Supplementary Materials for the paper "An Empirical Analysis of the Usage of Requirements Attributes in Requirements Engineering Research and Practice"

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Abstract. This document provides supplementary material to support the paper entitled "An Empirical Analysis of the Usage of Requirements Attributes in Requirements Engineering Research and Practice". The supplementary material contains tables including the attributes associated with: 1) stakeholders, roles, and organizations involved in managing and working with requirements, 2) changes, and the status of requirements, 3) traces between requirements and traces to other artifacts, and 4) the value of a requirement and other business or market aspects.
The supplementary material is available online from Figshare. If the paper is accepted for publication, this Supplementary Material will be made publicly available on Figshare to ensure reliable access and support reproducible research.

Keywords: requirements attributes · empirical study · literature review · requirements management

1 Introduction

	Attribute Name	Description	In papers	In case study	**M**anually/ **A**utomatically[3]	**I**ntrinsic/ **D**ecision/ **C**ommun[4]	Refs
13	Originator / Author	P3: Person responsible for entering the requirement into the database. P5: Who issued it? P8: The person who suggested the requirement and the company that the person works for P10: Submitter - the person who suggests the requirement CS: Creator CS: Submitter	1	1	A	C	[17,13,6,3]
15	Owner	P3:The person that maintains the requirement and reports the status of the requirement. P4: Requirements owner (a person that is responsible for the follow-up of the requirement and acts as an advocate of the requirement) P8: The person who is responsible for that requirement CS: Feature owner - owns the budget for implementing the feature and the business case of that feature P16: The person who is responsible for that requirement CS: Requirements Scope owner - a person responsible for decision-making about this requirement P3: Responsible Person: Person responsible for ensuring that the requirement is satisfied and maintains its status P4: Requirements Manager - An identification of the Product Manager responsible for the specification, placement, and work-up of the requirement P7: Ownership: Each work item usually has an owner who makes sure that the work item is finished. CS: Leading Feature Analysis Team CS: Feature lead - person or team responsible for leading the discussion/decision/implementation/delivery of this feature CS: Technical area team responsible for a feature CS: Analysing architect	1	1	M	C	[17,5,6,3,12]
16	Stakeholders	P3: Stakeholders: List of key stakeholders that have a stake in the implementation of the requirement and who will be involved in the review and approval of the requirement as well as any changes to the requirement. P8: Who needs the functionality in their work (intended users) P8: Which scanner groups have an interest in the requirement P6: Description of the stakeholders P7: Any user who had an account in the Jazz project repository. CS: Stakeholder	1	1	A	C	[17,6,12]
42	Business Unit	P3: A specific business unit within the enterprise that produces the product CS: GSM Review site CS: Development site / App Dev site	1	1	M	C	[17,13]

	Attribute Name	Description	In papers	In case study	**M**anually/ **A**utomatically[3]	**I**ntrinsic/ **D**ecision/ **C**ommun[4]	Refs
43	Business Line	P3: A specific brand or line of product within a given business unit. P8: Who needs the functionality in their work CS: Platform CS: Requirement Stream (product line) CS: Proposed products that a requirement applied to CS: Requested products for a given app installed on a product CS: Lead product	1	1	M	C	[17,6]
54	Name of the person who changed a requirement last	CS: Last changed by		1		C	
57	Sub-contractor delivering the requirement	CS: sub-contractor delivering the software		1		C	

Table 1: The attributes associated with stakeholders, roles, and organizations involved in managing and working with requirements.

	Attribute Name	Description	In papers	In case study	**M**anually/ **A**utomatically	**I**ntrinsic/ **D**ecision/ **C**ommunication	References
6	States and Modes	P3: The state or mode of the system to which the requirement applies.	1		M	S	[17]
14	Date Requirement Entered	P3: This is the date the author entered the requirement into the repository. P4: Date of creation P5: Submission date P7: User story creation date CS: Created Date	1	1	A	C	[17,5,13,12]
17	Change Board	P3: Change Board: The organizational entity that has configuration management authority of changes to the requirement and set of requirements of which it is a part.	1		A	C	[17]
18	Change ID	P2: Identifier of the change	1			I	[9]

