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Product-Oriented vs. Service-Oriented Software: A Comparative Bibliometric Analysis (2010–2025)

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Abstract

Objective: To identify key trends, contributors and themes in POS and SOS research. To examine the intellectual structure and collaboration networks within and between these research areas. To evaluate the alignment between academic discourse and broader changes in software industry practices. Methods: This research takes a bibliometric analysis method to compare and contrast academic studies on Product-Oriented Software (POS) and Service-Oriented Software (SOS) systematically. The Scopus database was chosen as the main source of data for this research. Two complementary tools were employed for analysis: VOSviewer, for visualizing co-authorship and keyword networks and Bibliometrix, for in-depth bibliometric analysis. Results: The analysis of 309 documents identified publication trends, leading sources, keyword evolution and author/institution contributions in POS and SOS research from 2010 to 2025. POS literature is primarily focused on commercialization, software product lines and firm capabilities. SOS literature demonstrates broader thematic diffusion covering SaaS models, architecture, cloud deployment and platform-based services. Conclusion: The study offers insights into the evolution of software business models and highlights directions for future research and practice. This study has many findings which helps to guide software companies and practitioners to frame their development policies to align with technological advancements.

Keywords: *Bibliometric Analysis, Product-Oriented Software, Service-Oriented Software, Software Industry, Software Development, SaaS, Cloud Computing.*

Introduction

The growth of the software business is a matter of changing balance between two dominant paradigms: service orientation and product orientation. The early decades of computing witnessed software being developed and sold primarily as a service.

But then personal computing arrived on the scene in the 1980s and 1990s and the industry started to move toward a product model. Software was being written, packaged and sold as a standalone product

In recent years, the pendulum has swung back towards service software (SOS) with the help of internet infrastructure, cloud computing and subscription-based models..

These changes are not only technical. They are an evolution of fundamental principles of how software is constructed, delivered, sold and serviced.

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- **Plain Language Summary:** This study looks at how research has changed over time in two ways of developing software: Product-Oriented Software (POS) and Service-Oriented Software (SOS). We used a method called bibliometric analysis to study trends in publications, key authors and important topics in these areas. We found that POS research focuses more on selling and managing software, while SOS research is broader, covering things like cloud computing and online software services.
- **Funding Statement:** The funding for this study is using self-funds of the two authors Padmakumar B. and Chinmoy Kumar. This research has not received or utilized any external grants or funding.
- **Ethical Compliance**: Ethical standards prescribed for institutional and/or National research committee has been followed in the procedures in the study. It is in line with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.
- **Data Access Statement**: The corresponding author can make available the data supporting this publication based on request.
- **Conflict of Interest declaration**: The authors declare that they have no affiliations with or involvement in any organization or entity with any financial interest in the subject matter or materials discussed in this manuscript.

Background and Context

The return of service orientation has been fueled by a number of technological developments.

In contrast, product-oriented software (POS) adheres more traditionally to development, licensing and version basedupdates..

Research Gap and Significance

Although both product-focused and service-focused approaches to software have gainedincreasing prominence, a lot of academic research has studied them individually.

There is an obvious lack of long-term, comparative bibliometric studies that show how academic interest in these two areas has changed over time..

This study addresses some of that gap by using bibliometric analysis to examine research output trends, contribution of authors and publication trends.

Research Objectives

This study conducts a comparative bibliometric analysis of Product-Oriented Software and Service-Oriented Software research between 2010 and 2025. The main objectives are:

- To identify key trends, contributors and themes in POS and SOS research.
- To analyze the intellectual structure and collaboration networks within and between these research areas.
- To assess the alignment between academic discourse and broader shifts in software industry practices.

These objectives are framed around the following research questions:

RQ1: How have publication patterns in POS and SOS evolved over time?

RQ2: Who are the leading authors, institutions and journals in each domain?

RQ3: What are the main research themes and clusters in POS and SOS literature?

RQ4: How interconnected are the two streams and what can be learned from their evolution?

Literature Review

This literature review discusses how the scholarly knowledge of Product-Oriented Software (POS) and Service-Oriented Software (SOS) has evolved over time.

