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Bibliometric Analysis of the Application of Platinum Nanoparticles in the Field of Biomedical Research During 2012-2022 Using VOSviewer

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Abstract. Platinum nanoparticles are materials with excellent biocompatibility, high surface mass ratio, small size, and high reactivity in their biomedical applications. The purpose of this research is to perform bibliometric analysis on the application of platinum nanoparticles in the biomedical field using VOSviewer. The data used in this study were obtained and collected using the Publish or Perish software. The data obtained are based on the keywords "nanoparticles, platinum, biomedical". Based on the analysis conducted, obtained 985 articles relevant to the keywords used in the 2012-2022 range. The results show that the application of platinum nanoparticles in the biomedical field is unstable every year. Research fluctuations occurred from 2012-2018 (57, 53, 72, 63, 75, 70, 93 publications per year respectively). In 2019-2020 there was an increase in research, namely from 118 studies (2019) to 149 studies (2020) and in 2021-2022 there was a decrease in research, from 147 studies (2020) to 88 studies (2022). This research is expected to help and become a reference for other research as consideration for determining the research theme to be taken.

Keywords: bibliometric, biomedic, nanoparticles, platinum

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1. Introduction

Platinum nanoparticles (PtNPs) have received a lot of attention for their various applications which include the chemical industry, the automotive sector, the biomedical field, and the therapeutic field [1] . In particular, PtNPs have attracted researchers' interest in their biomedical uses which can be attributed to their excellent biocompatibility, high surface/mass ratio, small size, high reactivity, and electrocatalytic [2], which is why they have been used as nanoenzymes due to their excellent behavior. similar to superoxide dismutase and catalase [2]. In addition, the optical characteristics of PtPNs associated with surface plasmon resonance (SPR) allow them to be candidates as radiotherapy agents. With respect to other metal nanoparticles, PtPNs have been reported to have higher catalytic activity compared to palladium nanoparticles. PtPNs have a greater cytotoxic effect, which can be used in cancer therapy because platinum ions can interact with DNA inhibiting its replication [3] . PtPNs also exhibit antibacterial activity against Gram-positive and Gram-negative pathogens, which are similar to silver nanoparticles (AgPNs), although these exhibit greater toxicity than PtPNs, which limits their clinical use [4].

Nanomedicine is an aspect of nanotechnology that continues to develop because of its various applications in the biomedical field. It has been reported that nanoparticles used as nanotherapy have

higher desired effects compared to conventional drugs, this can be attributed to the surface functionalization, which improves solubility, biocompatibility and specific targeting capacity. Metal nanoparticles can be functionalized by conjugating antibodies, nucleic acids, peptide ligands, and drugs on their surfaces [5]. Recently, researchers have reported the selectivity of functionalized platinum nanoparticles on cancer cells via specific pathways. They can also potentiate radiotherapy because they accumulate specifically at the tumor site. Platinum nanoparticles have also been used in disease diagnosis. Therefore, this review focuses on recent reports on the functionalization of platinum nanoparticles with bioactive molecules such as antibodies, biocompatible polymers, peptides, and biomolecules, among others, and their biomedical applications.

Analysis of bibliometric data that is displayed visually through a mapping tool will be very helpful to map the trends of the research being carried out. Based on Al Husaeni and Nandiyanto (2022) [6] Bibliometrics can be a tool used to evaluate research trends qualitatively and quantitatively in a study from time to time. This method uses a literature database and the metrological characteristics of the literature. This method is quite popularly used to broaden the horizons of a particular research field. Free software available for bibliometric analysis is VOSviewer [7] [8] . This software is quite popular to use because besides being free it is also easy to use [9].

In this study, we analyze the trend of research conducted on the application of platinum nanoparticles in biomedicine in the period 2012 to 2022. This study aims to conduct a bibliometric analysis of the application of platinum nanoparticles in biomedicine with bibliographic data on article titles, keywords, and abstracts. Bibliometric analysis was performed using VOSviewer software on data that had been collected with Publish or Perish. This research is expected to help and become a reference for other researchers as a consideration for determining the research theme to be taken.

2. Method

The research data used in this study is research data obtained from articles published in journals indexed by Google Scholar. Google Scholar is used because the site can be accessed for free, in contrast to Scopus which is not freely accessible. In this study, Publish or Perish as the reference manager was used to obtain research data. Every article data obtained must be from articles indexed by Google Scholar and have relevance to the themes needed in this research and will then be backed up in a file that will be used for analysis with VOSviewer.

