

Using Defect Taxonomies for Requirements Validation in Industrial Projects

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*"This work shows how **defect taxonomies** are seamlessly **integrated into the RE process** and successfully applied for **requirements reviewing and testing**."*

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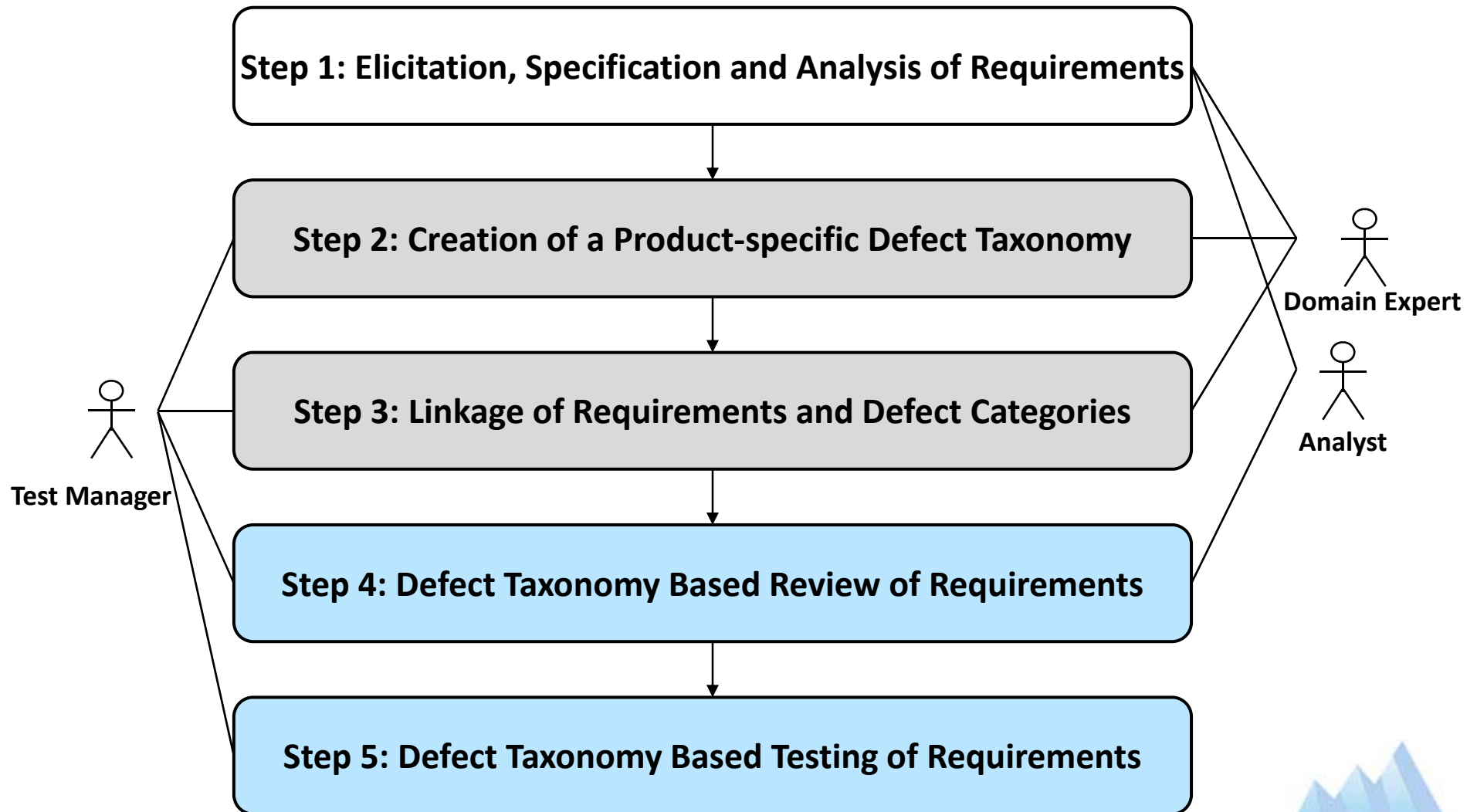


