



Bibliometric Computational Mapping Analysis of Publications on Virtual Reality Technology and Fashion Industry Using Vosviewer

Zakiah Pawitan^{1,*}, Barra Purnama Pradja², Taswadi¹, Ramadita Fetrianggi³, Palupi Argani³

¹ Department of Fine Arts Education, Faculty of Arts Education and Design, Universitas Pendidikan Indonesia, Bandung, West Java, Indonesia

² Department of Mathematics Education, Faculty of Teacher Training and Education, Universitas Muhammadiyah Tangerang, Cikokol Tangerang, Banten, Indonesia

³ Department of Visual Communication Design, Faculty of Arts Education and Design, Universitas Pendidikan Indonesia, Bandung, Indonesia

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ABSTRACT

This study examines the evolution of the fashion industry in virtual reality research through a bibliometric approach with computational mapping analysis using VOSviewer. Article data is taken from the Google Scholar database using a reference management application and sorts only journal articles that are analyzed. Article titles and abstracts are used to guide the search process with reference to the keywords "Fashion Design" and "Virtual Reality". It found 989 articles that were considered relevant. The study period used as study material is Google Scholar indexed articles for the last 5 years (2019 to 2023). The results showed that by using fashion design and virtual reality as keywords resulted in 3 big terms that showed the biggest area that has been researched, the terms are: fashion industry, model, and reality technology. The term "fashion industry" is associated with 38 links with a total link strength of 81. The term "reality technology" has 42 links with a total link strength of 125 and the term "art" has 25 links with a total link strength of 60. The results of the analysis of the development of the fashion industry and virtual reality publications in the last 5 years show a progressive increase. In 2020-2022, it increased sharply from 159 in 2020 to a very popular 322 articles in 2022. The year 2023, although only running for half a year, has shown a figure of more than half of 2022. The results of the investigation show that there are still great opportunities for exploration of smart textile and smart fashion-themed research, especially when it comes to virtual technology.

1. Introduction

The fashion industry and computational analysis of reality technologies have not previously become the subject of core study. Scholarly proven in this literature review, the two realms are widely apart, therefore each research represents its own discipline. Virtual reality (VR) is a technology that can simulate a process, event, and state in the environment virtually [1]. Understanding virtual reality according to Yang [2] that explains that virtual reality is a collection of hardware combined, used to create simulations about the environment. The created environment is a replica of the real

* Corresponding author.

E-mail address: zpawitan@upi.edu

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environment with three-dimensional arrangements, images and sounds. Thus, virtual reality is a technological product that offers a simulation of unreal reality, which can look like the real world, or it can be imaginary that is far different from reality. Meanwhile, fashion operates in the retail domain, which is sometimes isolated from technological research.

The present generation of fashion designers seeks advancement in fashion creatively to build smart fashion that catches up with the enormous developments in the fields of fashion design and fashion technology. In this case, choosing a cutting-edge innovative approach that uses virtual reality technology for visual merchandising fashion reduces advertising costs, consumes less time, and produces fewer defective goods [3]. This is one of the most fundamental requirements demanded by the fashion industry. Those requirements are referred to as virtual and interactive mannequins, as well as interactive smart displays as many studies have conducted before. Additionally, a 3D interactive virtual fitting room is available to help consumers select the right accessories, colors, and sizes for their skin tones. For instance, shoppers may digitally wear and interact with clothing in stores to improve shopping. Customers may virtually put on and wear various apparel products in stores when they are in front of an electronic screen, significantly improving the buying experience as researched previously [3-5]. Numerous fashion stores in the present scenario are already showcasing their collections on avatars in showrooms as well as digital virtual displays [6]. Additionally, it permits decreasing the quantity of materials used and the number of operations during the production process, which is greatly beneficial from an economic standpoint. As a result, the ideas of reality technology have been implemented in the development of many kinds of technology such as artificial intelligence, technology for gaming, animation, virtual fashion [7], information [8], and distant fashion education study [9]. Since it is still required and exhibits good reciprocity, fashion continues to be utilized more and more within virtual reality, which proves that it continues to thrive. However, it is still uncertain whether the fashion industry work in the virtual reality space is in high demand in the world of research, particularly in the field of fashion design.

The process is where fashion design and virtual reality truly diverge. Usually, fashion designs result in wearable cultural objects that influence physical culture. Even if virtual reality technology does not always result in the creation of a cultural item, its development is chronicled on everything virtual. For scholars in ethnography, anthropology, technology, or the social sciences, understanding the link between various cultural characteristics is a difficult task given virtual reality cultural treatment. In contrast, virtual reality technology has successfully established new achievements for the fashion industry since it has done so by constructing an unreal process to give life to virtual artifacts or by starting the creation of virtual apparel from the very beginning. Consequently, this unquestionably affects several facets of how fashion will exist in the future.