	Attribute Name	Description	In papers	In case study	**M**anually/ **A**utomatically	**I**ntrinsic/ **D**ecision/ **C**ommunication	References
19	Change Status	P3: Change Status: An indication that the requirement has a change proposed to it or the status of a proposed change.	1		A	C	[17]
20	Version Number	P3: An indication of the version of the requirement P4: Records version on requirements level rather than document-level P19: Version of the requirement	1		A	I	[17,5,4]
21	Approval Date	P3: Approval Date: Date the requirement was approved.	1		A	C	[17]
22	Date of Last Change	P3: Date of Last Change: Date the requirement was last changed P4: When the last change was performed CS: Last changed date (general can be any attribute associated with a requirement) CS: Date of last consolidation state change CS: Date of the last description change CS: Date of the last stakeholder state change CS: Date of the last scope owner state CS: Date of the last architecture state change CS: Date of the last development state change	1	1	A	C	[17,5]
23	Stability	P3: Stability: the likelihood that the requirement will change. P2: Volatility, a ratio calculated from cost	1		M	I	[17,9]
24	Requirement Verification Status	P3: (True/false, yes/no, or not started, in work, complete) An indication that the requirement has been verified.	1		A	S	[17]
25	Requirement Validation Status	P3: Requirement Validation Status*: (True/false, yes/no, or not started, in work, complete) An indication that the requirement has been validated.	1		M	S	[17]

	Attribute Name	Description	In papers	In case study	**M**anually/ **A**utomatically	**I**ntrinsic/ **D**ecision/ **C**ommunication	References
26	Status (of requirement)	P3: Status of the requirement (draft, in development, ready for review, in review, approved). A status of "approved" should only be allowed if the above requirement verification and requirement validation status are both "True"; the requirement expression is stable (unlikely to change) P4 : A requirement in RAM can have different states giving information on the status of the requirement P5: Created / Approved / Specified / Discarded / Planned / Developed / Verified / Released P13: What state is the req. is in at present, e.g., new, dismissed, specified, planned for release, released, etc" P9: Working state of a requirement (initial, defined, agreed upon, released) CS: Stakeholder state CS: Scope owner (product owner) state CS: Consolidated state (general state of a requirement)	1	1	A	S	[17,5,13,4,16]
27	Status (of implementation)	P3: Status (of implementation): Indicator of the status of the implementation or realization of the requirement. For example, not meeting requirement and no plan to do so, not meeting requirement but have plan to do so, design addresses the requirement, SOI verification complete. CS: Development state CS: Configuration state	1	1	M	S	[17]

Table 2: The attributes associated with changes, and the status of requirements.

	Attribute Name	Description	In papers	In case study	**M**anually/ **A**utomatically	**I**ntrinsic/ **D**ecision/ **C**ommunication	References
28	Trace to Interface Definition/ Architecture	P3: Trace to Interface Definition Document. P5: Links to design documents P6: Influence - "Activities of the software process affected by the quality attribute" CS: Link to architecture rational description or rationale	1	1	M	C	[17,13,10]

	Attribute Name	Description	In papers	In case study	**M**anually/ **A**utomatically	**I**ntrinsic/ **D**ecision/ **C**ommunication	References
29	Trace to Peer Requirements / Parent Requirements / Dependencies	P3: Trace to Peer: Links to requirements on the same abstraction level. P3: Parent Requirements P6: Decomposition - link to parent requirement P6: Where - List of the actors influenced by the quality attribute and also a list of models (e.g. use cases and sequence diagrams) requiring the quality attribute P6: Contribution - Represents how the quality attribute affects other quality attributes. This contribution can be positive (+) or negative (-) P4 : Relation/dependency - one or several links to other requirements on the same abstraction level P5: Link to sales contract enforcing requirement P5: Links to Use Case, Textual Specification P5: Parent-of / Child-of – links to other req's P7: Links between user stories and defects P13: Dependency and type of dependency P14: IVALUEpendencies between requirements P15: Dependencies (AND, OR, REQUIRE, TEMPORAL, CVALUE, ICOST) P17: Interaction between requirements - Iteration can be positive, negative or unspecificified P12: "Does the requirement increase/decrease the value of other selected requirements?" P12: "Technical dependencies" Functional and temporal dependencies between the requirements P11: Product level requirement - Representation of requirements that are used at product level P11: Feature level requirement - Representation of requirements that are used at Feature level P11: Function level requirement - Representation of requirements that are used at Function level P11: Component level requirement - Representation of requirements that are used at component level CS: Feature Information Link - link to more information about the feature CS: Outgoing links to other features CS: IDs of other features associated with this feature	1	1	M	C	[17,9,5,4] [8,1,14,2] [7,10,12,13]

