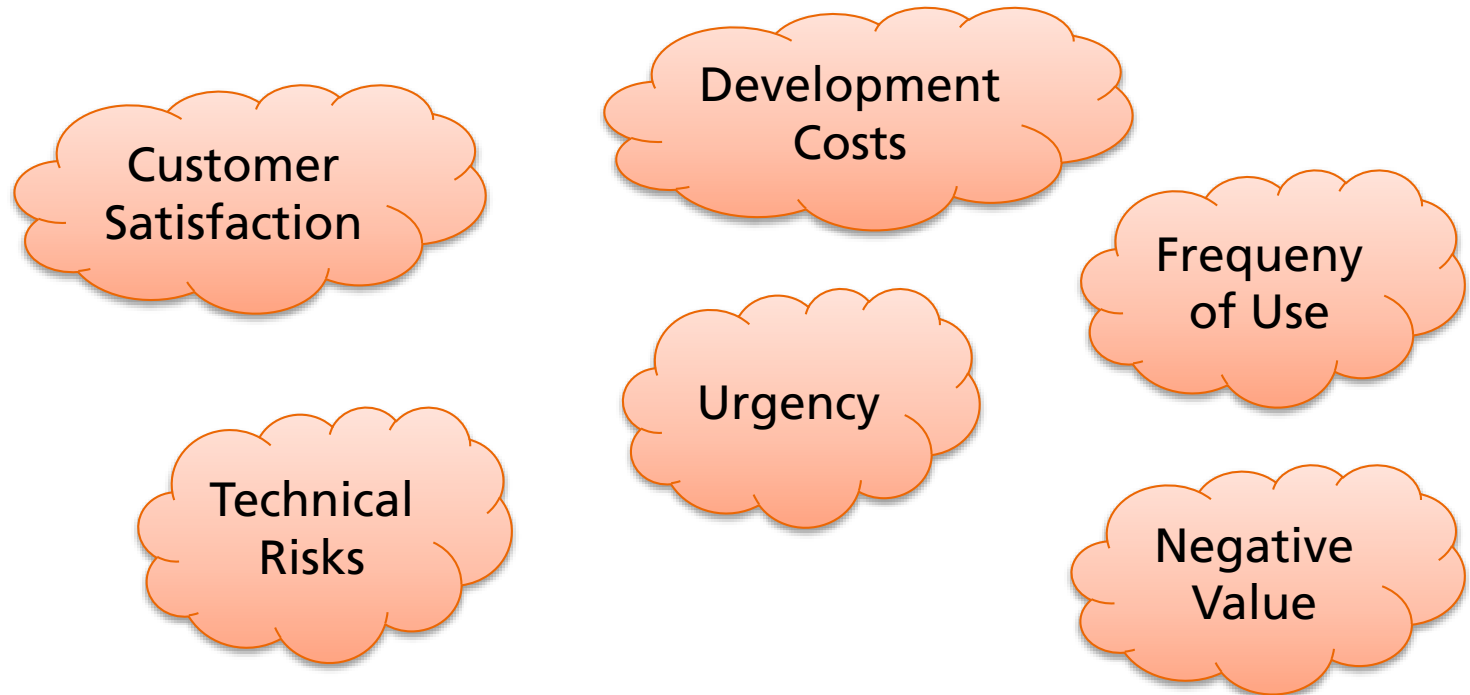

A SYSTEMATIC LITERATURE REVIEW OF REQUIREMENTS PRIORITIZATION CRITERIA

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A Definition...

Prioritization Criterion

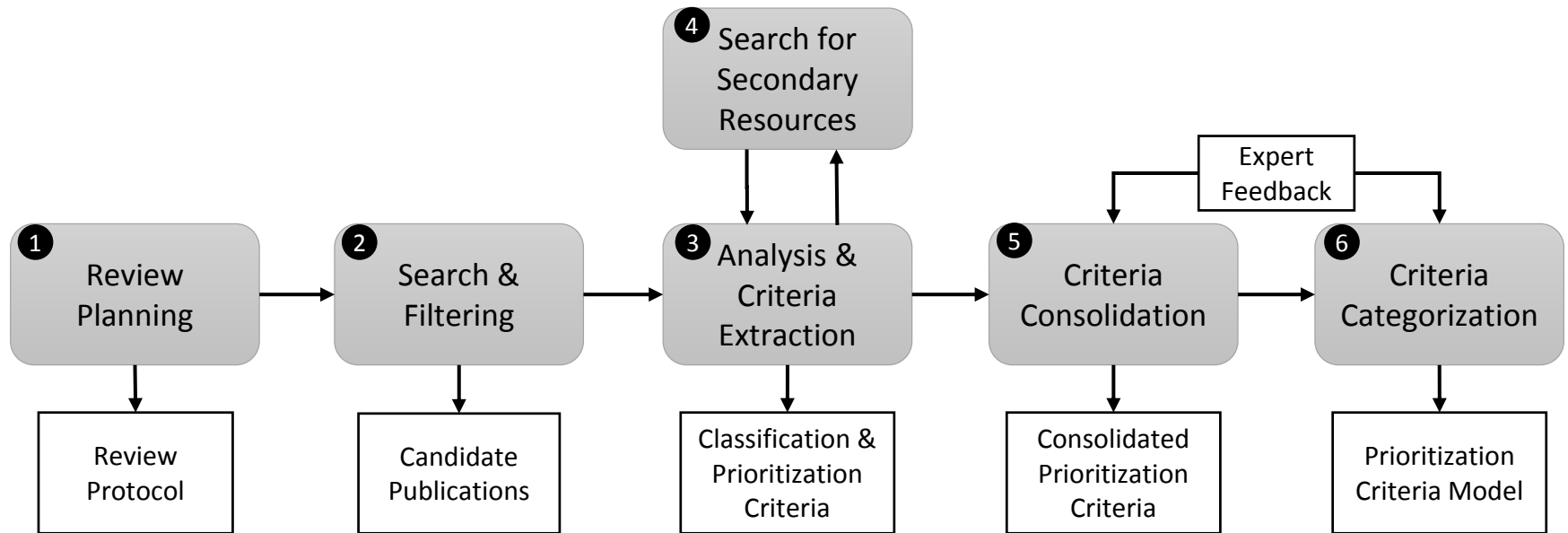
A prioritization criterion is a characteristic mark relevant for a certain requirements type and that is used to make a judgment on a requirement concerning its priority.