We must comprehend the function of virtual reality technology in the fashion sector in order to comprehend its influence as stated by Tavares *et al.*, [10]. The battle for virtual reality, artificial intelligence, and other opportunities that technology may provide remains an ongoing battle on its own by factors such as attitudes toward technology and acknowledgments of what it can and cannot achieve. Then, designers come up with different predictions and expectations on the possible uses of technology and virtual reality in media and companies.

Virtual reality in the field of fashion design is a branch of reality technology relevant to the fashion business, even if they are still seen as being in separate domains. The digital and reality technologies are both related to the fashion business. Only the digitization element, particularly in some design and production processes such as a virtual laboratory [11] that may be considered the closest science to the fashion industry to date. Reality technology, which is adapted to the intimate interaction between consumer and economic factors, is also closely tied and is used in every stage of production.

Thus, in this study, there is no direct relationship between the innovation of aspects of fashion industry production with reality technology.

Subsequently, the evolution of fashion industry research and its connection to virtual reality require analysis, namely bibliometric analysis. When evaluating the bibliographic content and citation analysis of journal articles and other scientific works, researchers can use bibliometric analysis, a type of meta-analysis of research data. However, the gap is, there is no research has been conducted on computational mapping of bibliographic analysis of publication data in the field of fashion industry and virtual reality, specifically to determine research and development. Specifically, we will use the VOSviewer application to conduct a bibliographic analysis of the last five years of research articles from 2019 to 2023. Hence, this study used VOSviewer software to conduct computational research mapping the bibliometric analysis of publications indexed by Google Scholar. This research was conducted with the intentional purpose that it will serve as a guide for future studies and help researchers select appropriate research subjects, especially for studies related to the field of fashion industry and virtual reality.

2. Methodology

The research from publications that have appeared in journals that are indexed by Google Scholar serves as the basis for the article data used in the study. Because the Google Scholar database is open source, we chose it for this investigation. A management reference tool called Publish or Perish was used to collect study data. A literature review on our chosen subject is carried out with the help of the Publish or Perish program.

Using the Publish or Perish tool, academic publications with the keywords "Fashion industry" or "Virtual Reality" in the title are chosen. The release of statistics occurs between 2019 and 2023. The research information system (.ris) and the comma-separated value format (*.csv) are then used to export the final discovery data. The article data from the first database is then mapped after that. Employing bibliometric maps, the VOSviewer software originated to display and determine trends. The VOSviewer application will produce network visualization, density visualization, and overlay visualization, three different forms of visual mappings. As researched by Nandiyanto & Al Husaeni [12] the stages of this research are as follows: (i) looking for publication data using the Publish or Perish application, (ii) processing the data obtained using the Microsoft Excel application, (iii) analyzing the mapping from bibliometric publication data using the VOSviewer application, and (iv) further analyzing the results of the computational mapping. The frequency of keywords is set to at least three occurrences when creating a bibliometric map. As a result, 23 of the gathered terms and less relevant keywords were deleted.

3. Results

3.1 Publication Data Search Results

After identifying the data in the Google Scholar database with the Publish or Perish reference management program, 989 data articles that met the research criteria were discovered. Author name, title, year, journal name, publisher, number of citations, linkage to the paper, and relevant URL are all gathered in the form of article metadata.

Table 1 shows many samples of published data from the VOSviewer evaluation of this study. As data samples, 25 papers were chosen from the top 30 most cited papers were listed, unrelated study to the fields were eliminated. There are 6159 total citations from all publications utilized in this

research, with 989 citations each year and 16.52 citations per article. The average author in the articles used is 2.27, all articles have an average h-index is 52, and the g-index is 106.

