A Quality Model for Residential Houses Construction Processes

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Structure

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Introduction

- In general, construction of houses consists of individual processes leading to an individual building; for residential houses the processes may be standarizable to a certain extent.
- SMEs are the most active players in the residential houses sector: problems to build up a quality management system (too expensive and time-consuming)
- Quality demands and competition are rising in the construction sector.
- Lack of general quality description in the construction industry.

Need for a general quality model!
Need for a quality support tool for SMEs!

Project QuCon
Development of a Real Time Quality Support System for the Houses Construction Industry

Financing:
AIF / European Commission

Partners:
Cyprus: Frederick University Nicosia (FIT), Synectics Ltd Nicosia (SYN), Cyprus Quality Association Nicosia
Germany: Federation of Quality Research and Science Frankfurt (FQS), University Stuttgart (USTUTT)
Netherlands: Bouwend Nederland, TU Delft (DUT)
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Project Objectives

- Investigating and analysing the building process
- Developing a quality model and quality parameters as well as assurance indices
- Optimizing the indices with respect to time and money
- Developing a prototype software appropriate for SMEs
- Studies and analyses of the current quality assurance practices realized by different SMEs in different countries
- Development of guidelines for performance improvement and quality parameter optimization

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Project Structure

Main Tasks of University Stuttgart, IAGB

- Development of a consistent quality model
- Real-time determination of quality assurance indices
Different available Quality Models

- **Civil Engineering**
  - tolerances as product-related quality parameters

- **Geodesy**
  - accuracy, reliability and sensitivity as product-related quality characteristics (geodetic nets)

- **Geodata / Traffic Telematics**
  - complete quality model with the characteristics: availability, up-to-dateness, completeness, consistency, correctness, accuracy

Construction Process for Residential Houses

- Process as base for quality model.
- Hierarchical structure preferred:
  1. total process,
  2. sub-processes,
  3. activities.
- Level of detail differs:
  - Germany: appr. 100 activities,
  - Cyprus: appr. 500 activities.
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- activities of one sub-process
- further detail levels or alternatives possible
- integration of checkpoints to measure quality
- checked parameters have to be defined (partly)
- relationships are still missing:

Gantt Chart

### Gantt Chart

**exemplary relationships**

![Gantt Chart](image.png)
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Quality Model

Process-related Characteristics (1)

**Expense:** Adherence to the expense plan.
The process is carried out within / exceeds / falls below the budget.

**Timeliness:** Adherence to the time schedule.
The (sub-) process begins and ends at the scheduled points of time / shows a time delay / is ahead the time schedule.

**Process-Correctness:** Adherence to the predetermined procedure.
Correctness is regarded with respect to the technical demands; e.g. correct sequence of working steps or of compliance with all regulations.
These criteria may be fulfilled, partly fulfilled or not fulfilled.
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Process-related Characteristics (2)

**Resources:** Adherence to the predetermined resources.
The process is carried out within/ exceeds / falls below the predetermined resources.

**Synchronization:** Adherence to the overall predetermined inter-process workflow.

<table>
<thead>
<tr>
<th>Task/Workstage</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>site facilities</td>
<td>1</td>
</tr>
<tr>
<td>survey/research for basement excavation</td>
<td>9</td>
</tr>
<tr>
<td>earthwork: basement excavation</td>
<td>9</td>
</tr>
<tr>
<td>Other work e.g.: basement safeguarding</td>
<td>10</td>
</tr>
<tr>
<td>acceptance excavation ground inspection (excavation depth)</td>
<td>11</td>
</tr>
<tr>
<td>connection shaft</td>
<td>11,12,13</td>
</tr>
<tr>
<td>Survey: building of alignment stage</td>
<td>14</td>
</tr>
<tr>
<td>Earthwork: base pipe (connection to canalization), foundation trench, soil improvement</td>
<td>14</td>
</tr>
<tr>
<td>Acceptance drainage</td>
<td>15</td>
</tr>
</tbody>
</table>

**Resources:**

Adherence to the predetermined resources.

The process is carried out within/ exceeds / falls below the predetermined resources.

**Synchronization:**

Adherence to the overall predetermined inter-process workflow.

Product-related Characteristics (1)

**Availability:** Overall quality characteristic that takes into account all other definitions.

Product is completed at the required point of time within the budget using the planned resources. The characteristic is not purely product-related. It is the combination of process and product-related characteristics.

**Completeness:** Adherence to defined completeness of product.

Product is completed correctly as defined and planned or it is fragmentary.

Condition: only correctly realized products are counted as completed.
Product-related Characteristics (2)

Product-Correctness: Adherence to the defined demands, requirements, standards, generally recognized codes of practice and technical demands written in the contract.

The demands, requirements, standards, etc. are fulfilled or not.

a) The correctness of the product is measurable. These characteristics can be parameterized using accuracy parameters.

b) Some characteristics are not measurable. In these cases there are checks only, e.g. visual controls. If requirements are not fulfilled, the product is incorrect.

Accuracy: Degree of adherence to demands, etc.

Accuracy is the basis for correctness decisions of variant a) of product-correctness. It takes into account random deviations only.

Examples

Expense for earthwork:

- relative expense rate \( E \% \): with \( E_a \) actual expenses and \( E_b \) budget (planned expenses), e.g. 95\% of the predetermined costs for earthwork have been expended.

- absolute expense difference \( € \): e.g. 150€ have been economized for earthwork.

Completeness for building alignment stage measuring procedure:

\[ CRR = 75\% \] (12 from 16) ground marks were correctly marked according to the plan, with \( CP_a \) actual completed product parts / ground marks and \( CP_b \) product parts / ground marks in case of 100\% completion.
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Measuring Quality

• Quality control measurements follow ISO 4463-1
• The measurement methods are described among others in this standard and are generally assigned to a surveyor
• Concrete descriptions regarding process- and product-correctness as well as accuracy are given
  "e.g. if the measurements of the angles between two points are carried out with a theodolite and made in two sets, the RMS can be calculated. If the shorter side of the angle equals 100m, for the angle the permitted deviation is ± 0.01 gon. If \( \sqrt{\text{RMS}} < 0.01 \text{gon} \), the angle is regarded as correct, otherwise it is incorrect."
• Restriction on geometric accuracy, additional measurements are described in e.g. ISO 3443-8, DIN EN 14992

Conclusions

• New quality model for construction of residential houses
• Consideration of product and process quality
• Integration into quality assurance tool is objective in the EU-project QuCon
• Checkpoints for quality measurements have to be defined
• Surveyor as quality controller shall be established in the future
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Thank you very much for your attention!

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