Bibliometric Analysis on Technical and Vocational Education and Training (TVET) Research

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Abstract
Purpose – This research aims to comprehensively analyse the area of Technical and Vocational Education and Training (TVET) research. The objectives of this study are to identify the current states and trends of publications in TVET research, analyse the most cited documents in TVET research, determine the most productive contributors, examine the most frequent keywords in TVET research, and explore the current states of knowledge structure in terms of co-citation, collaboration, and co-occurrence networks. This research uses bibliometric analysis to analyse the database of publications on TVET research. Bibliometric analysis was conducted using Biblioshiny, which is a shiny app for the R package. The researcher extracted the database from 1993 to 2023 via Scopus.Starting in 2016, the total publication was higher than the previous 23 years. The highest total publication in TVET research was achieved in 2022. The most cited paper identified is the research conducted by Oketch (2007), with a total of 79 citations. The most productive author is Ismail A. The most productive country in TVET research is Malaysia, while the most productive institution or affiliation is Universiti Tun Hussein Onn Malaysia. Three of these analyses are consistent, as all are in Malaysia context in terms of author, country, and university. The most frequent words used in TVET research are "technical and vocational education and trainings", followed by "students" and "vocational education" and "apprentices". The most prolific authors identified based on the result of co-citation analysis are Mcgrath S. and Oketch, who highlight the strategy for TVET. Moreover, the collaboration between Malaysia and Indonesia contributes the most to TVET research. According to the co-occurrence network conducted, the biggest cluster of themes is "technical and vocational education and trainings" and "students" which consists of keywords such as "apprentices", "personnel training", "teaching", "teaching training", "learning systems", "education", "sustainable development" and others related keywords.
Keywords: Bibliometric Analysis, Biblioshiny, R Package, TVET, Technical and Vocational Education and Training.

Introduction

Technical and Vocational Education and training (TVET) refers to the education process involved and the acquisition of technical skills, attitudes, and understanding of the knowledge that can be applied to industry (UNESCO, 2003). In order to improve the TVET system and develop future skilled workers for the nation, many nations have made significant efforts to develop local human resources through incentives and initiatives (Hussain et al., 2021). In Malaysia, for example, the government has allocated RM6 billion to the TVET field in the Malaysia Budget 2021 (Chia et al., 2023). TVET is one of the main contributors to the socioeconomic development of a country. This is because TVET enhances the skills of students that are needed for future careers to increase the employability rate in a country (Salleh & Sulaiman, 2016). Besides, TVET graduates are able to reduce dependency on foreign labour (Economic Planning Unit, 2021).

Since the traditional job has been replaced by smart technologies nowadays, many countries have been putting effort into upgrading the workforce for Industry 4.0 (Yang & Gu, 2021). For instance, The Ministry of Human Resources and the Ministry of Education in Malaysia have developed the policy for TVET to implement an agenda aligned with these industries' needs (Ishar et al., 2020). TVET is able to guarantee the graduate bright career prospects, especially in the job market of Industry 4.0 (Chia et al., 2021). The jobs of Industry 4.0 include programme engineers, application developers, and technology experts (Ishar et al., 2020).

There are 17 goals adopted by the United Nations called Sustainable Development Goals (SDGs) to help the region's countries start the new vision of sustainable development set forth in 2030 (United Nations, 2018). UNESCO adopted a strategy for TVET 2016-2021 with the aim of contributing to the implementation of the SDG (UNESCO, 2022). SDG 4 which is quality education, has enhanced the role of TVET as a contributor to the wellbeing of nations by providing accessibility to quality TVET education (UNESCO, 2021).

TVET graduates can be seen as an important driving force in the economy and are highly demanded in industry nowadays. However, TVET qualifications is still looked down upon by society (Bong, 2019). This perception led to a low enrolment rate in TVET (Azahar, 2022). Many researchers conduct studies on factors that affect student's tendencies to enrol in TVET to assist the government and policymakers in proposing strategies for promoting TVET (Chia et al., 2023). There is a need to provide an overview of TVET research to provide insight to the government and policymakers about the current concerns in TVET.

According to Abdullah (2021), there are many publications in educational research that conduct analysis on studies with specific themes. For instance, an overview on entrepreneurship in TVET publication (Daud & Nordin, 2023). According to Abd Majid et al. (2022), the evolution of global scientific research on TVET is still limited. Although Abd Majid et al. (2022) conducted a bibliometric analysis to examine global scientific publication in TVET, the authors searched the data from the Web of Science (WoS) database and only covered the data from 1999 to 2021. The authors excluded the data from other recognized databases. In contrast to this previous review, this study aims to conduct a bibliometric analysis of publications in TVET-related research from 1993 to 2023 through the Scopus database. This study is able to provide insight to researchers about the future study areas in TVET research and can broaden their research collaboration with other countries. Moreover, this study is

beneficial for policymakers and TVET institutions to propose suitable strategies by gaining insight into the current concerns of people in TVET programme and analysing the trend of topics in TVET research.

This study is developed to answer following research questions:

RQ1: What are the current states and trend of publications in TVET research?
RQ2: What are the most cited documents in TVET research?
RQ3: Who are the most productive contributors in terms of authors, countries, affiliations in TVET research?
RQ4: What are the most frequent keywords in TVET research?
RQ5: What are the current states of knowledge structure in terms of co-citation, collaboration and co-occurrence network in TVET research?