The research was conducted through several stages:

(i) Collection of publication data using the publish or perish application.
(ii) Processing of bibliometric data for articles that have been obtained using Microsoft Excel application.
(iii) Computational mapping analysis of bibliometric publication data using the VOSviewer application.
(iv) Analysis of computational mapping results.

In this study, each article was screened only articles related to the biomedical application of platinum nanoparticles. This data was obtained through a search on the Publish or Perish application with the keywords "platinum, nanoparticle, biomedic" which matched the title, keyword, and abstract criteria. From the search results, obtained 985 articles that match the selected topics published in the 2012-2022 range. The data obtained were then collected and stored in RIS format. Furthermore, analysis using VOSviewer to visualize and analyze trends using bibliometric maps. The data obtained are divided into three types, namely, network visualization, density, and overlay. In addition, the search for terms that will be included in the visualization of the VOSviewer network mapping.

3. Result and Discussion

3.1 Publication data search results

Based on data searching through the publish or perish application from the Google Scholar database, 985 article data were obtained that met the research criteria. The data obtained in the form of article metadata consisting of the author's name, title, year, journal name, publisher, number of citations, article links, and related URLs. Table 1 shows some examples of published data used in the VOSviewer analysis of this study. Data samples were taken from the 20 best articles that had the highest number of citations.

Table 1. Publication data of platinum nanoparticles in biomedicine

No	Authors	Title	Year	Cites
1	I Khan, K Saeed, I Khan	Nanoparticles: Properties, applications and toxicities	2019	2908
2	XF Zhang, ZG Liu, W Shen, S Gurunathan	Silver nanoparticles: synthesis, characterization, properties, applications, and therapeutic approaches	2016	1856
3	W Yu, H Xie	A review on nanofluids: preparation, stability mechanisms, and applications	2012	1597
4	S Jain, DG Hirst, JM O'Sullivan	Gold nanoparticles as novel agents for cancer therapy	2012	1085
5	J Singh, T Dutta, KH Kim, M Rawat, P Samddar	'Green'synthesis of metals and their oxide nanoparticles: applications for environmental remediation	2018	912
6	SH Lee, BH Jun	Silver nanoparticles: synthesis and application for nanomedicine	2019	748
7	P Kuppusamy, MM Yusoff, GP Mania.	Biosynthesis of metallic nanoparticles using plant derivatives and their new avenues in pharmacological applications–An updated report	2016	742
8	K Jyoti, M Baunthiyal, A Singh	Characterization of silver nanoparticles synthesized using Urtica dioica Linn. leaves and their synergistic effects with antibiotics	2016	683
9	A Abdal Dayem, MK Hossain, SB Lee, K Kim	The role of reactive oxygen species (ROS) in the biological activities of metallic nanoparticles	2017	646
10	J Estelrich, MJ Sánchez-Martín	Nanoparticles in magnetic resonance imaging: from simple to dual contrast agents	2015	575
11	BY Xia, HB Wu, X Wang, XW Lou	One-Pot Synthesis of Cubic PtCu3 Nanocages with Enhanced Electrocatalytic Activity for the Methanol Oxidation Reaction	2012	563
12	M Moritz, M Geszke-Moritz	The newest achievements in synthesis, immobilization and	2013	557

		practical applications of antibacterial nanoparticles		
13	V Sanna, N Pala, M Sechi	Targeted therapy using nanotechnology: focus on cancer	2014	556
14	D Lombardo, MA Kiselev, MT Caccamo	Smart nanoparticles for drug delivery application: development of versatile nanocarrier platforms in biotechnology and nanomedicine	2019	530
15	J Conde, G Doria, P Baptista	Noble metal nanoparticles applications in cancer	2012	515
16	Y Dai, H Xiao, J Liu, Q Yuan, P Ma	In Vivo Multimodality Imaging and Cancer Therapy by Near-Infrared Light-Triggered trans-Platinum Pro-Drug-Conjugated Upconverison Nanoparticles	2013	499
17	S Vardharajula, SZ Ali, PM Tiwari, E Eroğlu	Functionalized carbon nanotubes: biomedical applications	2012	475
18	S Ponarulselvam, C Panneerselvam, K Murugan	Synthesis of silver nanoparticles using leaves of Catharanthus roseus Linn. G. Don and their antiplasmodial activities	2012	457
19	D Sharma, S Kanchi, K Bisetty	Biogenic synthesis of nanoparticles: a review	2019	445
20	SE Lohse, CJ Murphy	Applications of colloidal inorganic nanoparticles: from medicine to energy	2012	441
21	N Pantidos, LE Horsfall	Biological synthesis of metallic nanoparticles by bacteria, fungi and plants	2014	421
22	AP Blum, JK Kammeyer, AM Rush	Stimuli-responsive nanomaterials for biomedical applications	2015	417
23	BY Xia, HB Wu, Y Yan, XW Lou…	Ultrathin and ultralong single-crystal platinum nanowire assemblies with highly stable electrocatalytic activity	2013	405
24	PG Jamkhande, NW Ghule, AH Bamer	Metal nanoparticles synthesis: An overview on methods of preparation, advantages and disadvantages, and applications	2019	399
25	S Sarkar, E Guibal, F Quignard	Polymer-supported metals and metal oxide nanoparticles: synthesis, characterization, and applications	2012	390
26	AC Anselmo, S Mitragotri	A review of clinical translation of inorganic nanoparticles	2015	386
27	SC Baetke, T Lammers	Applications of nanoparticles for diagnosis and therapy of cancer	2015	367