Table 1
 Fashion industry and virtual reality publication data

| No. | Authors | Title | Year | Cites per author | Ref. |
|-----|---|--|------|------------------|------|
| 1. | P Gazzola, E Pavione, R Pezzetti, and D Grechi | Trends in the fashion industry. The perception of sustainability and circular economy: A gender/generation quantitative approach | 2020 | 323 | [13] |
| 2. | J McCann, and D Bryson | Smart clothes and wearable technology | 2022 | 148 | [14] |
| 3. | MF Manesh, MM Pellegrini, G Marzi... | Knowledge management in the fourth industrial revolution: Mapping the literature and scoping future avenues | 2020 | 57 | [15] |
| 4. | F Caboni, and J Hagberg | Augmented reality in retailing: a review of features, applications and value | 2019 | 72 | [16] |
| 5. | OE Sosa, J Salinas, and B De Benito | Emerging technologies (ETs) in education: A systematic review of the literature published between 2006 and 2016 | 2022 | 34 | [17] |
| 6. | S Ahmad, S Miskon, R Alabdan, and I Tlili | Towards sustainable textile and apparel industry: Exploring the role of business intelligence systems in the era of industry 4.0 | 2020 | 25 | [18] |
| 7. | SL Han, M An, JJ Han, and J Lee | Telepresence, time distortion, and consumer traits of virtual reality shopping | 2020 | 32 | [19] |
| 8. | L Light | Artificial Intelligence for Fashion How AI is Revolutionizing the Fashion Industry | 2019 | 22 | [20] |
| 9. | N Ameen, S Hosany, and A Tarhini | Consumer interaction with cutting-edge technologies: Implications for future research | 2021 | 78 | [21] |
| 10. | Y Yang, Y Wu, C Li, X Yang... | Flexible actuators for soft robotics | 2020 | 26 | [22] |
| 11. | Y Rogers, H Sharp, and J Preece | Interaction design: beyond human-computer interaction | 2023 | 14 | [23] |
| 12. | RKJ De Silva, TD Rupasinghe... | A collaborative apparel new product development process model using virtual reality and augmented reality technologies as enablers | 2019 | 23 | [24] |
| 13. | M Abdinejad, B Talaie, HS Qorbani, and S Dalili | Student perceptions using augmented reality and 3d visualization technologies in chemistry education | 2021 | 21 | [25] |
| 14. | Y Borgianni, and L Maccioni | Review of the use of neurophysiological and biometric measures in experimental design research | 2020 | 15 | [26] |
| 15. | E Pangilinan, S Lukas, and V Mohan | Creating augmented and virtual realities: theory and practice for next-generation spatial computing | 2019 | 30 | [27] |
| 16. | E Baek, HJ Choo, X Wei, and SY Yoon | Understanding the virtual tours of retail stores: how can store brand experience promote visit intentions? | 2020 | 20 | [28] |
| 17. | Y Wang, E Ko, and H Wang | Augmented reality (AR) app use in the beauty product industry and consumer purchase intention | 2022 | 15 | [29] |

Table 1. Continued

Fashion industry and virtual reality publication data

| No. | Authors | Title | Year | Cites per author | Ref. |
|-----|---|--|------|------------------|------|
| 18. | R Boardman, CE Henninger, and A Zhu | Augmented reality and virtual reality: new drivers for fashion retail? | 2020 | 56 | [30] |
| 19. | AIM Elfeky, and MYH Elbaly | Developing skills of fashion design by augmented reality technology in higher education | 2021 | 14 | [31] |
| 20. | To Jimeno-Morenilla, P Azariadis, and R Molina-Carmona. | Technology enablers for the implementation of Industry 4.0 to traditional manufacturing sectors: A review | 2021 | 53 | [32] |
| 21. | J Lee, and Lee | Does online shopping make consumers feel better? Exploring online retail therapy effects on consumers' attitudes towards online shopping malls | 2019 | 51 | [33] |
| 22. | HK Song, E Baek, and HJ Choo | Try-on experience with augmented reality comforts your decision: Focusing on the roles of immersion and psychological ownership | 2020 | 46 | [34] |
| 23. | H Lee, and Y Xu | Classification of virtual fitting room technologies in the fashion industry: from the perspective of consumer experience | 2020 | 45 | [35] |
| 24. | PS Aithal, and S Aithal | Management of ICCT underlying technologies used for digital service innovation | 2019 | 45 | [36] |
| 25. | V Kaushik, A Kumar, H Gupta, and G Dixit | Modelling and prioritizing the factors for online apparel return using BWM approach | 2020 | 41 | [37] |

3.2 Research Development in the Field of Fashion Industry and Virtual Reality

According to statistics, interest in fashion design and virtual reality has recently increased, and research on reality technology and the fashion industry is becoming increasingly popular. Table 2 features an overview of research on the fashion industry and virtual reality terms recently published in journals indexed by Google Scholar. Based on the information in Table 2, there will be 989 study articles in the field of fashion and virtual reality industry from 2019 to 2023. There were 138 papers published in 2019, 159 articles in 2020, 230 articles in 2021, 322 articles in 2022, and 133 articles in 2023. According to several publications, research on virtual reality and the fashion industry has increased recently, especially in the previous five years (2019-2023). As observed in Figure 1, the growth is also very progressive in terms of numbers.

Table 2

Development of fashion industry and virtual reality research

| Year of publications | Number of publications |
|----------------------|------------------------|
| 2019 | 138.0 |
| 2020 | 159.0 |
| 2021 | 230.0 |
| 2022 | 322.0 |
| 2023 | 133.0 |
| Total | 989.0 |
| Average | 197.8 |