Based on the research questions, the research objectives are formed:

RO1: To identify the current states and trend of publications in TVET research.
RO2: To analyse the most cited documents in TVET research.
RO3: To determine the most productive contributors in terms of authors, countries, affiliations in TVET research.
RO4: To examine the most frequent keywords in TVET research.
RO5: To explore the current states of knowledge structure in terms of co-citation, collaboration and co-occurrence network in TVET research.

Literature Review
Technical and Vocational Education and Training (TVET)
Technical and Vocational Education and Training (TVET) is designed for students to acquire skills needed in the workplace to guarantee students a job in the future. It allows students to gain vocational knowledge that can be applied at different levels (Astuti et al., 2023). TVET helps people obtain skills that are in demand in the workforce (Alanazi, 2023).

TVET is the education system that mixes formal, informal, and non-formal learning (UNESCO, 2021). TVET is growing worldwide due to colonization. Currently, most countries conduct TVET to allow students to acquire skills and knowledge required by industry (Aziz et al., 2020). Additionally, students can receive appropriate training for future careers (Ido & Udo, 2022). In short, TVET is able to produce a high-skilled workforce (Razak et al., 2022). High-skilled workforces that are developed by TVET are important for country development (Azeem et al., 2022). However, according to Ibrahim & Nashir (2022), the inability of TVET institutions to provide the skills needed by the current industry results in unsustainable numbers of TVET graduates. The authors also mentioned that the TVET system's activities are important to manage to avoid mismatches between the programmes learned and industries. Malaysia is one example of a country that puts effort in updating the TVET system's activities to meet the requirements of industry. The effort was conducted not only to avoid a mismatch between the TVET programme and industries but also for the purpose of increasing the enrolment of students in TVET (Mohammad Hussain et al., 2021).

Bibliometric Analysis

A "bibliometric" term was created by Faithorne in 1969 to explain the statistical information about the published articles in a particular area or field and highlight the particular trends, methods, keywords, citations, and sources of scientific publication (Broadus, 1987). Bibliometrics is a quantitative and qualitative method used to explore the pattern of trends in a particular field (Wang et al., 2023). According to Verma & Gustafsson (2020), bibliometric study is significant in several aspects. For instance, bibliometric studies applied the science mapping approach to minimize bias. Subsequently, it extended to conducting an in-depth analysis of a particular theme. Lastly, it analysed the research topics, identified research gaps to be addressed, and provided future practice in a particular field (Verma & Gustafsson, 2020).
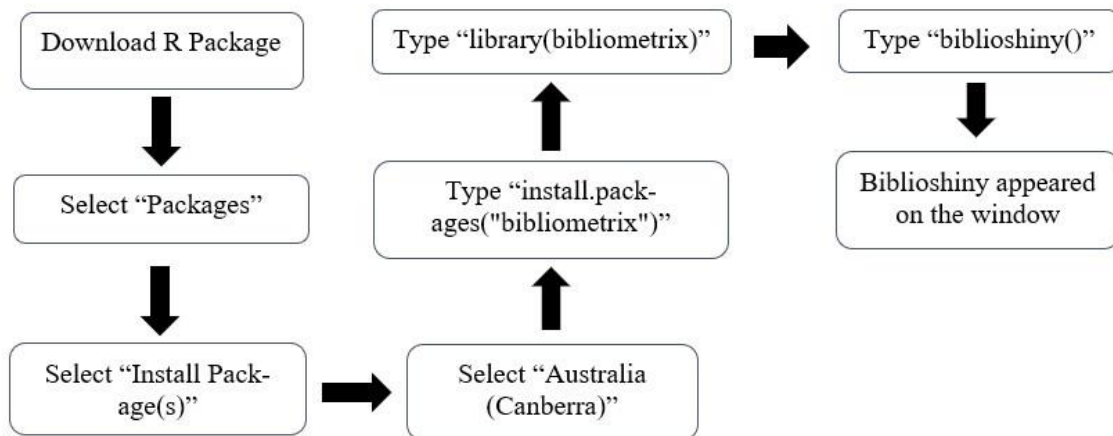
Bibliometric analysis has been conducted in the education field of research in recent years to assess the literature published (Ishak et al., 2023). For examples, literature related to virtual learning (Chen et al., 2021), educational leadership (Hallinger & Kovacevic, 2021), and learning tactics (Song et al., 2019). In this study, bibliometric analysis is conducted in the education field, which includes TVET-related literature from 1993 to 2023. The analysis is based on a database from Scopus.

Materials and Methods

The method used to conduct the study is called bibliometric analysis. The researcher can examine and document a source of metadata and knowledge transmission to readers using the bibliometric analysis method (Abdul Rahman et al., 2022). The Biblioshiny app for the Bibliometric R package was used to conduct the bibliometric analysis.

This bibliometric study examines the publications collected from the Scopus database. Scopus was chosen because it indexes documents more quickly and offers a wider variety of coverage (Amaechi et al., 2022). According to Fahimnia et al (2015), Scopus is the largest abstract and citation database of literature in the fields of science, technology, social science, art, and the humanities. All the peer-reviewed literature published at Scopus is from well-known publishers such as Emerald, Elsevier, and Springer (Abdul Rahman et al., 2022). The researcher used a title-only search strategy to find publications related to TVET research. Figure 1 shows the flow of running Bibliometric analysis using biblioshiny. Figure 2 shows the flow diagram of search strategy. The analysis includes all the publications that were identified in the initial record, which is 497.

