

# VOSviewer Analysis of Studies on Software Selection in the Logistics Sector

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**Abstract** – Outsourcing in logistics is an important step to reduce costs and increase operational efficiency. In this sense, it is possible to come across outsourcing in many areas of logistics processes. One of the outsourcing steps is the decision to select the software. Choosing the right software can affect the market share of the organization and the implementation time, effort, and cost. The findings of this research will help the marketing and sales teams of software product companies to develop key points and also enable end users to make informed decisions in selecting software packages for the organization. In this study, the studies in the literature were examined through the Scopus database, and co-citation analysis was performed using the VOSviewer program. As a result of the analysis, the articles analyzed were divided into four clusters and explained.

**Index Terms** — Logistics, Software Selection, VOSviewer

## I. INTRODUCTION

In a changing business world, businesses face increasing global competition, expanding international markets, and rising customer expectations. These changes pressure businesses to reduce total costs along the entire supply chain, shorten production time, reduce inventories, expand product selection, provide better lead times and customer service, improve quality, and effectively coordinate global demand, supply, and production. More than ever, businesses must change and improve their business processes and practices as they build an integrated model. To do so, they must increasingly share the internal information they once sought to protect with their suppliers, distributors, and even customers (Loizos, 1998). They also have to improve their internal functions to produce and utilize accurate and timely instant information. To achieve all these objectives, companies are turning to software systems.

Software systems are the backbone of the organization. To capture the continuity of change in an intensely competitive environment and to find solutions that are compatible with goals and policies, it is necessary to choose the right software technologies at the beginning. The compatibility of the selected software with the organization's existing human resources and information resources is important.

This article examines the criteria considered in the software selection process. In this context, the studies in the literature were analysed by bibliometric analysis method, and a map of the studies was drawn. VOSviewer program was used for mapping and analysis processes.

Selecting a software program can be difficult since it requires a careful consideration of many conflicting factors in order to meet the needs of the company. As a result, scientists are working to develop more useful standards for evaluating and selecting software products. In order to improve the software selection process, the current study reviews earlier studies on assessing and choosing software packages. Consequently, we tackle the subsequent research inquiries:

- RQ1: How can one analyze the relationships between articles using the VOSviewer program?
- RQ2: What processes do companies follow when choosing software?
- RQ3: What role does literature have in the assessment and choice of software packages?
- RQ4: What is the distribution of software selection criteria-related articles in the literature?

Using the Scopus database, a thorough literature analysis was carried out to find all pertinent articles in order to answer these research questions. The four sets of articles were subjected to a more thorough analysis using VOSviewer in order to address the research questions and offer recommendations for further

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investigations. In order to establish a standard and meet the demands of modern organizations, the software selection criteria mentioned in the literature were analysed and rearranged in the study's second section.

## II. METHODOLOGY

Bibliometric mapping, an important research approach in the field of bibliometrics, is a program or software-based analysis technique that involves the analysis and visualization of a wide range of scientific studies in a particular field. The program aims to present the conceptual, social or intellectual structure, development process and dynamics of the scientific research field with visual outputs (Gupta, 2021). VOSviewer is a free, open-source ([www.neesjanvaneck.nl/vos/](http://www.neesjanvaneck.nl/vos/)) bibliometric mapping program that allows the creation of maps based on network, bibliographic and textual data, their visualization and exploration in various contexts detailed in the following sections. The program, developed by Nees Jan van Eck and Ludo Waltman, uses author, country, journal, citation, keywords, abstract, and funding agency data to create maps based on existing or researcher-created data. Van Eck and Waltman (2010, p. 536) point out that unlike many programs used for bibliometric mapping, VOSviewer pays special attention to the graphical representation of bibliometric maps and emphasizes that the program visualizes bibliometric maps, especially those consisting of large data, in an easy-to-interpret format.

