

## **SYSTEMATIC MAPPING STUDY ON MANAGING VARIABILITY IN SOFTWARE PRODUCT LINE ENGINEERING**

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**ABSTRACT:** -Revision for literature and searching for the sources of an information in the different database are considered to be the most important pillar of the scientific research, whether a researcher, academic in preparing the scientific documents or any research. That is the most important part which helps the researcher in understanding any subject or research, besides it helps him to know the different opinions regarding the subjects, thus, it provides the researcher with the suitable and correct information that helps him to take the right decision regarding his study and knowing the possible ways he needs to. This paper has been prepared, according to the tables and charts showing the progress of the workflow that was chosen in the name managing variability in software product line engineering .the systematic mapping study process, it has gone through several stages in the first of, the search process automatic and manual in various databases IEEE Xplore, ACM digital library and other search engine, conference, relevant journals, etc.). All of them process provide snowballing papers. It provides (1450) papers and other types (book, technical reports, litterateur, others). Second stage we did screening of papers according to (inclusion, exclusion) criteria. And the subsequent process were filtering process produced (77) final papers after three filters ,distribution of primary studies coordinating years, classifications charts in to ( facet1, facet2, facet3), representation finding by using bubble chart mapping between domain and different types of our subject (classes of research, managing variability SPLE type) . The concluding remarks were after indexing (77) papers its relationship out of (1450) papers. These papers (77) provide to answer question relevant managing variability in software product line engineering. [1]

### **1. INTRODUCTION**

Brainstorming, which is used to produce keywords and reuse order string to get results search on any search engine become un-useful in front of engine strategy. Complexity in the structure of engine search and Determinants made researchers to find methodology to reach goals research in tremendously Information within the various databases. The systematic mapping study process to screening research results can be definition through is method to build classification scheme and structure a software engineering field of interested. The analysis of results focuses on frequencies of publications for categories within a predefined scheme (Peterson et al .2008).[2]

A systematic mapping study allows the evidence in a domain to be plotted at a high level of granularity ( Kitchenham 2007 ) .[2]

The process of searching for a specific topic in the search engines or specialized libraries is difficult to find satisfactory results. Researchers putting solutions and processing to reach accurate information or targets relevant. Build a descriptive schemes give the views of the

variable according to the needs researcher. There are dozens of researchers they put the foundations Search, description, schemes, tools to facilitate extraction comprehensive vision about any subject being searched in the internet or digital library .[1]

This paper, explain steps stage systematic mapping study process and we chose article “managing variability in software product line engineering “ and we defined main goal and research question that related with our articles and we determined methods screening of papers ,faltering according criteria , distribution of primary study according years ,classifications scheme ( facet1, facet 2,facet3 ) ,representation finding by bubble chart mapping and conclusion remarks .

## **2. RESEARCH QUESTIONS**

**Table (1):**

### **A. Definition of the research question:**

#### **Question 1:**

This type of questions determines the target and identifies it through analysis, configuration and the used tools and techniques. That’s why this question always comes in two equal parts to determine and identify the target. [3,7]

#### **Question 2:**

This type of questions informs the researcher which kind of sources has been used, especially that is related to a large database.[3,7]

#### **Question 3:**

This type of questions is used to evaluating the works and the empirical studies to check its genuineness and to make sure the results are applicable or not.[3,7]

#### **Question 4:**

This type is used to identifying the different ways and mechanisms in analyzing the research address mentioned above which helps by a large percentage to extract an appropriate number to be analyzed and strategies to be followed.[3,7]

## **3. KEYWORDS AND SEARCH STRING MAP**

### **A. Identify keywords**

Managing software , analysis software , product line managing , family management ,managing in variability , managing technology , strategy managing , approach , methods and analysis ,types managing, variability product .

### **B. Search String**

We can use various search engines via World Wide Web, you must select keywords to be successful and effective in the search process. The formation and composition of keywords string to complete research. It is affective and a specific goal to reach good result. in this search , we used keyword and build string that we believed it achieved Satisfactory results as shown below . [3,4]

## **4 . SEARCH IN DATA BASE**

There are a lot of database provide data in world. We can classification its according to methods search and there are two methods search automatic, manual search. for example , we can search in ACM digital library , IEEE explorer , springer link , science direct , SCOPUS and engineering village or other . As we search by using DBLP, journals, conferences they have extensive information. [1,7] In this search after three refinements we can see in bellow table distributed type result.

IEEE	ACM	DBLP	SCOPUS	EV	SD
74	3	0	0	0	0

## **5. SCREENING OF PAPERS**

There are two criteria to screening of papers to find out which will be included in future

study from research and previous literature. The results appeared according to build research question. In this search we can see how to execute these criteria: [2]

**A. Inclusion criteria :**

We kept all paper, books, work shop report technical that include managing variability in SPLE and the methods, approaches, analysis, all aspects of management variability and managing tools. While reading the titles should check the answer to everything related to the subject, showing in figure (1).