28	G Sharma, A Kumar, S Sharma, M Naushad	Novel development of nanoparticles to bimetallic nanoparticles and their composites: A review	2019	367
29	IL Bergin, FA Witzmann	Nanoparticle toxicity by the gastrointestinal route: evidence and knowledge gaps	2013	361
30	S Rajeshkumar, S Menon, SV Kumar	Antibacterial and antioxidant potential of biosynthesized copper nanoparticles mediated through Cissus arnotiana plant extract	2019	357
31	KS Soni, SS Desale, TK Bronich	Nanogels: An overview of properties, biomedical applications and obstacles to clinical translation	2016	346
32	JK Patra, KH Baek	Green nanobiotechnology: factors affecting synthesis and characterization techniques	2014	346
33	P Elia, R Zach, S Hazan, S Kolusheva	Green synthesis of gold nanoparticles using plant extracts as reducing agents	2014	328
34	B Ramezanzadeh, Z Haeri	A facile route of making silica nanoparticles-covered graphene oxide nanohybrids (SiO2-GO)	2014	325
35	M Xuan, Z Wu, J Shao, L Dai, T Si	Near infrared light-powered Janus mesoporous silica nanoparticle motors	2016	325
36	H Padalia, P Moteriya, S Chanda	Green synthesis of silver nanoparticles from marigold flower and its synergistic antimicrobial potential	2015	316
37	CH Wu, IJ Liu, RM Lu, HC Wu	Advancement and applications of peptide phage display technology in biomedical science	2016	295
38	S Ahmed, S Ikram	Biosynthesis of gold nanoparticles: a green approach	2016	290
39	G Unsoy, S Yalcin, R Khodadust, G Gunduz	Synthesis optimization and characterization of chitosan-coated iron oxide nanoparticles produced for biomedical applications	2012	288
40	S Mukherjee, S Paria	Preparation and stability of nanofluids-a review	2013	267
41	P Malik, R Shankar, V Malik, N Sharma	Green chemistry based benign routes for nanoparticle synthesis	2014	266
42	SZH Naqvi, U Kiran, MI Ali, A Jamal	Combined efficacy of biologically synthesized silver nanoparticles and different antibiotics against multidrug-resistant bacteria	2013	265
43	D Ramimoghadam, S Bagheri	Progress in electrochemical synthesis of magnetic iron oxide nanoparticles	2014	259

44	R Kaur, I Badea	Nanodiamonds as novel nanomaterials for biomedical applications: drug delivery and imaging systems	2013	250
45	T Maiyalagan, X Dong, P Chen, X Wang	Electrodeposited Pt on three-dimensional interconnected graphene as a free-standing electrode for fuel cell application	2012	244
46	M Khan, M Khan, SF Adil, MN Tahir	Green synthesis of silver nanoparticles mediated by Pulicaria glutinosa extract	2013	239
47	F Jia, X Liu, L Li, S Mallapragada, B Narasimhan	Multifunctional nanoparticles for targeted delivery of immune activating and cancer therapeutic agents	2013	235
48	LKEA Abdelmohsen, F Peng, Y Tu	Micro-and nano-motors for biomedical applications	2014	226
49	K Vijayaraghavan, T Ashokkumar	Plant-mediated biosynthesis of metallic nanoparticles: a review of literature, factors affecting synthesis, characterization techniques and applications	2017	226
50	MS Wason, J Zhao	Cerium oxide nanoparticles: potential applications for cancer and other diseases	2013	226

