Covid-19 Pandemic as a Catalyst for Digital Transformation: A Bibliometric Analysis using Vosviewer

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ABSTRACT

The pandemic of Covid-19 has become a global event that has an effect on every aspect of life. Since the announcement of Covid-19 as a pandemic on March 11, 2020 by the World Health Organization (WHO), until the end of December 2020 the pandemic is still ongoing in various parts of the world, a number of studies related to the impact of Covid-19 have been published in various international journals. This research aims to examine 446 articles related to Covid-19 as a catalyst for digital transformation in various fields that have received the researchers' attention. By using a systematic literature review methodology and a bibliometric analysis approach, the results of the Vosviewer software analysis divide the emergence of keywords in both article titles and abstracts as many as 14 clusters which are divided into three subject areas of concern to researchers, namely psychology and health, socio-economics, and education. From those three fields, various digital technologies are utilized for digital transformation purposes, such as the internet of things, artificial intelligence, biosensors, digital health, e-learning, and others that can be used for further development for the benefit of more specific fields.

ABSTRAK

Pandemi Covid-19 telah menjadi peristiwa global yang berdampak pada setiap aspek kehidupan. Sejak diumumkannya Covid-19 sebagai pandemi pada 11 Maret 2020 oleh Organisasi Kesehatan Dunia (WHO), hingga akhir Desember 2020 pandemi masih berlangsung di berbagai belahan dunia, sejumlah penelitian terkait dampak Covid-19 telah dipublikasikan di berbagai jurnal internasional. Penelitian ini bertujuan untuk mengkaji 446 artikel terkait Covid-19 sebagai katalisator transformasi digital di berbagai bidang yang mendapat perhatian para peneliti. Dengan menggunakan metodologi tinjauan pustaka yang sistematis dan pendekatan analisis bibliometrik, hasil analisis perangkat lunak Vosviewer membagi kemunculan kata kunci baik dalam judul artikel maupun abstrak sebanyak 14 klaster yang dibagi menjadi tiga bidang pokok yang menjadi perhatian peneliti, yaitu psikologi dan kesehatan, sosial ekonomi, dan pendidikan. Dari ketiga bidang tersebut, berbagai teknologi digital dimanfaatkan untuk tujuan transformasi digital, seperti internet of things, artificial intelligence, biosensor, digital health, e-learning, dan lainnya yang dapat digunakan untuk pengembangan lebih lanjut demi kepentingan bidang yang lebih spesifik.

INTRODUCTION

WHO declared COVID-19 as a global pandemic on March 11, 2020, until now the world has still not recovered from its effects. Experts create predictive models for the impact of the outbreak originating in China (Vasiljeva et al., 2020), the rapidly spreading plague around the world,

prompting the implementation of strict measures by world governments in an effort to isolate cases and limit the rate of transmission of the virus (Ibn-Mohammed et al., 2020). As the result of the Covid-19 pandemic, the ways of working, collaborating and playing have changed. Various businesses are affected, from travel, hospitality, education, retail and health sectors to become helpless when faced with an outbreak that appears suddenly and spreads rapidly (Mancl, 2020). Digital transformation role has caught the world's attention after the emergence of the Covid-19 outbreak (Mardani et al., 2020), organizations are competing to change their structure and governance in response to new social, environmental and economic challenges (Casado-Aranda et al., 2020).

Some researchers define digital transformation as the use of new digital technologies that refer to external concepts affect political, business and social issues (Collin, 2015; Henner Gimpel, 2017) such as social media, HP, analytics, or embedded services that enable big business increased by improving the customer experience, simplifying operations, or creating new business models (Fitzgerald et al., 2013). (Reis et al., 2018) defines digital transformation as the use of new technologies that allow large businesses to increase and affect all customer life's aspects.

Digital transformation plays an important role in encouraging organizations to shape value by adopting information and communication technology (ICT) to trigger positive changes in the social, business and economic environment (Zoppelletto et al., 2020). Thus digital transformation is increasingly becoming a theme and continues to be discussed constantly by both academics and practitioners (Hanelt et al., 2020), especially COVID-19 pandemic increasingly encourages organizations to increase awareness of the need to accelerate digital transformation to maintain and increase competitive advantage, satisfy stakeholders, increase productivity and market share, reduce costs, spur profits and sales, as well as the ability to expand into global markets (Fitzpatrick et al., 2020; Karabulut, 2020; Siri et al., 2020). Currently there has been no research with a bibliometric analysis approach that explains how the Covid-19 pandemic has become a catalyst for digital transformation and in what fields this transformation occurs.