**B. Exclusion criteria :** We eliminated all:

- Papers , books , reports that unreal outputs for managing variability in SPLE
- Titles doesn't written in English and Papers duplicated
- Papers incomplete and Literature just available in form of abstract
- Power point presentation and Posters and advertising
- Short papers less < 2 pages
- Deleted lecture and all documents that not related with our topic

## **6. BUILDING DIFFERENT VIEWPOINTS USING A VARIETY OF SCHEMES**

We can explain any scheme or description to any subject through build schemes.

Defining Comprehensive vision to articles for any subject and deal with it through some of schemes. In this paper we will show How to use these schemes? As we explain below [2, 3]

**A. Distribution of primary studies according to years**

This chart show distribution number of studies to years and show percentage of publishing every year and it focus which paper is full or short pages and it described through using different colors to implementation this purpose. [5, 7]

Figure (2) show distribution of primary studies according to years

**B. Venue chart**

This chart shows another viewpoint to researcher. It used distribution papers according to years, No. of papers, which one short or full page and types of papers if it is conference, workshop, book and journals [7] . Figure (3) show Venue chart

## **7. CLASSIFICATION SCHEMES TO EXTRACTION DATA**

There are three schemes show classification data according (facet1, facet2, facet3). In facet 1 classes of research (research type facet) it show criteria according to validation research, evaluation research, solution research, philosophical papers, opinion papers and experiences papers. [2, 7]

**A. Facet 1 \_Classes of Research type.** Fig (4)

**B. Facet 2 \_Managing Variability SPLE type.** Fig (5)

In this chart we show managing variability research types and we are restricting eight types for managing variability (requirements, design, test, architecture, quality, UML, JAVA, ADL).

**C. Facet 3 \_ Domains,** Fig (6)

In this chart we show domain research in our articles “managing variability in software product line engineering “, and how we distributed papers according to highlighting top of (10) domains for managing variability in SPLE. we chose these articles from all papers after read and analysis it ( variability SPLE, strategy of managing variability , modeling SPLE , driven approach ,analysis requirements ,testing and tracing SPLE , process driven managing , viewpoint variability , language and tools and design and rational )

## **8. CONCLSION**

We search in automatic and manual variant database such as Google scholar, we find **1450** papers various classifications (papers, book, report workshop, presentation, lecture, and others etc.) .We apply screening of all papers by two filters on form two stage filtering in the first stage reduced it in to 488 papers and after that in second stage eliminated all papers

in filters in to 77 papers that is hold it .After applying filters to elimination useful papers the result was: Used 1450 papers, 1373 elimination Paper, 77 Kept papers. In the facet 3 domains that is highlighting top 10 domains on “ managing variability in SPLE “ if it classification according to research type criteria we can see gaps in philosophical papers , opinion papers were are weak in representation and this means candidate samples (77 ) of papers did not contain or little appeared . Also in the facet3 domains contain two classifications were weak appeared, domain driven managing all of them did not appeared and viewpoint with most of them just one. Domains with managing search types were contain two classification were weak, design and relational weak representation and little with all of them, strategy of managing variability did not appeared with all of them. [3,7].

The classification of our articles distributed between many different classifications: The existence of many questions helps the researcher to determine the research direction properly which guarantees to him to reach the information quickly he was seeking for. There are some questions aim to identify the target through the analysis and tools, while there are some aims to find-out the forms and types, while some seeks for knowing the subject properties and the activities performed by. There are also some questions uses the ways and mechanisms to search for, whereas some searches for the standards and the criteria of the chosen subject. There also some searches for the empirical studies to make sure of a subject to see if it’s applicable or not, or these researches reached its targets or not. The most important type of these questions is those which search for the different opinions in studies and analysis. All these details and others should be taken in consideration by the researcher to determine his questions according to a particular trend. [3,7]

