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Advanced Topics in Software Architecture (E23)

Quality Attributes – 2. Tactics

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Agenda

→ Presentation of you experiments
→ Empirical Research in Software Architecture
→ Quality Attributes – 2. I4.0 Qallity model
→ Quality attributes – 2. Tactics.
→ Exercise – work with your exam hand-in

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Where are we?

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→ Use cases defined
→ System structure determined
→ Message bus(ses) considered
→ Patterns applied
→ Programming languages considered
→ Databases considered
→ System for experimentation created and run -> ready for experimentation

→ Next:
- → Patterns (lecture 6)
- → Analytical Architecture evaluation (lecture 6)
- → Consider and design experiment (lecture 7)
- → Peer review (lecture 8)
- → **Presentation of architectural experiment (lecture 9)**
- → Work with experiments and paper (lecture 10-12)

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Learning Objective

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→ Explain and discuss software architecture documentation
→ Explain and argue for software architecture and associated qualities attributes and architectural problems
→ Describe the architecture of software systems associated qualities
→ Analyze and specify architectural requirements for software architecture
→ Describe advanced software architecture topics to support software architecture processes and modeling
→ Ability to analyze and document software architectures and motivate the usage of adequate software architectures to obtain relevant quality attributes

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A Quality 4.0 Model for architecting industry 4.0 systems

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ISO25010

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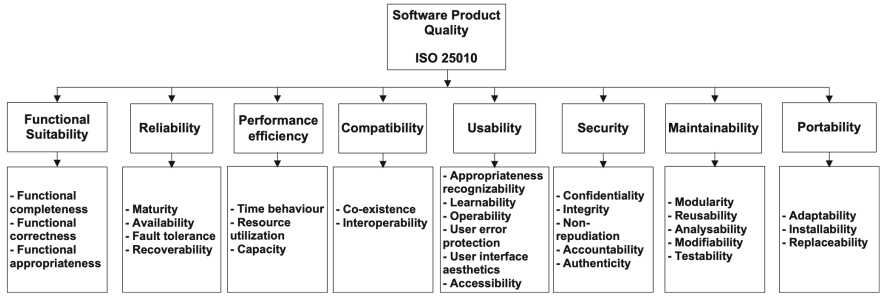

[Haoues, 2017]

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Research Questions

→ RQ1: What are adequate software and systems engineering quality and I4.0 standards for reasoning on the architectural quality of I4.0 systems?

→ RQ2: Which quality attributes are relevant to I4.0 systems?

→ RQ3: How can we relate relevant qualities to I4.0 standards and scenarios?

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Research Methodology

→ 1. Awareness of the problem
→ 1.1 Explore literature
→ 1.2 Collect quality standards
→ 1.3 Identify relevant scearios

→ 2. Solution development
→ 2.1 Analyze collected literature
→ 2.2 Analyse quality standards
→ 2.3 Define quality model

→ 3. Evaluation
→ 3.1 Evaluate literature review (independent)
→ 3.2 Evaluate standards
→ 3.3 Evaluate quality model (by experienced engineers)

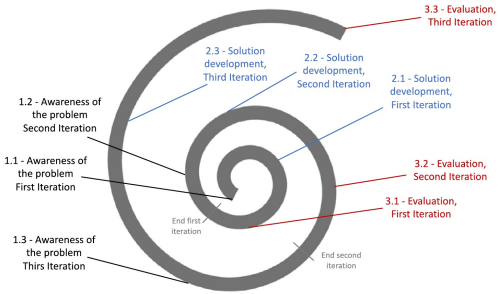

Fig. 1. Research methodology.

[Antonino, 2022]

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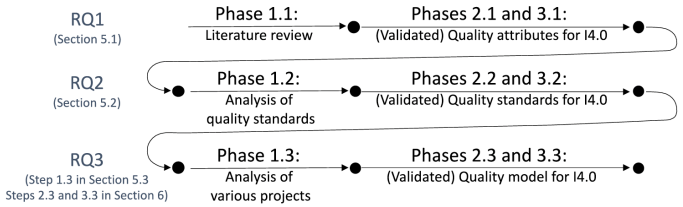
Research Methodology mapped to RQs



[Antonino, 2022]

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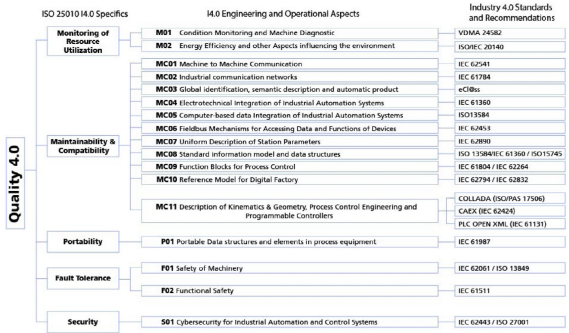
Quality Model



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Evaluation

→ **No Solution Adequacy (NSA**): Means that the Quality 4.0 aspect is not addressed by the platform.
→ **Partial Solution Adequacy (PSA):** means that the platform partially implements the Quality 4.0 aspect, providing foundations for the quality concept but not addressing it to the full extent.
→ **Full Solution Adequacy (FSA):** means that the platform implements the Quality 4.0 aspect to its full extent, offering capabilities for addressing the quality recommendations to the full extent.