Part A: Run Biblioshiny

Download R Package → Select "Packages" → Select "Install Package(s)" → Select "Australia (Canberra)" → Type "install.packages("bibliometrix")" → Type "library(bibliometrix)" → Type "biblioshiny()" → Biblioshiny appeared on the window

Part B: Run Bibliometric Analysis

Go to Scopus http://www.scopus.com → Search the keyword of research → Select all publication and extract as CSV file → Open Biblioshiny app → Select "Load Data" → Choose "Import raw file(s)". → Choose "Scopus" in the box of "database" → Choose the CSV file that has saved before → Click "Start" to run the bibliometric analysis
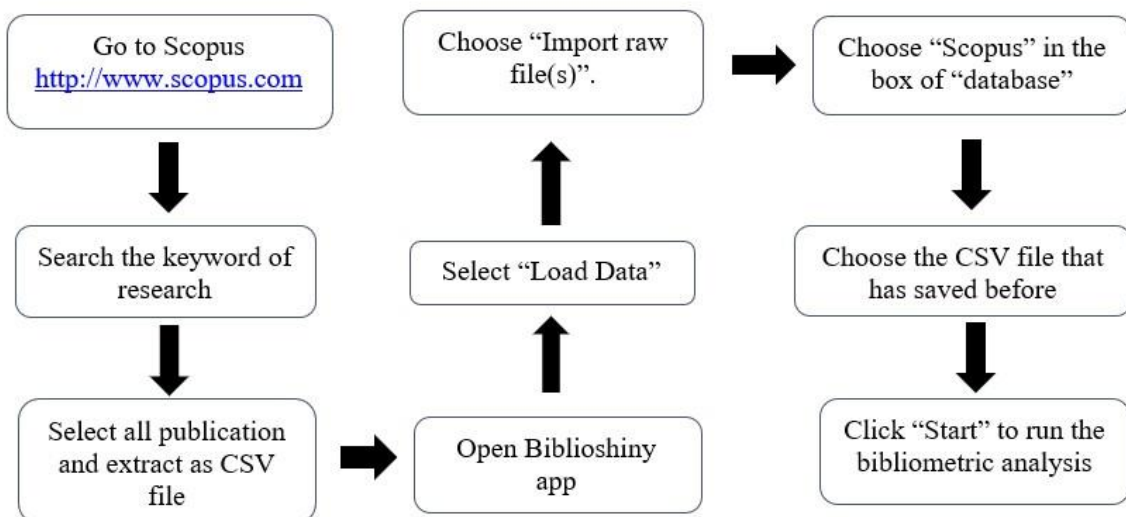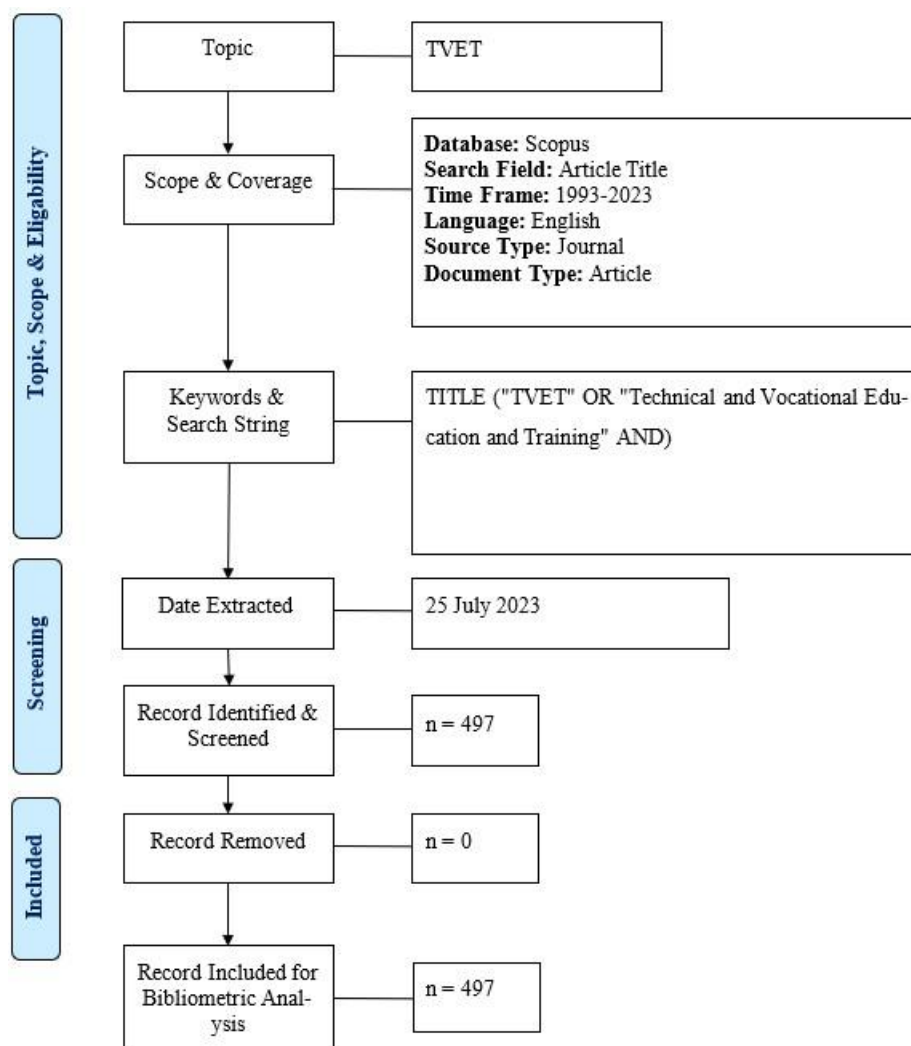
Figure 1: Flow of bibliometric analysis