## **APPENDIX A**

1. A Metamodeling Approach to Tracing Variability between Requirements and Architecture in Software Product Lines
2. A Process-Driven and Ontology Based Software Product Line Variability Modeling Approach
3. Agile constructor and evaluation of Product line architecture
4. An Analysis of the Variability in Forty Preprocessor-Based Software Product Lines
5. An Approach to Addressing Entity Model Variability within Software Product Lines
6. An Approach to Developing Domain Requirements as a Core Asset Based on Commonality and Variability Analysis in a Product Line
7. An Approach to Variability Management in Service-Oriented Product Lines
8. An Integrated Software Management Tool for Adopting Software Product Lines
9. Approach to modelling feature variability and dependencies in software product lines
10. Behavior Specification of Product Lines via Feature Models and UML Statecharts with Variabilities
11. C2MV2: Consistency and Composition For Managing Variability in Multi-View Systems
12. Configuration of Multi Product Lines by Bridging Heterogeneous Variability Modeling Approaches
13. Consistency checking Rules in software product line engineering
14. Criteria for Comparing Requirements Variability Modeling Notations for Product Lines
15. Design and Rationale of a Quality Assurance Process for a Scientific Framework
16. Disambiguating the Documentation of Variability in Software Product Lines: A Separation of Concerns, Formalization and Automated Analysis
17. Dynamic Variability Management in Product Lines: An Approach Based on Architectural Contracts
18. Employing Fuzzy Logic in Feature Diagrams to Model Variability in Software Product-Lines
19. Extreme Product Line Engineering: Managing Variability & Traceability via Executable Specifications

20. Feature Unweaving: Efficient Variability Extraction and Specification for Emerging Software Product Line
21. Handling Database Schema Variability in Software Product Lines
22. Improving Guidance when Restructuring Variabilities in Software Product Lines
23. Integrated Variability Modeling of Features and Architecture in Software Product Line Engineering
24. Integrating Software Product Line Engineering and Agile Development
25. Languages and Tools for Managing Feature Models Mathieu
26. Managing Variability for Software Product Lines: Working with Variability Mechanisms
27. Managing Variability for Software Product-Line
28. Managing Variability in Software Product Lines
29. Model Checking of Domain Artifacts in Product Line Engineering
30. Modeling and Using Product Line Variability in Automotive Systems
31. Modeling Variability and Testability Interaction in Software Product Line Engineering
32. Modeling Variability in Software Product Line using First Order Logic
33. Modelling Requirements Variability across Product Lines
34. On the Notion of Variability in Software Product Lines
35. Optimization of Variability in Software Product Lines
36. Product Line Requirements Reuse based on Variability Management
37. Product Line Tool-Chain: Variability in Critical Systems
38. Product Line Variability Modeling based on Model Difference and Merge
39. Product Line Variability with Elastic Components and Test-Driven Development
40. Reactive Variability Management In Agile Software Development
41. Recovering Feature-to-Code Mappings in Mixed-Variability Software Systems
42. Reengineering Legacy Software Products into Software
43. Representation of Variability in Software Product Line Using Aspect- Oriented Programming
44. Restructuring Variability in Software Product Lines using Concept Analysis of Product Configuration
45. Security Requirements Variability for Software Product Lines
46. Software Product Line Engineering, Foundations, Principles, and Techniques (Klaus Pohl · Günter Böckle Frank van der Linden , Springer, ACM Computing Classification (1998))
47. Software Product Line Variability Management
48. Software Variability Management An Exploratory Study with Two Feature Modeling Tools
49. Supporting the Evolution of Product Line Architectures With Variability Model Fragments
50. Tracing Software Product Line Variability – From Problem to Solution Space
51. Two-dimensional Framework for Analyzing Variabilities in Software Product Lines
52. Using aspects and the Spring framework to implement variabilities in a software product line
53. Using Feature diagrams with Context Variability to model Multiple Product Lines for Software Supply Chains
54. Using Requirements Management Tools in Software Product Line Engineering: The State of the Practice
55. Variabilities as First-Class Elements in Product Line Architectures of Homecare Systems
56. Variability Driven Quality Evaluation in Software Product Lines
57. Variability Identification and Representation in Software Product Line UML Sequence Diagrams: Proposal and Empirical Study
58. Variability Management in Embedded Product Line Analysis
59. Variability Management in Product Lines of Safety Critical Embedded Systems
60. Variability Management in Software Product Line Engineering

61. Variability Management in Software Product Lines (Tommi Myllymäki 2001)
62. Variability Management of Reliability Models in Software Product Lines: an Expressiveness and Scalability Analysis
63. Variability Management with ACM (Adaptable Component Model) for Insurance Product Line
64. Variability Modeling for Product Line Viewpoints Integration
65. Variability Modeling for Service Oriented Product Line Architectures
66. Viewpoint-Oriented Variability Modeling
67. A Status Report on the Evaluation of Variability Management Approaches
68. A Survey on Software Variability Management Approaches
69. A Systematic Mapping Study of Software Architectures for Cloud Based Systems
70. An Approach to Analyzing Commonality and Variability of Features using Ontology in a Software Product Line Engineering
71. Combining Feature Modeling and Object Oriented Concepts to Manage the Software Variability
72. Managing Variability in Software Architectures
73. Managing Variation in Services in a Software Product Line Context
74. Product Line Engineering Solutions for Systems and Software
75. Software Engineering – Sommerville
76. Software Product Lines: State of the art
77. The Systems and Software Product Line Engineering Lifecycle Framework