Looking at the relevant literature, it is seen that the VOSviewer program has been used in a large number of studies in the last decade, such as social, humanities and administrative sciences (Santos, Marques, & Ferreira, 2018), engineering (Bornmann & Haunschild, 2016), sustainable maritime transportation (Mollaoglu et al. 2023), sports sciences (Yamanaka, Campos, Roble, & Mazzei, 2021), health sciences (Imani, Mirezati, & Saberi, 2019), educational sciences (Wang, Liu, Li, & Gao, 2017). When the topics covered in the studies are evaluated, it is seen that they are mainly used to provide an overview of the topics studied in the research field, to identify research trends, to reveal the concepts emphasized in the research, to draw attention to the pioneering researchers who contribute to the field and the actors who play a leading role in the efficiency of the country, resources and institutions. It is understood that the analysis techniques used for these purposes are bibliographic matching, co-citation, co-authorship, citation network, concept association; and the units of analysis are author, document, source, country, institution, abstract, keywords (Bornmann & Haunschild, 2016; Gurbur, et al, 2021; Imani, et al., 2019; Onyancha, 2018; Santos, et al., 2018; Tomaszewski, 2020; Wang, et al., 2017; Zhao, et al., 2019). The increase in the number of studies conducted with the VOSviewer program every year has made it necessary to conduct studies that provide guidelines for the use of the program. Accordingly, in the international (McAllister, Lennertz, & Atencio Mojica, 2022; Orduña-Malea & Costas, 2021; van Eck & Waltman, 2022) and national literature (Artsin, 2020), the existence of applied and technical studies that provide guidelines for researchers in the use of VOSviewer draws attention.

In this study, the Vosviewer method was used for analysis. Scopus database was used to obtain the data to be analyzed. Scopus is a source-independent abstract and citation database with more than 1.8 billion cited references; more than 87 million archival records; 17.6 million author profiles; 94.8 thousand institutional memberships and finally more than seven thousand publishing organizations since 1970 (Scopus, 2022). The scopus database is frequently used in bibliometric analysis research because it includes articles published in elite journals. The "Logistics or supply chain and software selection" keywords entered into the database were searched. The year range is set from 1994 to the present (the first article is found in 1994.) Only articles in English were selected. As a result, 258 articles were accessed as of September 2023. The distributions of the 190 studies by year, country, and study type are shown in Figures 1, 2, and 3, respectively. 101 studies were excluded for being outside the scope of the study by the VOSviewer program.

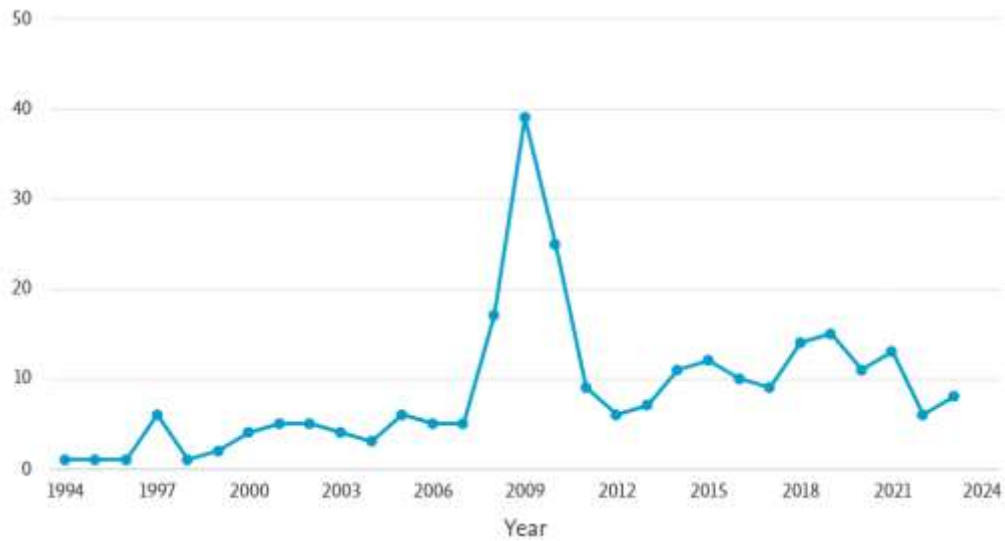


Figure 1. Annual Number of Studies on Topic

Figure 1 shows the distribution graph of the studies by year. According to this, it was observed that the studies on software selection in logistics and supply chain increased in 1997, 2009, 2019, and 2021. The highest increase was experienced in 2009. The graph shows that the number of studies is also on the rise today.