Figure 2: Flow diagram of the search strategy (Source: Zakaria et al., 2020)

Analysis and Results
This section shows the bibliometric analysis and result about the status of publication on TVET research which extracted the database from Scopus.

Descriptive Analysis
This section discusses the sources of publication from 1993 to 2023 that related to TVET research. This section consists of main information, annual trend publication, most cited paper, most productive authors, most productive countries, most productive affiliations, and most frequent word.

Main Information
The time range of TVET research-related publications is from 1993 to 2023. Table 1 shows the main information regarding selected articles, which includes information about document average age, average citation per document, document contents, author's detail, author collaboration, and document types.

Table 1
Main Information Regarding Selected Articles

Description	Results
MAIN INFORMATION ABOUT DATA	
Timespan	1993:2023
Sources (Journals, Books, etc)	212
Documents	497
Annual Growth Rate %	9.9
Document Average Age	4.35
Average citations per doc	3.022
References	17093
DOCUMENT CONTENTS	
Keywords Plus (ID)	512
Author's Keywords (DE)	1244
AUTHORS	
Authors	1096
Authors of single-authored docs	99
AUTHORS COLLABORATION	
Single-authored docs	119
Co-Authors per Doc	2.89
International co-authorships %	17.3
DOCUMENT TYPES	
article	319
book	3
Book chapter	97
conference paper	58
Editorial	4
Erratum	3
Note	1
Retracted	1
review	11

Annual Publication Trend

Annual publication trends show the total publication, citations per year, and citable years from 1993 to 2023. The annual publication trends are shown in Table 2 and Figure 3. It can be seen that the total number of publications increased significantly from 2015 to 2016. Starting in 2016, the total publication was higher than the previous 23 years. The highest total publication in TVET research during the year 2022 with total number of 88.

Table 2

Total Publication Per Year, Citation Per Year and Citable Year

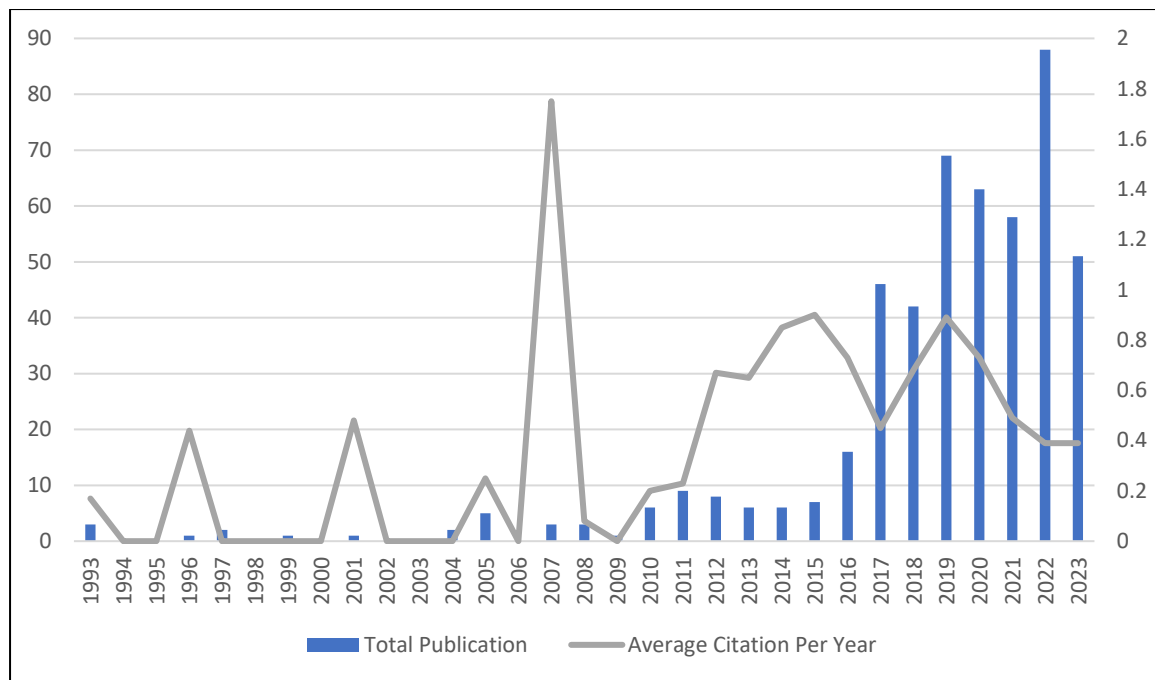| Year	Total Publication	Citation per year	Citable year
1993	3	0.17	31
1994	0	0	30
1995	0	0	29
1996	1	0.44	28
1997	2	0	27
1998	0	0	26
1999	1	0	25
2000	0	0	24
2001	1	0.48	23
2002	0	0	22
2003	0	0	21
2004	2	0	20
2005	5	0.25	19
2006	0	0	18
2007	3	1.75	17
2008	3	0.08	16
2009	1	0	15
2010	6	0.2	14
2011	9	0.23	13
2012	8	0.67	12
2013	6	0.65	11
2014	6	0.85	10
2015	7	0.9	9
2016	16	0.73	8
2017	46	0.45	7
2018	42	0.68	6
2019	69	0.89	5
2020	63	0.73	4
2021	58	0.49	3
2022	88	0.39	2
2023	51	0.39	1