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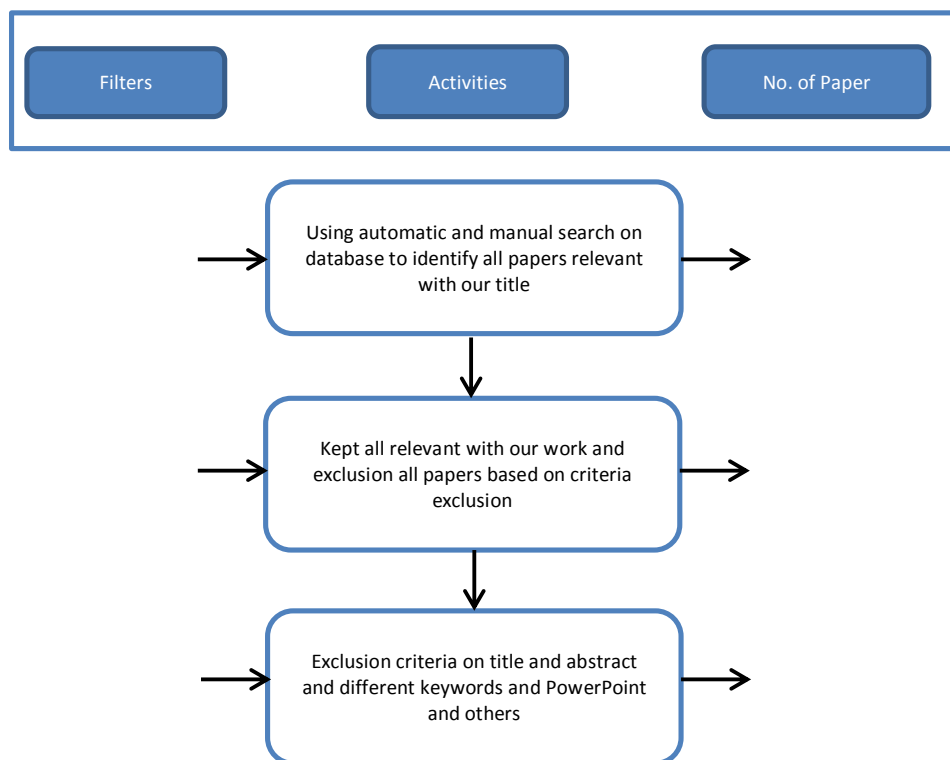
- 1) A Systematic Mapping Study on Software Ecosystems (Olavo Barbosa<sup>1,2</sup>, Carina Alves<sup>1,1</sup>- Center of Informatics, Federal University of Pernambuco, Cidade Universitária - 50740-560 - Recife/PE, Brazil - Proceedings of the Workshop on Software Ecosystems 2011)
- 2) [https://prezi.com/ax\\_8s4sldmw/a-systematic-mapping-study-on-domain-specific-languages/](https://prezi.com/ax_8s4sldmw/a-systematic-mapping-study-on-domain-specific-languages/)
- 3) A SYSTEMATIC MAPPING STUDY ON SOFTWARE ENGINEERING TESTBEDS (Emanuel Francisco Sp\_posito Barreiros- Universidade Federal de Pernambuco Centro de Ciências Exatas e da Natureza Centro de Inform\_atica DISSERTAC\_ ~AO DE MESTRADO
- 4) Systematic Mapping Studies in Software Engineering (Kai Petersen<sup>1,2</sup>, Robert Feldt<sup>1</sup>, Shahid Mujtaba<sup>1,2</sup>, Michael Mattsson<sup>1</sup>School of Engineering, Blekinge Institute of Technology, Box 520 SE-372 25 Ronneby
- 5) A Systematic Mapping Study on Software Engineering Test beds (Emanuel Barreiros, Adauto Almeida, Juliana Saraiva and Sérgio Soares) Informatics Center Federal University of Pernambuco Recife, Brazil- 2011 International Symposium on Empirical Software Engineering and Measurement
- 6) <http://www.youtube.com/watch?v=4FyImh2G7N0>
- 7) Software evolution visualization: A systematic mapping study ( Renato Lima Novais a,d,fl, André Torres a, Thiago Souto Mendes a,d, Manoel Mendonça a,b, Nico Zazworka Information and Software Technology 55 (2013) 1860–1883