3.2 Research Developments in the Field of Applications of Platinum Nanoparticles in Biomedical

This study analyzes the development of research on the application of platinum nanoparticles in biomedicine which was carried out in the period 2012 to 2022. **Figure 1** shows the curve of the application of platinum nanoparticles in biomedicine for 10 years. Based on **Figure 1**, it can be seen that the research related to the application of platinum nanoparticles in biomedicine is quite a lot but the research shows that the application of platinum nanoparticles in the biomedical field is unstable every year. Research fluctuations occurred from 2012-2018 (57, 53, 72, 63, 75, 70, 93 publications per year respectively). In 2019-2020 there was an increase in research, namely from 118 studies (2019) to 149 studies (2020) and in 2021-2022 there was a decrease in research, from 147 studies (2020) to 88 studies (2022).

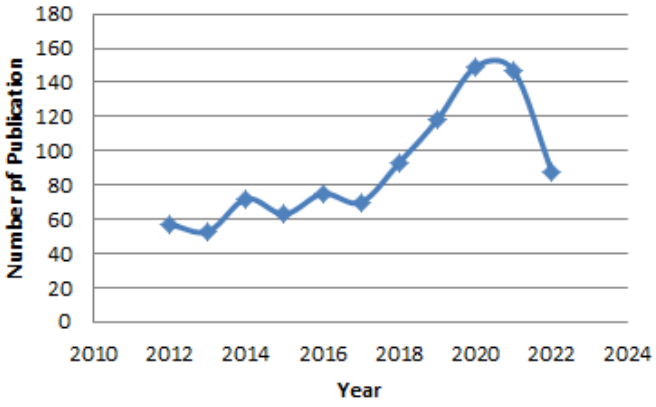

Figure 1. Progress of application of platinum nanoparticles in biomedicine

3.3 Visualization of Applications of Platinum Nanoparticles in Biomedical using VOSviwer

Research related to the application of platinum nanoparticles in biomedical analysis based on mapping visualization is divided into 8 clusters, namely:

(i) Cluster 1 has 44 items, 44 items are advancement, anticancer agent, biomedical application, biomedical imaging, biomedical purpose, cancer, cancer therapy, chemical, chemotherapy, cisplatin, co delivery, delivery, drug, drug delivery, drug delivery system, effect, efficacy, example, facile synthesis, Fe_3O_4, inorganic nanoparticle, iron oxide nanoparticle, light, magnetic nanoparticle, mesoporous silica nanoparticle, msn, nanomaterial, nanoparticle, nanotechnology, platinum drug, poly, preparation, recent progress, researcher, self assembly, silica, silica nanoparticle, superparamagnetic iron, system, therapy, toxicity, tumor, use, vitro.

(ii) Cluster 2 has 37 items, 37 items are ability, advantage, analysis, biomedical research, biosensor, carbon, carbon nanotube, carbon paste electrode, composite, counter electrode, detection, determination, development, distribution, dopamine, efficiency, electrode, environmental application, glassy carbon electrode, glucose, graphene, graphene oxide, hyperthermia, magnetite nanoparticle, metal oxide, nanomedicine, palldium nanoparticle, platinum nanoparticle, platinum wire, possibility, role, sensitive detection, sensor, structure, surface.

(iii) Cluster 3 has 31 items, 31 items has addition, antibacterial application, antioxidant activity, biogenic synthesis, biological application, biological property, biomedical science, biomedicine, catalysis, catalytic application, cathode, cytotoxicity, fept, fept nanoparticle, field, hyfrogel, iron platinum nanoparticle, mechanism, modification, nanoparticle synthesis, oxide nanoparticle, physicochemical properties, plant extract, protein, recent advance, solution, state, step, synthesis. Zinc oxide nanoparticle.

(iv) Cluster 4 has 28 items, 28 items are AgNP, agriculture, antibacterial activity, anticancer, anticancer activity, attention, Au NP, bimetallic nanoparticle, biosynthesis, cancel cell, characterization, copper, cytotoxic activity, eco friendly synthesis, engineering, iron nanoparticle, medicine, metal, metal nanoparticle, metallic nanoparticle, noble metal, palladium, platinum, silver, silver nanoparticle, titanium , utilization, zinc.