Figure 3: Total Publication and Average Citation Per Year

Most Cited Papers

The top 10 most globally cited papers are shown in Table 3. In general, the most cited paper was Oketch (2007), with a total of 79 citations. The author studied perspectives on current trends and issues in TVET in Africa. The second most cited paper was by Tripney & Hombrados (2013), with a total of 30 citations. The authors studied TVET for young people in low and middle income countries. The third most cited paper is by Jayalath & Esichaikul (2020), who discuss gamification to enhance motivation and engagement in blended eLearning for TVET with 26 total citations.

Table 3
Top 10 Most Cited Papers

Authors	Title	Total Citation	Citation Per Year
Oketch (2007)	To vocationalise or not to vocationalise? Perspectives on current trends and issues in technical and vocational education and training (TVET) in Africa	79	4.65
Tripney & Hombrados (2013)	Technical and vocational education and training (TVET) for young people in low- and middle-income countries: a systematic review and meta-analysis	30	2.73
Jayalath & Esichaikul (2020)	Gamification to Enhance Motivation and Engagement in Blended eLearning for Technical and Vocational Education and Training	26	13.00
Hassan & Shamsudin (2019)	Measuring the Effect of Service Quality and Corporate Image on Student Satisfaction and Loyalty in Higher Learning Institutes of Technical and Vocational Education and Training	24	4.80
Yi et al. (2015)	Exploring the dropout rates and causes of dropout in upper-secondary technical and vocational education and training (TVET) schools in China	24	2.67
Singh (2012)	India's National Skills Development Policy and Implications for TVET and Lifelong Learning	23	1.92
Kanwar et al. (2019)	Changing the TVET paradigm: new models for lifelong learning	21	4.20
Zancajo & Valiente (2018)	TVET policy reforms in Chile 2006–2018: between human capital and the right to education	21	4.20
Tabbron & Yang (1997)	The interaction between technical and vocational education and training (TVET) and economic development in advanced countries	21	0.78
Hassan et al. (2019)	The Effect of Service Quality and Corporate Image on Student Satisfaction and Loyalty in TVET Higher Learning Institutes (HLIS)	19	3.80

Most Productive Authors
The top 10 productive authors are shown in Table 4 with information of their total citations, number of publications, publication year start, h-indexed, g-indexed and m-indexed. As shown in Table 4, the leading authors in TVET research are Ismail A and Makgato M with a total of 9

publications, followed by Sern LC and Yunos JM with 8 publications. Subsequently, Oavlova M, Omar MK, and Salleh KM have 7 publications.

Table 4
10 Most Productive Authors

Authors	h-indexed	g-indexed	m-indexed	Total Citation	Number of Publication	Publication Year Start
Ismail A	3	6	0.429	46	9	2017
Makgato M	2	2	0.400	8	9	2019
Sern LC	3	3	0.429	15	8	2017
Yunos JM	3	4	0.429	18	8	2017
Pavlova M	3	5	0.231	31	7	2011
Omar MK	2	5	0.333	29	7	2018
Salleh KM	2	3	0.250	13	7	2016
Hassan R	3	6	0.429	43	6	2017
Maclean R	3	4	0.150	16	6	2004
Rashid AM	2	5	0.333	27	6	2018

Most Productive Countries
Table 5 shows the top 10 most productive countries. Malaysia is the top productive country, with 584 documents, followed by South Africa with 149 documents. The third most productive country is Indonesia, which has 89 documents.

Table 5
10 Most Productive Countries

Country	Total Publication
Malaysia	584
South Africa	149
Indonesia	89
Nigeria	87
Germany	51
UK	41
China	35
Philippines	30
USA	28
India	19

Most Productive Affiliations
The researcher used Biblioshiny to identify the top 10 most productive institutions or affiliations. The top 10 most productive institutions or affiliations are shown in Table 6. Universiti Tun Hussein Onn Malaysia (UTHM) is the most productive affiliation, with a total of 127 articles. The second-most productive affiliations are the University of Nigeria with a total of 43 articles and Universitas Pendidikan Indonesia with 42 articles.

Table 6
Top 10 Most Productive Affiliations

Affiliation	Articles
Universiti Tun Hussein Onn Malaysia	127
University Of Nigeria	43
Universitas Pendidikan Indonesia	42
Universiti Putra Malaysia	32
Universiti Pendidikan Sultan Idris	26
Universiti Kebangsaan Malaysia	24
Universiti Teknologi Malaysia	23
Universiti Teknikal Malaysia Melaka	15
Universiti Utara Malaysia	14
Sultan Idris Education University	13

Most Frequent Keywords
Table 7 shows the most frequent keywords used in TVET research, while Figure 4 shows the word cloud of keywords. The researcher analyzed these results using Biblioshiny. The most frequent keywords used in TVET research are "technical and vocational education and trainings" (23), followed by "students" and "vocational education" (21) and "apprentices" (19). It can be seen that the biggest words appearing in the word cloud are "vocational education", "students," and "apprentices," which is consistent with the result in Table 7.

