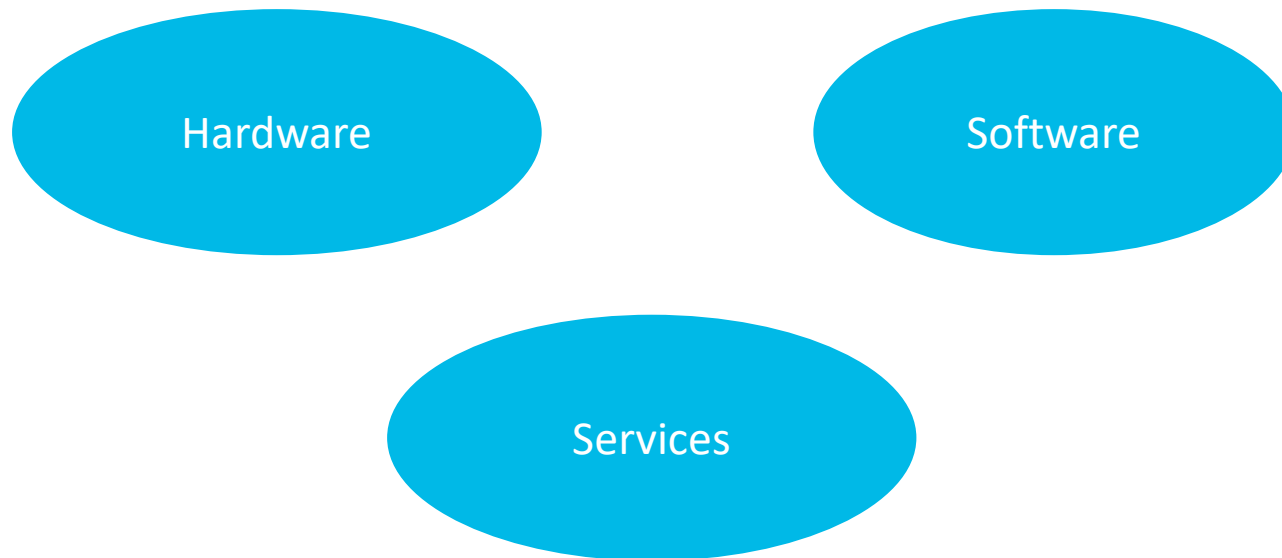


An empirical study in requirements engineering in cross domain development

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Challenge: integrated offerings with cross-domain content



How do companies work with requirements?

Purpose

Analyze	current internal work with requirements
for the purpose of	exploring practices
with respect to	efficiency and effectiveness
from the point of view of the	developers
in the context of	four large companies with cross-domain development.

Method

- Recorded interviews with eleven, self-selected subjects in four companies (Johansson, Tahir Sheikh)
- Analyzing recordings, classification (Buffoni)
- Discussion and conclusion (Nilsson, Sandahl)
- Results verified with involved companies

Context

Four companies:

- A has software as the main product, hardware is a special branch
- B develops hardware and electronics
- C develops hardware and services
- D develops both hardware and software
- Interviewees were developers or their immediate supervisors
- Development cycles 2-5 years

Generic Workflow

Requirements sources



Product management

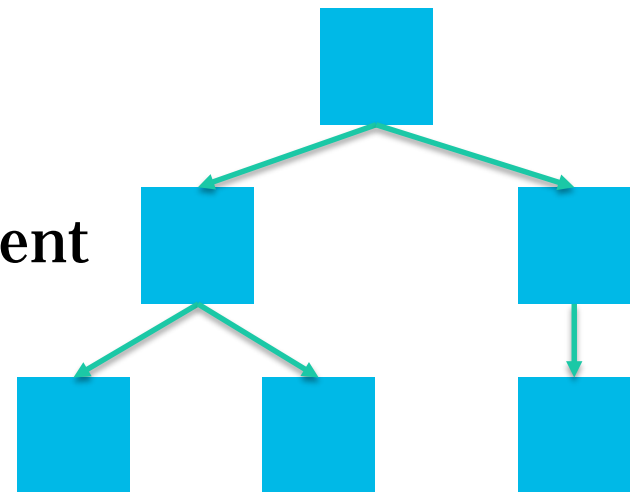


Breakdown classification

Levels:
product

department

team



Requirements sources

- sales and after sales departments
- senior management that lays out the large-scale goals and road maps to follow
- a selected group of customers, customer visits
- focus or analytic groups that study market trends, buzz words that are often vague concepts identified by use-cases (e.g Internet of Things)
- previous products or projects, experience