In January 2020 Chinese health authorities and WHO identified the new corona virus and announced it to the world. The virus was first called NcoV 2019 and later called the Severe Acute Respiratory Syndrome Coronavirus - Corona Viruses (SARS-CoV-2). This new virus has become the agent responsible for a contagious respiratory disease called COVID-19 (Ferreira et al., 2020), then on March 11, 2020, WHO announced that Covid-19 could qualify as a pandemic triggered by the Corona virus (Vasiljeva et al., 2020).

The Covid-19 pandemic has resulted in dramatic environmental changes, pandemic control policies carried out by government authorities often fall into situations of Volatility, Uncertainty, Complexity, and Ambiguity (VUCA) (Fletcher & Griffiths, 2020), volatility is a very fast changing and unstable business environment. Uncertainty describes a situation where it is difficult to predict the future, complexity describes an increasingly complicated situation with various challenges, and ambiguity describes a completely unclear business situation. In this condition, organizations are forced to carry out digital transformation in just a matter of days, if the slower adoption, the greater the digital inequality (Carrillo & Flores, 2020) in facing unfavorable situations (Priyono et al., 2020). Although no one can predict how this rapid change to the digital situation will affect various aspects of life, at least now as a result of the Covid-19 pandemic the use of digital technology is increasing

(Nagel, 2020), so the question arises whether the Covid-19 pandemic becomes a catalyst of the application of digital transformation?.

As a new perspective in the era of infectious diseases faced by humans and cannot be avoided (Kodama, 2020) and has broad implications (Raaper & Brown, 2020), the scientific community continues to strive to explain various problems caused by Covid-19 such as environmental and socio-economic impacts also recovery plans and adaptation policies needed (Sharifi & Khavarian-Garmsir, 2020). Researchers are competing to find a way out of this problem, such as research (Vial, 2019) encouraging organizations to take strategic steps from the above situation by implementing digital transformation strategies to increase productivity and efficiency, even though many organizations have difficulty carrying out transformation (Shahi & Sinha, 2020). Likewise, countries are taking quick action to save social and education from the VUCA storm (Azorín, 2020), digital gap, health and professional shortages are major concerns (Mbunge, 2020). Business leaders are "forced" to take risks investing in digital innovation to change their business environment (Pelser & Gaffley, 2020). so in this study the objective is to answer the following research questions:

RQ1 : How has Covid-19 been a catalyst for digital transformation into various sectors such as business, economy, education, health, tourism and others?
RQ2 : What are the most dominant areas discussed by researchers during the Covid-19 period, especially when this pandemic became a catalyst for digital transformation?

RESEARCH METHODS

Systematic Literature Review (SLR) is used as a research methodology with stages using the Prism framework (www.prisma-statement.org), namely identification, screening, eligibility, included (Moher D, Liberati A, Tetziaff J, 2009). To see the development of research after the Covid-19 outbreak, which is around March-December 2020, especially with regard to the impact of the Covid-19 pandemic on digital transformation, bibliometric analysis is used with the help of VosViewer software (Heersmink et al., 2011).

The focus of this research is looking for scientific articles related to the impact of the Covid-19 pandemic on the acceleration of the digital transformation process. The analysis unit was collected through several scientific article publishers such as the Wiley online library, Taylor & Francis, Springer, publichealth.jmir.org, ncbi.nlm.nih.gov, nature.com, medrxiv.org, mdpi.com, journal.sagepub, com, jmir.org, ieeexplore.ieee.org, emerald.com, elsevier, catalyst.nejm.org, cambridge.org, atlantis-press.com. A search is also carried out on GoogleSchoolar with the aid of the Publish or Perish (PoP) application using the keyword: Covid-19 impacts on "digital transformation". All articles were downloaded from March to December 2020, resulting in 751 scientific articles, with details of the PoP application as many as 603 articles (google schoolar) and 42 articles (indexed by Scopus), emerald insight as many as 106 articles. From 751 downloaded scientific articles, a screening was carried out with several stages, including: 1) checking for duplication (29 articles), 2) checking the suitability of titles, fields of study with themes, and 3) criteria for journals and publishers that were widely known. So that the total screening results were 521 articles.

