CONCEPT FOR A QUALITATIVE CONTENT ANALYSIS OF ARTICLES GATHERED FROM A SYSTEMATIC LITERATURE REVIEW

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AGENDA

■ Introduction and Motivation

■ Systematic Literature Review
    ☐ Overview
    ☐ Research Questions
    ☐ Current State

■ Data Extraction Phase
    ☐ Quality Assessment
    ☐ Data Extraction Strategy
        ● Coding System
        ● Questionnaire
        ● Tool Support

■ Data Synthesis Phase

■ Results and Next Steps

INTRODUCTION AND MOTIVATION I

■ Working Title: *Measuring object-oriented Design Principles*

■ In 1994 (Chidamber & Kemerer, 1994) proposed a metrics suite for measuring object-oriented design aspects

■ Expressing software design with simple metrics is not sufficient (Marinescu, 2004)

■ Design principles play an important role in designing software that has to fulfil quality characteristics

■ For measuring design principles a rule-based approach is applied

INTRODUCTION AND MOTIVATION II

Metric: „*Windows/Room*" = 1,7   **Rule**: *InstallAWindowInABathroom* = okay

INTRODUCTION AND MOTIVATION III

- Which design assessment approaches are discussed in the literature?

- Does an approach apply the idea of measuring design principles?

- Are rule-based approaches discussed in the literature?

- Are still metrics dominating the domain of measuring object-oriented software design?

- Fundamental articles have been identified but without understanding the entire domain.
  → Need for a Systematic Literature Review (SLR)

SYSTEMATIC LITERATURE REVIEW
## RESEARCH QUESTIONS

- Which approaches can be applied for measuring object-oriented software design?

- Which approaches can be applied for evaluating object-oriented software design?

- How important are design principles for measuring software design?

- How important are design smells for measuring software design?

- Which approaches explicitly deal with object-oriented concepts in software design?

- Is there a trend going from metric-based approaches to rule-based approaches?

- What is the underlying purpose of measuring software design?