**Table (1)** Research Questions for managing variability in software product line engineering:

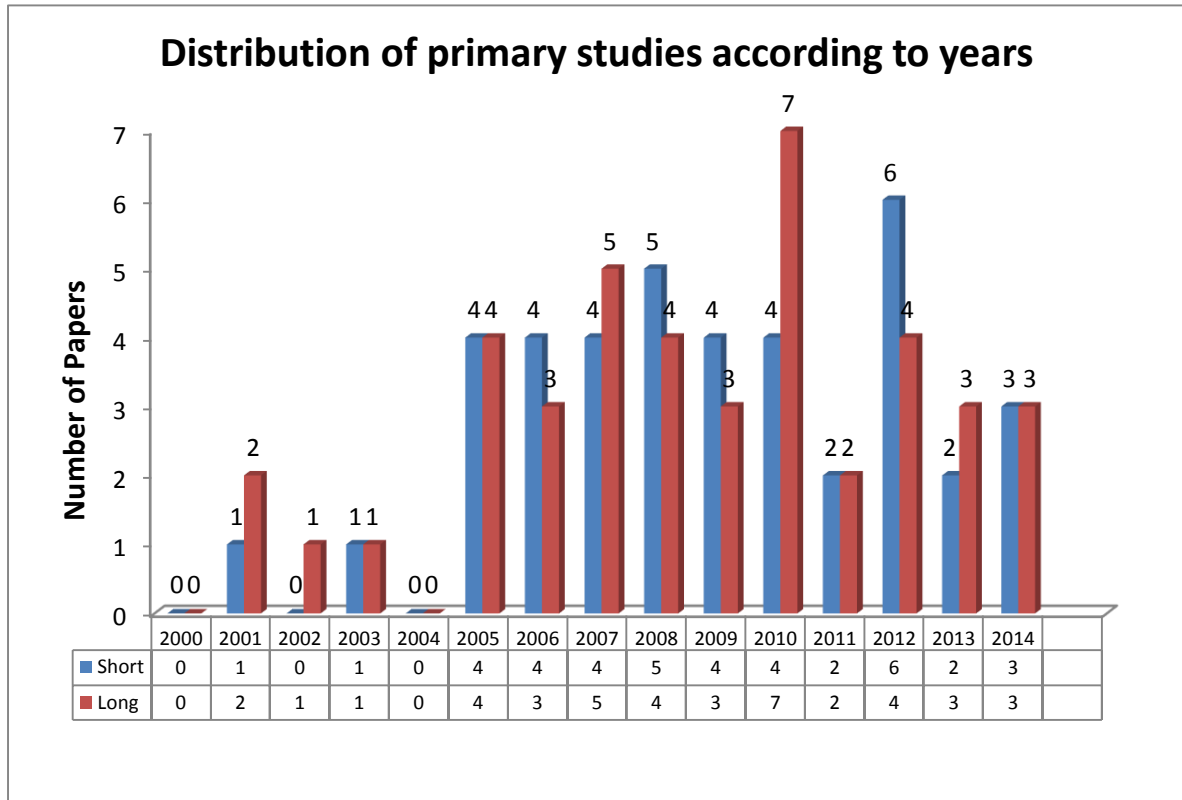
<p><b>RQ1:</b> What is management of variability in software product line engineering, and what are techniques for that?</p> <p><b>RQ2:</b> Which types of mechanism used for managing variability in software product line engineering?</p> <p><b>RQ3:</b> What kinds of evaluation for managing software product line engineering are done?</p> <p><b>RQ4:</b> Which strategy analysis is used in managing variability in software product line engineering?</p>
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**Table (2):** Managing Variability in SPLE Map