- **Product-Oriented Software (POS)**
  - **Definition and Historical Context**

Product-Oriented Software (POS) is software that is written, packaged and sold as a complete product.

- **Academic Perspectives and Early Research Focus**

In research in academic settings, POS has been identified as associated with manufacturing and product management concepts..

- **Agile Development and Evolving Product Models**

With the advent of agile development techniques, there was a shift towards elastic, people-focused methods.

- **Architecture, Methods and Organizational Alignment**

Various studies have shown that the software architecture has impact on product success factors such as winning product creation, value delivery to customers. This has been mentioned by Lucassen, Brinkkemper et al. (2014).

- **Productization and Business Transformation**

The software business is all about understanding customer needs and developing software to assist the end-user and improve their productivity.

The service industry players have developed techniques by which they can productize the software from the custom-built code.

- **Software Product Management Challenges and Practices**

Springer, Miller and Wrobel (2023) identify 5 common problems in software product management and propose solutions to overcome them. They have come up with guidelines which form part of a software product management guide.

- **Startups and the Product Manager Role**

The startups have to use their funds judiciously, especially when rising interest rates make it harder for them. Pattyn (2023) observes this in his article.

Product Manager role can play a crucial role in success of startups. This is more so in the Requirements engineering aspect. Pattyn(2023) addresses this aspect.

- **Service-Oriented Software (SOS)**
  - **Definition and Technological Enablers**

Service-Oriented Software (SOS) is a new style where software is provided as an extended service instead of a product. Rather than buying and installing software locally, customers use it over the web using subscription or pay-per-use.

  - **Research Themes in SOS: Technical and Business Perspectives**

SOS research cuts across technical and business aspects. Technically, research addresses scalability, common access by several users (multi-tenancy), service integration and reliability of the system.

  - **Industry Case Studies and Frameworks**

The telecommunication industry is motivated by general cost-cutting approaches. Two examples are use of software-as-a-service(SaaS) and Open Sourcesoftware(OSSw).. This has been mentioned by Frank et al (2012).

Software industry is getting ready to transition to a subscription-based software-as-a-service(SaaS) model.

In the software industry, SaaS market has been a fast growing segment. Chunmian and Huang(2011) studied this and try to explain it.

As the software industry changes from delivering software on-premises, they face challenges. The challenge is while trying to deliver software on-demand..Kaltenecker et al(2015) state this and say it is a company survival issue.

There are business processes that need to be handled in a collaborative manner. Cancian, Teixeira, Rabelo (2015) mention that it is needed throughout lifecycle.

SaaS companies differ widely in the way they price their products. Saltan &Smolander (2021) in their study observe this heterogeneity

The new SaaS model calls for new product strategies. It is needed to address all aspects of the model. The existing software companies are forced to re-develop products. Moroz, Saltan, Hyrynsalmi (2022) explain this and introduced a process model.

There is a convergence occurring between software product and software service industries. Teracino and Seo (2013) studied this and came up a framework for analyzing this.

The SaaS enterprises have the goal of reducing customer churn. It will help them a lot to predict customer churn.. Morozov et al(2021) studied the SaaS enterprises growth and development and came up with a hypothesis as above.

- **Comparison of POS and SOS**

POS and SOS are two philosophies of software development, delivery and usage. In POS, software is a completed product.

These distinctions also influence business models. POS typically consists of one-time payments or licensing charges, whereas SOS relies on ongoing revenue through subscriptions.

From a development point of view, POS had traditional planned release schedules with big-bang version numbers. SOS is different, making use of Continuous Integration and Continuous Deployment (CI/CD) where updates were made regularly and automatically.

Yet the boundaries between POS and SOS are beginning to blur.

- **Bibliometric Analysis in Software Research**

Bibliometric analysis is an informative technique for seeing how a research area develops over time through an analysis of trends in scholarly articles..

Although it is useful, bibliometric analysis has seldom been utilized to investigate significant paradigm changes, like the shift from product-oriented software (POS) to service-oriented software (SOS).. The research seeks to bridge that gap through the utilization of bibliometric resources to contrast and compare POS and SOS research between 2010 and 2025.

