0 and smart manufacturing. For example, Fatorachian & Kazemi (2018) has presented a general view of the implementation of Industry 4.0 and provided a framework for its operation. Smart manufacturing has also been defined as manufacturing incorporating IoT, Cloud Computing, Artificial Intelligence, Data Science, and service computing (Kusiak, 2018). One study (Tranfield, Denyer, & Smart, 2003) which has been placed in the middle of the map acts as the connector of two clusters. It can be said that this study played the role of a link because its main focus is on systematic review methodology. Since this study has analyzed the effectiveness of systematic review in management research, it has received citations from studies in both clusters .

Comparing the studies in periods, it can be said that digital transformation strategy, accepting novel technologies and making theoretical bases for them, and changing business models are the topics that can be placed among the ancestors in the first period (2003-2019). the ancestors of the second period can be

Comparing the studies in periods, it can be said that on one side, digital transformation strategy, accepting novel technologies and making theoretical bases for them, and changing business models are the topics that can be placed among the ancestors in the first period (2003-2019). on the ancestors, the fourth industrial revolution and digital technologies impact on businesses composed the ancestors of the second period (2020-2022).

4.5. The Descendants

According to Galvagno & Pisano (2021), we defined the descendants as the bibliographic coupling of the documents published in the last two years (i.e., 2021, 2022). We set the minimum number of received citations at 25. 58 documents met this threshold. In the final mapping, 55 documents were mapped and 3 documents were ignored because they were isolated. The final map was drawn with 6 clusters (Figure 9).

The Red Cluster, Digital Transformation Nature: studies included in this cluster were concerned about the nature of digital transformation. In explaining the nature of digital transformation, the steps to reach digital transformation, its difference from novel technologies, and its dark side are expressed. Verhoef et al. (2021) have described three steps to reach digital transformation which are digitization, digitalization, and digital transformation. Wessel, Baiyere, Ologeanu-Taddei, Cha, & Blegind Jensen (2021) stated that digital transformation differs from information technologies; and García-Peñalvo (2021) has shed light on the dark sides of digital transformation which is caused by the immoral use of technologies.

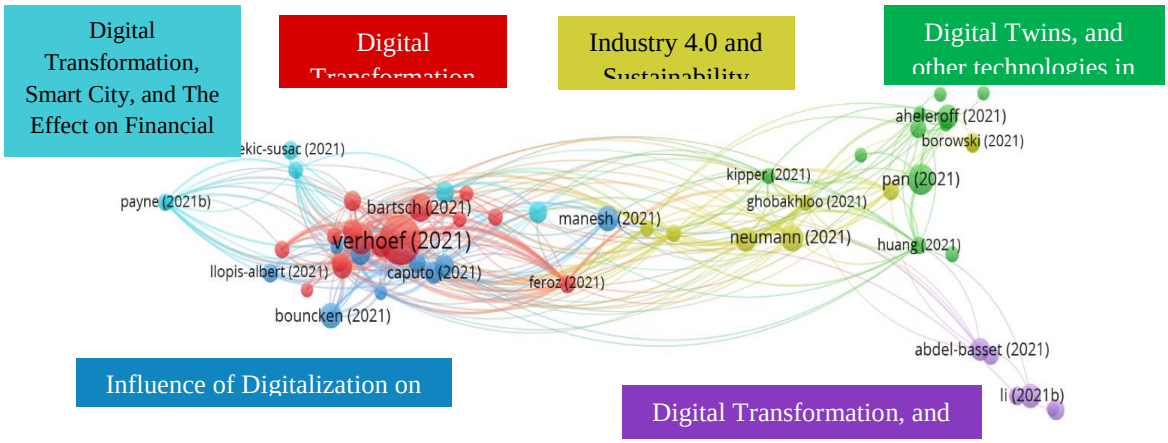

Figure 9*. Mapping the descendants*

The Blue Cluster, Influence of Digitalization on Business: this cluster is entangled with the red cluster and involves studies discussing mainly the effect of digitalization and novel technologies and their impact on business. For instance, Caputo, Pizzi, Pellegrini, & Dabić (2021) did a bibliographic analysis on research on digitalization and business. Ciampi, Demi, Magrini, Marzi, & Papa (2021) investigated the relationship between big data, which is an emergent technology, and business model innovation. Similarly, Haaker, Ly, Nguyen-Thanh, & Nguyen (2021) stated that IoT as another emergent technology requires a new business model. Other than developing models based on new technologies, redesigning models with emphasis on the size and type of enterprises has been studied (Julian M. Müller, Buliga, & Voigt, 2021) .