Industrial Context

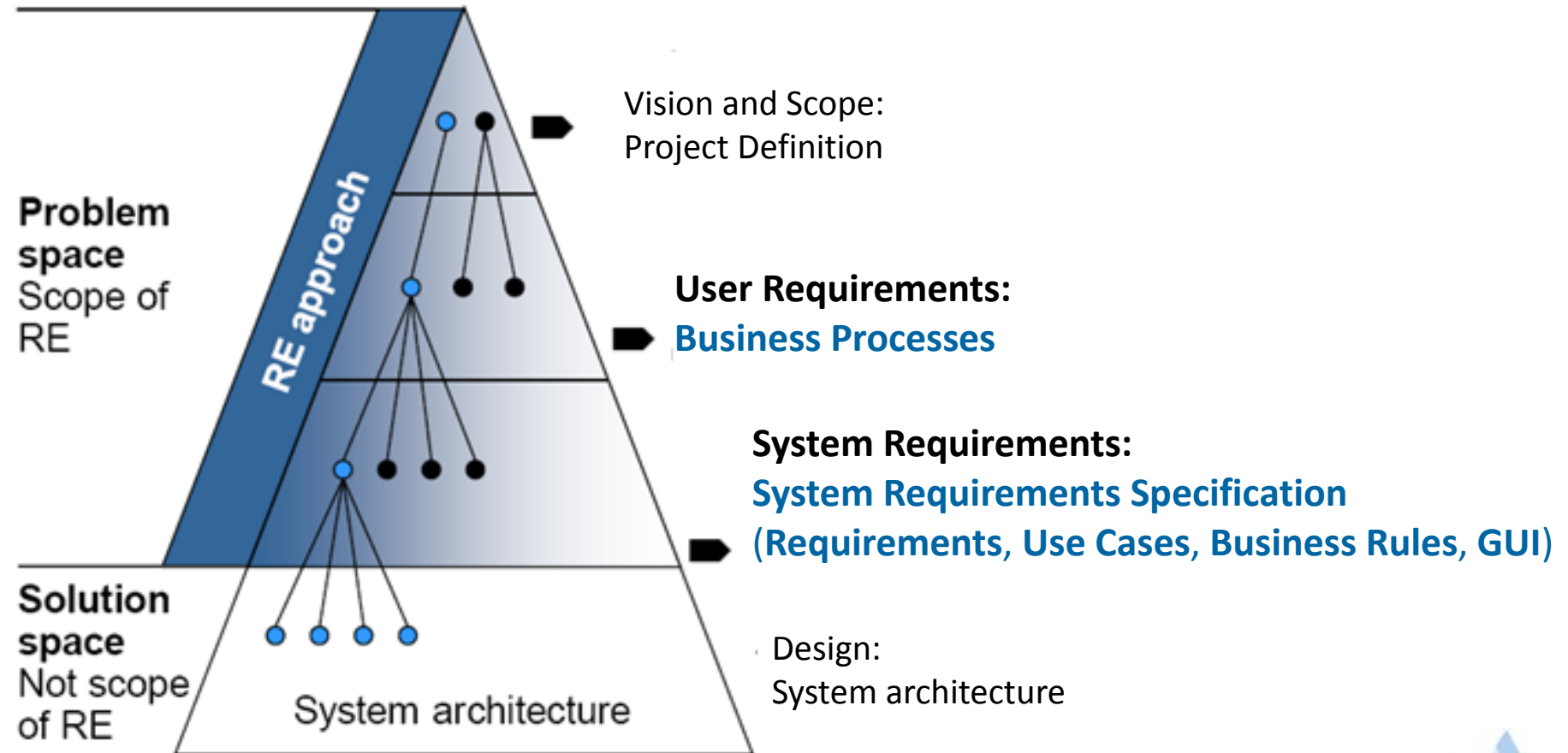
- **Public health insurance institution** in Austria
- **Incremental and iterative development** and test process
- Requirements and test management group supported by external consultants
- Defect taxonomies recognized as means to improve requirements quality and test effectiveness
- Motivated systematic application of **defect taxonomies for requirements review and testing**