- **Critical Evaluation and Research Gaps**

Although POS and SOS research is widespread, there are some significant gaps:

  - Lack of integrated studies: The majority of research deals with POS and SOS independently.
  - Limited cross-disciplinary views: Most studies concentrate on technical or business only
  - Time-based analysis is lacking: We still do not have a good appreciation for how research focus has changed over time from POS to SOS or whether industry developments are being mirrored in academia.

Bibliometric analysis provides a means of addressing such concerns by illustrating how ideas and themes have developed and how research communities are connected (or not).

Methodology

This research takes a bibliometric analysis method to compare and contrast academic studies on Product-Oriented Software (POS) and Service-Oriented Software (SOS) systematically.

Through the application of bibliometric techniques, this research seeks to provide an in-depth description of the development and spread of studies on POS and SOS during the past decade and a half.

- **Data Sources and Search Strategy**

The Scopus database was chosen as the main source of data for this research because it is widely covered, of high quality and has powerful tools for bibliometric analysis.

The process of data collection entailed the creation of accurate Boolean search queries to obtain documents on POS and SOS. Publications were obtained based on keyword occurrence in the title, abstract and keywords (TITLE-ABS-KEY) fields to guarantee relevance and topicality. Journal articles, conference papers and book chapters were included in search. Only English language documents were included. The documents published from 2010 to 2025 were included.

The two questions built for data gathering were the following:

- **Query 1 (POS Dataset – 141 documents)**

(TITLE-ABS-KEY("product-oriented software" OR "product oriented software" OR "software productization" OR "software product management" OR "software commercialization") AND TITLE-ABS-KEY("software" OR "software company" OR "IT company" OR "software industry" OR "technology company")) AND PUBYEAR > 2009 AND PUBYEAR < 2026 AND (DOCTYPE: ar, cp, ch) AND (LANGUAGE: English)

- **Query 2 (SOS Dataset – 168 documents)**

(TITLE-ABS-KEY("service-oriented software" OR "service oriented software" OR "service-oriented architecture" OR "SaaS" OR "Software as a Service") AND TITLE-ABS-KEY("software company" OR "IT company" OR "software industry" OR "technology company")) AND PUBYEAR > 2009 AND PUBYEAR < 2026 AND (DOCTYPE: ar, cp, ch) AND (LANGUAGE: English)

These queries were iteratively refined to enhance precision and reduce noise.

- **Data Analysis Techniques**

Bibliographic data were retrieved from Scopus and exported in CSV and BibTeX formats. Two complementary tools were employed for analysis: VOSviewer, for visualizing co-authorship and keyword networks and Bibliometrix (via the Biblioshiny interface in R), for in-depth bibliometric analysis.

The analysis proceeded through four main stages:

- **Keyword Co-occurrence Analysis -** This identified major thematic clusters and conceptual linkages across the POS and SOS literature, highlighting the evolution of research foci within each domain.
- **Author and Institutional Productivity Analysis -** By mapping prolific authors and institutions, the study examined geographic and organizational contributions to each paradigm using metrics such as publication counts and h-index.
- **Source Analysis -** Core publication venues-journals and conferences-were analyzed to reveal disciplinary alignments and dissemination patterns specific to POS and SOS.
- **Citation and Impact Analysis -** Highly cited documents, influential authors and key journals were identified using total citation counts, average citations per document and bibliographic coupling.

All datasets underwent cleaning and normalization to ensure analytical accuracy-this included removing duplicates, standardizing author and affiliation names and correcting inconsistencies

- **Validity, Reliability and Limitations**

For validation, search queries were deliberately planned using terms derived from the literature. Trial searches were employed for testing precision and recall and records only with titles, abstract or keywords that referred to POS or SOS explicitly were included to safeguard thematic relevance.

Reliability was ensured by utilising established clear tools and replicable procedures. All search filters, parameters and analytical stages were well recorded to enable replication.

Nonetheless, several limitations must be acknowledged:

- Citation-based metrics may not fully capture the qualitative or innovative aspects of scholarly work.
- Citation behavior varies by discipline and time, potentially affecting comparability.
- Relying solely on Scopus may omit relevant contributions indexed in other databases, limiting coverage.

