DIGITALIZING MUSEUMS: A BIBLIOMETRIC STUDY

LELY YULIFAR, ISMA WIDIATY*, DIANA NOOR ANGGRAINI, EKI NUGRAHA, RESTU MINGGRA, HANIFA WIDYA KURNIATY

Universitas Pendidikan Indonesia
Jl. Dr. Setiabudi no 229, Bandung 40154, Indonesia
*Corresponding Author: isma@upi.edu

Abstract

Industrial revolution 4.0 has brought digitalization to every sector of life, including museums as visitors prefer to have such an experience giving them either the authentic displays or the user friendliness through digital features. This study aims to analyse current issues related to digital museum, particularly concerning the development of research, article publication, and the most productive countries in the world in conducting this particular study. Data collection and analysis were carried out using VOS-viewer software with a bibliometric approach. The main findings show that the study of digital museum has been developing in line with the development of the field of computer science, which is the main basis for the digital museum development. The relevant fields of this study are also related to digital aspects and the latest technology such as digital humanities , virtual reality technology, and augmented reality.

Keywords: Co-authorship analysis, Digital Museum, Keyword analysis, Scientometrics, Visualization.

1. Introduction

The rapid development of technology has an impact on the development of museums which have begun to switch to digital platforms. The digital museum platform can be realized in various forms, namely online/ digital collection and online source material [1, 2], virtual and interactive museum [3], digital exhibition [4], as well as presenting objects in the form of e-tangible[5]. This change in the museum platform into digital one provides a new idea where museums become a part of a more interesting digital cultural heritage [6, 7], meaningful cultural knowledge [8], and museum content can be accessed with new navigation patterns that are more interactive [9] which is also known as tangential learning [10]. The change of this platform into digital still needs to pay attention to aspects of functional, emotional, and social value [11], as well as educational value [12-14], even aspects of hospitality and mobility [15].

The use of digital technology in museums can provide solutions to space limitations as well as opportunities to distribute museum content in a wider range [16]. The change from the cultural to digital heritage provides a positive nuance to give meaning to museums in the present context [17]. There are many other advantages, one of which is that visitors can do new ways of searching which of course will be a new, more enjoyable experience [18]. Digital museums can contribute to cultural diversity with interesting and diverse cultural offerings [19].

The most prominent aspect in the discussion about digital museums is the aspect of using the latest technology and its use by humans, namely technocentric versus humancentric [20, 21] which is also in line with the sociotechnical concept [22]. The tangible manifestation of the use of technology in the context of digital museums is the existence of various mobile applications where visitors can do virtual tours with audio tour guides [23-25] and the use of mobile devices in the form of Augmented Reality [26]. The use of new media in digital museums is also a rising issue. The media technology is in the form of digital image/ digital history [27] and 3D Modeling [28, 29].

The study of digital museums, as described above, focuses more on the platform of digital museums, the existence of digital museums in the current context as a result of the development of existing technology, as well as the use of new media in digital museums. This paper tries to capture other aspects, especially those related to the world researchers' concern about digital museums. This study is essential to possibly see the development of digital museums from year to year, the most productive countries in conducting digital museum studies, research collaborations among countries, subject areas that are of concern to researchers, the most country affiliations in conducting digital museum research, and the main keywords related to digital museum articles.

2. Methods

2.1. Database

The initial source of information used in this research is the Scopus database. The Scopus database, which is one of the biggest databases for scientific publication, consists of a collection of data that stores information about various types of research inputs, research outputs (which we collectively refer to as "research objects") along with various other types of data obtained from these objects.

Databases can be used as a process towards a complete picture of the entire research landscape and help to bring context, not only to individual research sections, but also the research field, country of origin, and many other key research-related entities that may be of interest to stakeholders in the research world. The Scopus database is in the form of metadata, making it possible to combine publicly available data with those from the object's ownership source. These various data can be used for the analysis and identification process with a technological approach.

To analyse the development of research related to the digital museum, it is necessary to create a strong search string to identify every existing reference. String determination can be done using the Boolean Retrieval approach, which is the process of finding information from queries that use Boolean expressions, namely logical AND, OR, and NOT. This approach is used to search for data sources, either those contained in titles, keywords, or abstracts (topic fields) that are available, namely TITLE-ABS-KEY ("museum digital " OR "digital museum").

