Quality of business process models
Tutorial CAiSE 2016
15/6-2016

John Krogstie
Professor, IDI, NTNU
Trondheim, Norway
Background on me

- Master and PhD in Information Systems at IDI, NTNU (1991, 1995)
- Employed 9 years in Andersen Consulting (Accenture)
- 2000-2005 senior researcher in SINTEF ICT (Oslo)
- Professor at IDI, NTNU since 1.august 2005 (earlier part-time position for 7.5 years)
- Lead IS and SE-group (ISSE) at IDI and faculty lighthouse of Open and Autonomous Digital Ecosystems (OADE)
- Previous chair of IFIP WG8.1 on design and evaluation of information systems. (2010-2015). Current vice-chair of IFIP TC8 – Information systems

![Background on me](image)
Overview of tutorial

- Characteristics of business process models including goals of business process modeling
- Overall presentation of the SEQUAL framework for assessing quality of models
- Examplifying the different aspects of the framework relative to business process modeling
- Examples of how the framework has been used in industrial settings

Based on

Survey on your background knowledge

- Open a browser (PC or mobile) going to kahoot.it
- Enter the pincode
- Enter a nick-name
Process modeling is a kind of conceptual modeling

- Models used for representing enterprises/organizations, problem analysis, requirements and design specification
- Primarily diagrammatic (2-dimensional diagrams)
- The languages used for modeling have a limited vocabulary
- The languages used are originally meant to be generally applicable (and not for a specific domain). Some exception e.g. using so-called domain specific modeling languages (DSL)
Business Processes

- A business process is a collection of related tasks that produce a specific service or product to address one or more goals for a particular actor or set of actors with the optimal use of resources.

<table>
<thead>
<tr>
<th>Dimension of value</th>
<th>What is wanted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>Fast</td>
</tr>
<tr>
<td>Quality of product/service</td>
<td>Right</td>
</tr>
<tr>
<td>Cost</td>
<td>Low</td>
</tr>
<tr>
<td>Flexibility</td>
<td>Sufficient</td>
</tr>
<tr>
<td>Resource-usage</td>
<td>Sustainable</td>
</tr>
<tr>
<td>Unwanted side-effects</td>
<td>None</td>
</tr>
<tr>
<td>Operations according to regulations</td>
<td>Compliant</td>
</tr>
</tbody>
</table>
Main elements of a modelling activity

Goal of Modelling

- Persons
- Area of interest
- Tools
- Existing resources
- Means for representation

Modeling task

Models
Goals of (business process) modeling

Current state

- Current model of ideal state

Future state

- Model of ideal future state

0. Model mapping

3. Quality assurance

Espoused model of current state

Model of current state

- Model of possible future state

Reference model

1. Sensemaking

2. Agreement

Perception of current state

4. Model analysis

5. Model deployment

6. Context of change

7. Model implementation

8. Standardization

Perception of future state

Model of possible future state
SEQUAL – A framework for understanding and assessing quality of models based on semiotics

- For models as a knowledge representation in general
- Can be extended and specialised towards specific types of model and modelling languages (e.g. business process models)
- Structuring existing material on quality of models and modelling languages
- Differentiate between quality of different levels based on semiotic theory
- Differentiate between goals of modelling (quality characteristics) and means to achieve these goals
- Set-oriented definition to enable a formal discussion of the different quality levels
- Takes into account that models are socially constructed, both subjective and objective aspects of quality
Sets in the quality framework

- **G**: The goals of the modelling
- **L**: What can be expressed in the modelling language
- **M**: What is expressed in the model
- **A**: What actors that develops or has to relate to (parts of) the model has access to. Actors can be persons or tools (technical actors).
- **D**: What can be expressed about the domain (area of interest) which is relevant to fulfil **G** (the goals of modelling)
- **K**: The explicit knowledge of the participating persons about the domain **D**
- **I**: What the participating persons interpret the model to express
- **T**: What relevant tools interpret the model to say