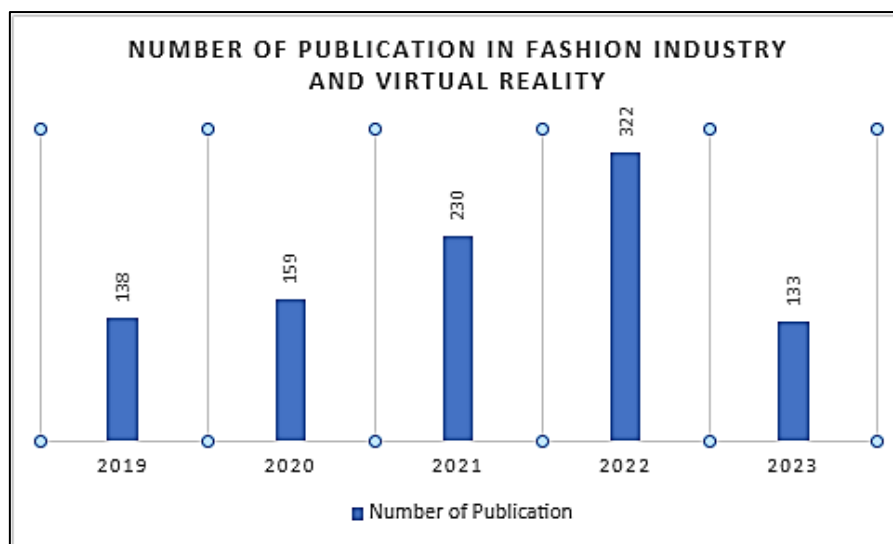


Fig. 1. Level of development in fashion industry and virtual reality research

Figure 1 illustrates the evolution of research on the fashion industry and virtual reality over the previous five years, from 2019 to 2023. According to the Figure 1, there has been growth in the development of research related to fashion industry and virtual reality. A sharp increase over the past four years, with as many as 849 articles were published in total, since 2019 until 2022. Research shows that 2023 will be highly competitive with 2022. A total of 133 items were featured in the first half year of 2023, compared to 161 articles in the first half year of 2022.

3.2.1 Discussion of visualization fashion industry and virtual reality topic area using VOS viewer

The article data undergoes computational mapping. VOSviewer is used for computational mapping. The results of the computational mapping revealed 55 items. Each entity related to reality technology in data mapping is categorized into 6 groups, namely:

- i. Cluster 1 has 14 items and is marked red. The 14 items are big data, covid, customer, digital technology, digitalization, fashion industry, future, internet, new technology, time, type, work and year.
- ii. Cluster 2 in blue has 12 items, namely addition, company, consumer, effect, example, implementation, opportunity, review, teaching, textile, university, and way.
- iii. Cluster 3 is green, has 10 items namely area, articles, cases, creativity, fashion industry education, fashion designer, garment, science, systematic review, and tools.
- iv. Cluster 4 is visualized in yellow, and has 9 items. The 9 items are art, aspect, game, interaction, mixed reality, perception, production, stage, sustainability.
- v. Cluster 5 consists of 6 items marked in purple. These items are architecture, digital fashion, discipline, engineering, innovation, and metaverse.
- vi. Cluster 6 in light blue has 4 items. Such items are enablers, international journals, models, and reality technologies.

To get information in VOSviewer, the terms used are limited by a minimum of 2. This analysis was conducted using the keywords "fashion industry" and "virtual reality". The data is then checked using VOSviewer and categorized into 6 clusters: (i) Cluster 1 is represented in Red, (ii) Cluster 2 is represented in Blue, (iii) Cluster 3 is represented in Green, (iv) Cluster 4 is represented in Yellow, (v) Cluster 5 is represented in purple, and (vi) Cluster 6 is represented in Cyan. Each

cluster consists of terms that are interconnected with other terms. The bibliometric mappings generated by VOSviewer are presented in three different visualization formats. These formats include network visualization (Figure 2), density visualization (Figure 3) and overlay visualization (Figure 4). Each term in the cluster is labelled with a coloured circle. The size of the circles and letters on the label indicates the frequency of keywords mentioned in the title and abstract.