(v) Cluster 5 has 25 items, 25 items are antimicrobial activity, bacterium, biological synthesis, biomedical use, cell, cytotoxic effect, dose, form, great

potential, green synthesis, influence, interaction, microorganism, oxidative stress, particle size, platinum electrode, potential biomedical application, present study, product, production, property, shape, stability, synthesized nanoparticle, zno nanoparticle.

(vi) Cluster 6 has 21 items, 21 items are catalyst, cobalt, core, diagnosis, hydrogen peroxide, imaging, ionic liquid, iron oxide, layer, ligand, metal oxide nanoparticle, morphology, particle, polymer, presence, pt nanoparticle, pt np, reaction, sample, sensing, water.

(vii) Cluster 7 has 15 items, 15 items are activity, amount, au nanoparticle, biomedical field, biomedical study, breast cancer, catalytic activity, challenge, coating, nanostructure, nanozyme, platinum np, progress, tio, treatment.

(viii) Cluster 9 has 8 items, 8 items are agent, biocompability, comprehensive review, mouse, potential, potential application, selenium, selenium nanoparticle.

3.4 Research developments in the field of Application of Nanoparticles in Biomedical

The visualization network displays the relationship between the terms found and visualized through the displayed image. Based on Al Husaeni and Nandiyanto (2022) **Figure 2** shows the relationship between the terms found described by a network or line connecting one term to another. From **Figure 2** it can be seen that each term found is divided into several clusters. The term platinum nanoparticles are combined in cluster 2 and connected to cluster 3 and cluster 4. In clusters 1 and 4 the biomedical terms and platinum are found. While in cluster 1 found the term nanoparticle. The term nanoparticle has 207 links with a total link strength of 2913, the term platinum has 184 links with a total link strength of 1391, and the term biomedical has 34 links with a total link strength of 48.

In this visualization, the cluster size indicates the number of publications. The bigger the cluster, the more publications. The distance between clusters shows the relationship between clusters in the quote. The closer the distance between the clusters, the stronger the attachment. Curved lines connecting groups represent the interrelationships between items [31] . The mapping visualization analyzed in this study consists of 3 parts: network visualization (see **Figure 2**), density visualization (see **Figure 3**), and overlay visualization (see **Figure 4**).

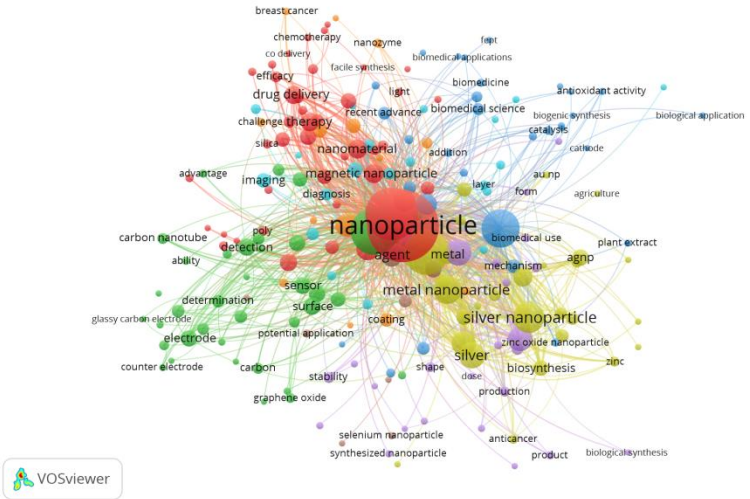

Figure 2. Visualization of the platinum, nanoparticle, biomedic keyword network.

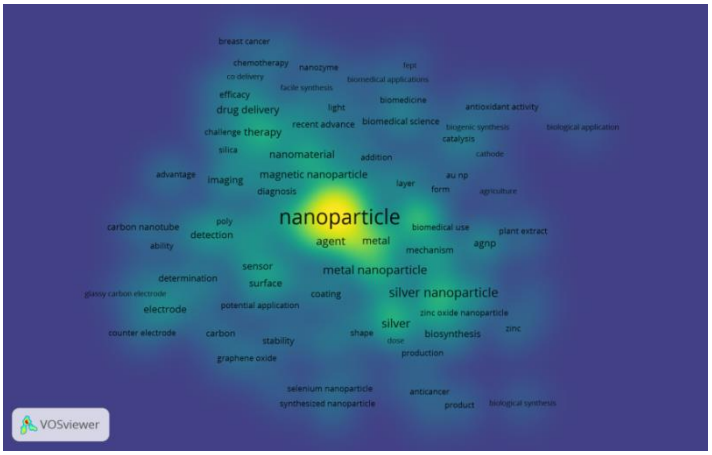

Figure 3. Density Visualization application of platinum nanoparticles in biomedicine