All of these sets evolves as part of modelling
Sets relative to main elements of a modelling activity
Overall structure of framework

- Quality type (physical, empirical…)
  - One or more quality characteristics per quality type
    - Means to achieve the quality characteristics
      - Beneficial existing quality
      - Model properties
      - Language properties
      - Modeling activities
      - Tool-functionality
Model example to illustrate the different quality levels

- Language: BPMN
- Domain: Conference organizing
- Goal: Design of conference system
Physical Quality

- Internalizability
  - Model persistence
  - Model availability to relevant actors
  - Currency (is the model up to date?)
  - Security

  -> Database functionality (model repository)
    - Model versioning
    - Model co-evolution (language model, main model, transformation models)
    - Model interchange
    - Global model management
    - Support for collaborative modeling
Empirical quality

- Look on aspects related to
  - Ergonomics
  - Graph layout
  - Readability (of textual parts of model)
- The model must be externalised (exist physically)
- Modelling and tool activities
  - (Automatic) graph-layout, readability index, grammar checking, evaluation of use of colour
  - Checking adherence to modeling guidelines
Example of poor graph-layout
Aesthetics

- Reading direction:
  - From left to right
  - From top to bottom

- Labels:
  - Align labels left or centered
  - Elements should not be significantly bigger than their labels
  - Highlight headlines / important elements

- Relations should not obstruct text
Alignment of model elements

- Minimize alignment points
  - Arrange elements in a way that there are as few horizontal and vertical alignment points as possible.
- Equidistance
  - If possible place all elements at the same distance to each other.
- Equality
  - Equal elements on the same abstraction level should have the same size.
- Distance
  - Don’t place elements and relations too close to each other.
Alignment of relations

- Do not cross other relations or elements
- Keep relations as short as possible
- Avoid parallel relations
- Don’t use too many different angles (45°, 90°, 135°)
Limited number of angles - example
Style guidelines BPM (Silver, 7PMG, Moreno-Montes and Snoeck 2014)

■ Number of elements
1. The model contains a high number of elements (i.e., gateways, activities and events) -> Decompose models with more than 31 elements.
2. The model contains duplicate elements (e.g., identical start events, identical end events, identical activities) or fragments, capturing the same control flow logic -> Avoid duplicate elements and fragments in the process models.
3. ..................

■ Composition of components
1. The model has deeply nested structured blocks -> Avoid deeply nested structured blocks.
2. The model contains multiple cycles -> Avoid cycles in the process models if possible, especially unstructured cycles (i.e., cycles with multiple exit points).
3. .........................
Syntactic quality

- Syntactic correctness: $M \setminus L = \emptyset$
- Two types of errors
  - Syntactic invalidity
  - Syntactic incompleteness
- The model must be externalised
- Language properties
  - Formal syntax, language defined in a meta-model
- Activities
  - Error prevention
  - Error detection
  - Error correction (automatically or by suggestion ("spellcheck") )
Example of syntactic invalidity
Example of syntactic incompleteness
Semantic quality

- Quality characteristics
  - Validity: $M \setminus D = \emptyset$
  - Completeness: $D \setminus M = \emptyset$

- More realistic; $M \subsetneq D$

- Necessary/useful that the model is externalised and is syntactically correct

- Language properties: Formal semantics

- Activities: Model testing (consistency checking), reuse of (reference) models, ‘driving questions’, meta-model adaptation (changing the modelling language to fit the domain)

- For process models (e.g. BPMN): absence of deadlocks, reachability, no infinite recursion

- For to-be models the domain here is the improved future domain. Linked to business process improvement
Patterns for business process improvement

Based on wanted quality characteristic of business process (time, cost, resource usage...)