Process Steps and Roles



Requirements Specification and Requirements Artifacts



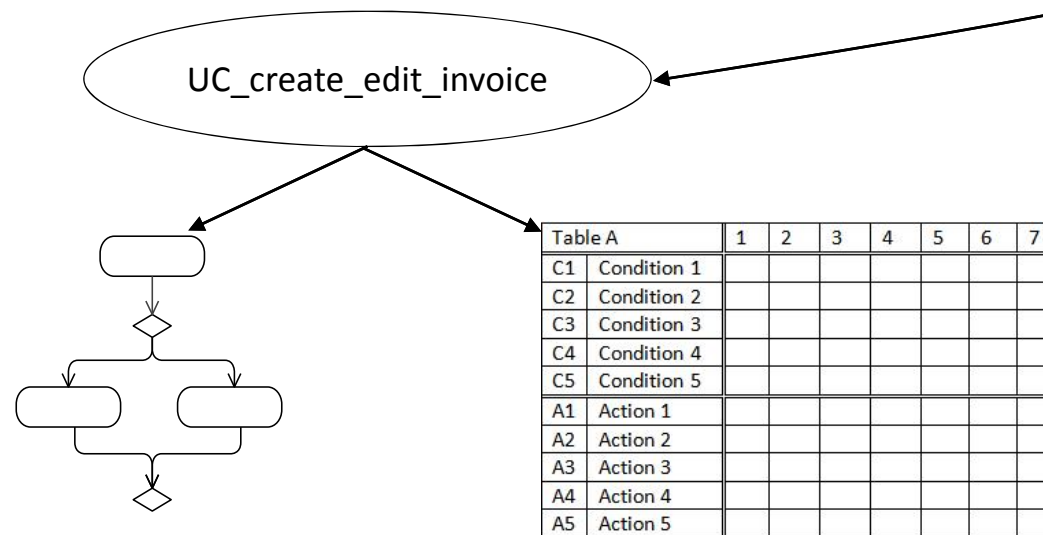
Project A

- Web application for refunding invoices of medical care and managing these cases
- Project duration
 - Two and a half years
 - 5 iterations
- Project staff
 - About 20
- Project size
 - 250 requirements
 - 45 use cases
 - 100 business rules



Requirements in Project A

ID	Requirement	Description	Assigned Use Cases, Business Process, Business Rule, GUI	Priority
...
REQ_0007	Performance	Response time should be less then 3 sec.	USC_display_invoice	medium
REQ_0024	Creation and editing of a detailed invoice	Invoice amount, VAT (Value Added Tax), date, Service-Acronym are recorded	USC_create_edit_invoice; BR_0020	high
REQ_0111	Charges for medical services	Charges of medical services are calculated automatically	USC_create_edit_invoice; BR_0036	medium



Defect Taxonomy of Project A

- Created on basis of generic top-level categories based on IEEE standard
- Low-level categories have
 - Identifier
 - Description
 - Severity value
- 4 to 9 sub-categories on each level are convenient and manageable
- Feedback of affected roles like testers or developers should be considered

Top-Level Categories	DC	Description Examples	Severity
Functionality (Process, GUI, Navigation etc.)	F1	Erroneous configuration of data display	critical
	F2	GUI-navigation, erroneous display of data	major
	F3	Insurant with attributes is not identified correctly	critical
	F4	Web Browser interaction (Firefox, IE)	normal
Data (Definition, Access, Processing)	D1	Erroneous access, saving of data of business case	major
	D2	Erroneous access, saving of invoice data	critical
	D3	Obsolete data	major
Interfaces	I1	Error on enterprise service bus	major
	I2	Erroneous interface to booking component or SAP	critical
	I3	Erroneous interface to business line of bank	major
Logic (Evaluation of business rules, Algorithms)	L1	Error in checking the status of service recipients (insurants)	major
	L2	Erroroneous calculation of the refunding of medical treatments and therapies	major
	L3	Error in checking of invoices amount	critical
Performance (Throughput, Load, Response time)	P1	Response time insufficient	major
	P2	Throughput insufficient	critical
Undefined	O		

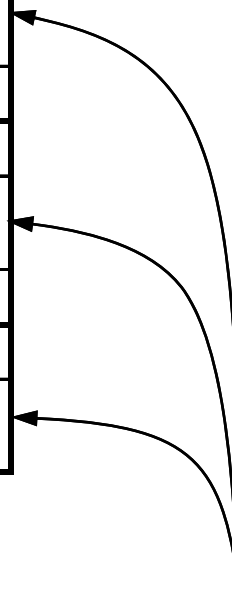
Linkage of Requirements and Defect Categories

Top-Level Categories	DC	Description Examples	Severity
Functionality (Process, GUI, Navigation etc.)
	F2	GUI-navigation, erroneous display of data	major

Data (Definition, Access, Processing)
	D2	Erroneous access, saving of invoice data	critical

Logic (Evaluation of business rules,
	L3	Error in checking of invoices amount	critical

REQ_0024	Creation and editing of a detailed invoice	Invoice amount, VAT (Value Added Tax), date, Service-Acronym are recorded	USC_create_edit_invoice; BR_0020	high
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Defect Taxonomy Based Review of Requirements

