Final Presentation Master’s Thesis:
Tool Support for Capability-Based Application Portfolio Management
- Conceptualization, Prototype Implementation, and Evaluation

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Agenda

1. RESEARCH QUESTIONS & APPROACH
2. RELATED WORK
3. APPLICATION LANDSCAPE EVALUATION
4. VISUALIZATION & PROTOTYPING
5. RESULTS

Final Presentation Master's Thesis – Fatih Yilmaz
Motivation

"What gets measured gets done."
- William Thomson (1824 - 1907)

"You can’t manage what you can’t measure."
- Peter Drucker (1909 - 2005)

Measurement important for productivity

"Ever since the beginning of computing there has also been an interest in performance measurement."

Performance measurement crucial in IT

"We had perhaps more than 80 [KPIs] throughout the business. Our objective was to achieve a increase in KPI visibility across our group, and understand what drives us."
- Statement of a German insurance company [Georges 2013]

Missing holistic view due to many Key Performance Indicators (KPIs)
Research Questions

What kind of application attributes can be used to evaluate the status of application landscapes (AL)?

How can the business capability map be used to visualize the application landscape’s status?

What kind of operational actions can be derived from the application landscape’s status?
### Related Work

<table>
<thead>
<tr>
<th>AL evaluation</th>
<th>Aggregated status view</th>
<th>Capability-based APM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aleatrati Khosroshahi (2016)</td>
<td>✓ complexity</td>
<td>✗</td>
</tr>
<tr>
<td>Schneider (2016)</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>Schneider (2015)</td>
<td>✓ complexity</td>
<td>✗</td>
</tr>
<tr>
<td>Podgórski (2014)</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>Schütz (2013)</td>
<td>✓ complexity</td>
<td>✗</td>
</tr>
<tr>
<td>Lagerström (2013)</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>Kandjani (2012)</td>
<td>✓ complexity</td>
<td>✗</td>
</tr>
<tr>
<td>Freitag (2011)</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Ulrich (2011)</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Mocker (2009)</td>
<td>✓ complexity</td>
<td>✗</td>
</tr>
<tr>
<td>Saqib (2008)</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>Jollands (2003)</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>Weill (1999)</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

Lack of research on holistic status evaluation of ALs by means of business capabilities
Agenda

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5. RESULTS
**KPI Aggregation Framework**

**Weighting schemes:**
- Direct monetization
- Expert assessment
- Public opinion polls
- Distance to target
- Distance to policy target
- Cost of distance to target
- Implicit weighting
- Statistical methods

**“Subindices”**

<table>
<thead>
<tr>
<th>Subindices</th>
<th>Stated relevance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of interfaces</td>
<td>[Mo09] [La08] [Schn15] [Schm13] [Re15] [Ki03] [Al16]</td>
</tr>
<tr>
<td>Operational costs</td>
<td>[me12] [La08] [Industry partner]</td>
</tr>
<tr>
<td>Number of incidents</td>
<td>[me12] [cap14] [La08]</td>
</tr>
<tr>
<td>Capability coverage</td>
<td>[Mor02] [Mo09] [Schm13] [Re15]</td>
</tr>
<tr>
<td>Strategic relevance</td>
<td>[Industry partner]</td>
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<tr>
<td>Application failure</td>
<td>[Mor02] [cap14] [Va05]</td>
</tr>
<tr>
<td>Incident processing time</td>
<td>[Industry partner]</td>
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<tr>
<td>Business impact</td>
<td>[Industry partner]</td>
</tr>
<tr>
<td>Application age</td>
<td>[Mo09] [Be13] [Ro06] [Sc04] [Al16]</td>
</tr>
<tr>
<td>Number of users</td>
<td>[La08] [Al16]</td>
</tr>
<tr>
<td>Number of technological components</td>
<td>[Mo09] [Schn15] [Schm13] [Re15]</td>
</tr>
<tr>
<td>Deviation from standard</td>
<td>[Mo09] [Bo09] [Schn15]</td>
</tr>
</tbody>
</table>

**Select weighting scheme**

- Calculate subindices
- Select subindices for inclusion in aggregation function
- Select appropriate aggregation function
- Weights needed?
- Yes
- Calculate weights
- Calculate aggregation function
- Report aggregate indices
- No