Motivation

- Prioritization often done on implicit criteria
 - Risk of wrong prioritization results
- Search for prioritization criteria time-consuming and laborious
 - Risk of missing important criteria
 - Risk of using unsuitable criteria
- No consolidated criteria collection available in the literature

- Goal:
 - Creation of consolidated model for
 - identification of suitable prioritization criteria &
 - identification of related literature references
 - in a time-saving manner

Prioritization Criteria Model: Research Approach



Legend:

Research Activity

Input / Output

Review Protocol (1/2)

Background	The survey is needed to build up a comprehensive base of prioritization criteria.
Research Question	Which prioritization criteria are discussed in requirements prioritization literature?
Search Strategy	<p>Search string: (requirements AND (value OR criteria OR metrics OR attributes OR measures OR factors) AND (prioritization OR negotiation OR "release planning" OR "decision making"))</p> <p>Primary Resources:</p> <ul style="list-style-type: none">• Scopus• ACM• Already known literature <p>Search Criteria:</p> <ul style="list-style-type: none">• Only computer science and related fields• All publication channels (e.g., conference and workshop proceedings, dissertations, books, journals etc.)• Search terms in Title, Abstract & Keywords• All types of publications: method papers, experience reports, case studies, long and short papers etc. <p>Search Approach:</p> <ol style="list-style-type: none">1. Search in the resources2. Exclusion of non-fitting papers3. Search for further papers in the reference list of the fitting papers if necessary

Review Protocol (2/2)

Study Selection Criteria and Procedures	<p>Exclusion Criteria:</p> <ul style="list-style-type: none"> • Does not deal with software requirements prioritization or similar (e.g., construction material selection, prioritization in networks etc.) • Does not fit to the search terms (i.e., is listed in the search result, but does not include the search terms)
Study Quality Assessment Checklists and Procedures	<p>Categorization in</p> <ul style="list-style-type: none"> • Category 1: (Software) Requirements prioritization and negotiation approaches, release planning models (i.e., publications where a concrete approach is described) • Category 2: Non-methodological publications in the context of requirements prioritization (e.g., empirical studies and literature reviews)
Data extraction strategy	<ul style="list-style-type: none"> • For category 1 publications: <ol style="list-style-type: none"> 1. Search in the method description and extraction of all prioritization criteria used / proposed in the approach 2. Search in the remaining parts of the publication about further discussed criteria which are not used / part of the approach (but mentioned) • For category 2 publications: <ol style="list-style-type: none"> 1. Search in the publication and extraction of all discussed prioritization criteria • Categorization of the extracted prioritization criteria into criteria model
Synthesis of the extracted data	<ol style="list-style-type: none"> 1. Consolidation of criteria (& identification of synonyms and homonyms) 2. Categorization of criteria

Classification

Category 1:

- (Software) Requirements prioritization and negotiation approaches and release planning models (i.e., publications where a concrete approach is described)
 - 61 Publications

Category 2:

- Non-methodological publications in the context of requirements prioritization (e.g., empirical studies and literature reviews)
 - 22 Publications