SYSTEMATIC LITERATURE REVIEW
OVERVIEW
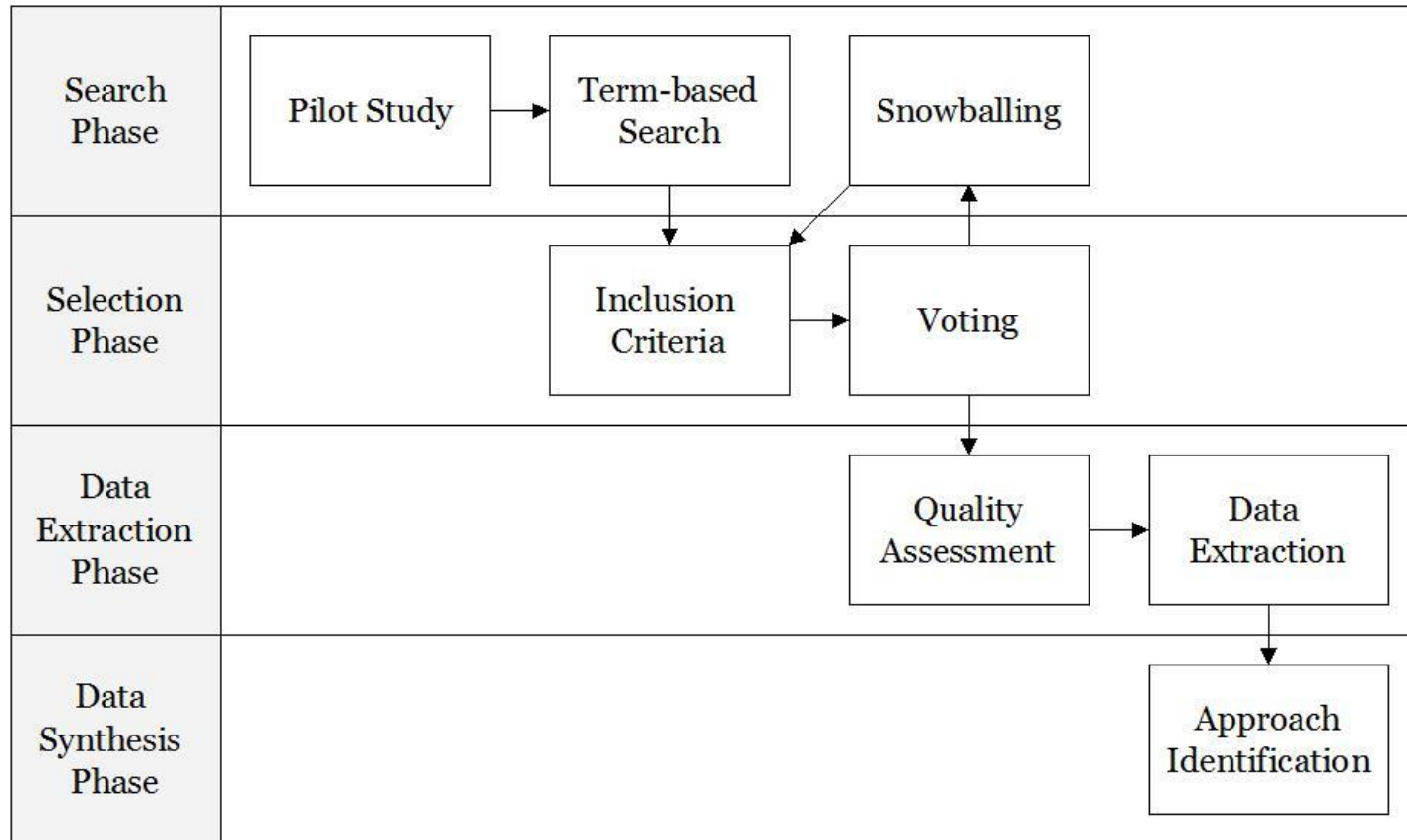
Process proposed by the guidelines of (Kitchenham & Charters, 2007)