The Yellow Cluster, Industry 4.0 and Sustainability: the third research cluster shown by yellow is concerned with sustainability and the fourth industrial revolution. In one study (Ghobakhloo, Fathi, Iranmanesh, Maroufkhani, & Morales, 2021), the authors claim that the adoption of Industry 4.0 could help with concerns related to sustainable development goals. Another study (Fonseca, Amaral, & Oliveira, 2021), evaluates the relationship of EFQM models, which includes sustainability, with industry 4.0 paradigms. Industry 4.0 has also been studied as a factor contributing to and affecting manufacturing industries (Felsberger, Qaiser, Choudhary, & Reiner, 2022).

The Green cluster, Digital Twins, and other technologies in industry 4.0: technologies having a role in industry 4.0 especially digital twins have been examined in different aspects by the studies in this research cluster. A comprehensive of digital twins (VanDerHorn & Mahadevan, 2021) and reference architecture models for digital twins in industry 4.0 has been proposed (Aheleroff, Xu, Zhong, & Lu, 2021). Sepasgozar (2021) has differentiated Digital Twins with 3D modeling technologies, digital shadows, and information systems. And Nguyen, Trestian, To, & Tatipamula (2021) have analyzed the application of digital twins in the fifth or higher generations. Drones, Building Information Modelling, and Artificial Intelligence and their use in the building industry (Elghaish et al., 2021), and the contribution of deep learning in fixing the flaws of industrial rotating machinery (Souza, Nascimento, Miranda, Silva, & Lepikson, 2021) are other technologies in industry 4.0 evaluated by this cluster .

The Violet Cluster, Digital Transformation, and Medicine: Medicine has also been affected by digital transformation. This cluster of descendants has emphasized this point. However, it is isolated and does not make a strong connection to other research clusters. One study (Abdel-Basset, Chang, & Nabeeh, 2021) in this research cluster has estimated the contributions disruptive technologies made to Covid 19 analysis. It has also proposed a framework to ensure the physical and mental health of employees. Another study (Thakur, Soklaridis, Crawford,

Mulsant, & Sockalingam, 2021) similarly explores the employment of digital technologies in solving problems concerning employees and medical students. One study (Li et al., 2021) has looked into digital transformation and ophthalmology which is a branch of medicine that faces transformations and technologies affecting its application.

The Clear Blue Cluster, Digital Transformation, Smart City, and The Effect on Financial and Economic Services: It is the smallest cluster on the map including papers looking into financial services. For example, they have examined the application of artificial intelligence in value co-creation (Manser Payne, Dahl, & Peltier, 2021) and mobile banking (Manser Payne, Peltier, & Barger, 2021). Moreover, Circular Economy (CE) was also the focus of the two studies. CE has been defined analytically and it also has been analyzed regarding the practice of digital transformation in CE's implementation (Alhawari, Awan, Bhutta, & Ülkü, 2021). The CE's relation to the firm's performance and the mediating role of a big-data-driven supply chain in this relationship has also been examined (Del Giudice, Chierici, Mazzucchelli, & Fiano, 2021) .

Smart cities and their utilized technologies were evaluated by two papers in this cluster. In one item (Manfreda, Ljubi, & Groznik, 2021) self-driving cars as a technology appearing in smart cities have been studied regarding their role in millennials' life. The other item (Zekić-Sušac, Mitrović, & Has, 2021) has analyzed the smart cities considering their optimal energy management using machine learning.

Finding all the topics studied in each relation, we put them in a hierarchy of ancestors, fathers, and descendants. This hierarchy made the genealogy of Digital Transformation (Figure 10).