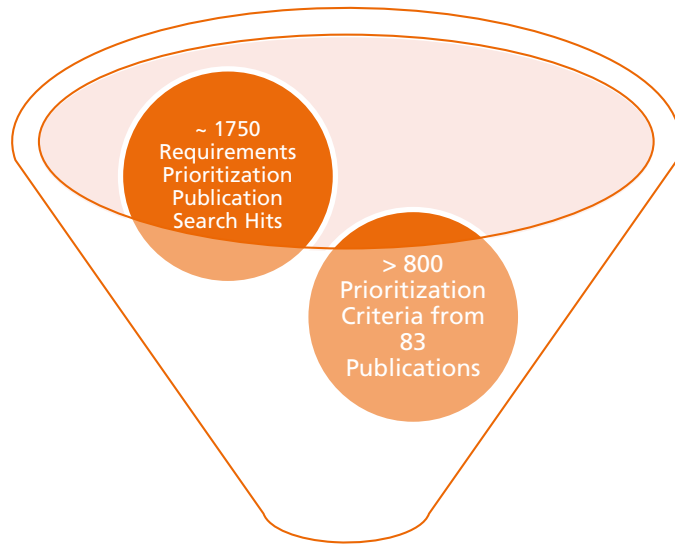
Major Challenges

- Mostly no descriptions / definitions of criteria in the literature
 - Identification of synonyms and homonyms is hard
- No common usage of terms in the literature
 - „Implementation costs“ vs. „Development costs“
- Very different abstraction levels of criteria
 - „Market value“ vs. „Number of times use case appears in model“
- Usage of generic terms for criteria

Threats to Validity

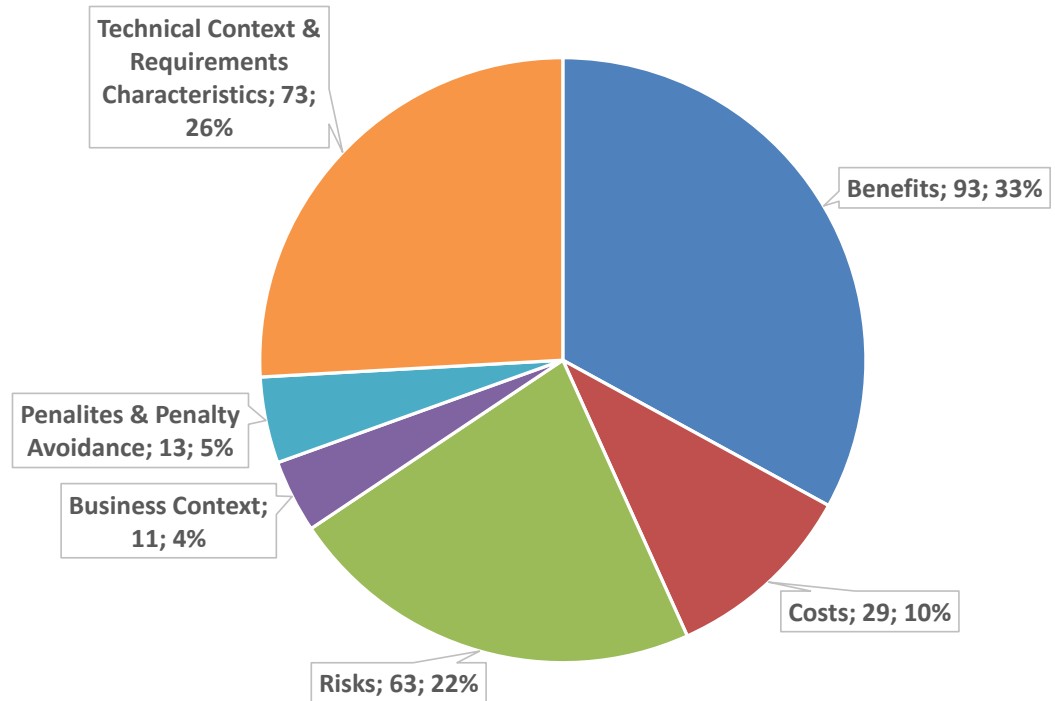
- Possibility of missed important publications
 - Not indexed in database
 - Not extracted during search
 - However, little impact on model expected
- False interpretation of criteria during consolidation
 - Inadvertent rejection of „false synonyms“
 - Counteract: not eliminating questionable criteria