SYSTEMATIC LITERATURE REVIEW
CURRENT STATE
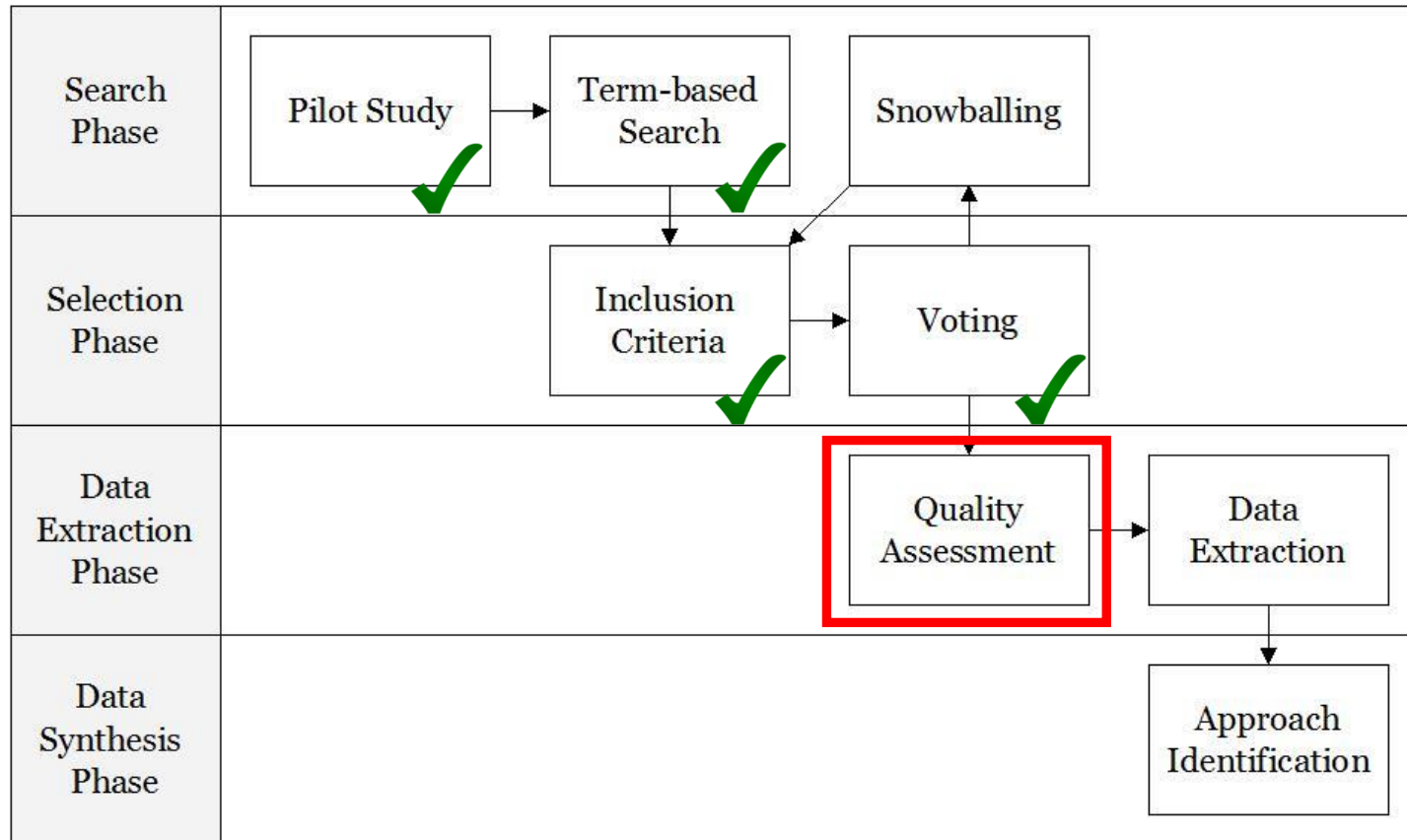
SYSTEMATIC LITERATURE REVIEW
CURRENT STATE – RESULT OF VOTING

		Reviewer 1		
		Yes	No	Total
Reviewer 2	Yes	87	31	*118*
	No	15	194	*209*
		102	*225*	*327*

Agreement:	87	194	*281*
By Chance:	36.81	143.81	*181.4*

Cohen's Kappa:	**0.68**

According to (Landis & Koch, 1977) and (Bortz & Döring, 2007) a Cohen's Kappa value of 0.68 reaches substantial agreement.

■ Finally, 122 articles are waiting to get qualitatively assessed

DATA EXTRACTION PHASE

Providing deeper insight into the quality of the articles
- ☐ to provide still more detailed inclusion/exclusion criteria,
- ☐ as a means of weighting the importance of individual studies when results are being synthesized,
- ☐ to guide the interpretation of findings and determine the strength of inferences, and
- ☐ to guide recommendations for further research.