This search string is designed to be inclusive, i.e. include all relevant output with the risk of submitting false positives. False positives are the addition of articles to the "digital museum" data set that are not centrally related to digital museums, but only mention museums and digital in passing without making them the central theme of the research results. Such articles are included in the results of this query. This approach makes sense in the current situation because, in a broader sense, the inclusion of this non-central article provides a signal that represents the level of interest of the academic community regarding digital museums and helps gauge the overall level of research activity related to digital museums. The dataset found from Scopus is also not limited to full journal articles, but also includes conference articles, book chapters, review results, and conference reviews. This is an attempt to measure, classify, and contextualize search results related to digital museums.

2.2. Data extraction and processing

A search of titles, keywords, and abstracts (topic fields) available on Scopus was done with a date limit of 20 August 2021 resulting in 517 articles. The data were then filtered to remove data with similarities, and 511 documents were obtained. Furthermore, the data were used as a dataset for further analysis. The data taken were Citation information, Bibliographical information, Abstract & keywords, Funding details, and other information. They were extracted in *.csv and *.ris formats so that they can be used in the analysis. The dataset in *.csv format was used for analysis using VOSviewer software (http://www.vosviewer.com/). VOSviewer is a bibliometric program in the form of map visualization. VOSviewer uses proximity to show relationships between nodes. The closer nodes indicated a stronger relationship, the farther apart they were , the weaker the relationship got. VOSviewer also had zooming capabilities. Other bibliometric mapping software, such as Pajek (http://pajek.imfm.si/doku.php) and SPSS (IBM, Inc.), used lines between nodes to show direct relationships. Pajek could also demonstrate this relationship by selecting a map layout like the one in VOSviewer. However, drawn lines and no zoom capability can result in overlap which can hinder the aesthetic aspects of the map and data interpretation [30].

The study also used the HistCite software to perform a bibliometric analysis by assessing the network among widely cited articles. Dataset in *.ris format used in

this analysis. We extracted and converted this *.ris format so that it could be analysed with HistCite. HistCite provided a timeline visualization of citations, showed the most cited articles, and showed the subsequent impact of those citations [31-33]. HistCite had also been widely used in various studies. HistCite could also analyse and demonstrate citations between articles [34, 35].

3. Results and Discussion

3.1. Timescales in digital museum

These timescales describe the development of digital museums, especially with regards to the development of digital museum research from year to year. The results show that research on this digital museum began in 1996 and has experienced a sharp increase from 2005 to 2021. This data is almost the same as the results of research conducted by three other researchers [36-38]. The data obtained from Scopus, as a database with very representative data for academic and scientific information from various studies, including this digital museum [39]. Digital museum studies also attract the attention of many people in the scientometric and scientific communication community, where this study from 2005 to 2021 continues to increase as shown in Fig. 1.
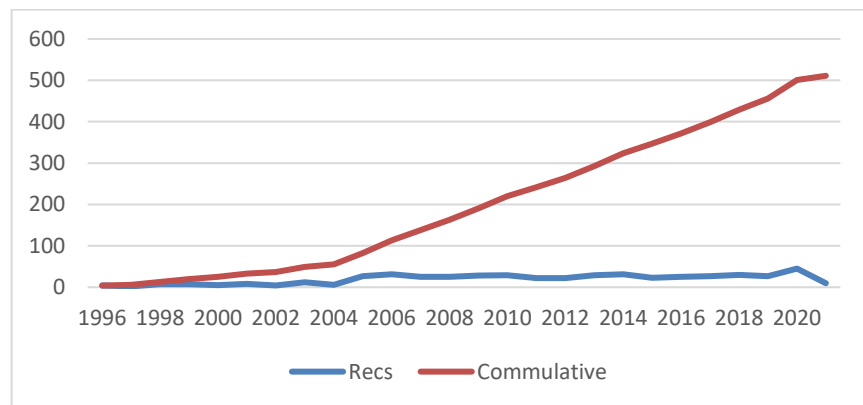
Fig. 1. Timescales in digital museum
(Source: Scopus.com, extract by Histcite).