- Review process based on IEEE 1028 in place in which requirements are inspected by
 - Analysts
 - Domain experts
 - Test managers
 - Developers
 - Testers
- Review with defect taxonomies complements established review by additionally checking requirements quality criteria

Additionally Reviewed Requirements Quality Criteria

Attribute	Definition
Completeness	All important elements relevant to fulfill the different stakeholder's tasks are considered
Ranked for importance	Each requirement specifies how essential it is for the success of the project
Verifiability	There is a process to check whether a requirement is fulfilled or not
Traceability	It is possible to reference a requirement in an easy way and to identify its origin
Comprehensibility	Requirements are specified and expressed in a way that is understood by all stakeholders
Right Level of detail	Information given in requirements is suitable for gaining a correct system understanding

- Defined for individual requirements or sets of requirements

Review with Defect Taxonomies

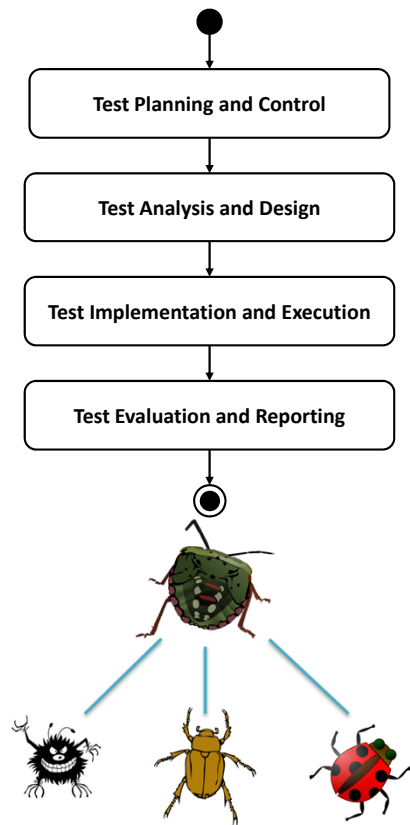
Attribute	Definition
Completeness	At least one requirement should be assigned to each defect category
Ranked for importance	Severity value of defect category can be used to check priority values of assigned requirements
Verifiability	Via defect categories, requirements are linked to appropriate test design techniques
Traceability	Via defect categories, requirements and the assigned requirements artifacts have direct links to tests and failures
Comprehensibility	Assigned defect categories enhance understandability of requirements, as examples of typical faults are provided
Right Level of detail	If assignment of defect categories to requirements is difficult, the requirement may not be defined at the right level of detail