- Rethink (why)
- Reconfigure (what)
- Reassign (who)
- Resequence (when)
- Relocate (where)
- Reduce (how much)
- Retool (how)

Concrete patterns from BPM literature (including Dumas et al. 2013, Rosemann and Recker 2015..)
Examples of resequencing patterns – Look upon relative to dimension of value to achieve (time, cost, flexibility…)

- Using predicting to increase efficiency
- Changing the decision moment
- Increasing flexibility with postponement
- Minimizing the number of interconnections and dependencies
- Changing the number of alternatives
- Resequencing the work
- Reorganizing partial processes
Example of semantic invalidity (and incompleteness)
Pragmatic quality

- Quality characteristics
  - Comprehension, do the audience understand what the model available to them express? (I = A)

- Useful that the model have high physical, empirical, and syntactic quality before evaluating pragmatic quality.

- Language properties:
  - Operational semantics
  - Executability
  - Explicit modelling of intention and source of part of the model

- Activities: Inspection, visualization, filtering/views, explanation generation, simulation, animation, reporting, execution/prototyping, model-generated solutions
Perceived semantic quality

- Quality characteristics
  - Perceived validity $I \setminus K = \emptyset$
  - Perceived completeness: $K \setminus I = \emptyset$

- Useful that the model has high physical, empirical, syntactic, and pragmatic quality before investigating perceived semantic quality

- Validation techniques
Trade-off semantic and pragmatic quality in metro maps
Less topographic detail, better understanding for navigation in the metro
Social quality

- Quality characteristics: Agreement
  - Agreement in knowledge/interpretation/model
  - Relative vs. absolute agreement
- Important first to address physical, pragmatic and perceived semantic quality
- Language properties: Possibility to explicitly express inconsistencies based on disagreement.
- Activities: Model integration and conflict resolution
Deontic quality

- The deontic quality of the model relates to
  - that all statements in the model contribute to fulfilling the goals of modelling (goal validity)
  - that all the goals of modelling are addressed through the model (goal completeness)
- Deontic quality introduce a context that relax wanted quality for a model on the other levels (e.g. trade-off between completeness of the model relative to cost).
- Expressed with the notion of feasible quality (particularly on the levels of semantic, pragmatic, perceived semantic and social quality)
- Goals include often aspects relative to participant learning and domain improvement (for to-be models)
Quiz

- Open a browser (PC or mobile) going to kahoot.it
- Enter the pincode
- Enter a nick-name
SEQUAL – language quality

- Social actor explicit knowledge $K$
  - Social actor interpretation $I$
  - Ontology $O$

- Modelling domain $D$
  - Goal of modeling $G$
  - Modeller appropriateness

- Language extension $L$
  - Comprehensibility appropriateness
  - Domain appropriateness
  - Modeler appropriateness
  - Participant appropriateness

- Technical actor interpretation $T$
  - Tool appropriateness
  - Organizational appropriateness
  - Participant appropriateness

- Participant appropriateness
  - Participant appropriateness
  - Participant appropriateness

- Ontological appropriateness
  - Ontological appropriateness
  - Ontological appropriateness

- Social actor interpretation $I$
  - Comprehensibility appropriateness
  - Comprehensibility appropriateness

- Domain appropriateness
  - Domain appropriateness
  - Domain appropriateness
Example of usage of the framework

- Evaluation of models
- Methodology guidelines for developing good models
- Evaluation and choice of modeling languages in organizations (UML, BPMN, others)
- Guidelines for developing and evolving new modeling languages
- Evaluation of a modeling language under development and evolution
- Evaluation of a modeling tool/environment
- Evaluation of a modeling methodology
Example – Business process modeling in oil company – Evaluation of process models using SEQUAL

- Oil company headquartered in Norway
- More than 20,000 employees in more than 30 countries worldwide
- Large resources used for model of the Quality System – in particular supporting the compliance of work to regulations to ensure safety of operations
- Large improvement on injury-frequency since the models were introduced.
- Model quality as a balance of syntactic, semantic, and pragmatic quality
Models in the company Quality system

- Models in a BPMN-variant made accessible through the ARIS-tool, from which all governing documentation (GD) is accessed by the end users.