Prioritization Criteria Model: Some Facts



**Prioritization
Criteria Model**

**Around 280 Criteria
in six major categories and
31 subcategories
from 83 publications**

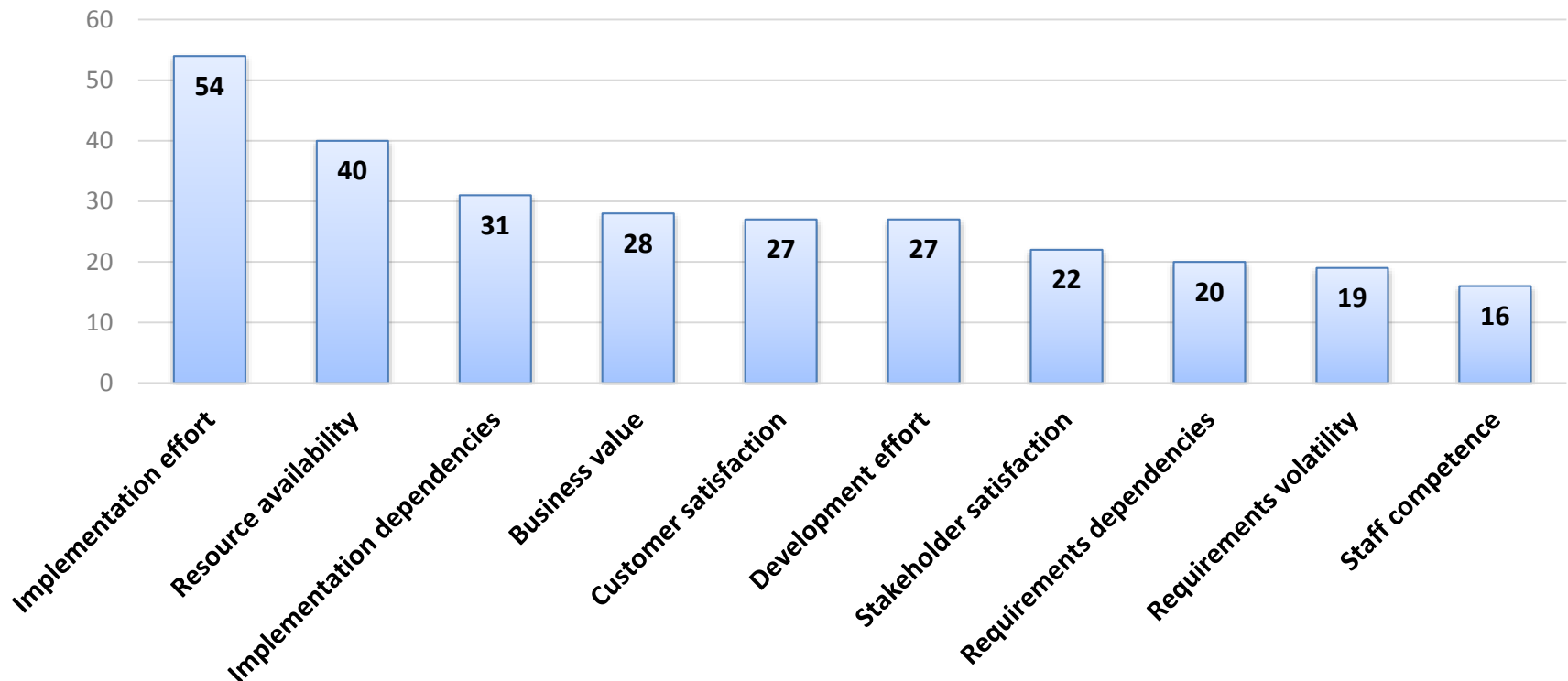


Prioritization Criteria Model: Some Facts

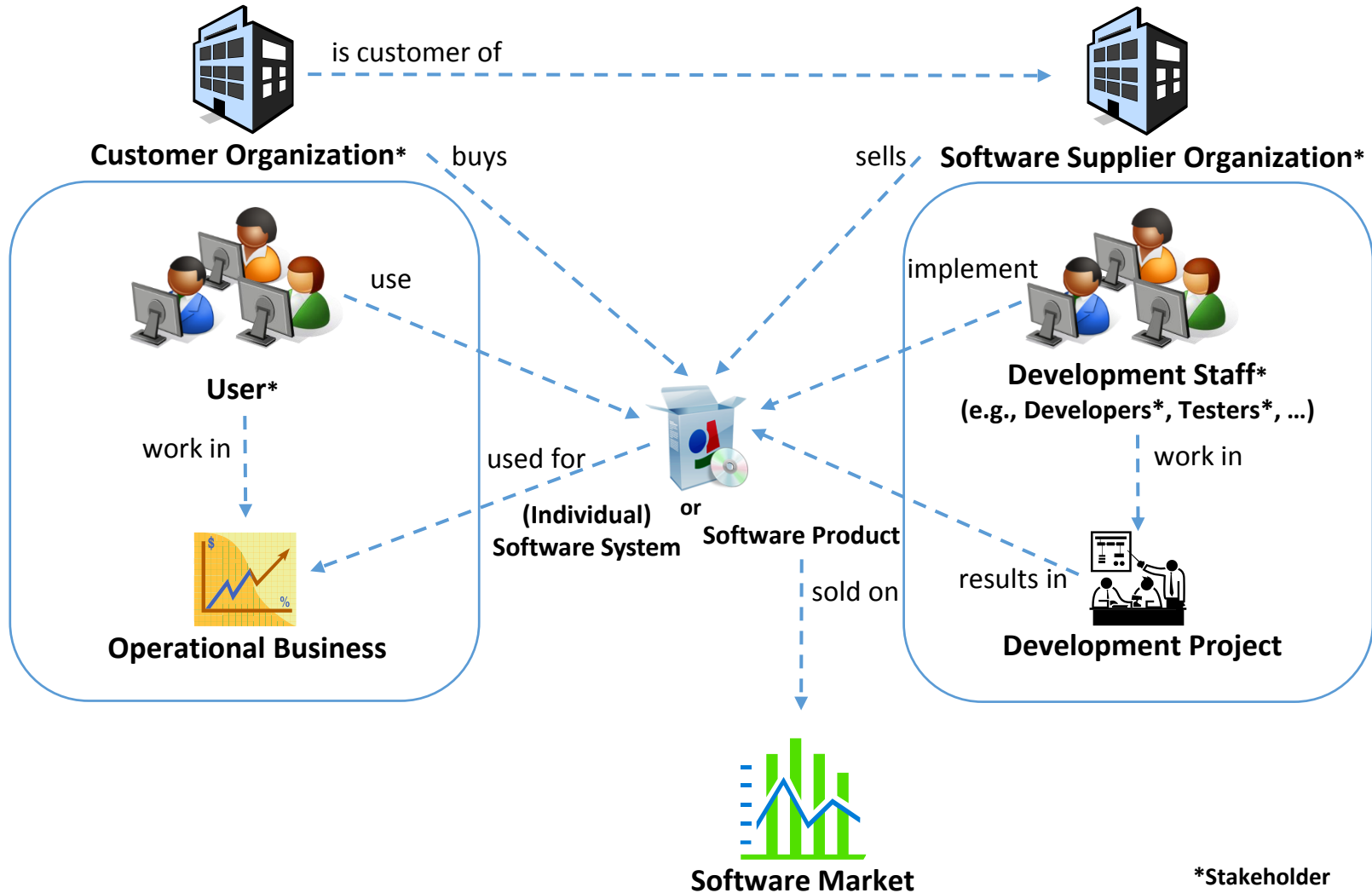
Around 60%
of criteria only
mentioned
one time