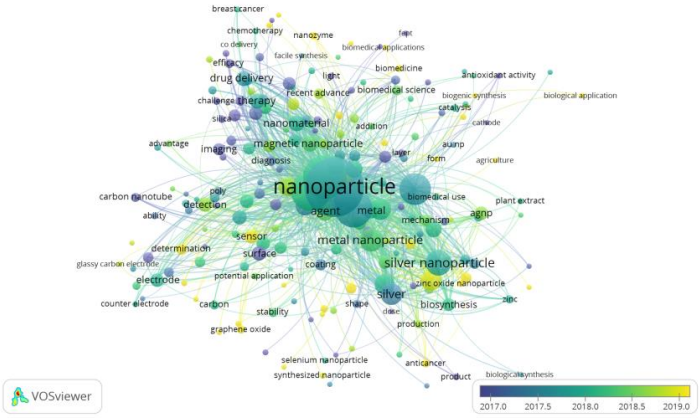

Figure 4. Overlay Visualization of platinum nanoparticles in biomedicine

4. Conclusion

In this study, bibliometric analysis was carried out related to the application of platinum nanoparticles in biomedicine using VOSviewer. The data analyzed was obtained from the reference manager application, namely Publish or Perish. The data collected are articles published from 2012 to 2022 which are filtered based on the keywords “nanoparticle, platinum, biomedic” with the term nanparticle having 207 links with a total link strength of 2913, the term platinum having 184 links with a total link strength of 1391, and the term biomedical. has 34 links with a total link strength of 48. The bibliographic data used in this study are topics, titles, keywords, abstracts. Based on the research results obtained 985 articles relevant to these keywords. By searching the data using the keywords “nanoparticle, platinum, biomedic”, you get 8 clusters with various number of terms.

5. Reference

[1] M. Jeyara, S. Gurunathan, M. Qasim, M. Kang and J. Kim, "A Comprehensive Review on the Synthesis, Characterization, and Biomedical Application of Platinum Nanoparticles," *nanomaterials,* vol. 9, p. 1719, 2019.

[2] E. Boanini, P. Torricelli, P. Cassani, M. Rubini, K. Fini and M. Pagani, "Platinum nanoparticles supported on functionalized hydroxyapatite: Anti-oxidant properties and bone cells response," *Ceram. Int,* vol. 46, p. 19574–19582, 2020.

[3] H. Mohammadi, A. Abedi, A. Akbarzadeh, A. Mokhtari, H. Shahmabadi and H. Mehrabi, "Evaluation of synthesized platinum nanoparticles on the MCF-7 and HepG-2 cancer cell lines," *Int. Nano Lett,* vol. 3, p. 28, 2013.

[4] R. Nisanthi, S. Malathi, S. P. John and P. Palami, "Green synthesis and characterization of bioinspired silver, gold and platinum nanoparticles and evaluation of their synergistic antibacterial activity after combining with different classes of antibiotics," *MaterSci. Eng. C,* vol. 96, pp. 693-707, 2019.

[5] A. Abed, M. Derakhshan, M. Karimi, M. Shiramizinia, M. T. Mahjoubin and M. Homayonfal, "Platinum Nanoparticles in Bio medicine: Preparation, Anti-Cancer Activity, and Drug Delivery Vechicles," *Front.Pharmacol,* vol. 13, p. 797804, 2022.

[6] F. D. Al Husaeni, " Bibliometric using vosviewer with publish or perish (using google scholar data): from step-by-step processing for users to the practical examples in the analysis of digital learning articles in pre and post covid," *ASEAN Journal of Science and Engineering*, vol. 2(1), pp. 19-46, 2022.

[7] E. Garfield, "Citation analysis as a tool in journal evaluation," *Essays of an Information* , vol. 1(178), pp. 527-544, 1972.

[8] A. T. Malik, "The top 50 most-cited articles on cervical spondylotic myelopathy," *World Neurosurgery*, vol. 116, pp. 168-180, 2018.

[9] E. a. Orduña-Malea, " Link-based approach to study scientific software usage The case of VOSviewer," *Scientometrics,* vol. 126(9), pp. 8153-8186, 2021.

[10] N. J. Eck, " Citation-based clustering of publications using CitNetExplorer and VOSviewer," *Scientometrics*, vol. 111(2), pp. 1053-1070, 2017.