- Restricted version of BPMN, with detailed guidelines for labling etc (TR0002)

- Disp, a tool which supports handling applications for deviation permits
Goals of (model of) quality system

- Contributing to safe, reliable and efficient operations and enabling compliance with external and internal requirements -> compliance management
- Helping the company incorporating their values, people and leadership principles into everything they do
- Supporting business performance through high-quality decision-making, fast and precise execution and continuous learning
Usage of models in the case

Current state

Espoused model of current state

Model of current state

Current model of ideal state

Future state

Model of possible future state

Reference model

Perception of current state

Perception of future state

1. Sensemaking

0. Model mapping

2. Agreement

3. Quality assurance

4. Model analysis

5. Model deployment

6. Context of change

7. Model implementation

8. Standardization

Model of possible future state
Overall model-structure (in total more than 2000 diagrams on the lowest workflow level)
Simple model example on lowest level
Evaluation of existing model-solution

- Based on a user survey
- 4828 employees took part in the survey (about half of those invited)
- Many challenges were identified from the survey, related to
  - the management system itself,
  - learning processes
  - work practice
- Many of the issues can be connected to model quality structured using the quality-levels of SEQUAL
Physical quality

- More than half of the respondents are unsure that they have found all relevant documentation.
- The search function often does not produce the desired result.
- Many are not satisfied with the way changes to models and governing documents (GD) affecting their work are communicated.
- Employees are not aware of the possibility for staying updated on changes, and when they do, they experience that the reasoning behind the changes are not clearly communicated.
- 14% of the respondents report using paper copies to access GD, so unless employees are clearly notified of changes they might keep using old versions.
Empirical quality

- Graphical layout not particularly mentioned
- Use of abbreviations in models noted as a problem by many
Syntactic quality

- There are many guidelines on this level (TR0002)
- There are many examples that these are only partly adhered to.
- Still this was not explicitly mentioned as an issue.
Semantic quality

- 68% feel that the governing documentation has the right amount of detail
- but is also often seen as too rigid to account for local needs and variations, which leads to a lot of requests for deviations.
- 17% of survey respondents report often seeing gaps between what is described in the GD and what is being done in practice
- The process of handling improvement proposals appear to be too slow and inconsistent
Pragmatic and social quality

- About half of the respondents feel that governing documentation is easy to understand.

- By others, governing documentation is perceived as vague and ambiguous, especially when it comes to authorities and responsibilities.

- Only 44% satisfied with the support (including coursing) they are given.

- About half of the respondents have participated in organised training related to the use of GD. These have a higher score for confidence in, use of and compliance with GD than the ones who have not participated in a training program.

- Good leadership support reported to have strong positive effect on use.
Deontic quality

- The results from the survey indicate that the models contribute a lot to high safety (as confirmed by 75% of the respondents), moderately to high reliability, but not to high efficiency (37%).

- One in five of the respondents feel that safety and efficiency is not properly balanced.
Summary of case

- The (model of the) quality system of Statoil is developed supporting in particular compliance to requirements to reduce risk, an area where large improvements have been observed over the last decade.
- Still one find challenges with among other things the comprehension of some of the models
- SEQUAL works as an appropriate framework to identify and categorize model quality issues
- Whereas the requirements given in TR0002 are quite detailed and structured, they focus mostly on empirical and syntactic quality.
- Quality on these levels is also important for pragmatic quality, but are not always followed.
- The use of SEQUAL to structure this discussion points to issues also on higher quality levels (semantic, pragmatic, social, and deontic) based on processes around the implementation and evolution of models
- the use of modelling within the company has evolved over the years, and models and modelling practices that were regarded as good on an earlier stage might no longer be looked upon as being sufficient.
Final remarks

- The tutorial have provided an overview of SEQUAL, a framework for assessing and understanding quality of models
- Applied in particular to business process modeling
- More on detailed techniques and methods for using the framework in the books
- Please also feel free to contact me if you or your PhD-students want to use the framework: krogstie@idi.ntnu.no
Quality of business process models

Questions?

John Krogstie
Professor, IDI, NTNU