Results

This section provides the results of the bibliometric analysis, presenting a comparative and comprehensive overview of Product-Oriented Software (POS) and Service-Oriented Software (SOS) research between 2010 and 2025.

- **Service Oriented Software Companies**
  - **Publication Statistics**

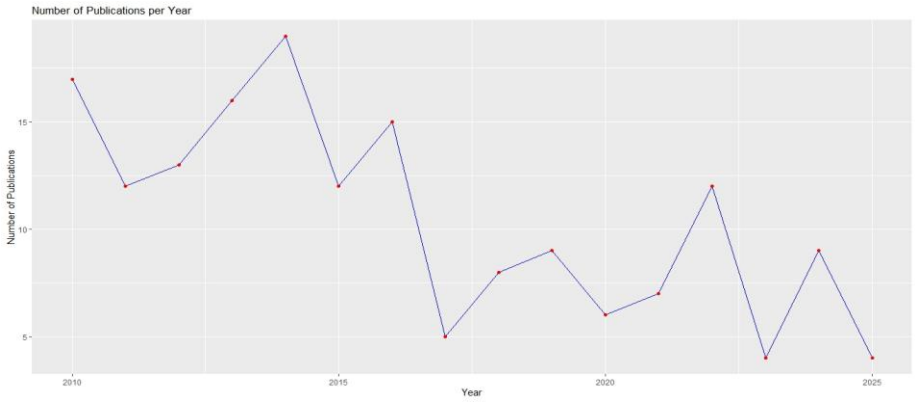


Fig. 1: Number of Publications per Year (2010–2025)

168 publications on the chosen topic were found between the years 2010 and 2025. As indicated by Fig 1, the distribution of publications throughout time is marked by a seesawing pattern.

- **Top Publication Sources**

Table 1: Top 10 Source Titles by Number of Publications (2010–2025)

Source Title	Number of Publications
Lecture Notes in Business Information Processing	8
ACM International Conference Proceeding Series	5
Communications in Computer and Information Science	5
Lecture Notes in Computer Science (including subseries Lecture Notes in AI and Bioinformatics)	5
IFIP Advances in Information and Communication Technology	4
CEUR Workshop Proceedings	3
IEEE Access	3
Journal of Systems and Software	3
Procedia Computer Science	3
CLOSER 2012 – Proceedings of the 2nd International Conference on Cloud Computing and Services Science	2

Table 1 shows the top 10 publication venues that have contributed to the literature on the subject between 2010 and 2025.

- **Key Authors and Collaborations**

The dataset includes a **total of 434 unique authors**, with an **average of 3 authors per publication**. This suggests a moderate level of collaboration, which is typical in technical fields where interdisciplinary contributions are common.

Table 2: Top Contributing Authors: Documents, Citations and Link Strength

Author	Documents	Citations	Total Link Strength
Luoma, Eetu	5	18	0
Nannyur, Venky	4	26	4
Pradhan, Satya	4	26	4
Kuvaja, Pasi	3	6	9
Markkula, Jouni	3	6	9
Oivo, Markku	3	6	9
Tausan, Neboja	3	6	9

Ge, Chunmian	3	14	3
Huang, Ke-Wei	3	14	3
Hess, Thomas	3	67	0
Rabelo, Ricardo J.	3	6	0
Saltanandrey	3	10	0
Seo, Dong Back	3	15	0

Table 2 reports the leading contributing authors according to the number of documents, citation frequency and strength of co-authorship network.

- **Authorship Patterns**

Table 3: Authorship Pattern in Publications (2010–2025)

Paper Type	Number of Papers
Co-authored	145
Single-authored	23

As can be seen from Table 3, the vast majority of papers (145 out of 168) were co-authored and only 23 were single-authored.

With regard to publishing outlets, analysis revealed 128 distinct source titles, highlighting strong source diversity.

- **International Collaboration**

Table 4: Country-Level Co-authorship in POS and SOS Publications (2010–2025)

Country	Documents	Total Link Strength
India	25	1
China	21	1
Finland	19	0
United States	15	2
Germany	12	2
Spain	9	3
Brazil	8	0
Netherlands	6	2
Italy	5	2
South Korea	5	2
Pakistan	5	1

Table 4 highlights global distribution of scholarly collaboration in product- and service-oriented software research.