	Attribute Name	Description	In papers	In case study	**M**anually/ **A**utomatically	**I**ntrinsic/ **D**ecision/ **C**ommunication	References
33	Key Driving Requirement (KDR)	P3: KeyDrivingRequirement(KDR):A KDR is a requirement that, to implement, can have a large impact on cost or schedule. A KDR can be of any priority or criticality—understanding the impact that a KDR has on the design allows better management of requirements.	1		M	C	[17]
50	Trace to test cases	P5: Links to test documents P13: Links to test cases P1: TestingCases: This is a pointer to the testing cases associated with the requirement. This attribute is currently used in mainstream industrial practice, but the authors decided to include it into the TeqReq set, due to its close association with testing.	1			C	[13,4,15]

Table 3: The attributes associated with traces between requirements and traces to other artifacts.

	Attribute Name	Description	In papers	In case study	**M**anually/ **A**utomatically	**I**ntrinsic/ **D**ecision/ **C**ommunication	References
37	Region	P3: Region: Region where the product will be marketed, sold, and used	1		M	C	[17]
38	Country	P3: Country: Country(ies) where product will be marketed, sold and used	1		M	C	[17]
39	State/Province	P3: State/Province: State(s) or province(s) within a country or region where the product will be marketed, sold and used	1		M	C	[17]
41	Market Segment	P3: Segment of the market who will be using the product P5: Market segment for which requirement is important P5: Functional domain P8: The clinical areas in which the requirement is needed (for example, neurology or cardiology) CS: Target Market	1	1	M	C	[17,13,6]
46	Bussiness Complexity	P2: difficulty of a requirement expression by the customer	1			C	[9]

	Attribute Name	Description	In papers	In case study	**M**anually/ **A**utomatically	**I**ntrinsic/ **D**ecision/ **C**ommunication	References
48	Internal Business Value	P2: Business Novelty - How novel is the requirement to existing business processes? (ordinal, subjective) P8: "Value from the product management perspective" P12: “ROI is expressed as a relationship between gain and cost, where: Gain is value presented by a requirement in terms of potential sales or cost savings. P12: “Investment payback time, i, e. when and how fast the brake-even of the investment can be obtained?” P12: “Level of uncertainty in the value offering of a requirement” P12: “Can requirement be delivered by the targeted market window?” CS: Justification: Value for the company	1	1		C	[9,6,11]
49	End User Value	P8: "Value from the application specialist perspective" P8: "Value from the customer support perspective"	1			C	[6]

Table 4: The attributes associated with the value of a requirement and other business or market aspects.

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	Attribute Name	Description	In papers	In case study	**M**anually/ **A**utomatically	**I**ntrinsic/ **D**ecision/ **C**ommunication	References
1	Rationale	P3: Rationale*: Rationale states the reason for the requirement’s existence. P13: A description of the rationale/benefit of the requirement from the req. source’s perspective P8: The reason behind the requirement P10: The reason behind the requirement P4: Why the requirement is specified and the benefit of it CS: Justification CS: One slider (link)	1	1	M	I	[17,8,6,4]
2	System of Interest (SOI) Primary Verification Method (VM)	P3: The planned primary method of verification (test, demonstration, inspection, analysis) to prove that the designed system meets the requirement. that is being proposed to provide proof that the designed and built system meets the requirement.	1		M	C	[17]