3.2. Top countries and research collaborations in digital museum studies

China plays the biggest role in the study of this digital museum. It is then followed by Japan, Taiwan and The United States. As recorded in the Scopus database, China published 148 articles during 1996 - 2021. Meanwhile, Japan had 96 articles, Taiwan 41 articles and The United States 40 articles out of 511 total articles. Figure 2 shows the Top 10 Number of articles by country.
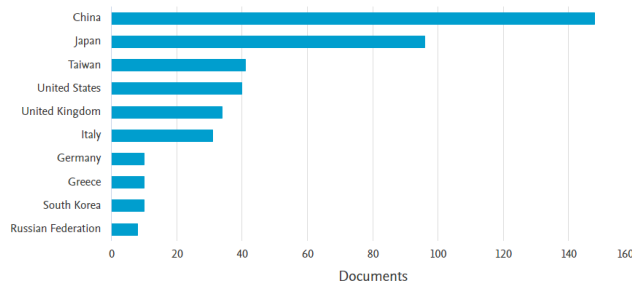
Fig. 2. Top 10 number of articles by country.

Research collaboration between countries is shown in Fig. 3. Analysis using VosViewer on 511 datasets, visualizing co-authorship networks by country. Co-authorship is one of the most tangible forms of research collaboration. Co-authoring network is a social network in which authors through participation in one or more publications that have been indirectly connected to one another. This study uses co-authorship analysis to obtain a co-authorship network of 511 articles related to digital museum indexed by Scopus during 1996 - 2021.

The research was conducted using a scientometrics approach and using co-authorship by countries network analysis. It was found that China, the United States, the United Kingdom, Taiwan, and Italy are major countries that collaborate with each other in some of Digital Museum studies, followed by several other countries. Meanwhile, Japan as one of the second largest contributors in the number of articles, tends to work on its own.
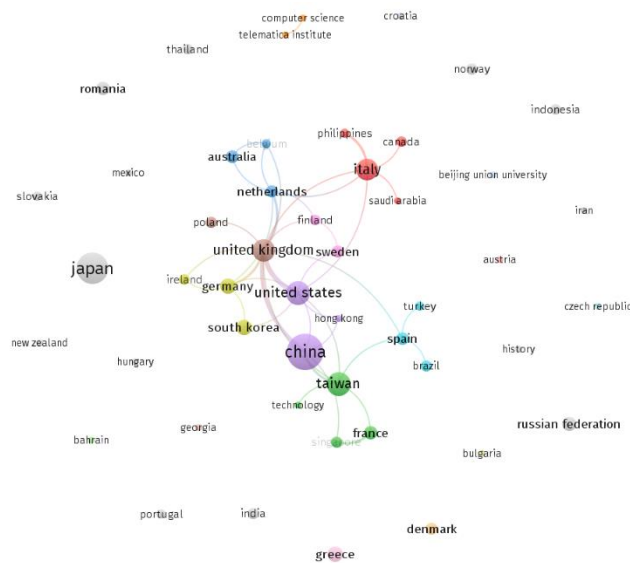
Fig. 3. Research collaboration among digital museum researchers. Co-authorship by countries, Full counting with minimum number of documents of a country = 1 of the 55 countries, 55 meet the threshold.

3.3. Subject area and affiliation

The study of digital museum is related to certain subject areas as shown in Fig. 4. The most dominant subject area is related to computer science. This subject area is indeed the main foundation in the development of digital museum based on digital technology [40, 41] and also known as digital heritage [42]. Figure 5 presents the top 10 institutions that produce articles on the topic of digital museum. From these 10 affiliations, it can be identified that China is very dominant in digital museum studies, such as studies conducted by [16, 43, 44], although the most productive one in conducting studies is The University of Tokyo.
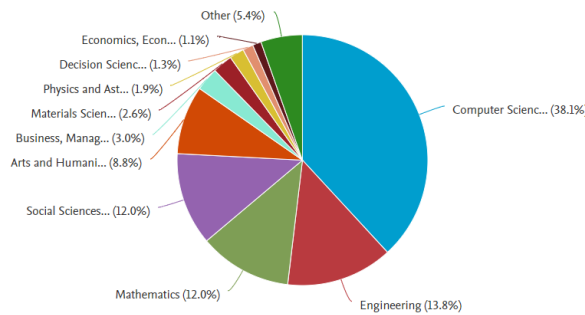