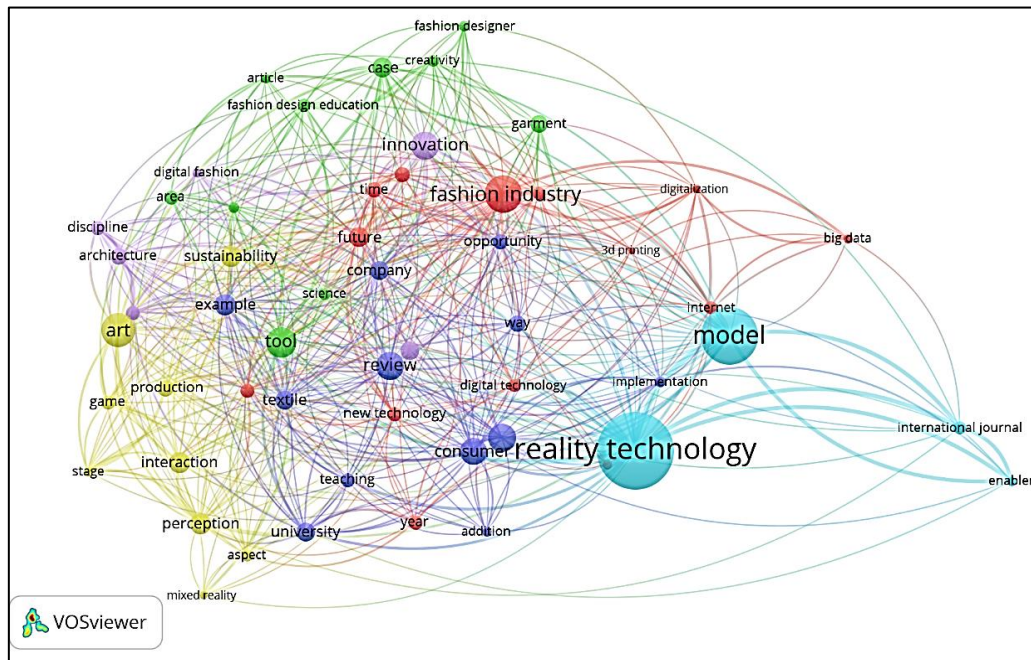


Fig.2. Network visualization of fashion industry and virtual reality keywords

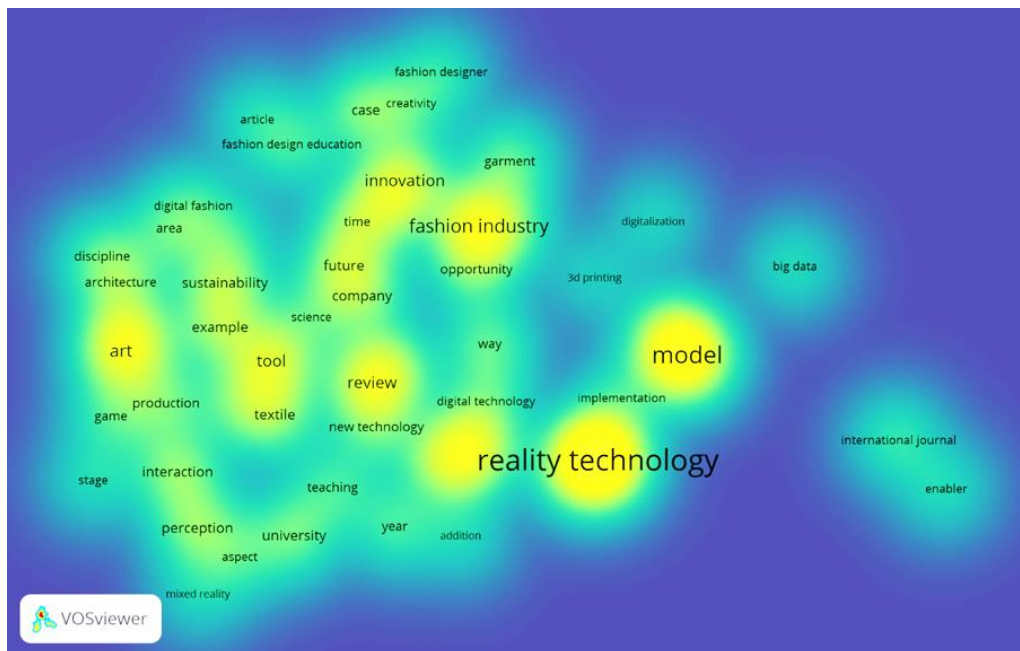


Fig. 3. Density visualization of fashion industry and virtual reality keywords

Originally, we included the term virtual reality fashion technology, Figure 2 shows the relationship between the fashion industry (fashion designers belong to this cluster) and reality technology. Relationships between terms are described in interconnected networks. Figure 2 shows clusters of each frequently researched term related to a research topic of reality technology and the fashion

industry. From the clusters in network visualization, it can be seen that research on the fashion industry and reality technology can be separated into 3 fields, namely the fashion industry term in cluster 1 with a total of 38 links, 81 total link strengths, and 47 emergences (see Figure 5). The second term is a reality technology that belongs to cluster 6 with a total of 42 links, a total link strength of 125, and an emergence of 102 (see Figure 6), and the third term is an art term that includes cluster 4 with a total of 25 links, a total link strength of 60, and 43 occurrences (see Figure 7).