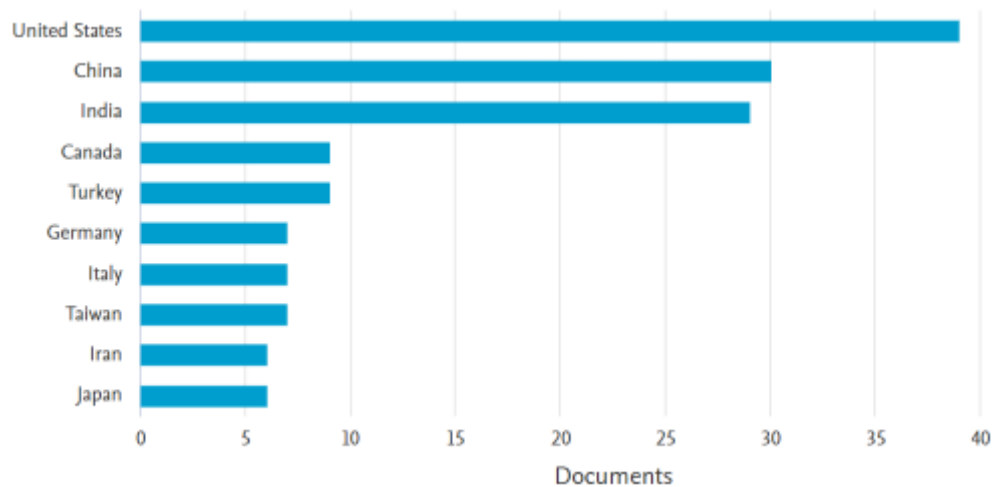
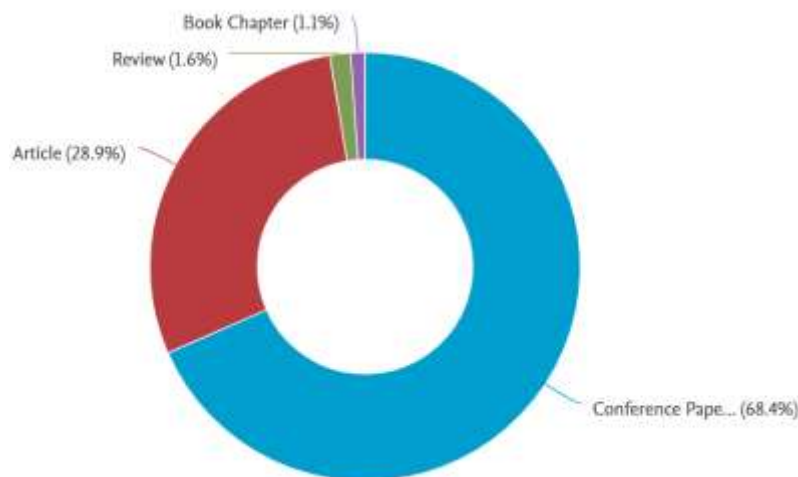


Figure 2. Documents by Country of Studies on Topic

Figure 2 shows the top ten countries that have conducted studies on software selection in the logistics and supply chain sector. The top three countries with the most studies are the USA, China, and India.



**Figure 3.** Documents by Type of Studies

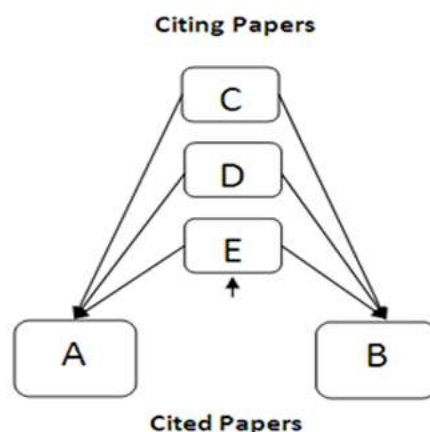
Figure 3 shows the distribution of studies on the topic according to study types. The most common studies were Conference papers (61.7%), journal articles (34.5%) and reviews (1.5%).

### III. ANALYSIS

In this section, the data obtained will be analysed. The results of the study will be presented by mapping method.

#### A. Co-Citation Analysis

Co-citation analysis is a variant of traditional citation analysis (Zupic & Cater, 2015, p. 431), and co-citation studies, including author co-citation analysis, are among the most widely used methods in quantitative science studies (Chen, Ibekwe-SanJuan, & Hou, 2010, p. 1386). In their independent studies, Marshakova and Small developed the co-citation approach in a variation similar to bibliographic matching (Marshakova, 1973; Small, 1973). This approach bases the relationship between two objects on the number of times the two objects are co-cited. Document classification is the goal of the similarity assessment. The document, its author, and the journal in which it is published are all included in the classified levels. If the number of times two sources are cited at the same time increases over time, it can be stated that there is a similar relationship between these two sources. It is also stated that the more the number of citations given to these two sources together, the stronger the co-citation power will be (Zan, 2019).



