

# A Systematic Literature Mapping on the Relationship Between Design Patterns and Bad Smells

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# Summary

- Introduction
- Systematic Literature Mapping
- Discussion of Results
- Threats to Validity
- Conclusion
- Future Work

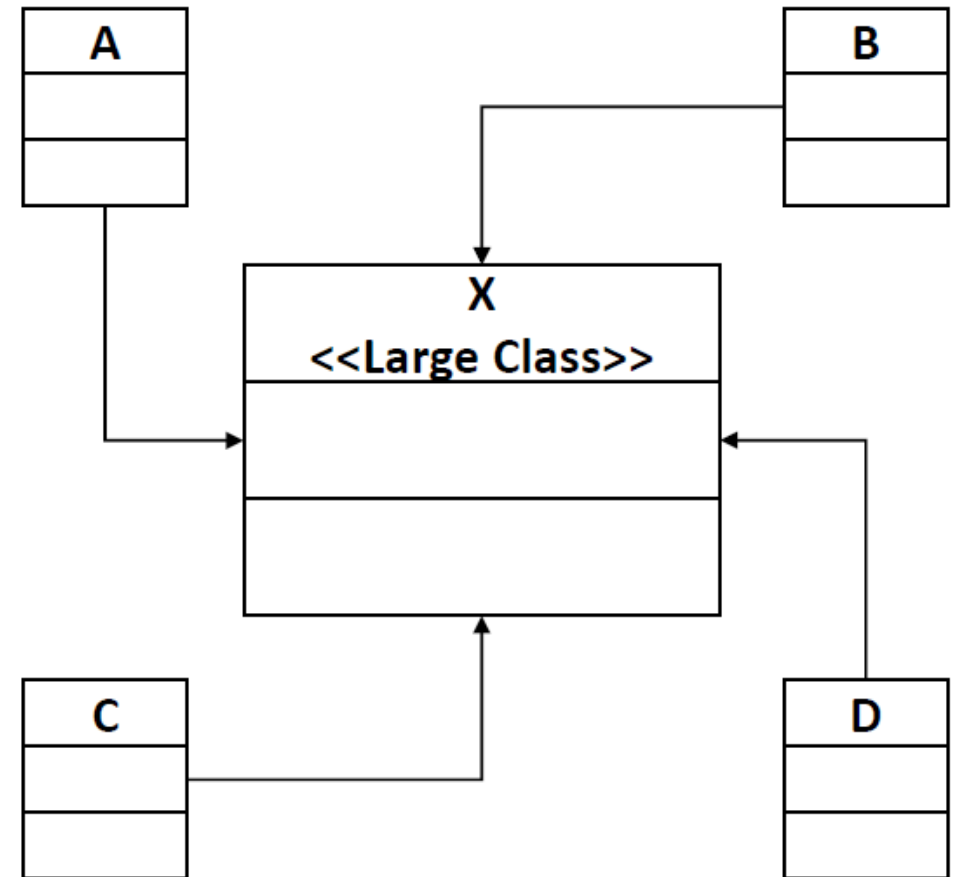
# INTRODUCTION

# Design Pattern

- General Solution to recurrent problems in software architecture
- Aims at creating high quality software systems.
- Good programming practices

# Bad Smell

- Symptoms of problems in the source code or structure of a software
- Affect negatively the software quality



# Problem

- Software systems that apply design patterns are free of bad smells?
- What are the findings in the literature about this question?