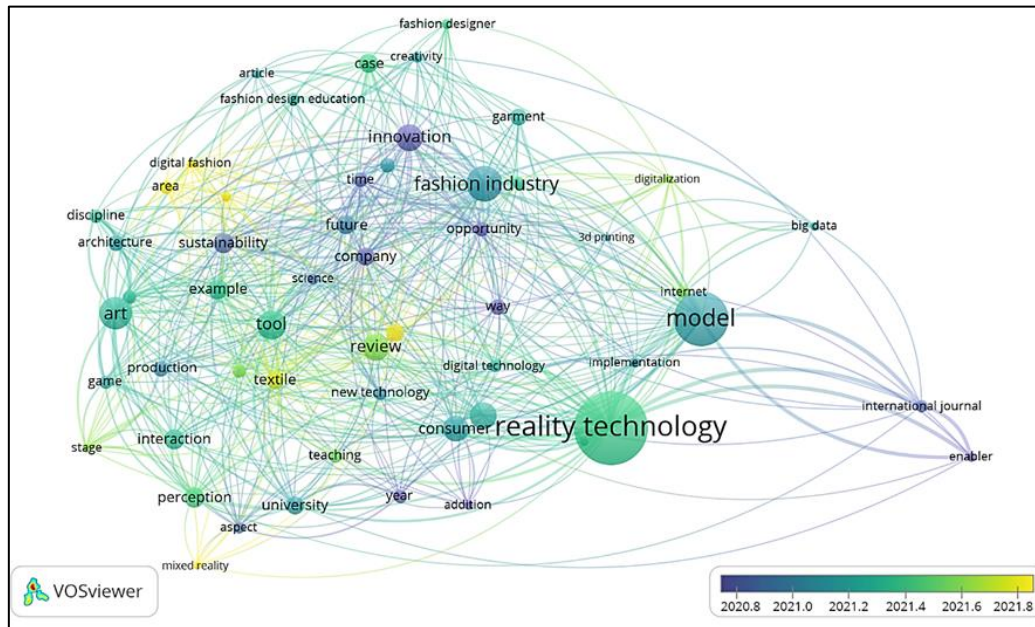


Fig. 4. Overlay visualization of fashion industry and virtual reality keywords

The density representation depicted in Figure 3 shows that the more intense the yellow color and the larger the circle size, the higher the keyword concentration, signalling an increase in the frequency of research on this topic. Conversely, if the color decreases and merges with the green background, it signifies a decrease in the number of studies conducted by Fitria [38]. Figure 3 shows the fashion industry has the most increasing amount of research, such as the keywords innovation, future, digital technology, new technology, digitalization, art, tools.

Figure 4 illustrates overlay visualization in the fashion industry and virtual reality technology. This overlay visualization shows the originality of research on related concepts. Figure 4, as described in Figure. 8, describing that research on the fashion industry and virtual reality is mainly conducted between 2021 and 2023. The popularity of the terms digital fashion, textiles, mixed reality, and virtual reality technology in research has increased over the past two years, from 2020 to 2022. As a result, it is feasible to produce new research on textiles that has not been linked to the concept of virtual reality/new technology, digital technology, or future terms, as illustrated in Figure 9. Therefore, we can conduct studies on innovative aspects of future textiles, new technologies, or advances in digital textile technology in the textile industry and relate them to terminology related to virtual reality, augmented reality, and virtual reality technologies.

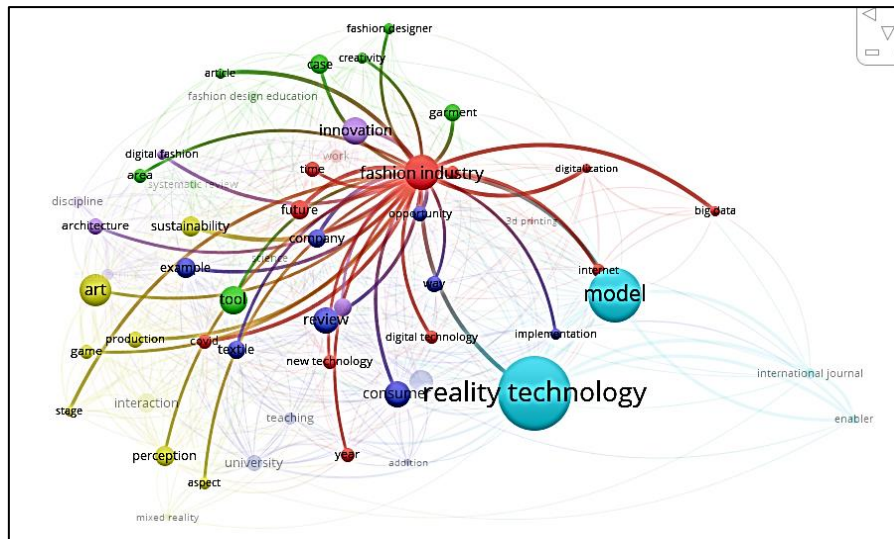


Fig. 5. Network visualization of fashion industry term

Figure 5 shows the network of fashion industry relations with other terms, namely reality technology, model, digitalization, big data, digital technology, internet, new technology, time, future, art, textiles, garment, creativity, case, fashion designer, digital fashion, tool, production, game, example, perception, innovation, opportunity, sustainability, company, implementation, review, architecture, area, time, year, and covid.