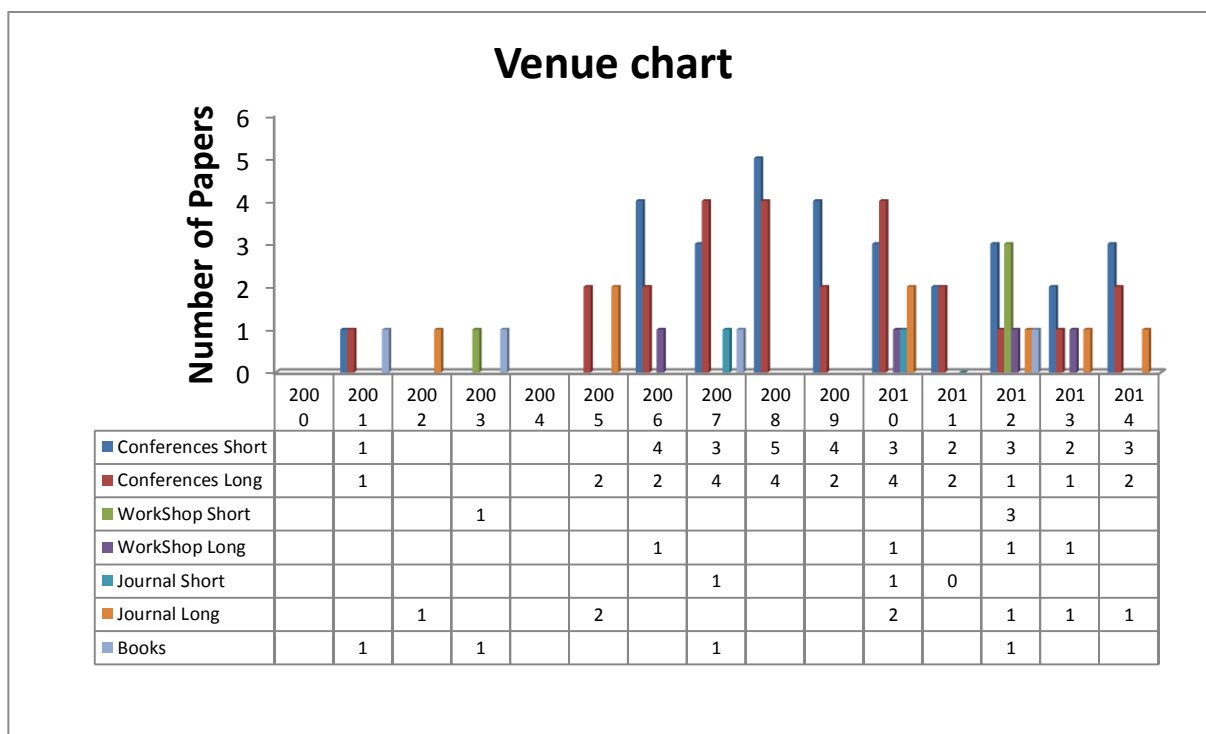
“Managing Software” And (" Product line" OR” product family") And ("Methods" OR "Approach" OR “strategy”) And ("Types" OR "technology" OR "classifying" OR “analysis”) And (" Managing" OR "Management") And ("Variability")
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**Figure (1)**