Around 80% of
criteria
mentioned less
than four times

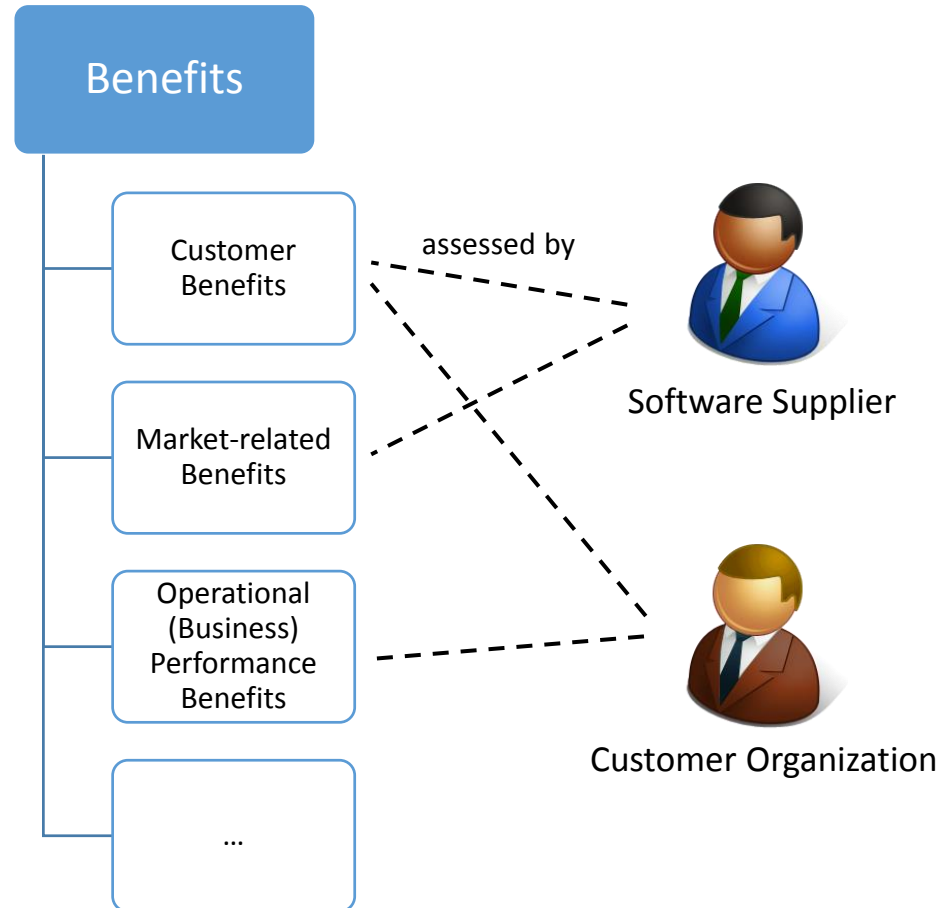
Number of mentions of
Top 10 criteria \approx 50%
of number of mentions
of all other criteria