# Systematic Literature Mapping

- Why?
  - More comprehensive than literature review
- Aim: collect evidence regarding relationship between design pattern and bad smell

# **SYSTEMATIC LITERATURE MAPPING PROCESS**





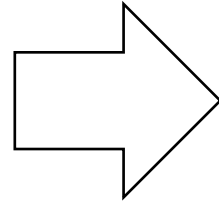
- Research Questions
- Search String
- Electronic Databases
- Inclusion and Exclusion Criteria

- Search Process
- Studies Selection Process
- Results Summarization

- Analysis of Results
- Discussion of Results

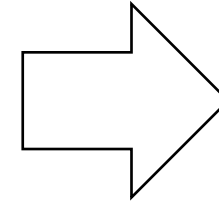
## Planning

- Research Questions
- Search String
- Electronic Databases
- Inclusion and Exclusion Criteria



## Execution

- Search Process
- Studies Selection Process
- Results Summarization



## Analysis

- Analysis of Results
- Discussion of Results

# Research Questions

**RQ1.** How has the literature addressed the relationship between design patterns and bad smells?

**RQ2.** Has the literature explored co-occurrence between design patterns and bad smells?

# Research Questions

**RQ2.1.** Which bad smells and design patterns are addressed by the literature for identifying co-occurrences?

**RQ2.2.** What co-occurrences have been identified by the studies?

**RQ2.3.** Which techniques have been used in the literature to find/establish co-occurrence?

# Search String

("code smell" OR "code smells" OR "bad smell"  
OR "bad smells" OR "anti pattern" OR  
antipatterns" OR "anti-pattern") AND ("design  
patterns" OR "design pattern")

# Electronic Databases

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#	Database	Address
1	ACM Digital Library	<a href="http://dl.acm.org/">http://dl.acm.org/</a>
2	Compendex (Engineering Village)	<a href="https://www.engineeringvillage.com">https://www.engineeringvillage.com</a>
3	IEEE	<a href="http://ieeexplore.ieee.org/">http://ieeexplore.ieee.org/</a>
4	Science Direct	<a href="http://www.sciencedirect.com/">http://www.sciencedirect.com/</a>
5	Scopus	<a href="http://scopus.com/">http://scopus.com/</a>
6	Springer	<a href="http://link.springer.com/">http://link.springer.com/</a>
7	Web of Science	<a href="http://webofknowledge.com/">http://webofknowledge.com/</a>