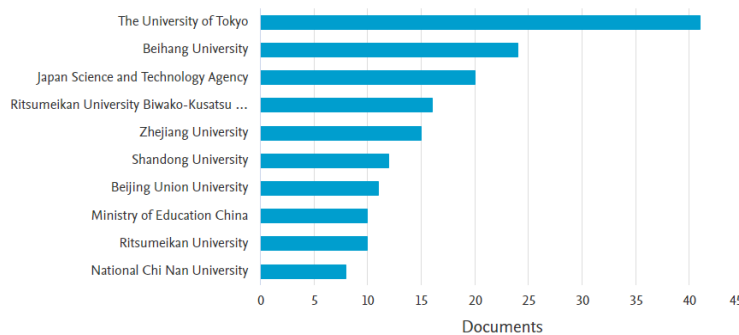**Fig. 4. Percentage of documents by subject area.**

Fig. 5. Documents by affiliation.

3.4. Keyword analysis

Our keyword analysis was done by analysing the co-occurrence of each author's keyword and keyword index [45, 46]. The results of the co-occurrence keyword analysis of 511 articles were visualized using VosViewer. Our full count was done with the minimum number of co-occurrence of keywords = 5. Out of 2979 keywords, 134 met the threshold. In the visualization, the node size indicates the number of items. The thickness of the line between the nodes indicates the degree of direct relationship between the keywords. The results of the co-occurrence measurements obtained can be seen in Fig. 6. Seven clusters were obtained, with the prominent keywords being; "digital museum", "museum", "virtual reality", "exhibition", "cultural heritage" three dimensional" "multimedia system", "digital

libraries" "human computer interaction" and "augmented reality". The interconnection of each keyword indicates that the development of research on this subject is related.

The overlay visualization shows the time difference of each keyword [47]. The results of the overlay visualization can be seen in Fig. 7. It is obtained based on the year of the article to see the novelty of the topic study. The dark blue to yellow colour range indicates that the latest articles are positioned at the brightest colour . It can be seen that the studies on digital museum that have the latest updates are about digital humanities, virtual reality technology, and augmented reality.

Fig 6. Co-occurrence from all keyword (author keyword and Index keyword), Full counting with minimum number of co-occurrences of a keyword = 5 of the 2979 keywords, 134 meet the threshold.

Fig. 7. Overlay visualization of co-occurrence from all keyword.

4. Conclusion

The study on digital museum began in 1999, but since the last 16 years (2005-2021), research on digital museum has increased from year to year. China is the country that produces the most articles about digital museum, which recorded between the years 1996-2021 in about 148 published articles. Research collaboration among countries shows that China, the United States, the United Kingdom, Taiwan, and Italy are big countries that collaborate with each other in this Digital Museum study. The most dominant subject area that appears when studying digital museum is related to computer science. In addition to being the country with the most articles, China is also the country that dominates in terms of affiliation (especially universities in China) in conducting studies on digital museum. Based on the co-occurrence analysis, the topics related to digital museum that produce the most keywords or novelty are those related to digital humanities, virtual reality technology, and augmented reality.

References

1. Westerby, G.; and Keegan, K. (2019). Digital art history and the museum: The online scholarly collection catalogues at the Art Institute of Chicago. *Visual Resources*, 35(1-2), 141-154.

2. Shephard, A.J.; and Pookulangara, S.A. (2020). Student use of university digital collections: the role of technology and educators. *Museum Management and Curatorship*, 35(4), 392-408.

3. Milosz, M.; Skulimowski, S.; Kęsik, J.; and Montusiewicz, J. (2020). Virtual and interactive museum of archaeological artefacts from Afrasiyab-An ancient city on the silk road. *Digital Applications in Archaeology and Cultural Heritage*, 18(2020), 1-12.

4. Ch'ng, E.; Cai, S.; Leow, F.T.; and Zhang, T.E. (2019). Adoption and use of emerging cultural technologies in China's museums. *Journal of Cultural Heritage*, 37, 170-180.

5. Schweibenz, W. (2018). The work of art in the age of digital reproduction. *Museum International*, 70(1-2), 8-21.

6. Uimonen, P. (2020). # MeToo in Sweden: Museum collections, digital archiving and hashtag visuality. *Ethnos*, 85(5), 920-937.

7. Walsh, D.; Hall, M.M.; Clough, P.; and Foster, J. (2020). Characterising online museum users: a study of the National Museums Liverpool Museum website. *International Journal on Digital Libraries*, 21(1), 75-87.