- **Contributing Organizations**

Table 5: Organizational-Level Co-authorship in POS and SOS Publications

Organization	Documents	Total Link Strength
Cisco Systems, Inc., San Jose, CA, United States	2	0
Department of Automation and Systems Engineering, [Affiliation truncated]	2	0
NOVA Information Management School (NOVA IMS), Universidade Nova de Lisboa	2	0
SAP Research, Darmstadt, Germany	2	0
University of Jyväskylä, Department of Computer Science and Information Systems	2	0

Table 5 identifies main organizations to the literature via co-authorship.

- **Keyword Analysis**

Table 6: Keyword Co-occurrence Analysis in SOS Research (2010–2025)

Keyword	Occurrences	Total Link Strength
Software as a Service (SaaS)	59	168
Software Engineering	51	156
Web Services	44	150
Software Industry	47	145
Information Services	35	109
Service-Oriented Architecture (SOA)	37	102
SaaS	36	85
Cloud Computing	26	84
Software as a Service	22	71
Application Programs	20	64
Software Design	25	60
Software-as-a-Service	19	53
Software Company	16	45
Industry	16	40

Table 6 lists the most co-occurring top-level keywords in scholarly literature in service-oriented software over the period of 2010-2025.

- **Keyword Co-occurrence Network Analysis**

Figure 2 illustrates the co-occurrence timeline of Service-Oriented Software (SOS) research from 2010 to 2025.

The co-occurrences are represented by links; the intensity of the link, the strength of the co-occurrence, the more intimate the bond between the words paired.

One of the most obvious points of Figure 2 is the timeline overlay, represented in the shape of the color gradient.

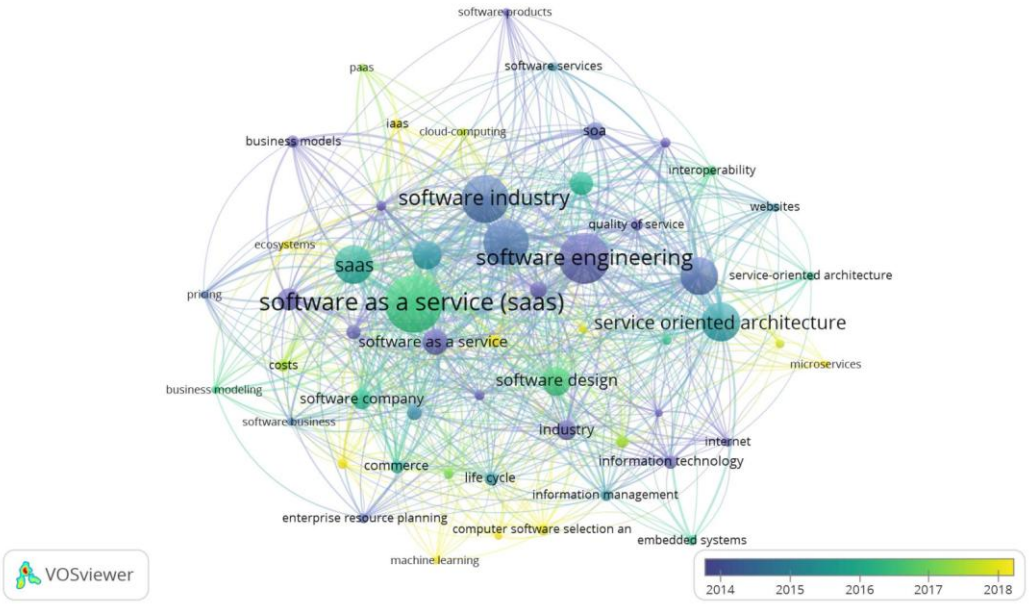
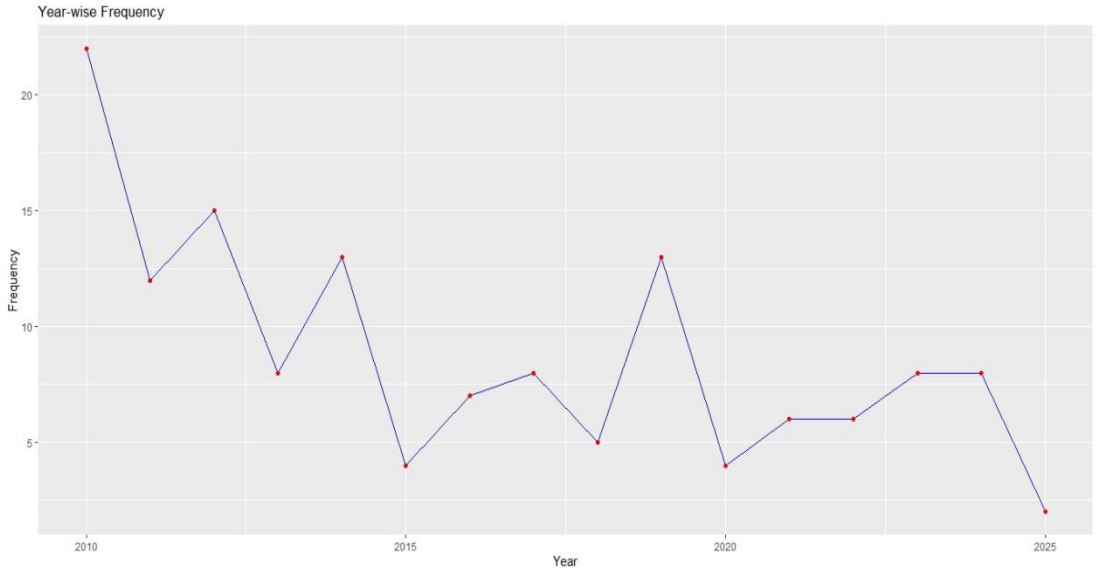