# Inclusion and Exclusion Criteria

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## Inclusion Criteria

Papers published in English

Complete papers

Papers published in Computer Science

Papers available in electronic format

Papers published in conferences or journals

Papers related to the search string terms

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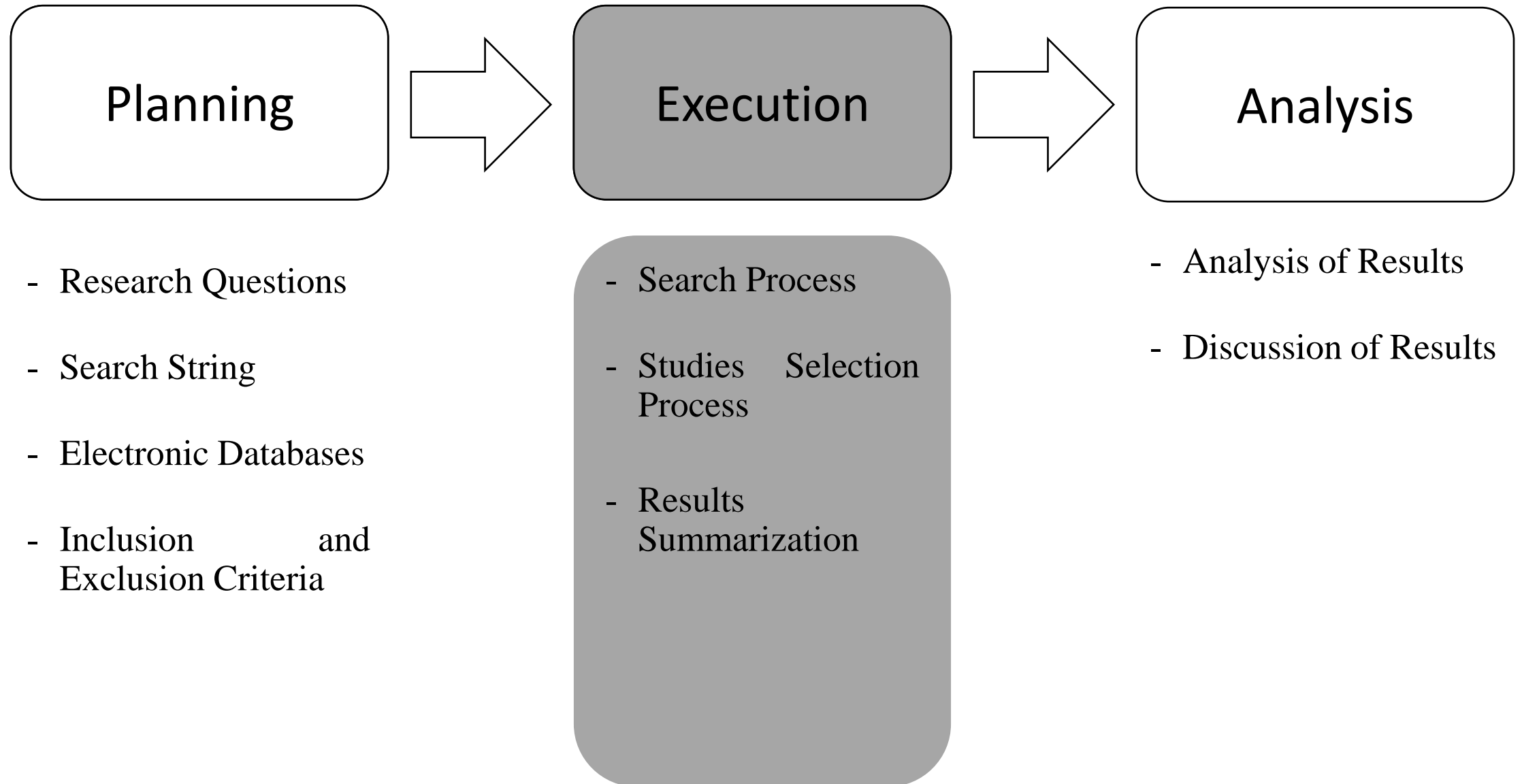
## Exclusion Criteria

Documents classified as tutorial, posters, panels, lectures, round tables, theses, dissertations, book chapters and technical report

Duplicate papers

Papers that can not be located

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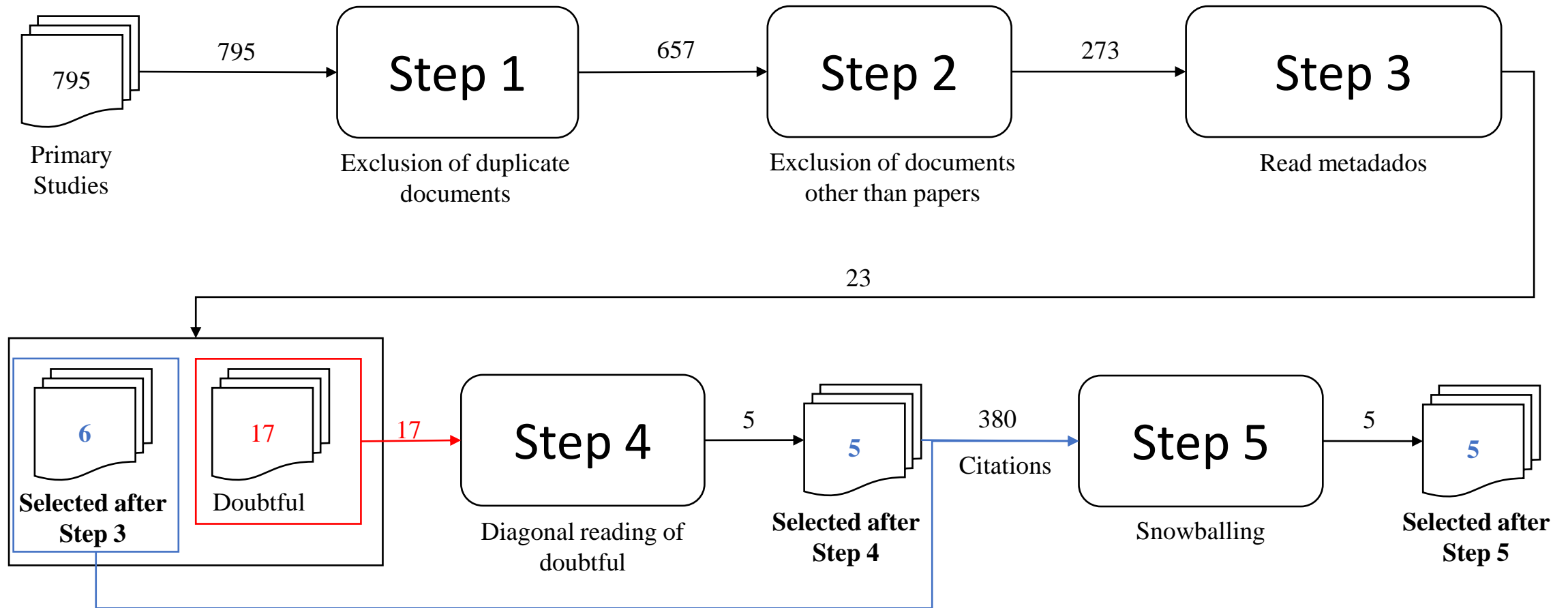