**Figure 4.** Co-citation Coupling

An example of co-citation is shared in Figure 4. In Figure 4, papers A and B are associated because they are co-cited in the reference list of papers C, D, and E. If papers A and B are both cited by many other papers, they have a stronger relationship. The more papers they are cited, the stronger their relationship is. The co-citation frequency is defined as the frequency with which two documents are cited together (Surware G., et al. 2011).

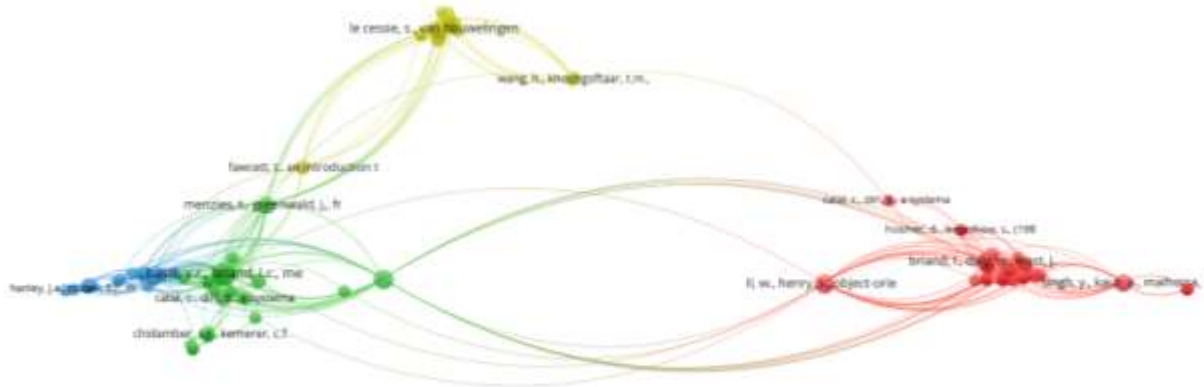


Figure 5. Co-citation Network Map for Studies

Figure 5 shows the co-citation maps of the studies. The articles were divided into 4 clusters with the Vosviewer program. clusters are shown on the map in red, blue, green, and yellow. The map shows a clear segregation of articles in the red group. The articles in green have connections with articles in other groups. While they have a strong connection with the articles in the blue group, their connection with the articles in the yellow and red groups is weak. Also, table 1 shows the most cited articles in the field.

Table 1. Most cited articles

Rank	Author	Article
1	Singh and Choubisa (2010)	Empirical validation of values in action-inventory of strengths (VIA-IS) in Indian context
2	Arar and Ayan (2016)	Deriving thresholds of software metrics to predict faults on open source software; Replicated case studies
3	Malhotra and Bansal (2015)	Fault prediction considering threshold effects of object-oriented metrics
4	Ghotra, Mcibtosch and Hassan (2015)	Revisiting impact of classification techniques on the performance of defect prediction models
5	Singh, Kaur and Malhotra (2009)	Comparative analysis of regression and machine learning methods for predicting fault proneness models
6	Malhotra (2012)	A defect prediction model for open source software
7	Malhotra (2014)	Comparative analysis of statistical and machine learning methods for prediction faulty modules
8	Singh (2008)	Predicting software fault proneness model using neural network
9	Li and Leung (2014)	Bayesian prediction of fault-preneness of agile-developed object-oriented system
10	Afzal (2010)	Using faults-slip-through metric as a predictor of fault-proneness