Fig. 2: Keyword Co-occurrence Network in SOS Research

- **Product Oriented Software Companies**
  - **Publication Statistics**

A total of 141 documents were identified and analyzed from the Scopus database to explore the scholarly trajectory of Product-Oriented Software (POS) research between 2010 and 2025. Figure 3 presents the yearly distribution of publications.

Fig 3: Annual Distribution of Publications on Product-Oriented Software



The publication activity was highest in 2010 at 22 papers, which coincides with increased interest in software product management and productization.

  - **Top Publication Sources**

The research on POS was published across a diverse array of journals and conferences, reflecting its interdisciplinary nature. Table 7 lists the most frequent publication sources.

Table 7: Top Publication Sources for POS Research (2010–2025)

Source Title	Count
Lecture Notes in Business Information Processing	16
Management for Professionals	11
CEUR Workshop Proceedings	8
Communications in Computer and Information Science	7
IWSPM 2010 – Software Product Management Workshop	7
Lecture Notes in Computer Science (incl. AI and Bioinformatics)	6
Information and Software Technology	5
Journal of Systems and Software	5
Lecture Notes in Informatics (GI Proceedings)	4
IWSPM 2011 – Requirements Engineering Conference	4
ACM International Conference Proceeding Series	3
IFIP Advances in Information and Communication Technology	3
International Journal of Information System Modeling and Design	3
IEEE Software	3
Empirical Software Engineering	2
Proceedings of the ACM Symposium on Applied Computing	2
Journal of Software: Evolution and Process	2

- **Authorship Patterns**

The POS dataset contains 501 authors with a mean number of 3.55 authors per document, which shows the high level of collaboration in this area.

Authorship patterns analysis identifies a significant difference between single-authored and co-authored research in the domain of product-oriented software (POS). From Table 8, it can be observed that most of the studies are collaborative with 118 co-authored and merely 23 single-authored studies.

Table 8: **Distribution of Single-Authored and Co-Authored Papers on Product-Oriented Software (2010–2025)**

Type	Total Papers
Single-Authored	23
Co-Authored	118
Total	**141**

The prevalence of co-authored papers follows the trend in most scientific disciplines, where inter-disciplinary and collaborative research are gaining momentum.