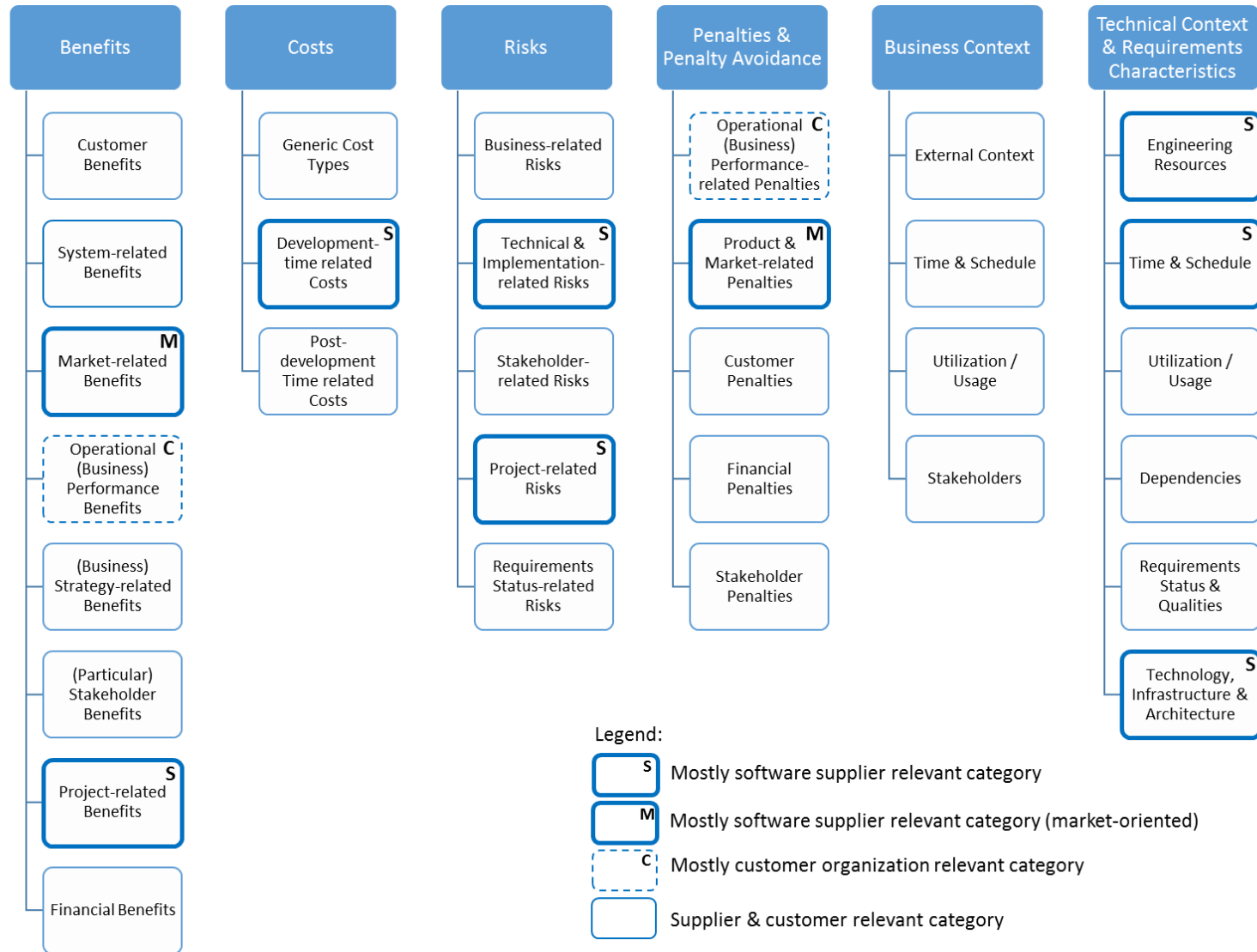
Terminology



Perspectives on the Model



Model Overview & „Navigation“



Model Excerpt from Category „Benefits“

Customer Benefits

- ❖ Customer value / satisfaction / preference
 - Efficiency gains for customer
 - Competitive gains for customer
 - Intermediary satisfaction

System-related Benefits

- ❖ Product / system value
 - Linkage to overall system goals
- ❖ Product / system quality
 - Ease of use / convenience
 - Scalability
 - Sustainability of solution
 - Changeable solution
 - Uniform solution
 - Performance
 - Stability
 - Security
 - Integrity
 - Availability
 - Testability
 - Accuracy

(Particular) Stakeholder Benefits

- ❖ Personal preference & stakeholder priority / preference / value / satisfaction / desire
 - End user value / satisfaction
 - Value creation for developer
 - Relevance to stakeholders' goals
- ❖ Fit with skills / training

Financial Benefits

- ❖ Financial benefit / revenue
 - Return on investment (ROI)

Market-related Benefits

- ❖ (Product) Market value
- ❖ Customer loyalty / retention
- ❖ Marketability / ability to sell
- ❖ New business potential / product and service enhancement
 - Additional customer sales
 - Extra cost customer will spend
- ❖ Market percentage
- ❖ Competitiveness
 - Creation of competitive advantage
 - Status of competitors with respect to the requirement
 - Innovativeness
- ❖ Market technology trends
- ❖ Brand protection
- ❖ (Feature) Influence on buying decision
- ❖ Resalable solution
- ❖ (Long term) Product strategy
- ❖ Fit with / effects on other products

(Business) Strategy-related Benefits

- ❖ Strategic alignment / suitability to business strategy
 - Importance / contribution to business goals
 - Criticality to mission success
- ❖ Long term strategic value / strategic benefit
- ❖ Tactical usefulness

Project-related Benefits

- ❖ Project value
 - Relevance to project success
 - Importance wrt. / contribution to overall release goal
 - Release theme
 - Feature contribution to project vision
- ❖ Synergy effects by combining tasks