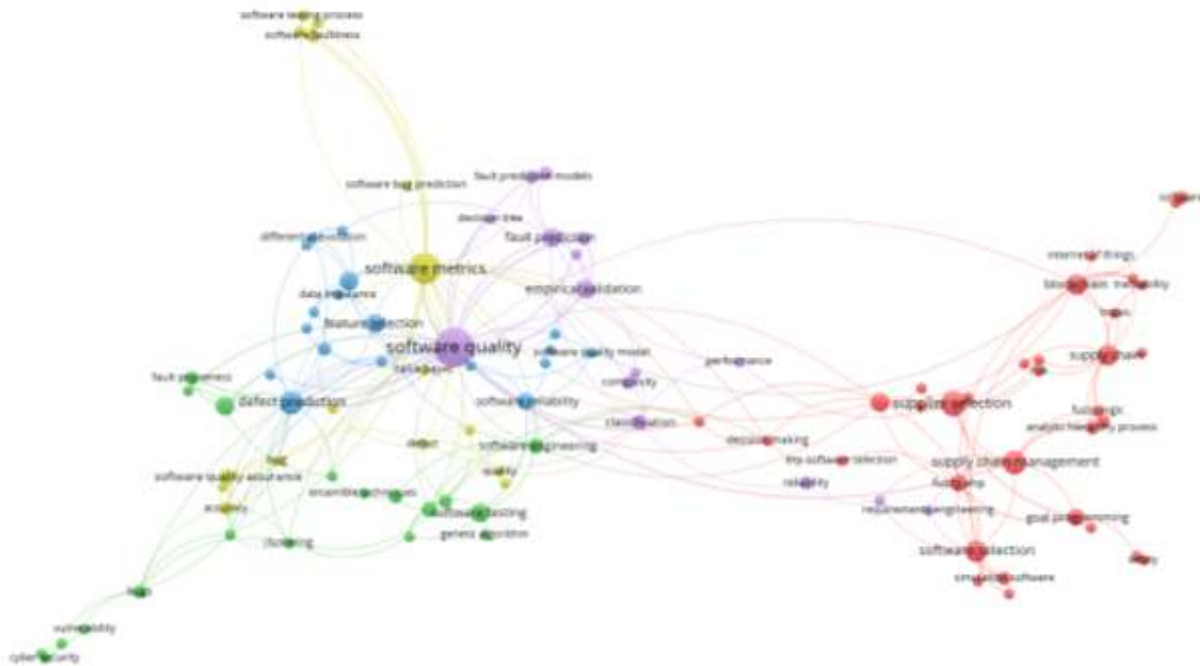


Figure 6. Author-Keywords Map

Figure 6 shows the author-keywords map of the studies on software selection in logistics and supply chain. Using VOSviewer to visualize frequently occurring keywords, a network based on author-defined keywords has been built to investigate the keywords linked to the publications in our dataset. We have chosen 107 terms and set a threshold of at least two occurrences to help us concentrate on the main areas of inquiry. The keywords were analyzed by dividing them into five groups. The most used keyword in the yellow group is “software metrics”. In the purple group, the keyword with the most links was “software quality”. In the red group, the most used keyword was “software selection”. In the blue group, the most used keyword was “defect prediction”. Finally, the most used keyword in the green group is “software testing”.

Table 2. Most Used Keywords in General

Rank	Keyword
1	Software Quality
2	Software Metrics
3	Empirical Validation
4	Fuzzy AHP
5	Supply Chain Management

Table 2 shows the five most commonly used criteria in the literature. When we look at the criteria, the methods used in software selection draw attention.

#### B. Cluster Component Analysis

In the study, the studies were divided into four groups. As can be seen in Figure 5, the article groups are far apart. This is due to the difference in the content, scope or methods used of the studies. For this reason, it is not easy to create homogeneous clusters. When the clusters are looked at in general, it can be seen that the AHP method is the most frequently used method. The TOPSIS method, used together with the AHP

method, is also a frequently used method. Researchers who want to differentiate themselves from the literature have recently used Hybrid methods and Fuzzy methods.

Many articles in the reviewed studies provide a preferred list of evaluation criteria for evaluating a particular software package; However, there seems to be a lack of a common list. Software evaluation criteria are not clearly defined and explained in the literature. The exact meaning of a criterion depends on the evaluator's interpretation, so authors may use different wording for the same criterion in the same literature, creating confusion and uncertainty for the software evaluator. As a result of the examination of the studies, the criteria used to create a common language were collected together as the main criteria in the continuation of the study.

### C. Software Selection Criteria

The majority sought to identify the selection criteria for software, with the remaining studies primarily focusing on applying the criteria. Remarkably, a thorough examination of the requirements did not turn up a shared list (Jadhav and Sonar, 2009). The standards do not yet satisfy the needs of enterprises, and new applications are being developed to promote sustainable activities, particularly in state institutions. This is another significant aspect. The insufficiency of the requirements fulfilling these and related circumstances hinders enterprises from fulfilling their present requirements.

Our goal in this study was to help organizations choose software by emphasizing these two aspects. To establish a common language, the criteria indicated in the examined papers were combined and made simpler.