After careful examination of the abstract, 30 released articles due to lack of relevance to the theme being studied. The total number of articles deemed eligible was 491 articles.

The final step is to read the entire text of the article with an emphasis on the abstract, background, findings, and conclusions, where there is a link between the Covid-19 pandemic and digital transformation in various fields, then 446 articles were obtained.

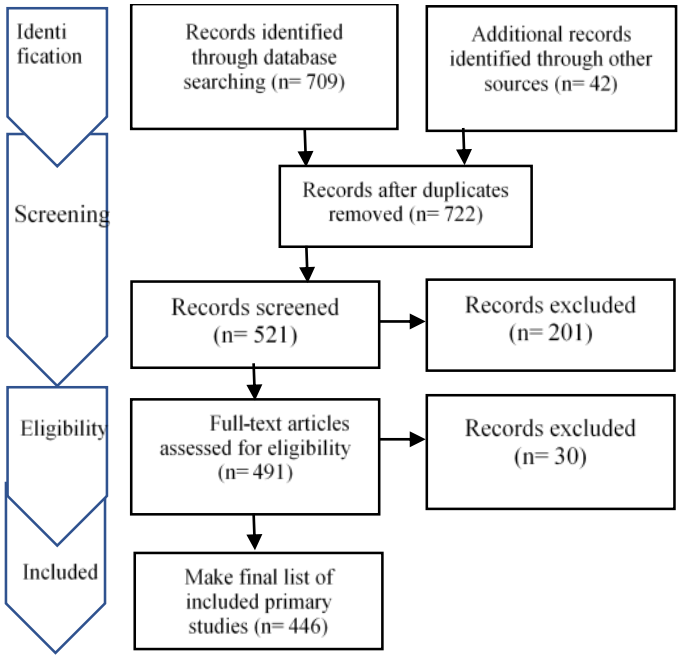

Figure 1. Stages of the PRISMA Framework for Filtering Articles

RESULTS AND DISCUSSION

How has Covid-19 been a catalyst for digital transformation into various sectors such as business, economy, education, health, tourism and others (RQ1). The pandemic situation has reminded business leaders that it is very dangerous to ignore the impact of VUCA on the smooth functioning of organizations. Digital transformation has provided lessons, firstly organizations must increase their digital maturity, secondly, organizations that are digitally less mature are more fragile and finally organizations with higher levels of digital maturity are generally more flexible (Fletcher & Griffiths, 2020).

It can be seen that amid the Covid-19 pandemic, reality has moved radically, both to reflect current conditions and future plans. The need for business leaders for speed and flexibility is continuously strengthened, barriers are removed, customer expectations are vigorously met, business agility is improved (Anderson et al., 2020). The Covid-19 pandemic has accelerated the process of digital transformation in all areas of society (Golinelli et al., 2020; Peláez et al., 2020). Apart from the negative impact felt from the pandemic, which has been running for about nine months, on the other hand it has become a catalyst for the digital transformation process in various fields of life.

Most Dominant Discussed Fields in Articles

What were the most dominant fields discussed by researchers during the Covid-19 period, especially when this pandemic became a catalyst for digital transformation (RQ2). From 446 articles analyzed through the Vosviewer software, there are at least three major themes due to the impact of the Covid-19 catalyst on digital transformation, namely socio-economic, psychology and health, and education.