8. Swensen, G.; and Guttormsen, T.S. (2020). Illusionary equality? Museum politics, practice and immigrant heritage. *Museum Management and Curatorship*, 35(1), 15-35.

9. Kyprianos, K.; Sifaki, E.; and Bantimaroudis, P. (2020). Digital gatekeepers and website visitors of the Acropolis Museum: revisiting gatekeeping theory in the cultural domain. *Museum Management and Curatorship*, 35(4), 409-423.

10. Anderson, S.L. (2019). The interactive museum: Video games as history lessons through lore and affective design. *E-Learning and Digital Media*, 16(3), 177-195.

11. Traboulsi, C.; Frau, M.; and Cabiddu, F. (2018). Active seniors perceived value within digital museum transformation. *The TQM Journal*, 30(5), 530-553.

12. Chiwara, D.; and Chipangura, N. (2018). Digital technology: The panacea to improve visitor experience and audience growth? *Museum International*, 70(1-2), 114-123.

13. Della Croce, R.; Puddu, L.; and Smorti, A. (2019). A qualitative exploratory study on museum educators' perspective on children's guided museum visits. *Museum Management and Curatorship*, 34(4), 383-401.

14. Herlitz, A.; and Westin, J. (2018). Assembling arosenius-staging a digital archive. *Museum Management and Curatorship*, 33(5), 447-466.

15. Ross, J. (2018). Casting a line: digital co-production, hospitality and mobilities in cultural heritage settings. *Curator: The Museum Journal*, 61(4), 575-592.

16. Dong, S.; Wang, X.; Xu, S.; Wu, G.; and Yin, H. (2011). The development and evaluation of Chinese digital science and technology museum. *Journal of Cultural Heritage*, 12(1), 111-115.

17. Machidon, O.M.; Duguleana, M.; and Carrozzino, M. (2018). Virtual humans in cultural heritage ICT applications: A review. *Journal of Cultural Heritage*, 33, 249-260.

18. Kim, J. (2020). The archive with a virtual museum: The (im) possibility of the digital archive in Chris Marker's Ouvroir. *Memory Studies*, 13(1), 90-106.

19. Gran, A.B.; Lager Vestberg, N.; Booth, P.; and Ogundipe, A. (2019). A digital museum's contribution to diversity-a user study. *Museum Management and Curatorship*, 34(1), 58-78.

20. Myrczik, E.P. (2020). Cultivating digital mediation: The implementation of publicly funded digital museum initiatives in Denmark. *International Journal of Cultural Policy,* 26(2), 239-254.

21. Higashi, J. (2018). The destruction and creation of a cityscape in the digital age: Hiroshima peace memorial museum. *Museum International*, *70*(1-2), 104-113.

22. Herman, A.M. (2018). Re-negotiating exhibitionary practices and the" Digital" Politics of display: The case of the MTL urban museum app. *Museum and Society*, 16(2), 260-278.

23. Chasapis, P.; Mitropoulos, S.; and Douligeris, C. (2020). A prototype mobile application for the Athens Numismatic Museum. Retrieved May 6, 2021, from https://www.emerald.com/insight/content/doi/10.1016/j.aci.2019.06.001/full/pdf?title=a-prototype-mobile-application-for-the-athens-numismatic-museum

24. Gutowski, P.; and Kłos-Adamkiewicz, Z. (2020). Development of e-service virtual museum tours in Poland during the SARS-CoV-2 pandemic. *Procedia Computer Science*, 176, 2375-2383.

25. Eghbal-Azar, K.; Merkt, M.; Bahnmueller, J.; and Schwan, S. (2016). Use of digital guides in museum galleries: Determinants of information selection. *Computers in Human Behavior*, 57, 133-142.

26. Ioannakis, G.; Bampis, L.; and Koutsoudis, A. (2020). Exploiting artificial intelligence for digitally enriched museum visits. *Journal of Cultural Heritage*, 42, 171-180.

27. Horne, R. (2020). Beyond lists: Digital gazetteers and digital history. *The Historian*, 82(1), 37-50.

28. Carvajal, D.A.L.; Morita, M.M.; and Bilmes, G.M. (2020). Virtual museums. Captured reality and 3D modeling. *Journal of Cultural Heritage*, 45, 234-239.