- ■ Quality Assessment
  - ☐ To assist the article selection.
  - ☐ To assist data analysis and synthesis.
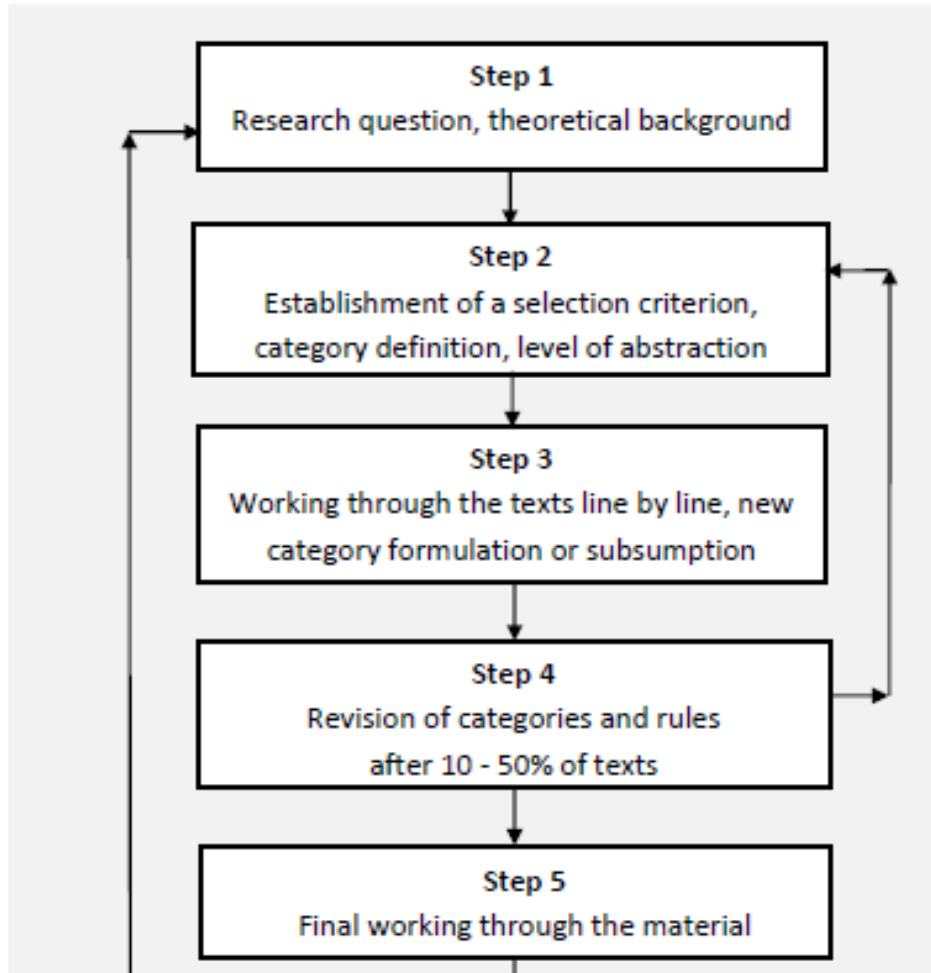
- ■ Data Extraction Strategy

QUALITY ASSESSMENT

#	Classification/Question
C1	Conference or Journal the article was published
C2	Year the paper was published
C3	Category: [Metric Validation, Design Assessment, Smell Evolution, etc.]
C4	Does the paper describe a measuring/evaluating approach? [yes, no]
C5	# of Citations reported by Google Scholar
Q1	Is there a problem definition for why this approach was developed?
Q2	Is there a clear statement of the advantages of the measuring approach?
Q3	Is the approach validation conducted within an industrial setting?
Q4	Do the authors describe the research design of the validation?
Q5	Is related work considered and compared to the proposed approach?
Q6	Are threats to validity discussed?

BASIC FORMS OF INTERPRETATION

According to (Mayring, 2010) there are the following three techniques for interpreting content:

- Summarizing
  - ☐ Inductive category formation

- Explication (context analysis)

- Structuring
  1. Definition of the categories
  2. Anchor samples
  3. Coding rules

CODING SYSTEM I

Process model for inductively building a category system (Mayring, 2010, p. 85)