Table 9: **Top Authors in Product-Oriented Software Research**

Author	Documents	Citations	Total Link Strength
Brinkkemper, Sjaak	27	496	33
Van de Weerd, Inge	18	335	26
Smolander, Kari	8	88	16
Maglyasandrey	7	73	14
Nikula, Uolevi	7	72	14
Vlaanderen, Kevin	7	143	12
Bekkers, Willem	7	201	11
Jansen, Slinger	8	186	8
Saftanandrey	8	31	7
Fricker, Samuel A.	5	56	4

The Table 9 above illustrates the authors who have made significant contributions to POS research, reflected by the number of documents published and the citations received.

- **Contributing Organizations**

Referring to organizational affiliations of co-authors, we can note that a number of research institutions and academic departments are actively engaged in the study of POS (Table 10).

Table 10: **Top Organizations in Product-Oriented Software Research**

Organization	Documents	Citations	Total Link Strength
Department of Information and Computer Science	7	59	4
Lappeenranta University of Technology	2	8	3
National Research University Higher School of Economics	2	8	3
Software Competence Center Hagenberg	2	11	2
Stiwa Automation GmbH, 4800 Attnang-Puchheim, Austria	2	11	2
Utrecht University, Utrecht, Netherlands	5	14	2
Blekinge Institute of Technology, Karlskrona, Sweden	2	26	1
Centro de Informática, Universidade Federal de Pernambuco, Brazil	2	14	1
Innovotiv Consulting, Rheinbreitbach, Germany	2	12	1
Bornheim, Germany (No specific organization)	7	4	0

- **5 International Collaboration**

The analysis of co-authorship also reflects the global nature of POS research (see Table 11).

Table 11: Co-Authorship Analysis by Country

Country	Documents	Citations	Total Link Strength
Finland	23	171	10
Netherlands	36	593	9
Germany	26	105	8
Sweden	20	365	8
Russian Federation	8	43	6
Brazil	7	48	4
Switzerland	4	50	4
Canada	7	51	2
United States	7	149	2
Austria	7	33	1

- **Keyword Co-Occurrence Analysis**

A keyword co-occurrence analysis was performed to determine the major themes and concepts behind the research on product-oriented software (Table 12).

Table 12: Top Keywords in Product-Oriented Software Research

Keyword	Occurrences	Total Link Strength
Software Product Management	107	218
Software Design	33	85
Software Products	26	80
Product Management	25	64
Requirements Engineering	24	64
Product Manager	18	63
Software Engineering	23	61
Product Development	15	56
Decision Making	12	35
Management	12	35

The frequent occurrence of terms such as software product management, software design and requirements engineering is an indication of the central significance of these terms within the field..

- **Keyword Co-occurrence Network Analysis**

Figure 3 represents keyword co-occurrence within product oriented software (POS) research. The network highlights salient themes and their interconnectedness in the field.

The connections between the nodes, marked by links, illustrate keywords' frequency of co-occurrence.

The color shades in the network are sets of keywords. Keywords within a set are more related to one another.

The color gradient highlighted timeline overlay shows the shift in keyword emphasis.