Examples for Identified Anomalies during Review in Project A

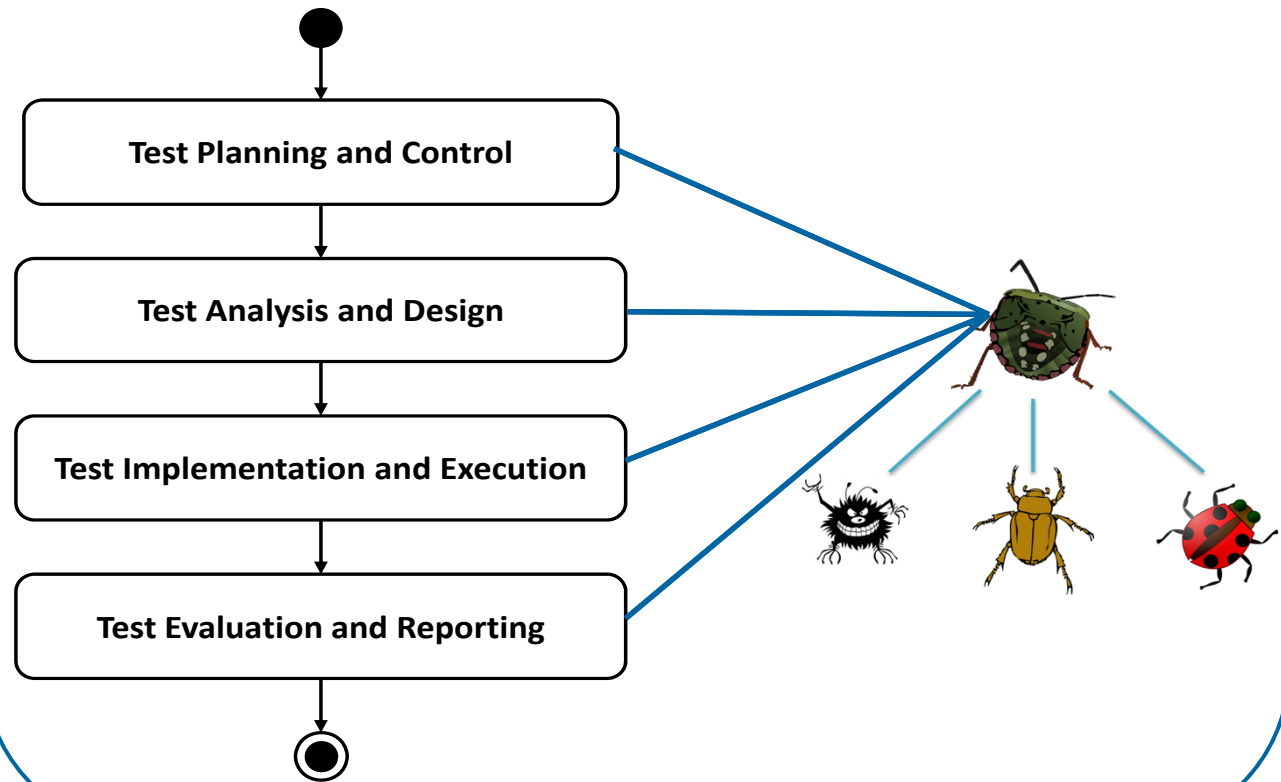
- **Anomalies** for all requirements quality criteria were **identified**, e.g.
- **Completeness**
DC P2 ("Throughput Insufficient") cannot be linked to a requirement ->
Requirement and test cases for throughput definition are added
- **Ranked for Importance**
REQ_0111 has priority "medium" but assigned DC D2 has severity "critical" ->
Test depth of REQ_0111 is increased
- **Verifiability**
Business rule BR_0020 of REQ_0024 specified in natural language but
assigned DC L3 has severity "critical" requiring decision table testing ->
Specification of decision tables for BR_0020

Defect Taxonomy Based Testing of Requirements (RTDT)

Before RTDT



RTDT



Test Design Techniques

	ID	Test technique	Test strength 1	Test strength 2	Test strength 3
S: Sequence oriented	TA1	Process Cycle Tess	Main paths	Alternatives positive	Alternatives negative

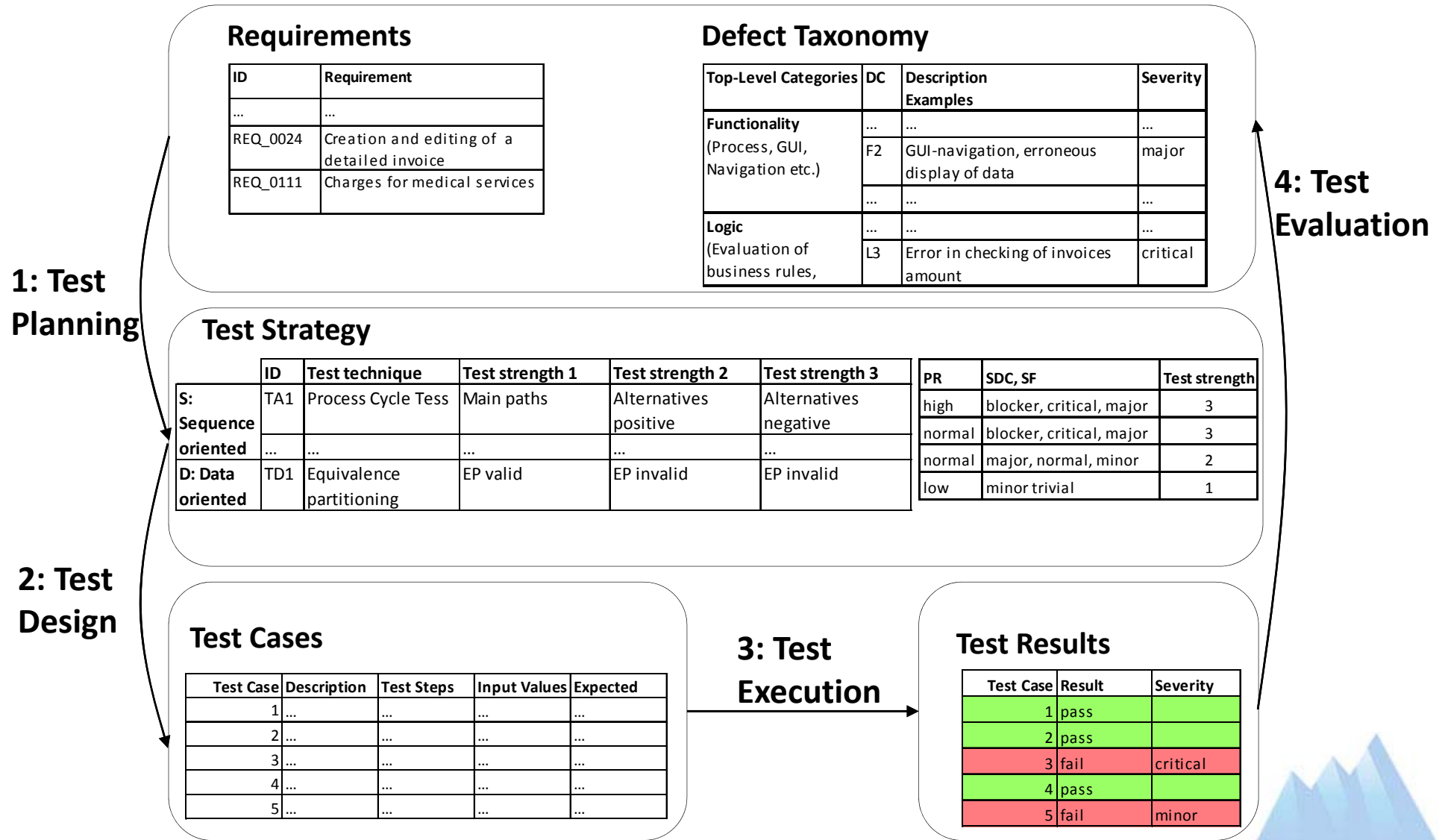
D: Data oriented	TD1	Equivalence partitioning	EP valid	EP invalid	EP invalid