Important for hardware

Requirements classification

- **Component or part of system specific requirements**
- **Trust mark or quality level requirements**
- **Cross function requirements, involving the whole system or behavioural requirements**
- **User experience requirements, using language such as comfortable, responsive, faster (than previous product) etc.**
- **Performance requirements (number of faults allowed, lifespan, etc.)**

Requirements analysis

- Specifications are never complete, salient knowledge is assumed to be present
- Conflicts are detected by cross-functional teams and negotiated (typically performance vs. cost)
- Decomposition down to team level
- Prioritization eats resources, more with larger projects. Company D prioritize to avoid future issues.

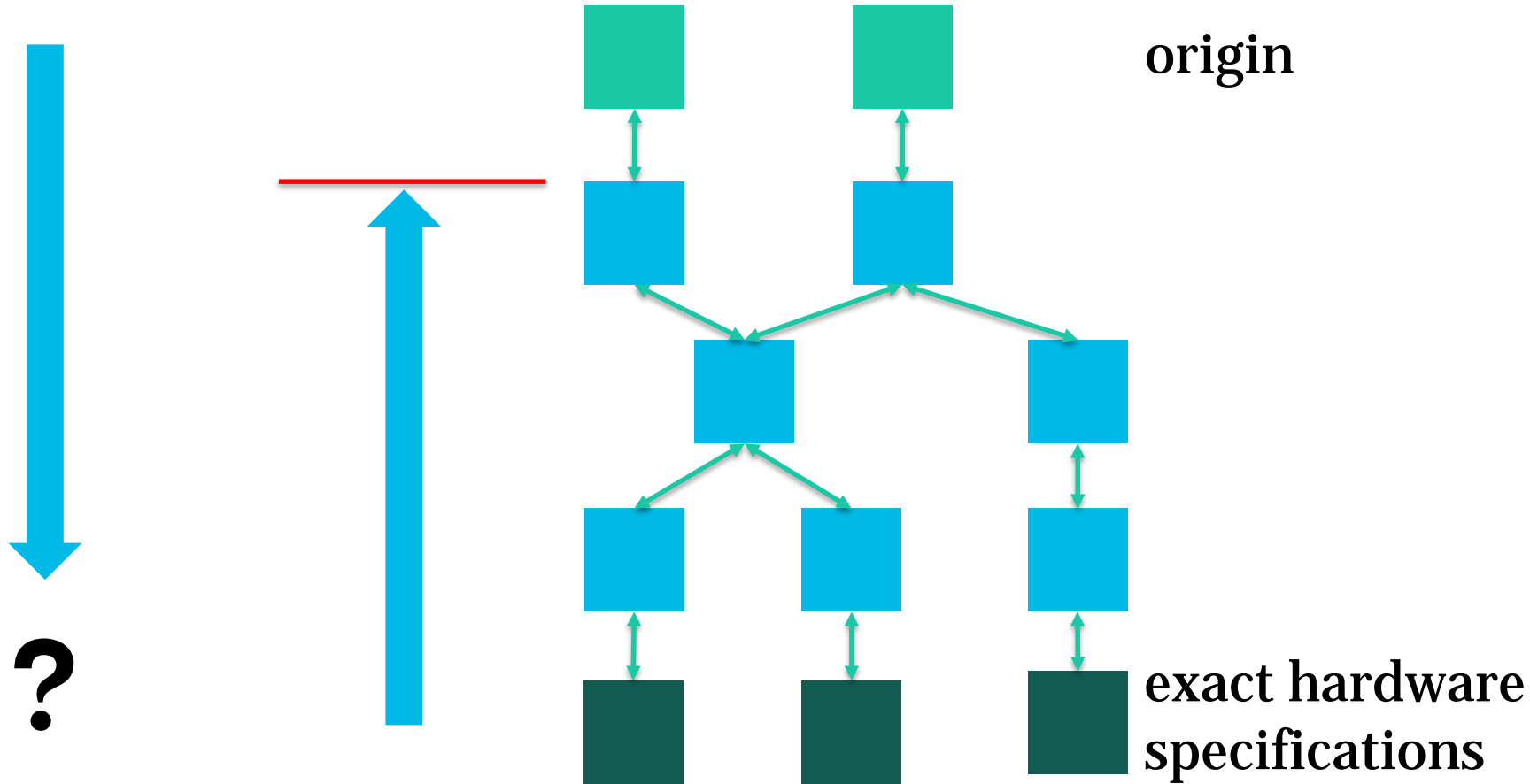
Standards

- **Internal standards for requirements used.**
- **No mention of an external standard**
- **Growing interest for standards for product safety**
- **“Standards are (too) open for interpretation”
(Company A)**

Tools

- **Company A and C use PLM tools based on a global relational database**