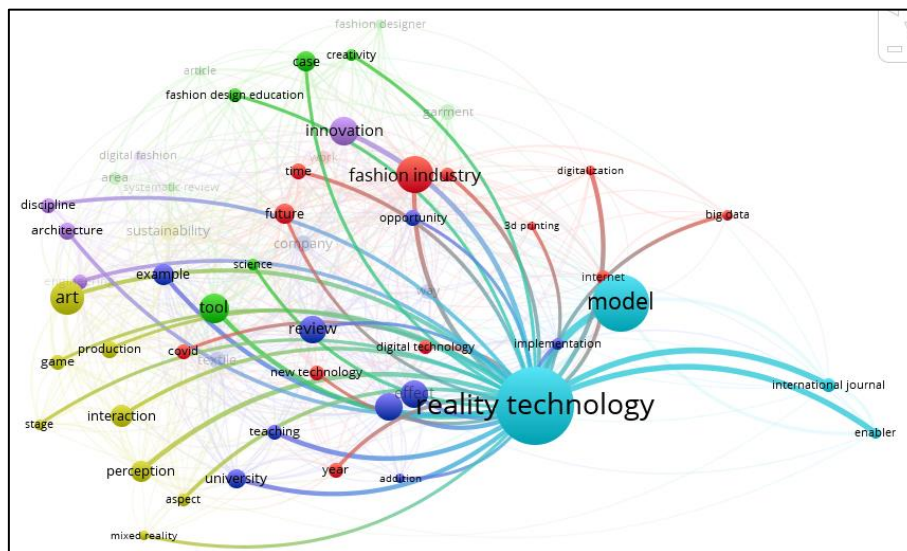


Fig. 6. Network visualization of reality technology term

Figure 6 shows the network of relationships between the term reality technology and existing terms, consisting of model, fashion industry, innovation, opportunity, fashion design education, implementation, case, creativity, time, future, digitalization, 3d printing, internet, art, example, science, review, digital technology, new technology, covid, production, game, interaction, stage, perception, aspect, university, teaching, year, addition, effect, mixed reality, discipline, architecture, big data, international journals and enablers.

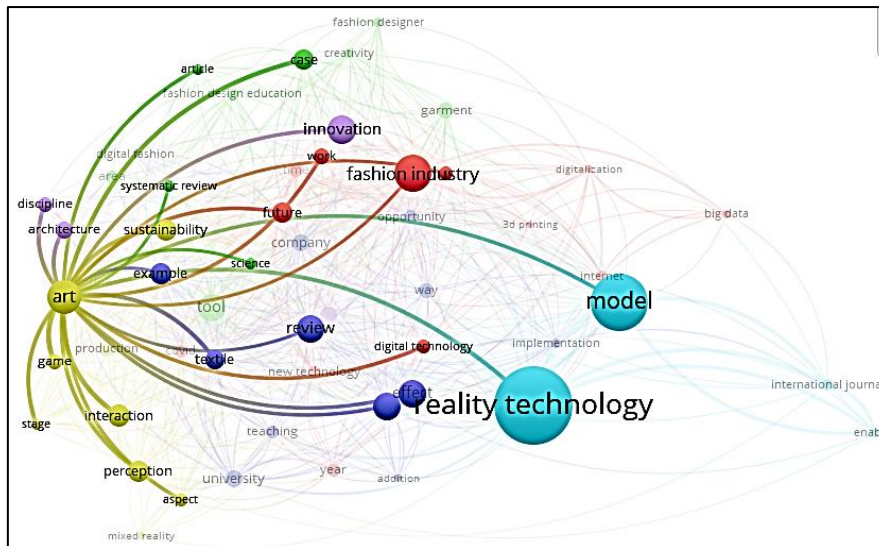


Fig. 7. Network visualization of art term

While Figure 7 shows a network of art terms that is already connected to reality technology. There are so many things to be discussed as research papers here, such as video mapping art which usually uses sensors in their laser projectors, so it can be appreciated interactively. Furthermore, in the art area there is also augmented reality in art museums or art galleries, virtual reality in pubs, cafes, stores that help enhance shopping experience for customers. All of those can be easily reported and analyzed as research papers.