	TD4	Decision tables	All-True	All-False	All-Variants

P: Performance	TD6	Syntax testing	Syntax valid	Syntax valid + invalid	Syntax valid + invalid
	TP1	Load testing	Experience-based criteria	Experience-based criteria	Experience-based criteria
	TP2	Stress testing	Ramp up low	Ramp up normal	Ramp up high

REQ_0024	Creation and editing of a detailed invoice	Invoice amount, VAT (Value Added Tax), date, Service-Acronym are recorded	USC_create_edit_invoice; BR_0020	high
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Process Steps and Artifacts of RTDT



Lessons Learned (1/3)

Prerequisites to Requirements Engineering

- Requirements with assigned priorities
- Requirements artifacts like use cases, business rules

Defect Taxonomies

- Central artifact of approach
- 4 to 9 subcategories on each level are manageable
- Subcategories require clear meaning supported by examples
- Data of completed projects and feedback of affected roles should be considered

Tool support

- Creation and linkage of defect taxonomy done in spreadsheet
- Spreadsheets easy to customize, frequently used, only edited by few persons
- Exchange of requirements and defects with other tools

Lessons Learned (2/3)

Quality of Requirements

- Especially quality attributes completeness, ranked for importance, verifiability, traceability, comprehensibility and right level of detail can be reviewed
- Additional anomalies compared to standard process based on IEEE 1028 are identified

Requirements-based testing and testability

- Seamless integration in standard requirements test process
- Support for phases test planning, design, execution and evaluation
- Test are more effective and more precise statement about release quality is possible

Defect Detection

- Significant reduction of number and severity of failures detected in operation

Lessons Learned (3/3)

Cost-Benefit Considerations

- Main benefits
 - (1) Increased quality of requirements, tests and especially released product
 - (2) Increased process quality providing decision support for release and test process
- Main costs
 - (1) Effort to create and maintain defect taxonomy and its links
 - (2) Additional effort of defect taxonomy based review
- Pragmatic approach to estimate costs and benefits is comparison of preparation and validation time with and without defect taxonomies

Summary

- Approach how defect taxonomies can improve requirements validation
 - Additional anomalies are detected during requirements review
 - Requirements tests are more effective and enable more precise release quality statement
- Requirements validation approach with defect taxonomies requires
 - Prioritized requirements
 - Product-specific defect taxonomy
 - Links between requirements and defect categories
 - Test design techniques assigned to defect categories
- Application in industrial project from public health insurance domain

Questions or Suggestions ?

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