	Attribute Name	Description	In papers	In case study	**M**anually/ **A**utomatically	**I**ntrinsic/ **D**ecision/ **C**ommunication	References
3	System of Interest Verification Approach	P3: SOI The approach or strategy suggested to verify a requirement. P5: A description of how to measure whether the requirement is met	1		M	C	[17,13]
4	Source	P3: Source, could be a stakeholder need, system concepts, user stories, use cases, regulations, standards, interviews with stakeholders, minutes of a stakeholder workshop, or an engineering change proposal. Sources could also be a functional area within an enterprise or business unit marketing, safety, compliance, etc. P4: This is a link to the source of the requirement. This can be a physical person, document, group or meeting. The exactness depends on the available information. P5: Submitter's company P13: The person that is the source of a requirement P8: Where the requirement came from P11: Where the requirement came from	1		M	C	[17,5,13,6] [7,4]
5	Condition of Use	P3: Condition of Use: A description of the operational conditions of use expected in which the requirement applies. CS: Customization Policy (if a feature is available in all products or selected)	1	1	M	I	[17]
7	SOI (System of Interest) Verification Level	P3: SOI Verification Level: The architecture level at which it will be proven that the system meets the requirement.	1		M	C	[17]
8	SOI Verification Phase	P3: SOI Verification Phase: The lifecycle phase during which it will be proven that the system meets the requirement.	1		M	C	[17]
9	SOI Verification Results	P3: SOI Verification Results: (Successful, partially successful, unsuccessful) The results of each SOI verification activity will most often be contained in a separate document. This attribute traces each requirement to the associated SOI verification results.	1		A	C	[17]
10	SOI Verification Status	P3: SOI Verification Status: (True/false, not complete/complete, percent complete) indicates the status of the SOI verification activities, including sign-off/approval of the SOI verification against the requirement.	1		A	S	[17]

	Attribute Name	Description	In papers	In case study	**M**anually/ **A**utomatically	**I**ntrinsic/ **D**ecision/ **C**ommunication	References
11	Unique Identifier	P3: Unique Identifier: can be either a number or a mixture of characters and numbers used to refer to the specific requirement. This identifier is used once and never reused. P19 Unique identifier of a requirement CS: ID CS: Unique link to the feature	1	1	A	I	[17,9,13,7] [4,14]
12	Unique Name	P3: Unique Name: This is a unique name or title for the requirement. P4: The title should reflect the contents of the requirement P5: Label- good descriptive name P8: Requirement P11: Requirement P13: Title for the requirement P17: Name CS: Title	1	1	M	C	[17,5,13,6] [3,4,14]
30	Priority	P3: Priority*: The importance of a requirement is to the stakeholders. P5: Importance category (1,2,3) P6: "Priority - Expresses the importance of the quality attribute for the stakeholders. A priority can be MAX, HIGH, LOW and MIN" P6: Obligation - Can be optional or mandatory P7: Priority P13: The priority of the req. on a scale of 1–5 where 5 is more P14: The selection and rejection criteria discussed and agreed upon that drive the requirements triage P12: What is the cost of not implementing the requirement? CS: Product Porfolio Priority - how important is a given requirement for planning a porfolio of products CS: Technology priority (in range from 0 to 1)	1	1	M	C	[17,13,4,8] [2,10,12]

	Attribute Name	Description	In papers	In case study	**M**anually/ **A**utomatically	**I**ntrinsic/ **D**ecision/ **C**ommunication	References
31	Criticality	P3: Criticality: A critical requirement is one that the system must achieve or the system cannot function at all—perhaps can be viewed as one of the set of minimum essential requirements or key performance requirements. .	1		M	C	[17]
32	Risk	P3: A risk value assigned to each requirement based on risk factors. Risk can also address feasibility/attainability in terms of technology, schedule, and cost. P4: Restrictions/Risks This attribute describes the restrictions and/or risks with the requirement that is not obvious in the description. P12: Does a requirement introduce disturbance in system architecture or hampers system evolution plans? P1: TestingRisk: It reflects the potential impact that bad testing of the requirement under consideration will exert on the system once delivered. CS: Risk of changes in a development environment when implementing this feature (the feature requires new development methods or changes in the environment)	1	1	M	C	[17,5,2,15]
34	Additional Comments	P3: Generic comment field that can be used to document possible issues with the requirement, such as any conflicts, status of negotiations, or actions. P11: Additional information that can be attached to the requirements CS: Minutes from the meetings short summaries of what happened with this requirement on the meetings CS: Comments from the software team	1	1	M	C	[17,7]