CODING SYSTEM II

Code	Definition	Example	Coding Rule
- **Metric Categorization**	Papers that deal with categorizing OOD metrics belong to this category.	The paper *Categorization of Object-Oriented Software Metrics* aims to categorize OOD metrics – as highlighted by the title.	Assign code to the title of the paper.
- **Metric Validation**	Papers that deal with validating OOD metrics belong to this category.	The paper: *An Empirical Analysis of Object-Oriented Metrics for Java Technologies* conducts a validation of metrics – in this case of CK metrics.	Assign code to the title of the paper.
- **Design Smell Evolution**	Papers that empirically evaluate the evolution of code smells (aka design smells, bad smells) belong to this category.	The paper: *The Evolution and Impact of Code Smells: A Case Study of Two Open Source Systems* shows the evolution of design smells in two Java systems.	Assign code to the title of the paper.
- **Threshold Validation**	Papers that empirically derive threshold values for metric measures belong to this category.	The paper: *Deriving Metric Thresholds from Benchmark Data* empirically determines metric thresholds from measurement data.	Assign code to the title of the paper.
- **Design Assessment**	Papers that deal with a design assessment method belong to this category. For this group of papers an additional questionnaire is available as shown in the next section.	The paper: *A Conceptual Framework for object-oriented Design Assessment* proposes a conceptual framework concerning OOD assessment.	Assign code to the title of the paper.
- **Design Quality Index / Rank**	Papers that propose a ranking mechanism based on the design assessment of a system belong to this category. These papers must contain a formula or approach for calculating the design quality index or rank.	The paper: *Rank-Based Quality Measurement of Software Systems in Standardized Source Code* discusses a metric-based ranking mechanism.	Assign code to the title of the paper.

CODING SYSTEM II

Code	Definition	Example	Coding Rule
ᴸ **Design Principle**	Design principles as they are understood by the reviewer team and documented in their project wiki.	"Checking adherence to principles and constraints is a valuable concept that can be incorporated in our design assessment method."	Assign code to text passage that mentions a general statement of design principles.
ᴸ ᴸ **Information Hiding**	Information hiding is a concrete design principle that aims to prevent certain parts (implementation) of a class or component from being accessible to clients.	"The degree of information hiding is presented and quantified as the invisibilities of all methods or attributes defined in all classes traditionally. The higher the value of the invisibilities, the higher is the encapsulation."	Assign code to text passage that argues about the information hiding principle.
ᴸ ᴸ **Single Responsibility Principle**	Single responsibility principle is a concrete design principle that states that a class should have only one scope of responsibility and thus there should be only one reason for changes	"We have created a layered organization of well-known design principles. Fine-grained principles (mainly from [26]) such as Acyclic Dependencies Principle (ADP), Single Responsibility Principle (SRP), and Liskov's Substitution Principle (LSP) [27] constitute the lowest layer."	Assign code to text passage that argues about the single responsibility principle.
ᴸ ᴸ **[new Code]**	*For adding an additional code to this level, use the name of the design principle as code name.*		
ᴸ **Design Smell**	In this context, the definition and understanding of design smells is take from (Fowler et al., 1999), in which a list of design smells is discussed.	"One possible way of identifying such design flaws in object oriented designs is the detection of 'code smells'."	Assign code to text passage that mentions a general statement about design smells.
ᴸ ᴸ **God Class**	God class is a concrete design smell that refers to a class that covers too much functionality.	"Their result showed that classes which are infected with the code smells Shotgun Surgery, God Class or God Methods have a higher class error probability than non-infected classes."	Assign code to text passage that argues about the design smell god class.
ᴸ ᴸ **[new Code]**	*For adding an additional code to this level, use the name of the design smell as code name.*		

QUESTIONNAIRE

#	Label	Questions / Considerations
D1	Executive Summary	• Paper Title and Reviewer • Describe the research context of the paper (industry, academic, product, etc.)? • What is presented in the paper (approach, concept, idea, etc.)? • Relevance of the approach (research, practice)? • Which application scenarios are mainly targeted by the approach? • Notes to the approach.
D2	Design Assessment Approach	• Which measuring approach is applied? (check box) - Manual approach - Metric-based approach - Rule-based approach - Expert-based approach - …
D3	Design Paradigm	• On which design paradigm is the approach leaned on? - Design principles - Code smells - Design smells - Design patterns
D4	Design Model	• Does the approach rely on a formal design model? • Is the model complete?
D5	Design Improvements	• Does the approach provide recommendations for design improvements? • In which way does a software engineer or architect get support?
D7	Validation	• Is the approach validated in an industrial or an academic environment? • Is the approach validated on an open-source or industrial project? • Size of validations (# of projects) • Notes for validation.
D8	Tool Support	• Is there a tool support for the approach?