**Based on [Jo03]**
**Initial objective:**
One distinct KPI representing the general AL status of the business capabilities

**Problem:**
Ambiguous statement of the KPI

**Solution:**
Multiple KPI categories

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<td>[Mo09] [Bo09] [Schn15]</td>
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</table>

**COMPLEXITY | QUALITY | IMPACT**

Based on [Jo03]
KPI Aggregation Framework

Requirements [Industrial partner]

- **Traceability**
  Traceable function

- **Robustness**
  Adaptable to different use cases

- **Comparability**
  Different market KPIs are comparable
**Complexity**

\[
\text{Complexity}_{c,m} = \frac{1}{|A_{c,m}|} \sum_{a \in A_{c,m}} \left( \frac{(i\_interface\_in_{a} + i\_interface\_out_{a}) \cdot P + e\_interface\_in_{a} + e\_interface\_out_{a}}{U_{m \in M} \text{total}\_\text{interfaces}\_\text{IN}_{m} + U_{m \in M} \text{total}\_\text{interfaces}\_\text{OUT}_{m}} \right) + \frac{\text{number}\_\text{of}\_\text{covered}\_\text{capabilities}_{a}}{U_{m \in M} \text{total}\_\text{number}\_\text{of}\_\text{capabilities}_{m}} + \frac{\text{age}_{a}}{\text{max}(U_{m \in M}\{\text{age}_{a,m}\})} + \frac{\text{number}\_\text{of}\_\text{technology}\_\text{components}_{a}}{U_{m \in M} \text{total}\_\text{number}\_\text{of}\_\text{technology}\_\text{components}_{m}} + (1 - \frac{\text{number}\_\text{of}\_\text{standard}\_\text{compliant}\_\text{technology}\_\text{components}_{a}}{\text{number}\_\text{of}\_\text{technology}\_\text{components}_{a}})
\]

- \(A\) denotes the set of all applications
- \(a\) denotes the observed application
- \(c\) denotes the observed business capabilities
- \(m\) denotes the observed markets
- \(A_{c,m}\) denotes the set of all applications used in the capability \(c\) of the market \(m\)
- \(P\) denotes the "Penalty" value for capability internal interfaces (e.g., 0.5)

\[
A_{c,m} := \{ a \mid a \in A \land c \in C \land m \in M \land \text{uses} (c, a) \land \text{located} (c, m) \}
\]

\[
\text{uses} \subseteq C \times A
\]

\[
\text{located} \subseteq C \times M
\]
KPI Aggregation Framework

Weighting schemes:
• Direct monetization
• Expert assessment
• Public opinion polls
• Distance to target
• Distance to policy target
• Cost of distance to target
• Implicit weighting
• Statistical methods

Select weighting scheme

No

Yes

Weights needed?

Select subindices for inclusion in aggregation function

Select appropriate aggregation function

Calculate subindices

Calculate aggregation function

Report aggregate indices

Exemplary values. Can be adjusted by the expert.

\[
\text{Quality}_{c,m,t} = \frac{1}{|A_{c,m}|} \sum_{a \in A_{c,m}} \left( \sum_{k \in K} \text{number of incidents}_{a,k,t} \times \text{avg processing time}_{a,k,t} \times P \right) + \text{sum of downtimes}_{a,t}
\]

\[ P = \begin{cases} 
0,1 & \text{if } k \in \text{Incident}_{\text{low}} \\
0,2 & \text{if } k \in \text{Incident}_{\text{medium}} \\
0,5 & \text{if } k \in \text{Incident}_{\text{high}} \\
1 & \text{if } k \in \text{Incident}_{\text{critical}} 
\end{cases} \]

\[
\text{Impact}_{c,m,t} = \frac{1}{|A_{c,m}|} \sum_{a \in A_{c,m}} \left( \frac{\text{operating costs}_{a,t}}{\max(U_{m \in M}(\text{operating costs}_{a,m,t}))} + \frac{\text{number of users}_{a,t}}{\text{number of employees}_{m,t}} + \text{critical business impact}_{a} + \text{strategic relevance}_{c} \right)
\]

\[ \text{critical business impact}_{a} := \{1,0\} \]

\[ \text{strategic relevance}_{c} := \{1,0\} \]
KPI Aggregation Framework

Weighting schemes:
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- Statistical methods

Select weighting scheme

Calculate weights

Weights needed?