- **Company D has a textual database**
- **Company B use Excel, each department has their own, but public format**
- **DOORS is mentioned by two companies, but deemed to cumbersome**

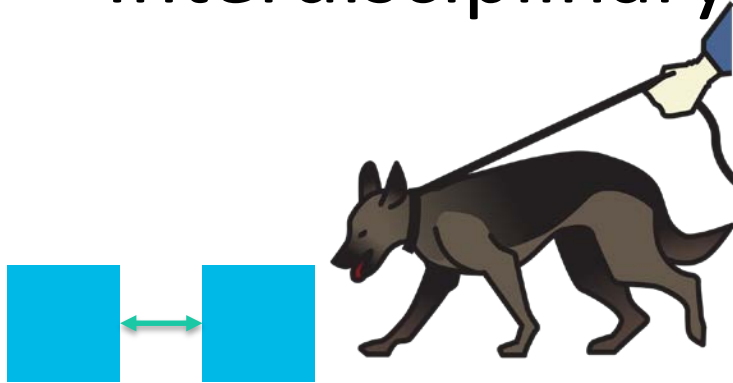
“Traceability can always be improved” (*)



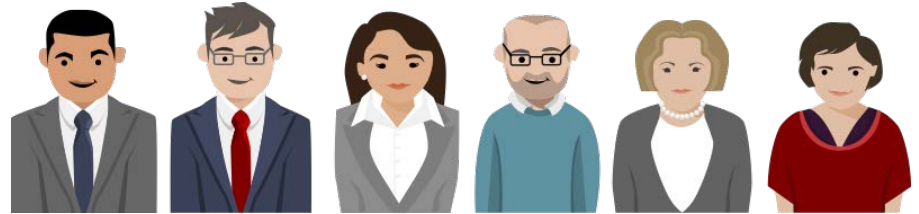
Interdisciplinary requirements

- *“you have to consider all the requirements all the time”* (Company C)
- *“communication is key for successful cooperation and the people factor is very important”* (Company A)

Interdisciplinary requirements



Interdependency tracker (B)



Cross-functional teams (A and D)



Representatives (D)



Moderators (A)

Interdisciplinary requirements - challenges

- **Have other departments re-prioritize takes time**
- **Differences in department size**
- **Physical distance**
- **Lack of tools for international collaboration**
- **Cost of constant organizational review**

Interdisciplinary requirements

- *“Thinking of other departments ... a more integrated mind set is something that should be aimed for”*
(Company D)