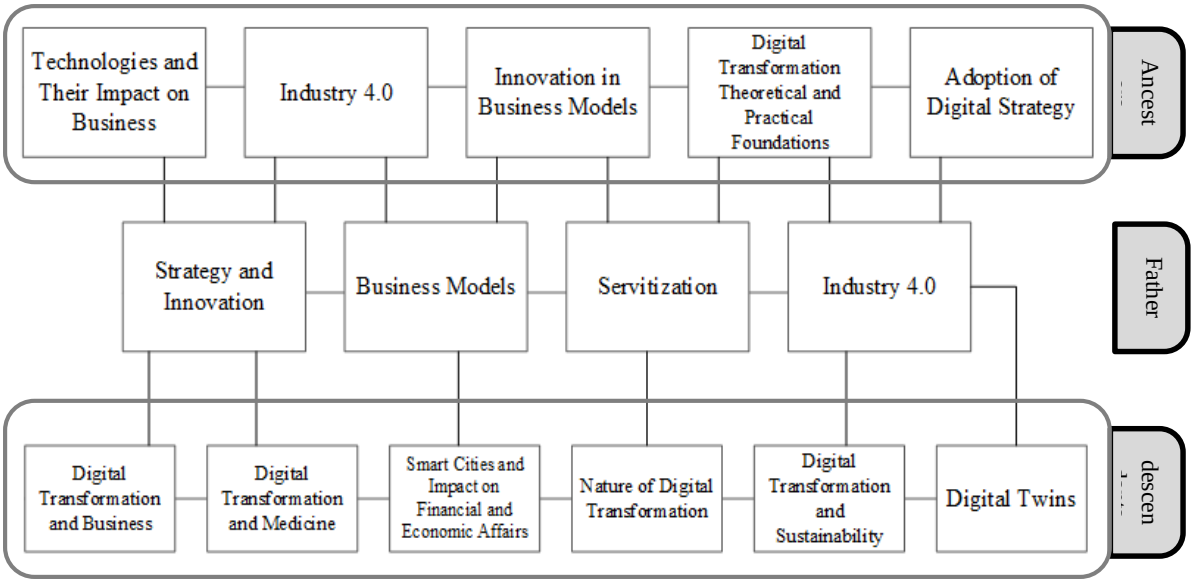

Figure 10. The Genealogy of Digital Transformation

5. Discussion

In this research, we generated the genealogy of digital transformation using documents containing this keyword. In generating the genealogy, ancestors, fathers, and descendants were identified. Building the genealogy started from the middle point (i.e., identifying the fathers). 127 documents were found in the father's position. This number is relatively high. It may be due to the threshold of received citations that was set to at least 50 citations which were distributed widely. Analysis of the WoS subject tag showed that Business & Economics is the general topic of the fathers' papers. The detailed investigation of the clusters reveals that Business models, Strategy and Innovation, Industry 4.0, and Servitization are the specific topics discussed by the fathers.

The first position of genealogy is the ancestors but, in this research, this position was determined in the second step. In finding the ancestors using the RPYS, the ancestors were divided into three ranges of time. The

documents discovered as the ancestors of each range failed to obtain many citations; so, some representatives out of each range were chosen to be placed in the ancestor's position. The majority of the ancestors identified in this way are published between 2017 and 2022 which caused fathers and ancestors to be overlapped.

As it was stated, some of the discovered ancestors were set aside since they did not receive a high citation percentage compared to the total citations. Therefore, the fathers were obtained again using citation analysis of their references. In fact, in this way ancestors were defined as fathers' fathers. Moreover, to visualize the ancestors' clusters and get more specific topics of the ancestors we needed to do a reference citation analysis. The obtained ancestors' clusters showed that the adoption of a digital transformation strategy, the fourth industrial revolution, and the necessity of theoretical foundations in digital transformation are the general topics studied by the ancestors. The subjects covered by the fathers and ancestors look alike to a great extent. It seems that the novelty of the digital transformation topic and lack of historical references have caused this similarity. In other words, it can be said that the historical generation of this topic has still not been generated and documents in the father's position are relatively playing the role of historical references .

The bibliographic coupling of the last two years determined the descendants of the genealogy. the documents placed in the descendants' position have studied digital transformation considering its impact on medicine, the economy, and sustainability. Specific technologies such as digital twins, self-driving cars, artificial intelligence, etc. These topics appear to be more specific than fathers and ancestors. However, this specificity did not impede the general topics to be included among the descendants .

The generated genealogy shows that researchers of Digital Transformation at early stages dealt with the topic of new information technologies and what these technologies bring about. For example, the necessity of adopting new strategies and theoretical infrastructures that have been aroused due to these technologies (as discussed by Hess et al., 2013; Matt et al., 2015; Porter & Heppelmann, 2014, etc,.), or the changes in new technologies brought to business models (as discussed by Berman, 2012; Bharadwaj et al., 2013, etc,.) can be seen among the earliest digital transformation research. The Fourth Industrial Revolution is another investigated topic that can be described as the framework including all these changes. After clarifying the strategies and models, the application of specific technologies and their roles in digital transformation comes forward. The contribution of deep learning to industrial machines (Souza et al., 2021) or artificial intelligence to the building industry (Elghaish et al., 2021) are only two instances of these specific innovations in digital transformation. It can be anticipated that future research in Digital Transformation will be focused on the new emergent technologies and their roles in the digital transformation of different industries.

6. Conclusion

In this research, we analyzed documents containing the "Digital Transformation" keyword to build the genealogy of the topic. The documents receiving 50 or more citations were identified and introduced as fathers. The research ancestors were determined using RPYS and they were mapped using reference citation analysis. the bibliographic coupling of the documents published in the last two years was identified and placed in the descendants' position. The research clusters of each relation were visualized and the dominant topics of each relation were determined. Finally, a genealogy of the research in digital transformation was generated by classifying the topics obtained through the analysis process.

Recommendations

The generated genealogy can act as a map by which managers can locate their companies' position and direct it towards digital transformation. Thus, it is recommended that managers use the generated genealogy and try to prioritize the concepts of each relation (i.e., ancestor, father, and descendants) respectively.

It can also be recommended that Digital Transformation Researchers define research

based on the concepts of the generated genealogy particularly in terms of descendants. The industry professionals can make use of the genealogy by using the ancestors' and fathers' concepts to lay the foundation of Digital Transformation in their industries; the descendants can be used in terms of defining and implementing new technologies.

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