Table 1. ***Socio-Economic Sector***

Researchers	(Akpan et al., 2020; Alqutob et al., 2020; Barneveld et al., 2020; Bushuyev et al., 2020; Davahli et al., 2020; Dunford & Qi, 2020; ElMassah & Mohieldin, 2020; Erokhin & Gao, 2020; Filotto et al., 2020; Hamilton, 2020; Heinonen & Strandvik, 2020; Ibn-Mohammed et al., 2020; Ivanov & Dolgui, 2020; Juergensen et al., 2020; Kraus et al., 2020; K. Li et al., 2020; Maltseva & Li, 2020; Nandi et al., 2020; Nhamo et al., 2020; Nicola et al., 2020; Notteboom & Haralambides, 2020; Okorie et al., 2020; Pantano et al., 2020; Prideaux et al., 2020; Ratten, 2020a; Robinson et al., 2020; Rowan & Galanakis, 2020; Sang, 2020; Sharifi & Khavarian-Garmsir, 2020; Shkalenko & Fadeeva, 2020; Song et al., 2020; Umar & Gubareva, 2020; Wang & Wang, 2020; Yasin Ar, 2020)
Findings	The Covid-19 pandemic has contributed to digital transformation in the socio-economic field. Various articles discuss the impact of the Covid-19 outbreak on the socio-economic sector, both positive and negative impacts that can offer new perspectives on how this situation can be used to direct the socio-economic sector to be better and more resilient. The average article discusses how companies / organizations are prepared to face the Covid-19 pandemic situation. The sub-fields of economy that appear discussed in the article are the fields of tourism, supply chain management, marketing, finance, banking industry, hospitality industry, manufacturing, small medium enterprises, retail, and digital economics.

Table 2. *Psychology and Health Sector*

Researchers	(Abdel-Basset et al., 2020; Alqutob et al., 2020; Appireddy et al., 2020; Atique et al., 2020; Barbash et al., 2020; Bayram, 2020; Bhaskar, Bradley, Chattu, et al., 2020a, 2020b; Bhaskar, Bradley, Sakhamuri, et al., 2020; Budd et al., 2020; CATTUTO & SPINA, 2020; Chamola et al., 2020; Chander et al., 2020; Chen et al., 2020; Chidambaram et al., 2020; Chimmula & Zhang, 2020; Chowdhury et al., 2020; Chung et al., 2020; Daniela et al., 2020; de Jong & Ho, 2020; Fairburn & Patel, 2017; Figueroa & Aguilera, 2020; Fisk et al., 2020; George et al., 2020; Golinelli et al., 2020; Hollander & Carr, 2020; Holmes et al., 2020; Huang et al., 2020; Husain et al., 2020; Javaid et al., 2020; Jazieh & Kozlakidis, 2020; Jia et al., 2020; Jovanović et al., 2020; Kajdy et al., 2020; Kamel, 2020; Kannampallil & Ma, 2020; Keesara et al., 2020; Krausz et al., 2020; J. Li et al., 2020; Lin et al., 2020; Lusignan et al., 2020; Machleid et al., 2020; Maeder et al., 2020; Mascitti & Campisi, 2020; Mbunge, 2020; Menon & George, 2020; Moss et al., 2020; Nascimento et al., 2020; Nuere & Miguel, 2020; Offodile & Aloia, 2020; Okan et al., 2020; Olayiwola et al., 2020; Owens et al., 2020; Pears et al., 2020; Pillay et al., 2020; Reay et al., 2020; Ribeiro et al., 2020; Sachs et al., 2020; Salvador-Carulla et al., 2020; Sarbadhikari & Sarbadhikari, 2020; Sust et al., 2020; Taiwo & Ezugwu, 2020; Tsou et al., 2020; Tummalapalli et al., 2020; Türközer & Öngür, 2020; Vandekerckhove et al., 2020; VolppKevin, 2020; J. Ye, 2020; Q. Ye et al., 2020; Yoshihiro, n.d.)

Findings	The Covid-19 pandemic is not only interpreted as a disaster, but also as an opportunity to rethink lifestyles, mindsets, produce scientific knowledge, provide health care, and relate to ecosystems. The Covid-19 pandemic has driven digital transformation in the health sector with the emergence of "digital health tools" such as the internet of things (IoT), biosensors, and artificial intelligence (AI) with the aim of providing telemedicine, health care "without touching". Several sub-fields of health that are interesting topics for researchers are health service innovation, telehealth, social media for health services, telemedicine, clinical transformation of oncology, health information systems, smart healthcare, mobile health, digital health innovation, chatbot, nursing informatics, mental health technology, clinical informatics digital hub and health care's digital revolution.