Verification methods differ

Verification methods	Company:	A	B	C	D
Comparison to previous versions of the product			X		
NDS NETWORK description specification - use case diagrams, flows, use case realisation documents, classes Data structures		X			
Prototypes					X
Providing third party suppliers with rigorous testing protocols				X	
Quality test stack - about 10 levels of testing			X		
Root cause analysis for unpredicted issues					X
Simulation			X		
Test laboratories or centres			X	X	
Test rigs				X	X
Test specifications		X			
Tests on actual hardware			X	X	
Verification standard for tests unique to each type of product			X		
Virtual verification of the system, up to a year before the release of the product, currently parts still need to be built physically, but the aim is to be fully virtual				X	

Some take-aways

- **Processes remarkably similar**
- **Human communication is the key practice**
- **No formal specification notations**
- **Increased focus on safety requirements**
- **Problem of combining safety and agile methods**
- **Cost-effectiveness of traceability and prioritization**
- **Some interest in modelling**

Conclusion and future work

- The challenges are similar
- Efforts in requirements reduce problems later
- It is possible to identify good practices
- Practices vary between companies

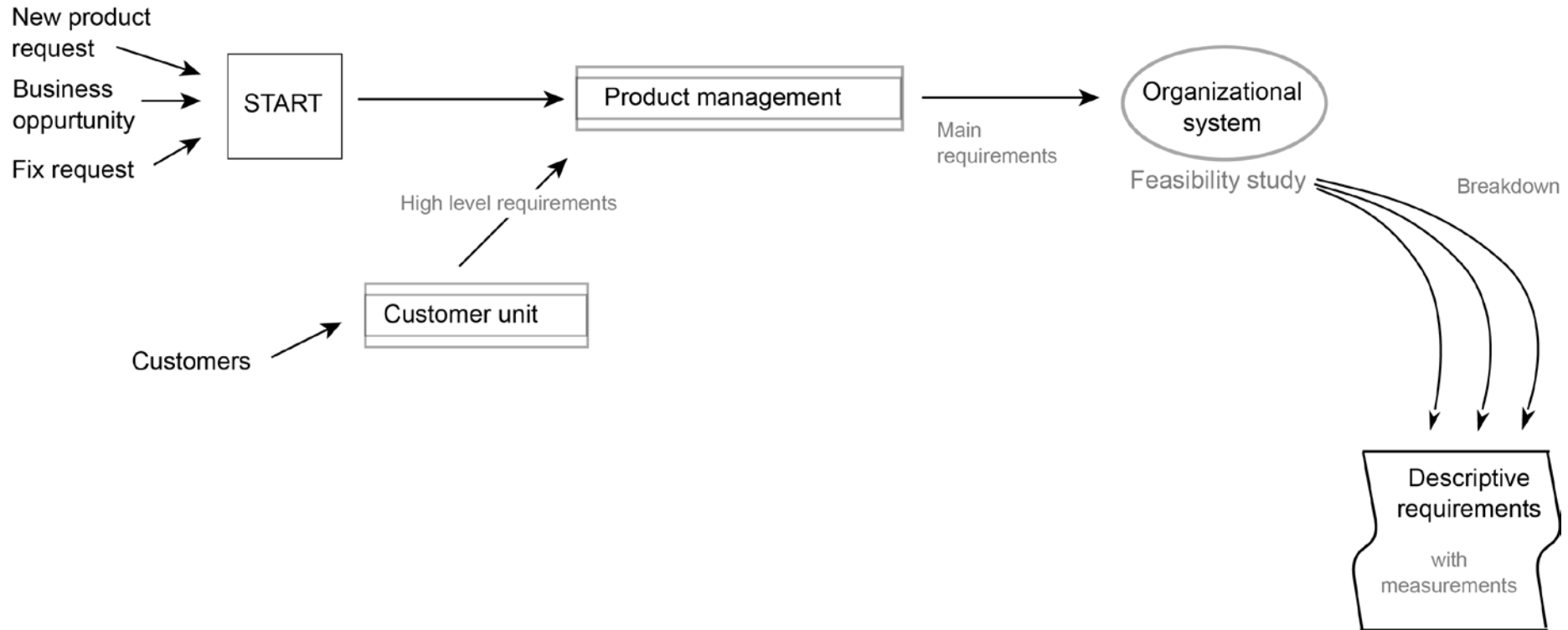
- Will continued studies form a more coherent picture?
?