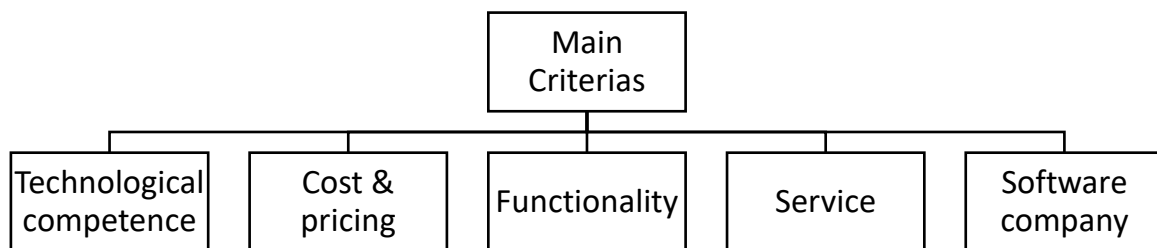


Figure 7. Main Software Selection Criterias

Figure 7 shows the list of criteria created. While some studies used 4 criteria, others used up to 40 criteria. For ease of implementation, the number of criteria were kept at an average number and the criteria were analyzed and grouped under five main headings.

## IV. DISCUSSION AND CONCLUSIONS

In information system projects carried out in enterprises, the software selection phase is the most important part of the project. Because once the software decision is made and the software package is purchased, there is no going back. Today, in many enterprises, it is seen that software selections made without a detailed system analysis study and as a result of this, without a detailed list of requirements are unsuccessful. Another problem in software selection in information system projects is which software package to choose according to the list of requirements. Because there are many software packages in the

market. The business-specific criteria created in the requirements list will determine which software package will be selected.

When examined in the Scopus database, it was seen that there were 190 studies in this field in the literature. By analysing 190 studies, it is aimed to benefit researchers and the sector.

The most important steps in evaluating software packages are identifying the criteria to be considered, assigning a weight to each criterion, creating a rating scale for each criterion, calculating the score, ranking the options and selecting the best one. Many papers provide a preferred list of evaluation criteria for evaluating a particular software package; however, there seems to be a lack of a common list. Software evaluation criteria are not clearly defined and explained in the literature. The precise meaning of a criterion depends on the evaluator's interpretation, so authors may use different wording for the same criterion in the same literature, thus creating confusion and uncertainty for the software evaluator. To overcome this problem, we have presented generic lists of evaluation criteria that can be applied in the evaluation of any software program.

In this study, the topography of such an important topic in the academic literature is discussed in detail by analysing it through VOSviewer. Detailed information on the selection of software, the countries with the most publications and citations, and the researchers are provided. Ultimately, the study serves as a guide for researchers. It is useful for researchers to familiarize themselves with the leading researchers, institutions and relatively new concepts in the literature and to save time before starting to study this phenomenon. In this respect, analysing through such software facilitates a quick familiarization with the field. In future studies, other database and other software tools such as Citespace and Biblioshiny can be used to provide a new perspective on the literature. Future work could create guidelines and develop an expert system to facilitate the decision-making process. This study used articles from a single database. Future work could extend the scope of the analysis by using different databases. In addition to this study, studies can be conducted on the use of software on a sectoral basis.

#### DECLARATION OF COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

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### VOSviewer analiza študij o izbiri programske opreme v logističnem sektorju

**Povzetek** - Podizvajanje v logistiki je pomemben korak za zmanjšanje stroškov in povečanje učinkovitosti poslovanja. Tako je podizvajanje možno na številnih področjih logističnih procesov. Eden od korakov podizvajanja je tudi odločitev o izbiri programske opreme. Izbira prave programske opreme lahko vpliva na tržni delež organizacije ter na čas, prizadevanja in stroške izvajanja. Ugotovitve te raziskave bodo pomagale trženjskim in prodajnim ekipam podjetij, ki proizvajajo programsko opremo, pri oblikovanju ključnih točk, prav tako bodo končnim uporabnikom omogočile sprejemanje informiranih odločitev pri izbiri programskih paketov za organizacijo. V tej raziskavi so bile obstoječe študije pregledane s pomočjo podatkovne zbirke Scopus, analiza socitiranja je bila opravljena s programom VOSviewer. Raziskave smo razdelili v štiri sklope in jih podrobno pojasnili.

**Ključne besede** - logistika, izbor programske opreme, VOSviewer