Table 7
Most Frequent Keywords

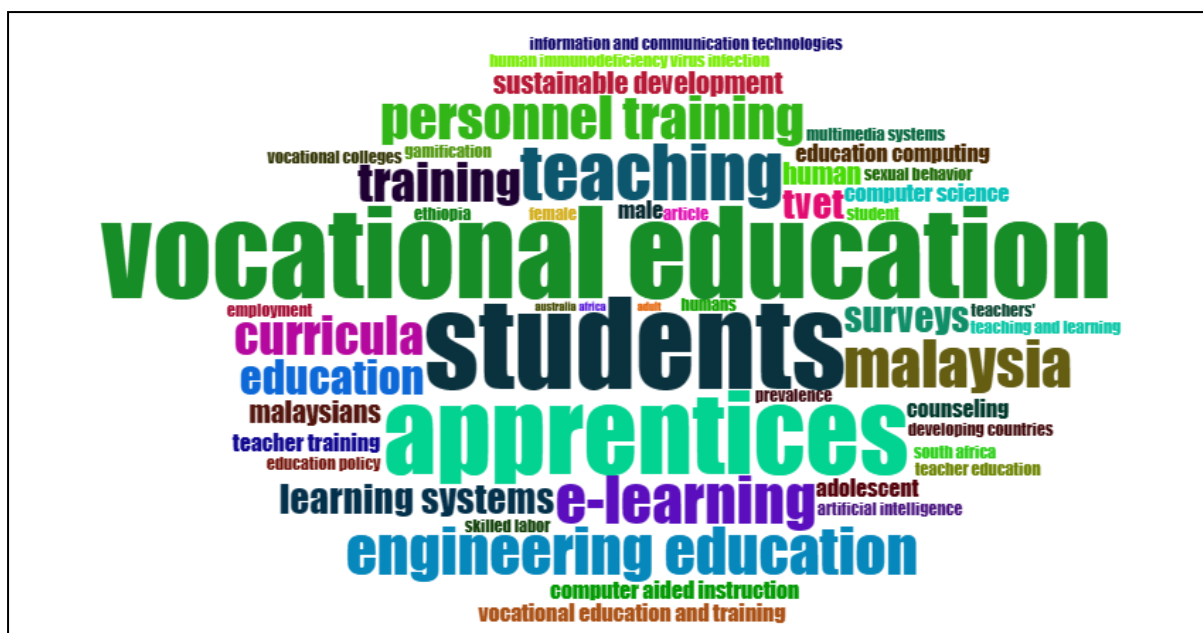| Words	Occurrences
technical and vocational education and trainings	23
students	21
vocational education	21
apprentices	19
teaching	13
e-learning	11
engineering education	11
malaysia	11
personnel training	10
curricula	9

Figure 4: Word Cloud

Network Analysis

Network analysis is one of the most popular bibliometric analysis tools. There are many tools for network analysis, such as VOSviewer and Gephi. Recently, Biblioshiny is the latest software that can conduct network analysis (Abdul Rahman et al., 2022). This section discusses the co-citation analysis, collaboration analysis, and co-occurrence network that have been conducted using Biblioshiny.

Co-Citation Analysis

Citation analysis refers to the number of frequencies in particular documents in a particular field (Abdul Rahman et al., 2022). Co-citation analysis allows the researcher to identify the most prolific authors in TVET research (Sobhi Ishak et al., 2023). Besides, co-citation helps identify the most important references in TVET research (Barbu, 2023). Figure 5 shows the co-citation analysis for TVET research. There are several common themes among the co-cited papers in the same clusters (Abdul Rahman et al., 2022). Based on Figure 5, the most prolific authors are Mcgrath S. and Oketch, who highlight the strategy for TVET.
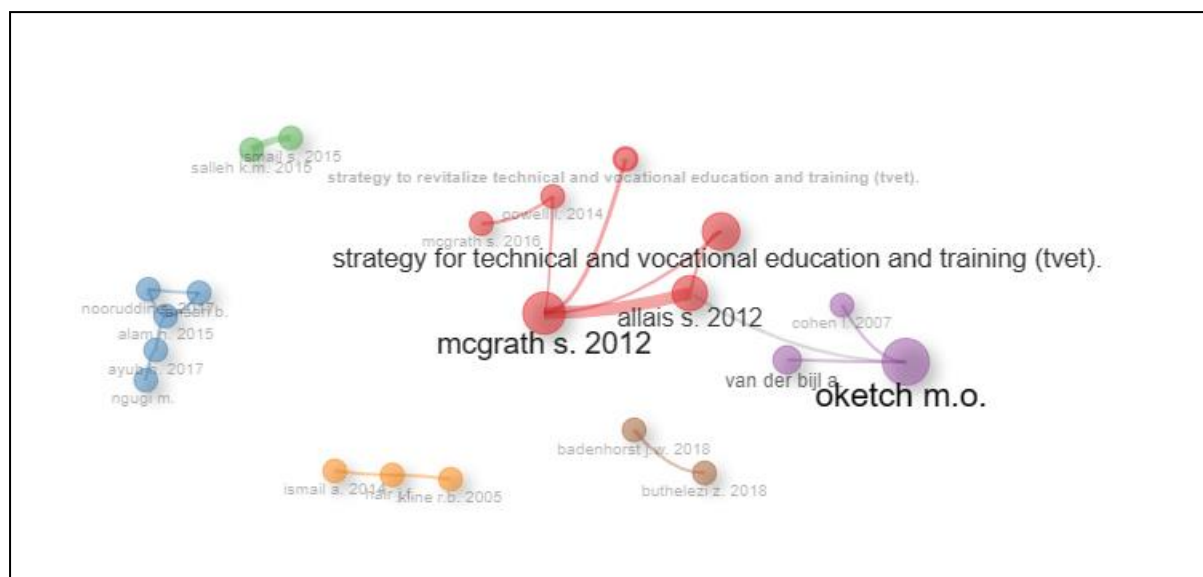
Figure 5: Co-citation Analysis