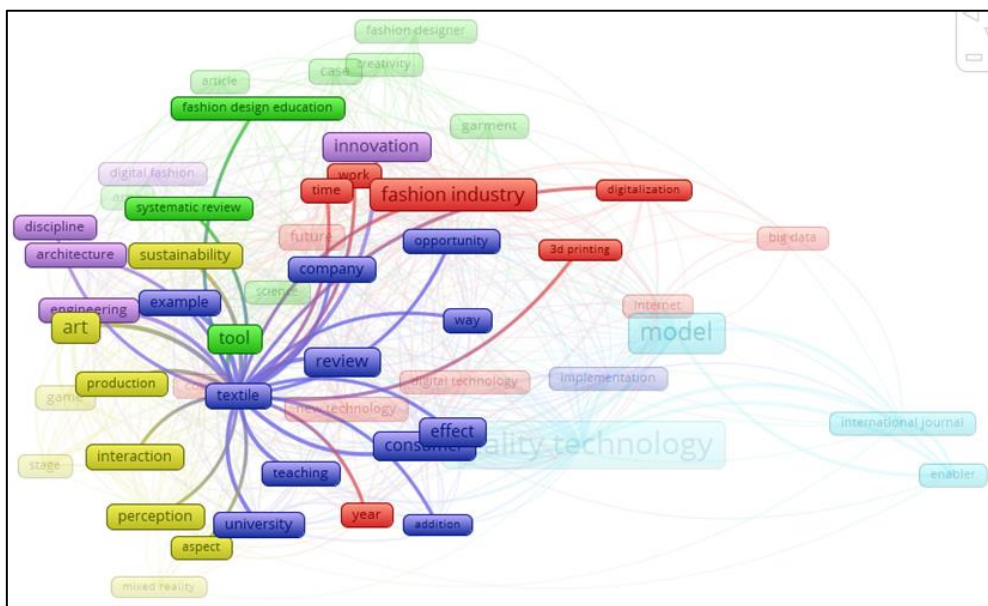


Fig. 8. The novelty of the research, textile, hasn't connected with digital technology

In addition, Figure 8 shows the connection of textile overlays that have not been connected to reality technology, as a novelty of this study. It is devastating to see that textile terms have not yet connected to virtual technology, since the topic area in the advancement are already used in many visual technologies, such as textile textures that are visualized in games, animation, cartoon, and other digital existence or virtual technology.

In Figure 9, there is another new research found in this term is fashion designers who also haven't connected to reality technology as seen. While the development of the fashion industry has

developed virtual reality technology for body fitting with customers, choosing fashion in online games, fashion in the metaverse or called Meta fashion, the relationship between design and virtual reality technology is revitalizing the fashion industry and enhancing the consumer experience. The virtual technology such as augmented reality system can be used by multiple users at the same time. This provides an opportunity to make collaboration in applications, such as engineering design, architecture, multi-user gaming, as well as in the field of education, as stated by Suhaimi [39]. Thus, virtual reality technology helps the collaboration process, such as a cooperation between pattern makers and fashion designers, so that they can work together at one time to improve the time efficiency of the production process in the fashion industry.

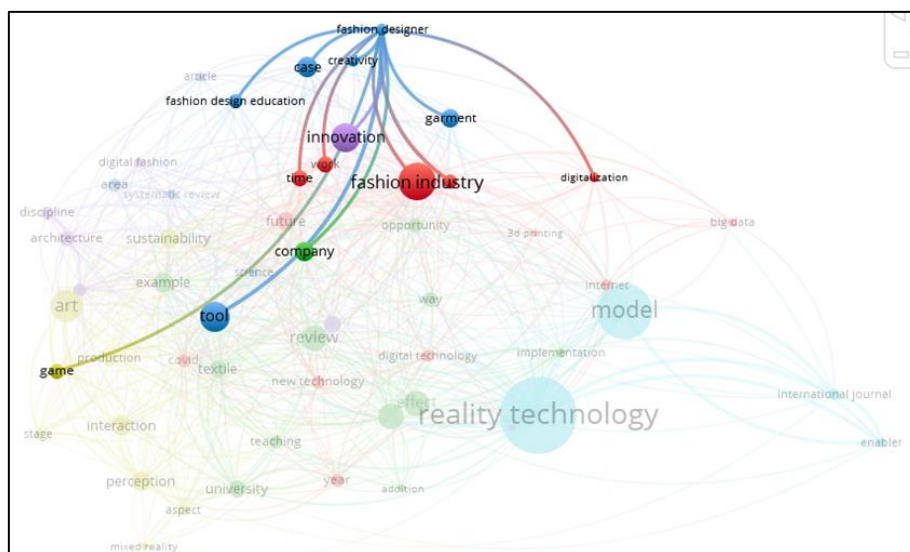


Fig. 9. Fashion designers' term that hasn't connected with digital technology

The virtual world has an important role in manufacturing in order to improve the quality and flexibility for products design and assembly [40], not to mention fashion manufacturing industry. And sequentially, will reduce the time cycle and costs. In addition, the changes and advancements implemented by fashion pioneers provide many platforms such as 3d costumes in video games, virtual modes, and evaluating virtual education in fashion making. The fashion industry has been keeping up with advances in the virtual world. Therefore, without the connection shown in Figure 9, the term fashion design is not yet connected to the term reality technology, which means that there are many research subjects that can be reported or examined in that topic area.

4. Conclusions

The bibliometric computational mapping analysis in this study focuses on the topics of "fashion industry" and "virtual reality" sourced from scientific publication journals Google Scholar database using the Publish or Perish program. From the search results, a total of 793 related papers were identified, ranging from 2019 to 2023. A progressive increase in the fashion industry and virtual reality technology sector is in 2020 to 2023, from 159 in 2020 to a very popular 322 articles in 2022. There is a missing link between the field of the fashion industry and the term reality technology, such as, the terms textile and fashion designer have not related to reality technology. These findings show the huge opportunities for smart textile and smart fashion research, especially when connected to reality technology.

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