29. Quattrini, R.; Pierdicca, R.; Paolanti, M.; Clini, P.; Nespeca, R.; and Frontoni, E. (2020). Digital interaction with 3D archaeological artefacts: evaluating user's behaviours at different representation scales. *Digital Applications in Archaeology and Cultural Heritage*, 18(2020), 1-8.

30. Decker, R.; and Lenz, H.J. (2007). *Advances in data analysis: Proceedings of the 30th Annual Conference of The Gesellschaft Für Klassifikation EV, Freie Universität Berlin, March 8-10, 2006.* Berlin: Springer Science and Business Media.

31. Mubaroq, S.R.; Abdullah, A.G.; and Setiawan, A.G.U.S. (2020). The evolution of smart working and sustainability in socio-technical perspective: a scientometrics technology analysis. *Journal of Engineering Science and Technology*, 15(3), 1868-1882.

32. Shah, S.H.H.; Lei, S.; Ali, M.; Doronin, D.; and Hussain, S.T. (2019). Prosumption: Bibliometric analysis using HistCite and VOSviewer. *Kybernetes*, 49(3), 1020-1045.

33. Buchanan, J.; and Shen, Y. (2021). Gambling and marketing: a systematic literature review using HistCite. *Accounting and Finance*, 61(2), 2837-2851.

34. Dong, J.; and Yin, Y. (2020). Overview of intelligent building research based on citation analysis. *Proceedings of the International Conference on Applications and Techniques in Cyber Security and Intelligence*. Fuyang, China, 779-784.

35. Chen, D.; Zhang, G.; Wang, J.; Chen, S.; Wang, J.; Nie, H.; and Tang, Z. (2021). Mapping trends in moyamoya angiopathy research: A 10-year bibliometric and visualization-based analyses of the Web of Science Core Collection (WoSCC). *Frontiers in Neurology*, 12, 253.

36. Srinivasan, R.; and Huang, J. (2005). Fluid ontologies for digital museums. *International Journal on Digital Libraries*, 5(3), 193-204.

37. Patel, M.; White, M.; Mourkoussis, N.; Walczak, K.; Wojciechowski, R.; and Chmielewski, J. (2005). Metadata requirements for digital museum environments. *International Journal on Digital Libraries*, 5(3), 179-192.

38. Fukuda, H.; Uchiyama, T.; Haneishi, H.; Yamaguchi, M.; and Ohyama, N. (2005). Development of a 16-band multispectral image archiving system. *Proceedings of the Color Imaging X: Processing, Hardcopy, and Applications.* California, United States, 136-145.

39. Klapka, O.; and Slaby, A. (2018). Visual analysis of search results in Scopus database. *Proceedings of the International Conference on Theory and Practice of Digital Libraries.* Porto, Portugal, 340-343.

40. Carvalho, A.; and Matos, A. (2018). Museum professionals in a digital world: insights from a case study in Portugal. *Museum International*, 70(1-2), 34-47.

41. Cassidy, C.A.; Fabola, A.; Miller, A.; Weil, K.; Urbina, S.; Antas, M.; and Cummins, A. (2018). Digital pathways in community museums. *Museum International*, 70(1-2), 126-139.

42. Wo, K.C.; and Hsiang, Y.Y. (2018). A digital heritage best practice from national palace museum: A case of "Rebuilding the Tong-An Ships". *International Journal of Social Science and Humanity*, 8(8), 225-229.

43. Pan, Z.; Chen, W.; Zhang, M.; Liu, J.; and Wu, G. (2009). Virtual reality in the digital Olympic Museum. *IEEE Computer Graphics and Applications*, 29(5), 91-95.

44. Zhou, M.; Geng, G.; and Wu, Z. (2012). *Digital preservation technology for cultural heritage*. Beijing: Higher Education Press.

45. Liu, Z.; Yin, Y.; Liu, W.; and Dunford, M. (2015). Visualizing the intellectual structure and evolution of innovation systems research: a bibliometric analysis. *Scientometrics*, 103(1), 135-158.

46. Nagy, G. (2018). Text mining-based scientometric analysis in educational research. Retrieved May 6, 2021, from https://papers.iafor.org/wp-content/uploads/papers/ece2018/ECE2018_42010.pdf

47. Liao, H.; Tang, M.; Luo, L.; Li, C.; Chiclana, F.; and Zeng, X.J. (2018). A bibliometric analysis and visualization of medical big data research. *Sustainability*, 10(1), 1-18.