Mapping of the Quality 4.0 model to I4.0 platforms (3/3).

Quality I4.0	BaSys		SITAM	
	Rat.	Rating reasoning	Rat.	Rating reasoning
P01 Portable Data structures and elements in process equipment	FSA	AAS, Submodels	FSA	Integration layer facilitates changeability
F01 Safety of Machinery	NSA	Not directly addressed	NSA	Not directly addressed
F02 Functional Safety	NSA	Not directly addressed	NSA	Not directly addressed
S01 Cybersecurity for Industrial Automation and Control Systems	PSA	Encrypted Communication, AAS allow specification of access permissions (ABAC)	PSA	Supports common security features

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Quality Attributes – 2 Tactics

→ Architectural tactics in software architecture: A systematic mapping study

[Marquez, 2023]

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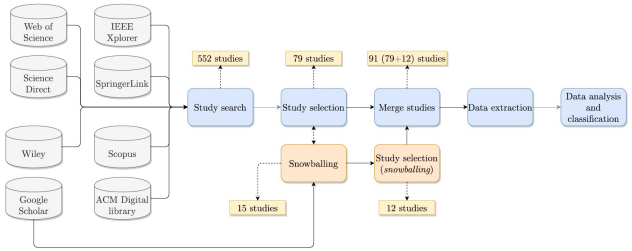
Method



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Research Questions

→ RQ1: Which quality attributes have been addressed by tactics research?

→ RQ2: Which techniques have been proposed to identify tactics?

→ RQ3: Which kinds of data sources are used to recognize tactics?

→ RQ4: What mechanisms are used to describe tactics?

→ RQ5: Which taxonomies of tactics have been proposed or updated?

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RQ1: Quality Attributes Addressed

Quality attributes addressed by tactics research.

QA	Description	# of studies
Adaptability	Adaptability controls how easy it is to change the system if requirements have changed (Tarvainen, 2008).	1
Dependability	Property of a system that delivers services at a specified reliability level and the system's ability to avoid failures that are serious and numerous (Avizienis et al., 2004).	1
Reliability	The degree to which a system, product or component performs specified functions under specified conditions for a specified period of time (ISO 25000 software and data quality, 2020).	1
Modifiability	The degree to which a product or system can be effectively and efficiently modified without introducing defects or degrading existing product quality (ISO 25000 software and data quality, 2020).	1
Interoperability	The ability of systems to share data and enable the exchange of information and knowledge between them (Bass et al., 2013).	1
Deployability	The time to get code into production after a commit (Bass, 2016).	2
Scalability	This quality attribute represents a system's ability to handle an increasing amount of work, or its potential to be expanded to accommodate growth (Kazman and Kruchten, 2012a).	3
Performance	Performance concerns itself with a software system's ability to meet timing requirements (Bass et al., 2013).	4
Safety	Attention to safety is required at each step of the software development process, identifying which functions are critical to the system's safe functioning and tracing those functions down into the modules that support them (System Safety Engineering, 0000).	4
Availability	Characteristic of architectures that measures the degree to which system resources are available for use by end-users over a given time period (ISO 25000 software and data quality, 2020).	4
Fault tolerance	This quality attribute is related to a system's ability to continue to function continuously in the event of faults (ISO 25000 software and data quality, 2020).	5
Security	The degree to which a product or system protects information and data so that individuals or other systems have the appropriate degree of access to data according to their types and levels of authorization (ISO 25000 software and data quality, 2020).	18

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RQ1

Key findings of RQ1

- The quality attribute that has yielded the most research is security.
- For primary studies, tactics are not only design decisions to achieve a quality attribute; they are also used to address other software architecture topics such as requirements description, application framework selection, proposing/refining patterns, among others.
- In terms of quality attributes, tactics have been used mainly to design architectures, support patterns and represent requirements.

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RQ2: Techniques to identify tactics

Key findings of RQ2

- The analysis of project documentation is the most common technique to identify tactics.
- Machine Learning techniques such as Decision Tree, Support Vector Machine, and AdaBoost emerge as an alternative to identify and classify tactics in source code.
- Natural Language Processing techniques such as Latent Dirichlet Allocation are used to discover tactic-related topics in source code.