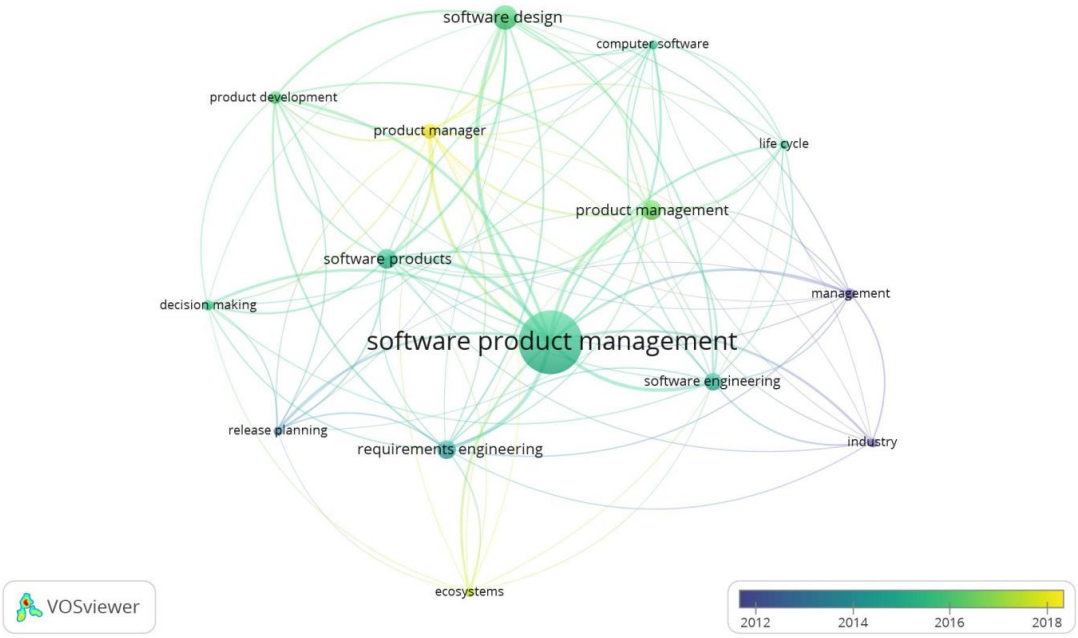


Fig 3: Keyword Co-occurrence Network in SOS Research (2010-2025)

Discussion

This part offers a full explanation of the bibliometric analysis results, framing them in relation to the research questions and placing them in the context of the current literature.

- **Interpretation of Findings**

The bibliometric analysis of POS and SOS research has produced several key trends, each of which provides insightful information about the development of the software industry and its further development. The most significant observation is the drastic increase in SOS-related publications during 2016-2022, which signals the growing supremacy of service-oriented models in the process of developing software.

Compared with this explosion of SOS research, POS research has registered slower but consistent growth. This indicates that while the market is trending towards service-based models, product-oriented software development remains importantly relevant.

The keyword extraction also highlights the disparate but interrelated nature of POS and SOS studies. The SOS literature focuses considerably on technology, including cloud computing, service-oriented architecture (SOA) and microservices.. In comparison, POS work is more concerned with business and management domains, including product management, commercialization strategy and product lifecycle management.

- **Comparison with Existing Literature**

The results of this study concur with and build on the current literature on POS and SOS studies.

This research does, however, find some subtle variations and emerging trends in these two fields of research. For example, the trend towards microservices and cloud-native systems in SOS research suggests a rather enormous and relatively recent innovation.

In addition, the study sheds light on the geographical dimensions of POS and SOS research. While POS research has relatively a more robust European academic base, SOS research has a global distribution.

- **Implications of the Study**

The results of this bibliometric analysis have significant theoretical and practical implications for research and business alike.

- **Theoretical Implications**: The research deepens the knowledge of the point of intersection of POS and SOS research. Through tracing the development, central themes and most influential contributors in both fields, it provides an overall picture of the intellectual landscape of software development.
- **Practical Implications**: Practically, the findings of this study are able to guide software firms and practitioners to frame their development policies to align with technological advancements. .

Limitations and Future Work

This section acknowledges the inherent limitations of the study and proposes directions for future research to build upon its findings.

- **Limitations**

This study provides an overview of a large body of studies on Product-Oriented Software (POS) and Service-Oriented Software (SOS) from 2010 to 2025, but it is limited in a number of ways that affect the interpretation of the results.

First, the study only accessed the Scopus database which although exhaustive and reliable is not all-encompassing in terms of academic work.

Second, the study only looked at English-language papers. This will have excluded quality studies from non-English-speaking countries, rendering it a language bias.

Third, the study relied on chosen keywords to obtain information. As meticulous as these words were researched, some relevant studies may have been left out due to the disadvantages of keyword-based searching.

Fourth, while bibliometric methods like citation counts and keyword analysis are helpful in showing trends, they also have some disadvantage

Finally, the research only took into account literature from 2010 up to 2025. This captures existing trends but fails to capture earlier foundation work or very new developments beyond 2025.

- **Future Work**

To further advance this research and extend POS and SOS studies, the following directions are suggested:

- Broader Data Sources:
- Language Coverage:
- Using Advanced Techniques:
- Merging Qualitative Analysis:

Future research could examine the degree to which POS and SOS research impacts actual business practices, through case studies or surveys to quantify effects on business and development processes.

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