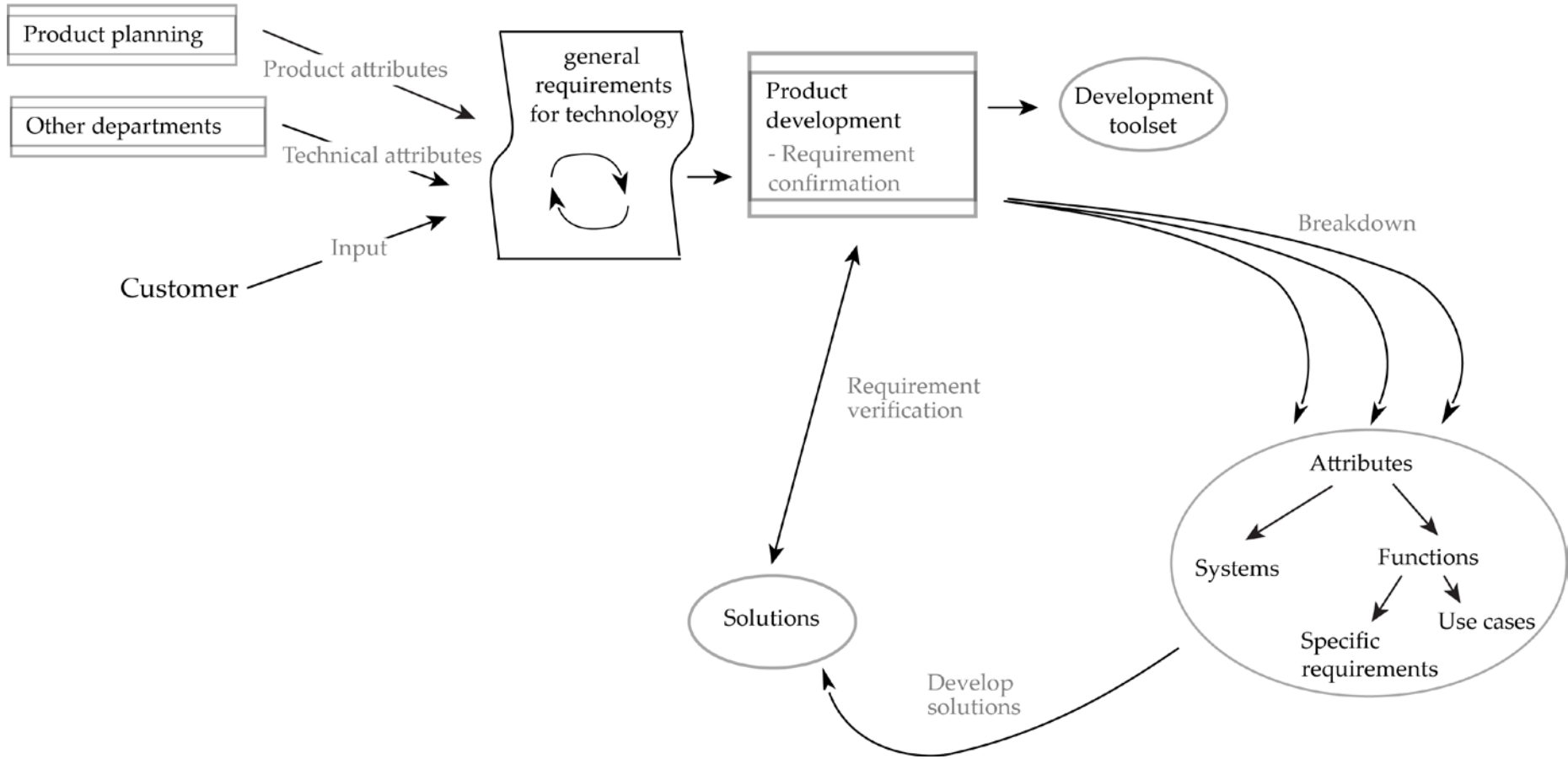
Welcome

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