# Search Process

#	Database	Returned Studies
1	ACM Digital Library	12
2	Compendex (Engineering Village)	57
3	IEEE Xplore	0
4	Science Direct	176
5	Scopus	86
6	Springer	433
7	Web of Science	31
<b>Total</b>		<b>795</b>

# Studies Selection Process





- Research Questions
- Search String
- Electronic Databases
- Inclusion and Exclusion Criteria

- Search Process
- Studies Selection Process
- Results Summarization

- Analysis of Results
- Discussion of Results

# RESULTS

**RQ1.** How has the literature addressed the relationship between design patterns and bad smells?

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<b>Category</b>	<b>Amount of Studies</b>
Impact on software quality	7
Refactoring	5
Co-occurrence	4
<b>Total</b>	<b>16</b>

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**RQ2.** Has the literature explored co-occurrence between design patterns and bad smells?

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<b>Category</b>	<b>Amount of Studies</b>
Impact on software quality	7
Refactoring	5
Co-occurrence	4
<b>Total</b>	<b>16</b>

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**RQ2.1.** Which bad smells and design patterns are addressed by the literature for identifying co-occurrences?

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## Study

## Design Pattern

Cardoso and Figueiredo

Adapter, Command, Composite, Decorator, Factory Method, Observer, Prototype, Proxy, Singleton, Strategy, State, Template Method and Visitor

Jaafar et al.

Command, Composite, Decorator, Factory Method, Observer and Prototype

Jaafar et al.

Command, Composite, Decorator, Factory Method, Observer and Prototype

Walter and Alkhaeir

Adapter, Command, Composite, Decorator, Factory Method, Observer, Prototype, Proxy, Singleton, Strategy, State, Template Method and Visitor

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Study	Brown et al. (1998)	Fowler and Beck (1999)	Lanza and Marinescu (2006)
Cardoso and Figueiredo	-	Duplicate Code	God Class
Jaafar et al.	Anti Singleton, Blob, Class Data Should Be Private, Complex Class , Spaghetti Code and Swiss Army Knife	Long Method, Long Parameter List, Message Chain, Refused Parent Bequest and Speculative Generality	-
Jaafar et al.	Anti Singleton, Blob, Class Data Should Be Private, Complex Class, Spaghetti Code and Swiss Army Knife	Long Method, Long Parameter List, Message Chain, Refused Parent Bequest and Speculative Generality	-
Walter and Alkhaeir	-	Data Class, Data Clumps, Feature Envy and Message Chains	External Duplication, God Class and Schizophrenic Class