Business value / business importance / gains for organization		Risks	
<p>Non-related risks</p> <ul style="list-style-type: none"> Product / service quality Linkage to external system goals Product / system quality Ease of use / convenience Reliability Changeability Integration solution Performance Usability Security Integrity Availability Flexibility Accuracy 	<p>Market related risks</p> <ul style="list-style-type: none"> Product / Market value Customer loyalty / retention Marketability / ability to sell New business potential / product and service Additional customer sales Low cost customer will expand Market penetration Competition Creation of competitive advantage Status of competition with respect to the requirement Low innovation Market technology trends Business processes (Future) Influence on buying decision Reusable solution Long term Product strategy Fit with effects on other products 	<p>Technical & Implementation-related Risks</p> <ul style="list-style-type: none"> Technical risks <ul style="list-style-type: none"> Architecture conflict Severe reduction of architecture Impact on essential non-functional requirements Database risks <ul style="list-style-type: none"> Product quality loss Performance risks Risk of maintenance Loss of confidential data Technical risk in current system Technical risk in proposed system (Technical) Complexity Implementation risk <ul style="list-style-type: none"> Implementation to existing risks / technology Scope IT with business processes Implementation difficulty Development risk Difficulty of programming language used Large Size Tedium Uncertainty Novelty Number of people involved Organizational constraints Implementation feasibility Ease of realization (technical feasibility) 	<p>Business-related Risks</p> <ul style="list-style-type: none"> Business risks <ul style="list-style-type: none"> Productivity loss Loss of reputation Loss of customer Negative value of individual events inherent in a future <ul style="list-style-type: none"> Security risks / misuse case risk Legal risks Reputation (economic feasibility) Ease of realization (social feasibility) Ease of realization (political feasibility) Asset uncertainty Sales barriers Commercial concerns Project-related Risks <ul style="list-style-type: none"> Overrun / schedule risk / loss Over budget risk Fixing cost (losses) (Implementation) Process risk Environment (development context) Project duration Project dependencies Impediment of attaining the requirement in the project
<p>Project-related Benefits</p> <ul style="list-style-type: none"> Support to project success Importance of contribution to overall release plan Release Benefit Feature contribution to project vision Project effects / effects to stakeholders <p>Stakeholder Benefits</p> <ul style="list-style-type: none"> Personal preference / risk / value / privacy / preference Value / satisfaction / desire Real user value / satisfaction Value creation for developer Reference to stakeholder goals Fit with goals / training 	<p>Operational (Business) Performance Benefits</p> <ul style="list-style-type: none"> Personal value Organizational effectiveness <ul style="list-style-type: none"> Support of work Fit with business processes Contribution to user task Feature / requirement support for main (target) system Organizational effectiveness / productivity improvement <ul style="list-style-type: none"> Cost saving / reduction Economies of production Reduction of IT costs Process / workflow / efficiency Speed <p>Stakeholder Benefits</p> <ul style="list-style-type: none"> Stakeholder benefit Business benefit Supplier relations Customer relations Competitor relations Business innovation Delivery Third party relations Marketing support Business making Learning and knowledge Organization culture Information Communication System formalization and planning Communication Flow of products / services Control and follow up (improved reporting) Change management Integration and coordination Flexibility 	<p>Requirements Status related Risks</p> <ul style="list-style-type: none"> Vague story Requirements volatility / stability Changes from business perspective Changes from technical perspective Market changes Legislative changes Users change Requirements become more clear during software life cycle 	<p>Stakeholder-related Risks</p> <ul style="list-style-type: none"> Personal risks Estimation risks (in size / team productivity) Risks of acceptance Decision / Impact Part of time member use
<p>Strategic dependencies</p> <ul style="list-style-type: none"> Strategic dependencies / flexibility in business strategy Flexibility to mission success Fit with strategic value / strategic benefit Technical self-dependence <p>Customer Benefits</p> <ul style="list-style-type: none"> Customer value / satisfaction / preference Efficiency gains for customer Competitive gains for customer Customer satisfaction 	<p>Operational (Business) Performance Benefits</p> <ul style="list-style-type: none"> Business innovation Delivery Third party relations Marketing support Business making Learning and knowledge Organization culture Information Communication System formalization and planning Communication Flow of products / services Control and follow up (improved reporting) Change management Integration and coordination Flexibility 	<p>Requirements Status related Risks</p> <ul style="list-style-type: none"> Vague story Requirements volatility / stability Changes from business perspective Changes from technical perspective Market changes Legislative changes Users change Requirements become more clear during software life cycle 	<p>Stakeholder-related Risks</p> <ul style="list-style-type: none"> Personal risks Estimation risks (in size / team productivity) Risks of acceptance Decision / Impact Part of time member use
<p>Cost Types</p> <ul style="list-style-type: none"> cycle costs development cost run / finance / budget <p>Technical self-dependence</p> <ul style="list-style-type: none"> hardware and costs software <p>Operational Time related Costs</p> <ul style="list-style-type: none"> development cost maintenance cost support costs operational costs shipping 	<p>Development Time / Time related Costs</p> <ul style="list-style-type: none"> Implementation cost / effort <ul style="list-style-type: none"> Development cost / effort <ul style="list-style-type: none"> Task size Complexity Functional implementation effort Technical implementation effort Quality cost <ul style="list-style-type: none"> Testing cost <ul style="list-style-type: none"> Integration testing cost User acceptance testing cost For finding defects detected during testing Quality (arbitrate) effort cost Risk mitigation effort / cost Product costs 	<p>Requirements Status related Risks</p> <ul style="list-style-type: none"> Vague story Requirements volatility / stability Changes from business perspective Changes from technical perspective Market changes Legislative changes Users change Requirements become more clear during software life cycle 	<p>Stakeholder-related Risks</p> <ul style="list-style-type: none"> Personal risks Estimation risks (in size / team productivity) Risks of acceptance Decision / Impact Part of time member use
<p>Costs & Penalty Avoidance</p> <ul style="list-style-type: none"> active value / loss / demand / penalty to business / loss of value avoidance 	<p>Financial Penalties</p> <ul style="list-style-type: none"> Cost of not implementing Financial penalty / profit impact (penalty) Regulatory / regulation Promised / contractual commitment <p>Stakeholder Penalties</p> <ul style="list-style-type: none"> Stakeholder Disincentive 	<p>Requirements Status related Risks</p> <ul style="list-style-type: none"> Vague story Requirements volatility / stability Changes from business perspective Changes from technical perspective Market changes Legislative changes Users change Requirements become more clear during software life cycle 	<p>Stakeholder-related Risks</p> <ul style="list-style-type: none"> Personal risks Estimation risks (in size / team productivity) Risks of acceptance Decision / Impact Part of time member use
<p>Local (Business) Performance related Penalties</p> <ul style="list-style-type: none"> not completed workload / workload in operation / performance impact 	<p>Financial Penalties</p> <ul style="list-style-type: none"> Cost of not implementing Financial penalty / profit impact (penalty) Regulatory / regulation Promised / contractual commitment <p>Stakeholder Penalties</p> <ul style="list-style-type: none"> Stakeholder Disincentive 	<p>Requirements Status related Risks</p> <ul style="list-style-type: none"> Vague story Requirements volatility / stability Changes from business perspective Changes from technical perspective Market changes Legislative changes Users change Requirements become more clear during software life cycle 	<p>Stakeholder-related Risks</p> <ul style="list-style-type: none"> Personal risks Estimation risks (in size / team productivity) Risks of acceptance Decision / Impact Part of time member use
<p>5. Market-related Penalties</p> <ul style="list-style-type: none"> actions from product / value / damage to loss lost share aspect (penalty) <p>Penalties</p> <ul style="list-style-type: none"> active value / loss / demand / penalty for / loss to customer dissatisfaction 	<p>Financial Penalties</p> <ul style="list-style-type: none"> Cost of not implementing Financial penalty / profit impact (penalty) Regulatory / regulation Promised / contractual commitment <p>Stakeholder Penalties</p> <ul style="list-style-type: none"> Stakeholder Disincentive 	<p>Requirements Status related Risks</p> <ul style="list-style-type: none"> Vague story Requirements volatility / stability Changes from business perspective Changes from technical perspective Market changes Legislative changes Users change Requirements become more clear during software life cycle 	<p>Stakeholder-related Risks</p> <ul style="list-style-type: none"> Personal risks Estimation risks (in size / team productivity) Risks of acceptance Decision / Impact Part of time member use
<p>Context</p> <ul style="list-style-type: none"> role support data dependencies external dependencies inter governmental demand <p>schedule</p> <ul style="list-style-type: none"> release time to market 	<p>Utilization / Usage</p> <ul style="list-style-type: none"> Frequency of use Actor priority / weight <p>Stakeholders</p> <ul style="list-style-type: none"> Originator of requirement Stakeholder agreement Likelihood of success 	<p>Requirements Status related Risks</p> <ul style="list-style-type: none"> Vague story Requirements volatility / stability 	