Yes

Select subindices for inclusion in aggregation function

Select appropriate aggregation function

No

Calculate subindices

COMPLEXITY

“Subindices” | Weight
---|---
Number of interfaces | 0,47
Capability coverage | 0,3
Number of technological components | 0,1
Deviation from standard | 0,1
Application age | 0,03

QUALITY

“Subindices” | Weight
---|---
Application failure | 0,53
Number of incidents | 0,33
Incident processing time | 0,13

IMPACT

“Subindices” | Weight
---|---
Operational costs | 0,33
Strategic relevance | 0,27
Business impact | 0,3
Number of users | 0,1

Based on [Jo03]
**KPI Aggregation Framework**

**Weighting schemes:**
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- Distance to policy target
- Cost of distance to target
- Implicit weighting
- Statistical methods

**Select weighting scheme**

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- Select appropriate aggregation function
- Calculate weights
- Report aggregate indices

**Complexity**
\[
\text{Complexity}_{c,m} = \frac{1}{|A_{c,m}|} \sum_{a \in A_{c,m}} (g(\text{int}) \cdot \frac{(i_{\text{interface\_in\_a}} + i_{\text{interface\_out\_a}}) \cdot P + e_{\text{interface\_in\_a}} + e_{\text{interface\_out\_a}}}{U_{m \in M} \text{total\_interfaces\_IN}_m + U_{m \in M} \text{total\_interfaces\_OUT}_m} + g(\text{cov}) \cdot \frac{\text{number\_of\_covered\_capabilities}_a}{U_{m \in M} \text{total\_number\_of\_capabilities}_m} + g(\text{age}) \cdot \frac{\text{age}_a}{\max(U_{m \in M}(\text{age}_a,m))} + g(\text{tec}) \cdot \frac{\text{number\_of\_technology\_components}_a}{U_{m \in M} \text{total\_number\_of\_technology\_components}_m} + g(\text{dev}) \cdot (1 - \frac{\text{number\_of\_standard\_compliant\_technology\_components}_a}{\text{number\_of\_technology\_components}_a})
\]

**Quality**
\[
\text{Quality}_{c,m,t} = \frac{1}{|A_{c,m}|} \sum_{a \in A_{c,m}} ((g(\text{inc}) + g(t)) \cdot (\sum_{k \in K} \text{number\_of\_incidents}_{a,k,t} \cdot \text{avg\_processing\_time}_{a,k,t} + P) + g(d) \cdot \text{sum\_of\_downtimes}_{a,t})
\]

**Impact**
\[
\text{Impact}_{c,m,t} = \frac{1}{|A_{c,m}|} \sum_{a \in A_{c,m}} (g(i) \cdot \frac{\text{operating\_costs}_{a,t}}{\max(U_{m \in M}(\text{operating\_costs}_{a,m,t}))} + g(u) \cdot \frac{\text{number\_of\_users}_{a,t}}{\text{number\_of\_employees}_{m,t}} + g(\text{bi}) \cdot \text{business\_impact}_a + g(s) \cdot \text{strategic\_relevance}_c)
\]
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Mock-Up

BUSINESS CAPABILITY MAP – APPLICATION COMPLEXITY STATUS

Germany 2016

CAT 1

Cap 1

Cap 1.1

Cap 1.2

CAT 2

Cap 2

Cap 2.1

Cap 2.2

Cap 2.3

Cap 2.1

Cap 2.2

Cap 2.3

CAT 3

Cap 3

Cap 3.1

Cap 3.2
LIVE DEMO
Agenda

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## Results

### Main contribution

<table>
<thead>
<tr>
<th>KPI Aggregation</th>
<th>Visualization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identification, filtering and categorization of</td>
<td>Continuous requirements elicitation</td>
</tr>
<tr>
<td>application status evaluating characteristics</td>
<td></td>
</tr>
<tr>
<td>Development and continuous improvement of aggregated</td>
<td>Conceptual design of the prototype</td>
</tr>
<tr>
<td>KPIs</td>
<td></td>
</tr>
<tr>
<td>Expert evaluation</td>
<td></td>
</tr>
</tbody>
</table>