Table 3. *Education Sector*

Researchers	(Ahmed et al., 2020; Al-Balas et al., 2020; Almekhlafy, 2020; Alzahrani et al., 2020; Aristovnik et al., 2020; Brammer & Clark, 2020; Casado-Aranda et al., 2020; Code et al., 2020; Giavrimis & Nikolaou, 2020; Gillis & Krull, 2020; Guraya, 2020; Ho et al., 2020; Ifijeh & Yusuf, 2020; Kedraka & Kaltsidis, 2020; Kerroum et al., 2020; König et al., 2020; Krishnamurthy, 2020; Langlois et al., 2020; Lee et al., 2020; Makarova & Pirozhkova, 2020; Martzoukou, 2020; Nuere & Miguel, 2020; Othman, 2020; Papouli et al., 2020; Pather et al., 2020; Peters et al., 2020; Prestiadi, 2020; Raaper & Brown, 2020; Ratten, 2020b; Rospigliosi, 2020; Skulmowski & Rey, 2020; Syani et al., 2020; Tabatabai, 2020; van Wyk, 2020; Vogelsang et al., 2020; Wallace, 2020; Watermeyer et al., 2020; Zuhairi et al., 2020)
Findings	The Covid-19 outbreak in early 2020 had an impact on disrupting educational activities around the world. A sudden and rapid shift occurred from classical learning modes to online or blended learning systems. Covid-19 forces a university to carry out digital transformation if it does not want it to be an abandoned university by its students. Massive Open Online Courses (MOOC) technology is used as one of the right choices to offer open access to various learning materials via internet.

Bibliometric Analysis

After identification, screening, eligibility, and included with the specified requirements, then 446 selected articles were carried out for bibliometric analysis using the Vosviewer application version 1.6.15 which was released on April 1, 2020. This software was developed by Nees Jan van Eck and Ludo Waltman at the Center for Science and Technology Studies (CWTS) Leiden University in 2010 (see: https://www.vosviewer.com). Mapping is done based on keywords that often appear, both those found in the article title and in the abstract. Visualization can be seen in Figure 2 as follows:

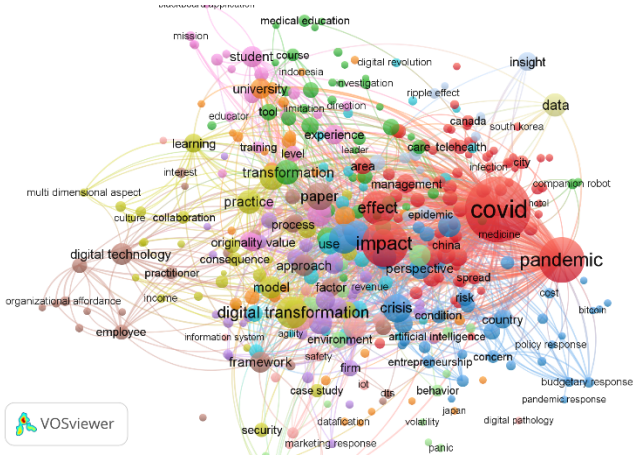

Figure 2. Network Visualization

The mapping above is formed based on the minimum requirements for the appearance of keywords in both the title and abstract article 3 times, and 5328 keywords are obtained with 642 keywords meeting the specified threshold, which are spread into 14 clusters, which are presented in table 4 below:

Table 4. *Keyword mapping cluster*

Cluster	Term & Occurrences
Cluster 1	area(26); australia(5); barrier(9); canada(10); capacity(3); china(22); city(14); closure(5); coravirus disease(11); coronavirus pandemic(4); covid(875); covid19(10); covid19 pandemic(6); current covid(5); demand(13); disaster(7); disease(14); economic activity(4); economic impact(11); economy(27); effect(162); environmental quality(3); financial sector(3); global economy(3); global pandemic(5); governance(16); health(17); health crisis(5); healthcare(12); healthcare system(7); hongkong(3); hospitality industry(6); hotel(3); hotel marketing(4); impact(360); india(5); infection(8); italy(9); lesson(19); management(34); measure(31); medicine(6); mental health(7); missinformation(3); negative impact(12); network(17); pandemic(333); patient(45); policy maker(4); potential impact(7); psychiatry(4); region(9); rise(5); robotic(5); service(33); severity(4); significant impact(11); social media(4); south korea(4); spread(14); supply(7); sustainable development(6); technique(6); telehealth(16); telepsychiatry(5); treat(8); tips(5); tourism(13); tourism industry(6); transmission(5); trend(16); united kingdom(5); united states(3); usa(3); virtual care(3); virus(10); workforce(4); word(51).
Cluster 2	Adoption(22); business leader(4); campus closure(4); care(17); companion robot(7); contribution(10); coronavirus(20); course(13); current pandemic(3); digital medium(3); digital poetry(3); elearning(7); employment(5); evidence(20); faculty(4); germany(3); health system(5); implication(44); infodemic(3); integrative framework(4); investigation(7); knowledge(15); leader(3); learning practice(3); limitation(6); lockdown(28); medical education(11); online(5); platform(12); robot(5); sars cov(4); scholar(15); school closure(3); software(5); student learning(3); student teacher(3); support(9); teacher(18); teacher education(5); teaching(21); telemedichine(23); tool(24); transformation(68).
Cluster 3	Attention(10); benefit(9); bitcoin(3); budgetary response(7); business model(8); challenge(75); change(65); concern(13); condition(18); cost(7);country(32); creation(5);

	crisis(100); crisis management(6); cryptocurrency(3); entrepreneur(11); entrepreneurship(12); financial crisis(3); investment(8); iot(3); magnitude(6); market(15); nation(6); pandemic response(3); perspektive(45); policy(23); policy response(4); policy maker(5); problem(17); response(52); risk(24); safe haven asset(3); social value co creation(3); society(35); solution(18); study(111); transition(10); uncertainty(10).
Cluster 4	Aspect(17); blockchain(9); blockchain technology(3); case study(15); collaboration(12); commentary(13); conceptual framework(7); consequence(16); culture(5); Digital age(7); digital divide(5); digital education(3); digital surge(2); digital technology education(4); digital transformation(137); digitalization(14); digitization(5); education(67); electronic resources(3); future(32); income(5); learning(34); life(28); model(55); multi dimensional aspect(4); new technology(5); online learning environment(3); Pandemic view(3); practice(63); regard digital technology(5); scale(8); school(14); secure source(3); security(17); survey(20); viewpoint(3); work(42).
Cluster 5	Action(16); activity(15); asia(7); business(58); business process(4); colombia(4); community(22); customer(9); digital economy(6); digital platform(3); digital skill(4); firm(23); food(8); growth(11); home(30); ict(3); icts(6); innovation(37); kuwait(4); manufacturing(6); marketing response(5); medium enterprise(3); operation(13); organization(28); population(11); privacy(7); product(7); service innovation(9); smes(15); social medium(12); strategy(37); sustainability(15); trust(18).
Cluster 6	Adaptation(4); agility(3); capability(17); company(26); consumer(6); convenience(4); decision(9); digital revolution(5); digital tool(6); digitization(6); economic(5); global supply chain(3); government(14); health care(9); major impact(7); novel corona virus(5); payment(5); positive effect(6); positive impact(8); post(9); post covid(20); relationship(13); report(8); resilience(12); resource(24); revenue(4); social impact(5); spain(6); supply chain(18); teleworking(4); use(50); value(14).
Cluster 7	Digitalization(3); distance(11); distance learning(4); implementation(17); improvement(8); indonesia(4); industrial sector(8); japan(3); medical student(4); performance(20); public health(7); quality(14); social implication(6); staf(6); system(32); university(42); worker(11).
Cluster 8	Application(22); approach(48); assessment(18); communication(15); digital literacy(18); digital technology(50); dts(4); employee(18); expert(7); factor(32); framework(43); hesitant fuzzy set(3); interest(7); manager(4); organizational affordance(6); organizational change(3); organizational level(3); practical implication(13); practioner(12); process(28); public health response(3); researcher(16); task(6).
Cluster 9	Academic librarian(3); access(7); catalyst(8); design methology approach(31); development(40); direction(7); educator(7); equity(5); experience (38); higher education(23); information(24); learner(4); level(21); mission(6);online learning (11); online teaching(4); opportunity(65); originality value(31); pandemic crisis(7); perception(17); student(44); training(10).
Cluster 10	Artificial intelligence(13); augmented reality(3); big data(6); digital pathology(3); disruptive technology(5); field(7); industry(57); information system(3); internet(10); iot(8); maturity modeling(3); safety(5); science(13); technology(87); web(5).
Cluster 11	Analysis(50); behavior(11); consumption(6); cryptocurrency market(3); digital maturity(3); effectiveness(12); environment(25); global crisis(4); leadership(5); organization(21); panic(4); reflection(8); service employee(7); virtual work envi(3); volatility(3).
Cluster 12	Control(9); deep learning application(3); digital(8); disaster preparedness(3); disruption(22); disruption propagation(3); dynamic(6); emergency(13); epidemic(10); insight(32); mitigation(4); outcome(12).
Cluster 13	Data(58); gaming(3); new consumer behavior(3).