Customer Benefits			
Criterion	References	Interpretation	Ex. Metric
❖ Customer value / satisfaction / preference	[1] [2] [4] [6] [7] [8] [9] [10] [11] [13] [14] [17] [24] [30] [35] [43] [46] [47] [49] [51] [54] [62] [63] [65] [66] [71] [80]	The benefit to the customer of any kind, if the requirement is implemented.	Qualitative
➤ Efficiency gains for customer	[40]	The gains for the customer in terms of efficiency [40] in its processes, if the requirement is implemented.	E.g., average time savings in [hours]
➤ Competitive gains for customer	[40]	The gains for the customer in terms of competitiveness [40] on the market, if the requirement is implemented.	Qualitative
➤ Intermediary satisfaction	[5] [11]	The satisfaction of intermediaries (such as local resellers or consultants) if the requirement is implemented [11].	Qualitative

Conclusion & Outlook

- Literature references and additional information can be found in
 - Riegel, N.: Prioritization Criteria Collection and Literature Sources. IESE-Report, 048.14/E
 - <http://publica.fraunhofer.de/documents/N-311309.html>
- In the meantime, model was already customized for IS / business-process-driven development domain
- Domain industry expert survey was conducted for evaluation with respect to prioritization effectiveness and efficiency
 - „Importance“ & „Ease of Assessment“ for each criterion
 - General benefits of the model

Thank you for your Attention!