Technique	Description	# of studies
Multifacetic	This definition concentrates on techniques described by the primary studies that do not resemble the other techniques identified, for example, analysis of architecture and design patterns, surveys, consensus analysis, etc.	3
Text analysis	This technique uses text processing techniques to identify, analyze and report tactics within empirically collected data.	4
Manual mapping	This technique's primary mechanism is to manually analyze project documentation.	10
Code analysis	This technique consists of the (systematic or semi-systematic) exploration of source code to extract information about software design in order to identify tactics.	10
Not described	There is insufficient information provided by the primary study describing the method used to identify tactics.	65

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RQ3: Data sources

Key findings of RQ3

- In general, studies do not bother to detail which data sources they use to recognize tactics.
- Project documentation and source code are the popular data sources for recognizing tactics.
- Recent studies are positioning repositories and web communities (such as Github and Stack Overflow) as favorites for exploring tactics.

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RQ4: Mechanisms to describe tactics

Key findings of RQ4

- A significant group of primary studies prefers abstract representation such as models to describe tactics.
- The general scenario template for describing quality attribute requirements can be adapted to describe tactics.
- There is interest for studies to propose their own definitions for tactics.

Mechanism to describe tactics identified in primary studies.

Mechanism	Description	# of studies
Formal language	Languages with formal syntaxis and semantics.	1
Description	Unstructured narrative.	9
Specific template	Usually some fields from the general scenarios described in Bass et al. (2013), complemented with some additional fields.	12
Model	Several kinds of model representation (such as UML, feature models, and others).	15
Not described	There is insufficient information provided by the primary study describing the data source used to describe tactics.	54

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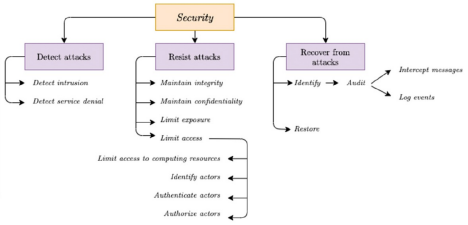
RQ5: Taxonomies

Key findings of RQ5

- Safety leads as the quality attribute with the most proposed taxonomies.
- Security is the only quality attribute for which only updates to the original taxonomy have been proposed.



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Discussion

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→ The original categorizations of tactics largely arose from interviews with architects and practitioners.

→ The primary studies do not dispute the nature of tactics; they only use them. But there is no widely agreed-upon method for defining a tactic.

→ The analysis of the primary studies reveals that there is little industrial evidence regarding the use of tactics. Table 10 describes the primary studies that have used industrial systems to validate their proposals.

→ There is limited evidence of architecture patterns in practice, and quality attribute requirements are not a factor in selecting architecture patterns: practitioners select them mainly based on functionality and technological constraints. Although this makes sense in a world where time and resources are limited, this study shows that systematic analysis of software architecture design is (still) not a priority for the industry. Thus there is insufficient evidence of tactics studies in the industry.

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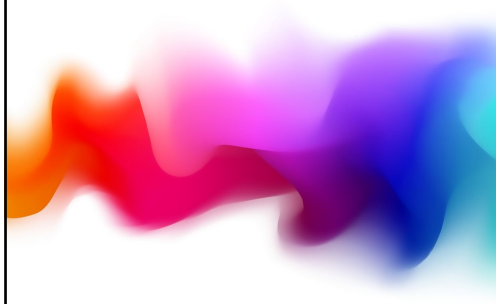

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Exercise

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→ Present your experiment

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References

→ [Haoues, 2017] M. Haoues, A. Sellami, H. Ben-Abdallah, and L. Cheikhi, “A guideline for software architecture selection based on iso 25010 quality related characteristics,” International journal of system assurance engineering and management, vol. 8, no. Suppl 2, pp. 886–909, 2017.

→ [Antonino, 2022] P. O. Antonino, R. Capilla, P. Pelliccione, F. Schnicke, D. Espen, T. Kuhn, and K. Schmid, “A quality 4.0 model for architecting industry 4.0 systems,” Advanced engineering informatics, vol. 54, p. 101801, 2022.

→ [Marquez, 2023] G. M´arquez, H. Astudillo, and R. Kazman, “Architectural tactics in software architecture: A systematic mapping study,” Journal of Systems and Software, vol. 197, p. 111558, 2023.

→ [Kassab, 2018] M. Kassab, M. Mazzara, J. Lee, and G. Succi, “Software architectural patterns in practice: an empirical study,” Innovations in Systems and Software Engineering, vol. 14, no. 4, pp. 263–271, 2018.

End of Presentation