TOOL SUPPORT - DEMO

■ MAXQDA 12 – Qualitative Content Analysis

■ Google Forms – Questionnaire
  ○ https://docs.google.com/forms/d/1K6Cw2e3y6zxFLhGprhguiAjY_R7pcDq7SQEM80iWgP4/viewform

DATA SYNTHESIS PHASE

■ Collecting and summarizing results in a descriptive and non-quantitivate manner

■ According to (Popay et al., 2006) the synthesis process is the key element of each systematic review

■ Some issues cannot be resolved until the data is actually analyzed

■ For conducting a data synthesis, a quantitative or a narrative approach can be used (Popay et al., 2006)
  ☐ Narrative (Descriptive) Synthesis
  ☐ Qualitative Synthesis

NARRATIVE/DESCRIPTIVE SYNTHESIS

- Textual Descriptions
  - Data Extraction Questionnaire (Form) is especially designed for conducting this task

- Grouping and Clustering
  - Category Code is used for grouping the pool of articles
  - MAXMaps from MAXQDA is used for visualizing the groups and building a mind-map

- Tabulation
  - SLR without tables (Excel spreadsheets) is unimaginable ☺

QUALITATIVE SYNTHESIS

■ Articles containing conclusions based on natural language may be interpreted differently.

■ For cleaning up data, (Noblit & Hare, 1999) propose following approaches:
  ☐ Reciprocal Translation

  ☐ Refutational Synthesis

  ☐ Line of Argument Synthesis

NEXT STEPS

■ Final working through the material (quality assessment)

■ (Building of main categories if useful)

■ Intra/Inter-coder agreement check

■ Final results, frequencies, interpretation (data synthesis phase)

■ Writing the final report
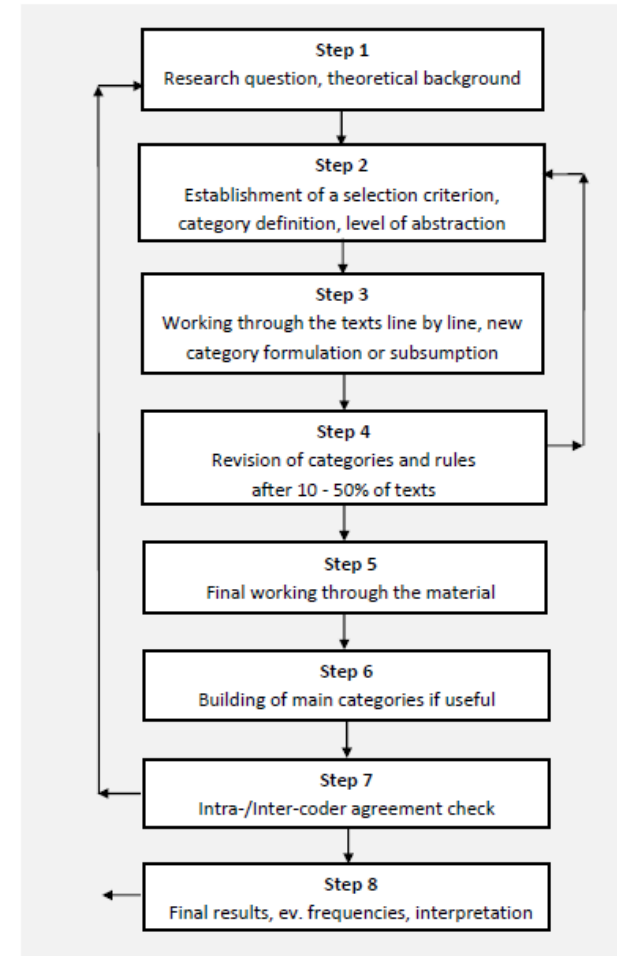
THANK YOU FOR YOUR ATTENTION!

JKU

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