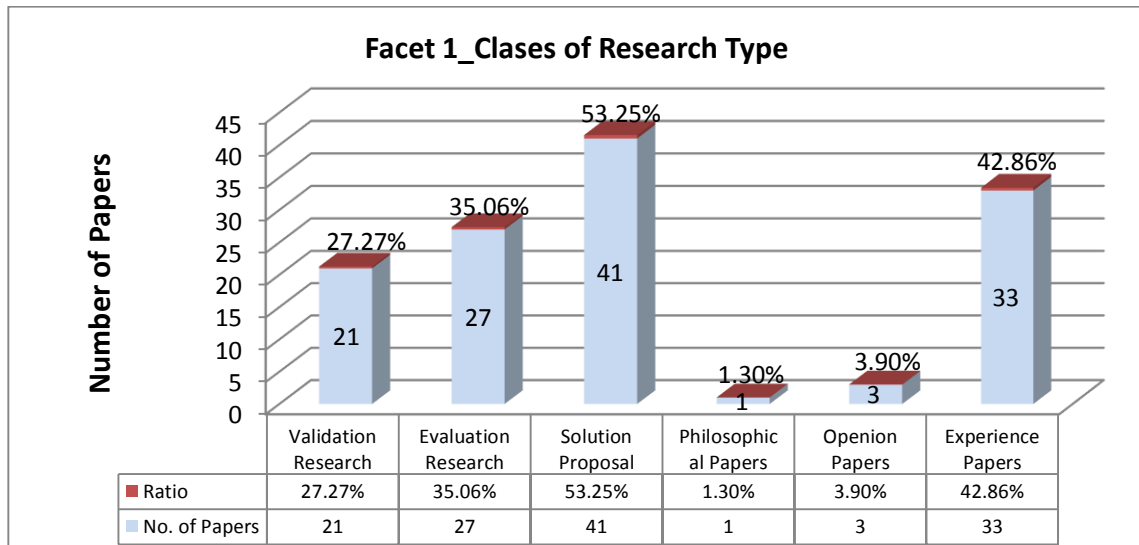


**Figure (2):** Distribution of primary studies according to years

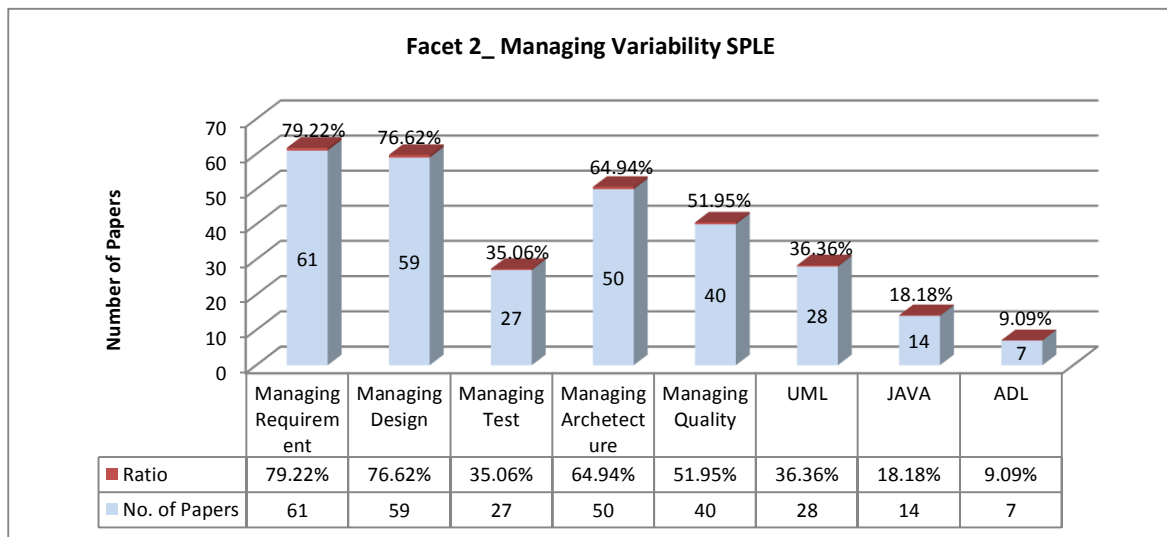


**Figure (3):** Venue chart