Collaboration Analysis

Table 8 shows the collaboration between countries worldwide on TVET research with at least 2 frequencies. It can be seen that collaboration between Malaysia and Indonesia contributes the most to TVET research. Malaysia and Indonesia have collaborated 14 times in conducting TVET research.

Table 8
Collaboration Analysis

Collaboration of Countries	Frequency
Malaysia and Indonesia	14
Germany and Thailand	4
Malaysia and Nigeria	4
China and USA	3
Nigeria and India	3
Nigeria and United Kingdom	3
USA and Canada	3
Australia and Fiji	2
China and Hong Kong	2
Ethiopia and Sweden	2
Indonesia and Germany	2
Kenya and Rwanda	2
Malaysia and Oman	2
Malaysia and Sweden	2
Malaysia and USA	2
Philippines and USA	2
South Africa and Ghana	2
United Kingdom and Chile	2
USA and Korea	2

Co-Occurrence Network

The keyword co-occurrence network is shown in Figure 6. The larger the node of a keyword, the more that keyword was utilized. Each cluster is differentiated by a different colour. The greater the proximity of keywords used in research, the closer the keywords are linked, which forms closer and stronger relationships (Abdul Rahman et al., 2022). Based on Figure 6, the biggest cluster of themes are "technical and vocational education and trainings" and "students" which consist of keywords such as "apprentices", "personnel training", "teaching", "teaching training", "learning systems", "education", "sustainable development" and other related keywords, as shown in Figure 6.
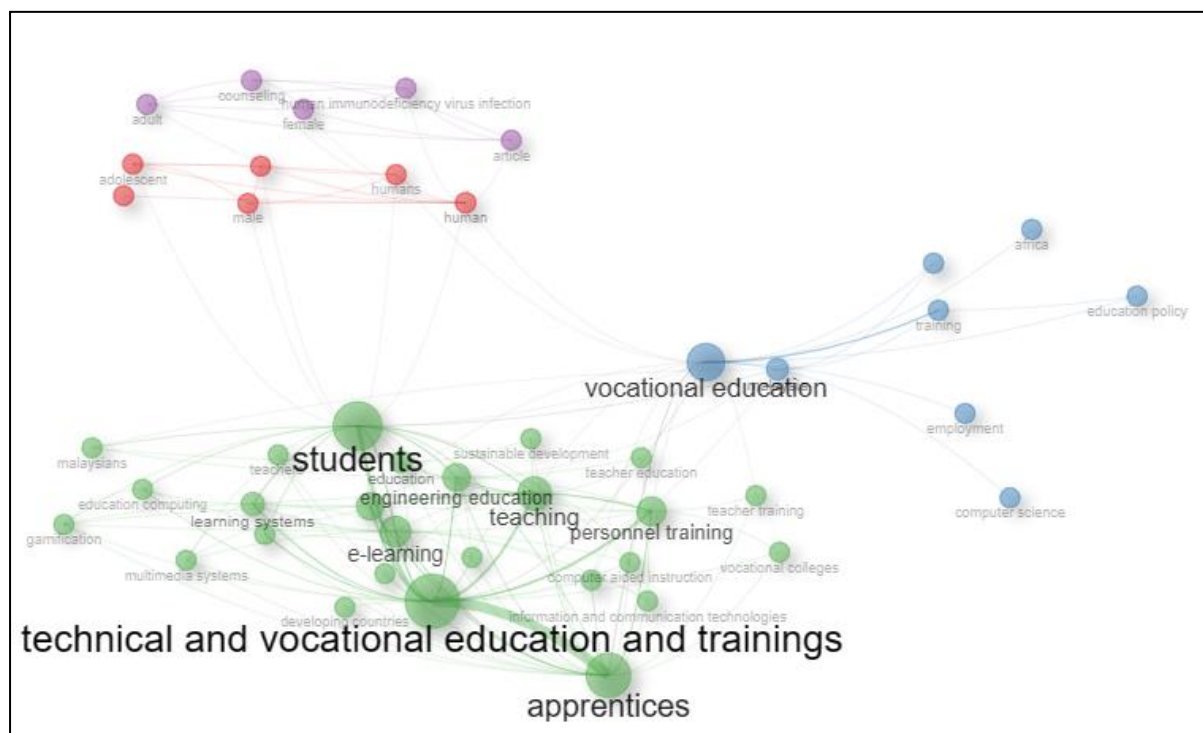
Figure 6: Co-Occurrence Network