Study	Tools	
	Design Pattern	Bad Smell
Cardoso and Figueiredo	DPDSS	JDeodorant and PMD
Jaafar et al.	DeMIMA	DECOR
Jaafar et al.	DeMIMA	DECOR
Walter and Alkhaeir	DPDSS	InCode

**RQ2.2.** What co-occurrences have been identified by the studies?

<b>Study</b>	<b>Design Pattern</b>	<b>Bad Smell</b>
Cardoso and Figueiredo	Command	God Class
	Template Method	Duplicate Code
Jaafar et al.	Command	Speculative Generality
		Class Data Should Be Private
		Long Method
		Long Parameter List
Walter and Alkhaeir	Composite	Data Class
		God Class

**RQ2.3.** Which techniques have been used in the literature to find/establish the co-occurrence?

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<b>Study</b>	<b>Method Used</b>
Cardoso and Figueiredo	Association Rules
Jaafar et al.	Fischer's Exact Test
Jaafar et al.	Fischer's Exact Test
Walter and Alkhaeir	Association Rules

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# THREATS TO VALIDITY

- Search String
- Electronic Database
- Language of documents restrict to English

# CONCLUSION

- Systematic Literature Mapping studies
  - Impact on Software Quality
  - Refactoring
  - Co-occurrence
- Co-occurrence is a current topic
- GOF design patterns

- Bad Smells
  - Brown et al. (1998)
  - Fowler and Beck (1999)
  - Lanza and Marinescu (2006)
- Command, Template Method and Composite were those that presented co-occurrence
- Situations
  - Misuse or inappropriate application of design pattern
  - Excessive assignment of functionality to the design patterns internal components

# FUTURE WORK

- Investigate other kinds of co-occurrence relationship
- Investigate the design patterns, bad smells and software failures relationship
- Build a refactoring recommendation system

THANK YOU!

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# ATTACHMENTS

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# **SUMARIZATION OF SELECTED STUDIES**

#	Title	Author	Year	Relationship
1	Assessment of Design Patterns During Software Reengineering: Lessons Learned from a Large Commercial Project	Wendorff	2001	Impact on software quality
2	Coupling of Design Patterns: Common Practices and Their Benefits	McNatt & Bieman	2001	Impact on software quality
3	Defect frequency and design patterns: An empirical study of industrial code	Vokac	2004	Impact on software quality
4	Do Design Patterns Impact Software Quality Positively?	Khomh & Gueheneuce	2008	Impact on software quality
5	Automated refactoring to the Strategy design pattern	Christopoulou et al.	2012	Refactoring
6	Analysing Anti-patterns Static Relationships with Design Patterns	Jaafar et al.	2013	Co-occurrence
7	A multiple case study of design pattern decay, grime, and rot in evolving software systems	Izurieta & Bieman	2013	Impact on software quality
8	Code Quality Cultivation	Speicher	2013	Impact on software quality

Selected Studies to conduct Systematic Literature Mapping

#	Title	Author	Year	Relationship
9	Automated pattern-directed refactoring for complex conditional statements	Liu et al.	2014	Refactoring
10	Automatic recommendation of software design patterns using anti-patterns in the design phase: A case study on abstract factory	Nahar & Sakib	2015	Refactoring
11	A proposal of software maintainability model using code smell measurement	Wagey et al.	2015	Impact on software quality
12	Co-Occurrence of Design Patterns and Bad Smells in Software Systems: An Exploratory Study	Cardoso & Figueiredo	2015	Co-occurrence
13	ACDPR: A Recommendation System for the Creational Design Patterns Using Anti-patterns	Nahar & Sakib	2016	Refactoring
14	Evaluating the impact of design pattern and anti-pattern dependencies on changes and faults	Jaafar et al.	2016	Co-occurrence
15	The relationship between design patterns and code smells: An exploratory study	Walter & Alkhaeir	2016	Co-occurrence
16	Automated refactoring of super-class method invocations to the Template Method design pattern	Zafeiris et al.	2017	Impact on software quality

Selected Studies to conduct Systematic Literature Mapping