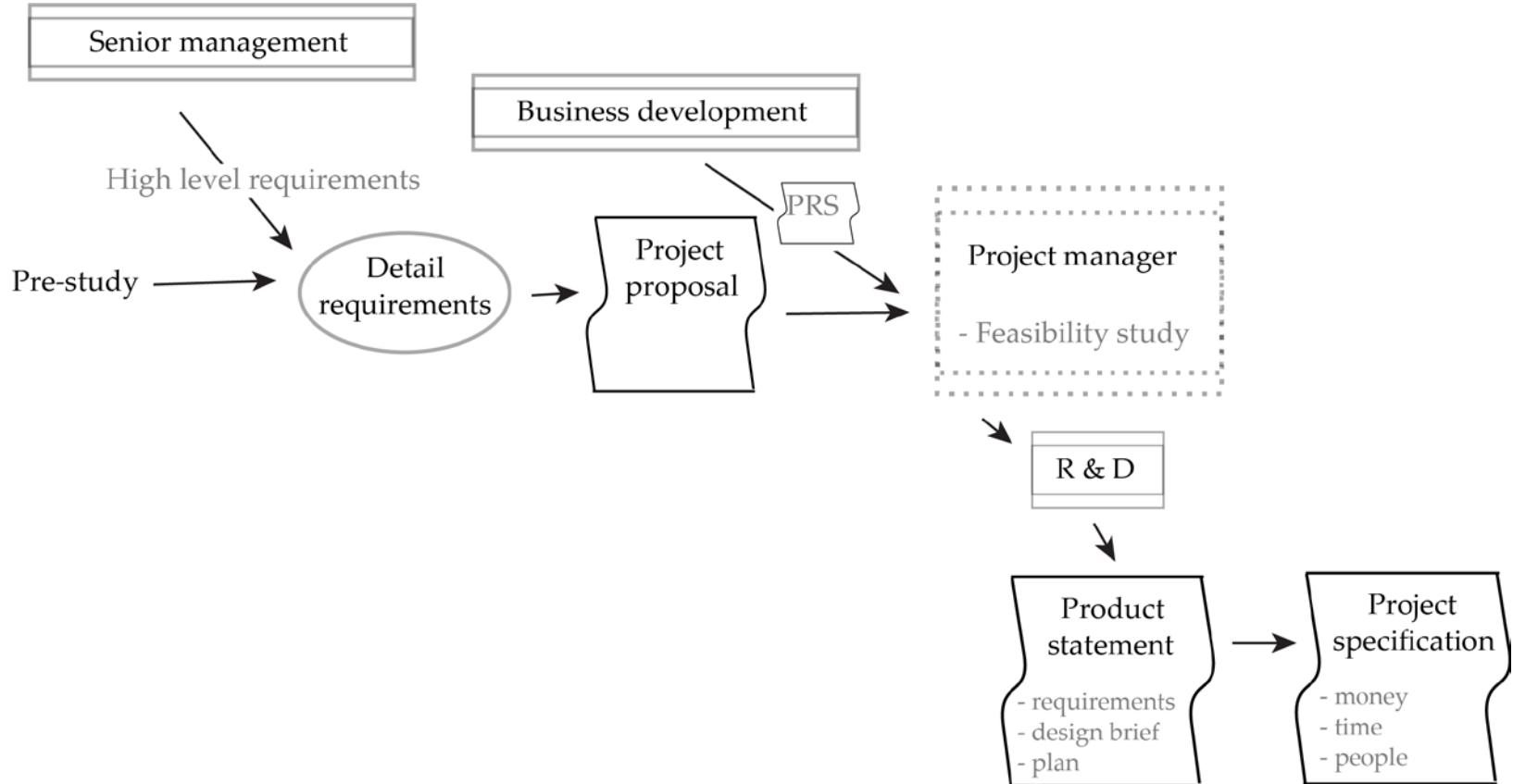
Workflow company A



Workflow company B



Workflow company C



Workflow company D