Cluster 14	Digital pathology system(3); remote review(3).

From table above, it can be seen that the names of the countries mentioned in the scientific article appear, as follows:

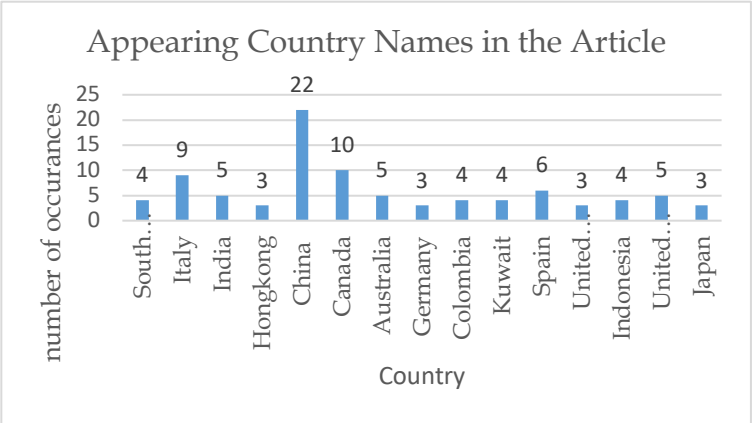

Figure 3. Appearing Country Names in the Article

Meanwhile, the level of keyword density can be described in the form of density visualization, where the keywords that often appear are in yellow, the stronger the color indicates these keywords widely researched and become a topic that is trending among researchers. While the green color and the outside shows that keywords still rarely appear in research so that the opportunity to become material for future research is still very open.

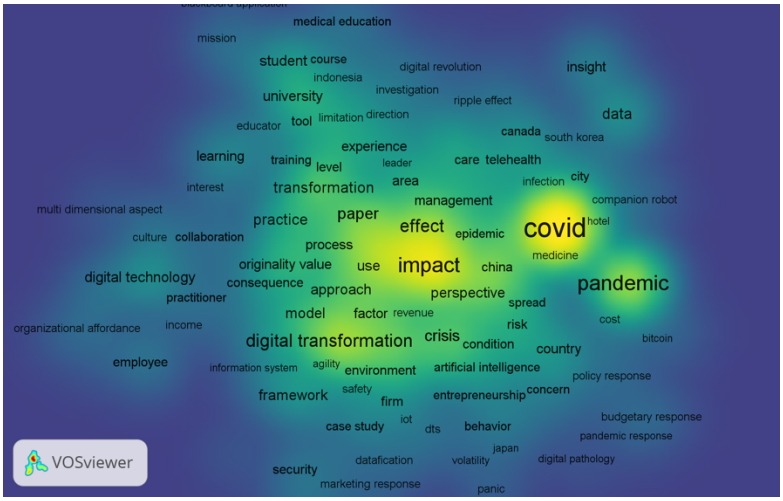

Figure 4. Density visualization

CONCLUSION

The emergence of the Covid-19 pandemic has brought global conditions into the VUCA situation; almost all areas of people's life are powerless to face the enormity of this pandemic. Not wanting to continue to be trapped in an unfavorable situation, business leaders are taking strategic

steps by making the Covid-19 pandemic a catalyst for digital transformation. The bibliometric analysis approach reveals that there are at least three areas of concern to researchers, namely socio-economics, psychology and health, and education.

Of the three fields, various digital technologies are utilized for digital transformation purposes, such as the internet of things, artificial intelligence, biosensors, digital health, e-learning, and others that can be further developed for the benefit of more specific fields.

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