Discussion

This study focuses on analysing publications in TVET research. A total of 497 publications have been extracted from the Scopus database. The first publication in TVET research was in Scopus in 1993. The annual publication trend from 1993 to 2023 increased slowly. The recent study of bibliometric analysis of TVET research by Abd Majid et al (2022), who extracted the database from WoS, shows a similar trend where the number of publications increases slowly. However, in this research, the researcher identified that the publication peaked in 2022. This is due to the fact that many countries start to focus on TVET programme in 2022. For example, The UNESCO-UNEVOC TVET Leadership Programme with the title "Re-thinking TVET systems and programmes to anticipate demand, adapt and take action for a just and green transition" runs from November 2022 to February 2023 (UNESCO, 2022). This programme aims to support the transformation of institutions into effective spaces for learning. More than 140 TVET leaders and managers from 61 nations obtain the opportunity to develop knowledge of greening concepts and trends (UNESCO, 2022). The publication dropped at 2023 because this research was conducted in July 2023.

The most cited paper is by Oketch (2007), who studied perspectives on current trends and issues in TVET in Africa. This shows that there are many researchers studying this related topic. The current trend and issues in TVET need to be concern because TVET is important in developing countries. TVET enhances the skills of students that are needed for future careers, which increases the employability rate in a country (Salleh & Sulaiman, 2016).

The most productive author is Ismail. The most productive country in TVET research is Malaysia, while the most productive institution or affiliation is Universiti Tun Hussain Onn Malaysia. Three of these analyses are consistent, as all are in Malaysia context in terms of author, country, and university. Ismail A is currently working at Universiti Tun Hussain Onn Malaysia and focuses on doing TVET research. UTHM is one of the universities in MTUN. UTHM is leading MTUN, and it has established the Faculty of Technical and Vocational Education (FPTV) to develop high skilled graduates to match the demand of industry (Universiti Tun Hussein Onn Malaysia, 2023). This shows that UTHM places emphasis on the TVET programme which is one of the reasons it has become one of the most productive institutions.

The most frequent keywords used in TVET research are "technical and vocational education and training", "students", "vocational education", and "apprentices". This shows that students are able to act as apprentices to learn skills through the TVET programme.

Co-citation, collaboration analysis, and co-occurrence networks have been analysed under the section of network analysis. Based on the co-citation analysis conducted, the most prolific authors are Mcgrath S. and Oketch, who highlight the strategy for TVET. This can be explained by the fact that more strategies need to be recommended for the government to develop in order to address the issues in TVET. Collaboration analysis shows that 14 times of collaboration between Malaysia and Indonesia contribute the most to TVET research. This shows that Asia countries contribute the most to TVET research. A co-occurrence network was conducted and shows the biggest cluster of themes are "technical and vocational education and trainings" and "students" which consist of keywords such as "apprentices", "personnel training", "teaching", "teaching training", "learning systems", "education", and other related keywords. This shows that many countries emphasize the facilities and competencies of instructors or teachers in TVET institutions. Instructors play an important role in boosting the critical thinking of students (Langari et al., 2022). The finding from Kipkemoi et al. (2014) shows that low instructor morale has an impact on the pattern of TVET enrolment. Therefore, more training should be delivered to instructors in order to enhance the quality of TVET students.

Conclusion
This paper evaluates the publication trends in TVET research from 1993 to 2023 using bibliometric analysis. The Biblioshiny app for the Bibliometric R package was employed to conduct this analysis. The study examines key areas such as publication trends, the most productive contributors in TVET research, the most cited documents, frequently used keywords, co-citation analysis, collaboration analysis, and co-occurrence networks.

The findings indicate a rising trend in TVET publications, particularly after 2016, with 2022 seeing the highest output, which reflects the growing global academic interest in TVET. The

most cited paper focuses on current trends and issues in TVET in Africa, emphasizing the need to address the vocationalization of education. To address this, strategies should be developed to improve societal perceptions that undervalue TVET qualifications. Malaysia stands out as the most productive country, with significant contributions from institutions like Universiti Tun Hussein Onn Malaysia and prominent Malaysian authors such as Ismail A., indicating that Malaysia's strong focus on advancing TVET. The analysis of frequent keywords in TVET research reveals that students often engage as apprentices to acquire skills through TVET programs. The co-citation analysis identifies McGrath S. and Oketch as the most prolific authors, who highlighting key strategies for TVET. Collaboration networks, particularly between Malaysia and Indonesia, demonstrate that the significant contributions of Asian countries to TVET research, with such collaborations being crucial in addressing global TVET challenges. Expanding international collaborations to include more countries could foster a more globalized approach to TVET. The co-occurrence network findings indicate that many countries emphasize the facilities and competencies of instructors or teachers in TVET institutions, suggesting that more training should be provided to instructors to enhance the quality of TVET students.

Overall, the objectives of this study have been achieved, providing researchers with valuable insights into potential future research areas in TVET. This study is valuable for policymakers and TVET institutions in developing strategies that address current concerns within TVET by gaining insight into the current concerns of people in TVET. However, the study is limited by its reliance solely on data from Scopus. It is recommended that future research include additional databases, such as Web of Science (WoS), to obtain more comprehensive and reliable data.

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