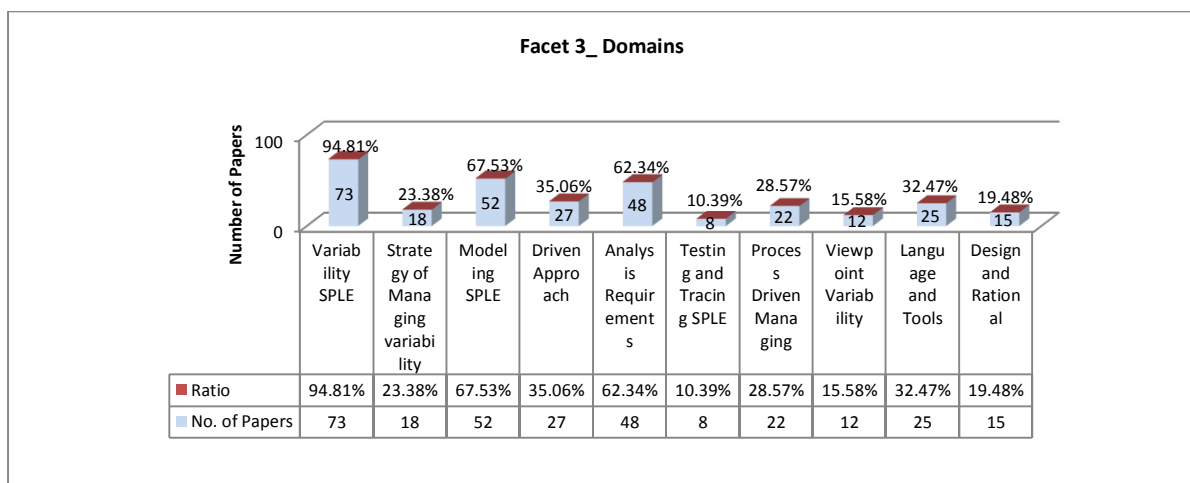




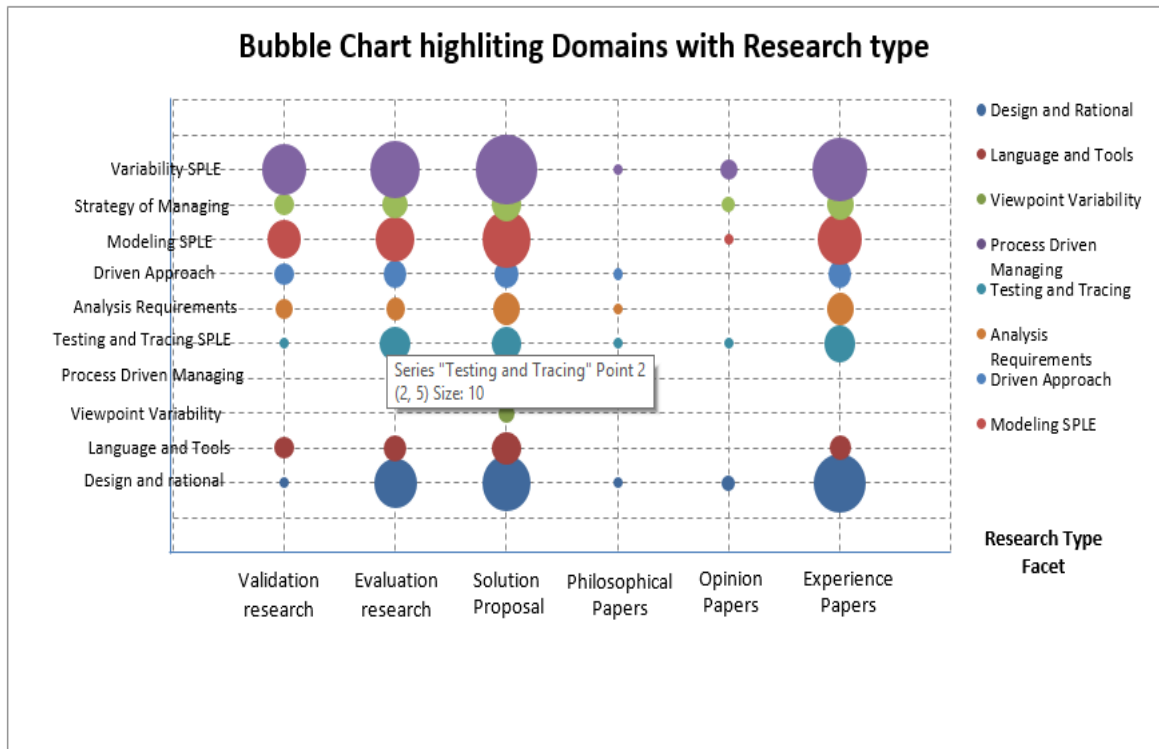
**Figure (4)**



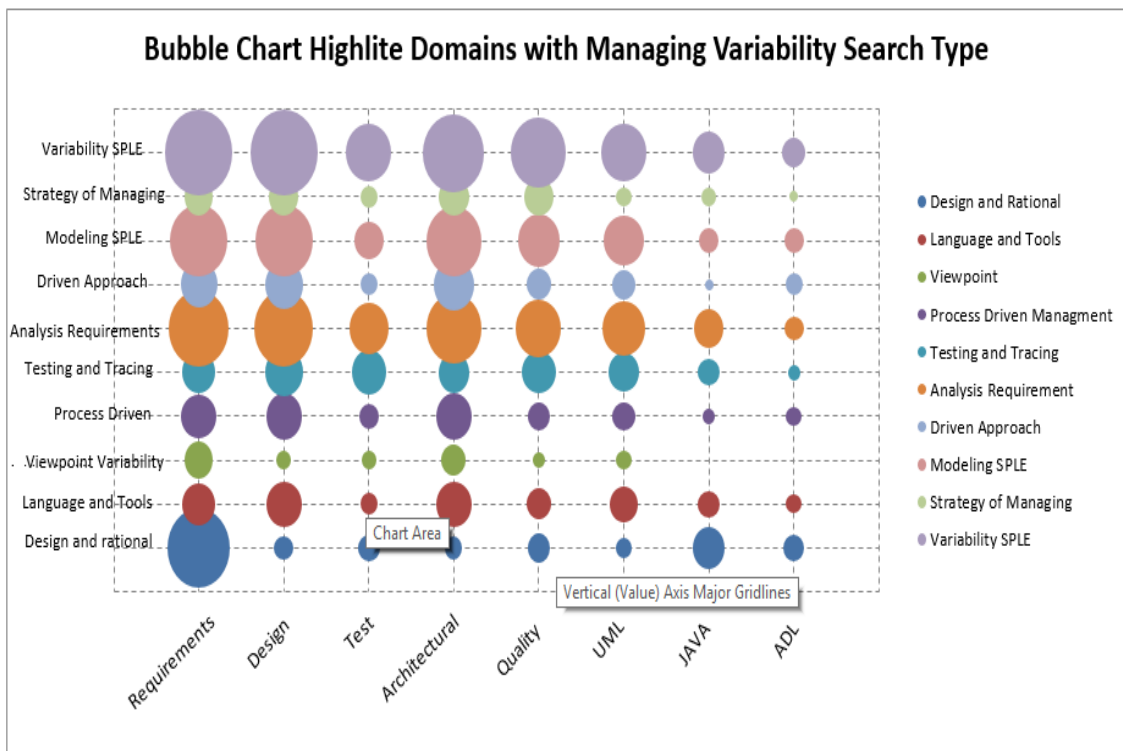
**Figure (5)**



**Figure (6)**



**Figure (7)**



**Figure (8)**