### Future work

<table>
<thead>
<tr>
<th>KPI Aggregation</th>
<th>Visualization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Robustness:</td>
<td>Flexibility:</td>
</tr>
<tr>
<td>• Use a larger data set for reliable multicollinearity</td>
<td>• Adaptable layout of the business capability map</td>
</tr>
<tr>
<td>and outliers tests</td>
<td>• Colour scale adjustment in the front end</td>
</tr>
<tr>
<td>Maturity:</td>
<td>Automatization:</td>
</tr>
<tr>
<td>• Widen expert evaluation for more precise weighting</td>
<td>• EAM tool connection for automatic data transfer</td>
</tr>
</tbody>
</table>
THANK YOU!

ANY QUESTIONS?

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fatih.yilmaz@tum.de
References


[me12] mega, "Keys to Get a Simple, Organized View of your Application Landscape", 2012
References


[Mor02] Morisio, Maurizio and Stamelos, Ioannis and Tsoukias, Alexis, "A New Method to Evaluate Software Artifacts Against Predefined Profiles", SEKE '02 Proceedings of the 14th international conference on Software engineering and knowledge engineering, Pages 811-818


References

[Ul11]

[Va05]

[We99]
1. Identify Application Characteristics
   Identification of needed application characteristics to evaluate the application

2. Screen relevant Application Characteristics
   Filter for relevant application characteristics

3. Conceptualization of AL evaluating KPIs
   Develop aggregated KPIs to evaluate the AL of business capabilities based on the application characteristics

4. KPI evaluation
   Evaluation of the developed KPIs by researcher and industrial experts

5. Data Collection and Cleansing
   Gathering, Cleansing and Analysis of the Cooperation Partner’s Data

6. AL Evaluation
   Individual AL assessment of each business capability by evaluating the included applications

7. Determine Recommendations for Action

Based on [We99, Sa06, Fa07, Kr09, Si10]
Research Approach

Identify problem and motivate

Define objectives of a solution

Design & Development

Demonstration & Evaluation

Discussion

Process iteration

Missing holistic view of AL status

Create a holistic view of AL status

Develop aggregated KPIs

Prototyping

Missing linkage between BCs and APM

Create a appropriate linkage of AL status and BCs

Use business capability map to visualize AL status

Expert interviews

Based on [Peffers 2008, Hevner 2004]
# Visualization Requirements

## General requirements

<table>
<thead>
<tr>
<th>Dashboard</th>
<th>Time period</th>
<th>Market</th>
<th>KPI type</th>
<th>Market comparability</th>
<th>Selection information</th>
<th>PowerPoint export</th>
</tr>
</thead>
</table>

## Capability visualization requirements

<table>
<thead>
<tr>
<th>Layout</th>
<th>Easy interpretation</th>
<th>High-level perspective</th>
<th>Strategic relevance</th>
</tr>
</thead>
</table>

## Application landscape visualization requirements

<table>
<thead>
<tr>
<th>Complexity</th>
<th>Quality</th>
<th>Impact</th>
<th>Application information</th>
</tr>
</thead>
</table>

## Application visualization requirements

<table>
<thead>
<tr>
<th>Application name</th>
<th>Components information</th>
<th>Transparency</th>
</tr>
</thead>
</table>

## Non-functional requirements

<table>
<thead>
<tr>
<th>Usability</th>
<th>Performance</th>
<th>Maintainability</th>
</tr>
</thead>
</table>
Visualization Logic

AL Complexity

Capability Map

Production

Product Design

Product Marketing

APP 002
APP 742
APP 019
APP 867
APP 900
APP 542
APP 019
APP 003

Interface to 50 other applications
- 5 within the same capability
- 45 not in the same capability

Used in 7 Capabilities

5 years since go-live

10 underlying technology components
Data Model

Business Capability
- id: int
- name: string
- lvl: int
+ complexity
+ quality
+ impact

Service
- id: int
- name: string
- incidents: int
- incidenttime: time
+ numIncidents

include
1..n
1..n

Application
- id: int
- name: string
- downtime: time
- costs: float
- strategic: boolean
- bimpact: boolean
- user: int
- age: int
+ complexity
+ quality
+ impact

1

0..n

interface to

involved in
1..n