	Attribute Name	Description	In papers	In case study	**M**anually/ **A**utomatically	**I**ntrinsic/ **D**ecision/ **C**ommunication	References
35	Type/ Category	P3: Type/Category of requirements include: a. functional/performance b. operational: interactions with external systems— input, output, external interfaces, environmental, facility, ergonomic, compatibility with existing systems, logistics, users, training, installation, transportation, storage c. quality attributes d. physical characteristics e. standards and regulations—policy and regulatory f. constraint—imposed on the project, and the project must show compliance g. business rule—a rule imposed by the enterprise or business unit h. business requirement CS: Feature type (new functionality, legacy systems, hardware component, vertical support) CS: Requirement classification (e.g., Hardware vs. software feature, quality improvement, development environment production, development environment testing, thermal improvement, power consumption)	1	1	M	I	[17]
36	Applica-bility	P3: Applicability: Can be used to indicate to which increment, build, release, or model a requirement applies P6: Focus of the requirements (Scope if it is a system scope or focus)	1		M	C	[17,10]
40	Application (Name / version)	P3: Application: The application of a specific product within a product line CS: Which application within a product a feature belongs to	1	1	M	C	[17,9]

	Attribute Name	Description	In papers	In case study	**M**anually/ **A**utomatically	**I**ntrinsic/ **D**ecision/ **C**ommunication	References
44	Cost Estimation (Effort Estimation, Technical Complexity)	P1: Testing Effort - an estimation of the effort for testing of a specific requirement P1: Cost of regression testing. It represents the total cost of planning, building, constructing, and executing the regression tests P2: Effort estimate of original requirement expressed in days (ratio. subjective) P2: Technical complexity P2: Cost of changes that a requirement brings to each domain P2: Total cost of all changes that a requirement brings P2: Technical novelty/challenge (for the team) - 1. Part of day job, 2. Occasionally used, 3. Occasionally used but not in this job, 4. Familiar with concept, 5. Entirely new idea P2: Volatility ratio calculated from the cost P5: Effort estimation in hours P7: Developers' estimation of how long a story will take to implement P13: Cost/time for implementation P14: Cost/time for implementation P14: Cost estimations - the cost of including a given requirement and also the potential losses of rejecting this requirement	1		M	C	[9,13,4,8] [15,12]
45	Description	P4: The requirement description should not be more than about five sentences and should be describing the central essence of the requirement. P5: Short textual description P13: Free description of the requirement P6: Quality requirements description CS: Description	1	1	M	I	[5,13,4,10]
47	Decision Rationale	P14: Decision rationale - The rationale behind the decision to select or reject an incoming requirements P4: The reason for rejecting a requirement from the scope of a product	1			C	[8,5]

	Attribute Name	Description	In papers	In case study	**M**anually/ **A**utomatically	**I**ntrinsic/ **D**ecision/ **C**ommunication	References
51	Release due date	P9: The date that the requirement should be implemented and delivered P4: "This attribute's purpose is to ascertain that requirements are not forgotten, e.g., put as draft indefinitely. The manual usage of the attribute can be in the case of, e.g., customer deadline, etc". P5: "Release for which it is planned for P5: "Official release name" CS: Estimation when the team deliver the featue with 90%/50% of certainty CS: Execution end date (90%)	1	1	M	C	[5,13,16]
52	Testing Emphasis	P1: Reflects the testing priority as established by the testing team. It is not necessarily related to the requirements implementation priority, the classic attribute that inspired this.	1			C	[15]
53	Deployment Target	CS: Deployment target (e.g., pre-load into the memory)		1		C	
55	Pervasiveness	P2: Pervasiveness of requirement (ordinal, subjective)	1			C	[9]
56	Open Source Contribution Strategy	CS: Strategy when to contribute the code back to open source community		1		C	

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