Research Project

Organisational Models and Contractual Incentive Systems for the Improvement of Construction Quality of Turnkey Building Projects

Abridged Report

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Numerous analyses demonstrate that the quality of building performance is often unsatisfactory. The difficult conditions under which construction is produced on site are often cited as justification, which while being true, nevertheless does little to convince the employer or client. Difficult production conditions should rather lead to an even more intensive, systematic use of quality assurance. However, it should be noted that in fact, quality assurance methods are used to a significantly lesser extent in the construction industry than in other sectors of the economy.

The enormous sums involved in rectifying defects requires the development of improved quality assurance methods for building projects if the future international competitiveness of the German building industry is to be secured. As a contribution to this task, the Chair of Construction Management and Construction Project Management in the University of Siegen has developed a cooperative project-organisational model which promotes the maintenance of qualitative standards through a financial incentive. The development of this novel model to promote quality assurance was supported by funding from the research initiative Future of Construction from the Federal Institute for Research on Building, Urban Affairs and Spatial Development; the testing and certification corporation, TÜV-Süd; the construction firm, Runkel of Siegen and the law firm of Kapellmann & Partner, Düsseldorf.
One essential requirement for the application of a quality assurance system is that the results of the system – the changes in quality – must be measurable. However, "quality" or quality level is mostly used as an indeterminate term. People usually speak vaguely of good and bad quality. A practical, binding quality incentive system, however, must be both transparent and verifiable for all those involved in the construction project; the quality level achieved during the building process must therefore be capable of being specified in quantifiable terms. In order to satisfy this fundamental requirement of a quality assurance system, a gap assessment system was developed within the scope of the research project. This includes the following factors:

- The effects of divergences in the functional complexes of a building project (sound insulation, thermal insulation, structural stability etc.)
- A weighting of these functional requirements as defined by the employer/client.
- The frequency of repeated qualitative divergences, as a measure of the speed of defects rectification.

The foregoing constraints are entered into an assessment system which results in a quality index (QZ). The quality index specifies the quality level of a project. In order to eliminate the effects of the project parameters such as construction period, construction volume and number of quality surveys it is necessary to standardise the quality index.

$$Quality\ Index = \frac{1}{\frac{\sum\ (Defect\ Value)}{BRI * \frac{QA}{PW}}}$$

BRI = Gross Room Volume [m^3]

QA = Quality Surveys [–]

PW = Project weeks [W]

With the aid of a standardised quality index it is possible to directly compare the quality indices of various projects. A higher value of quality index indicates good quality, a lower quality index, poor quality. There is, however, a distinction between the specific and non-specific quality index, not in the method of calculation, but in their fundamental bases. The **specific quality index** is determined of the basis of requirements defined by the employer. The **non-specific quality index** is based on uniform weighting factors and thus enables a comparison in quality.

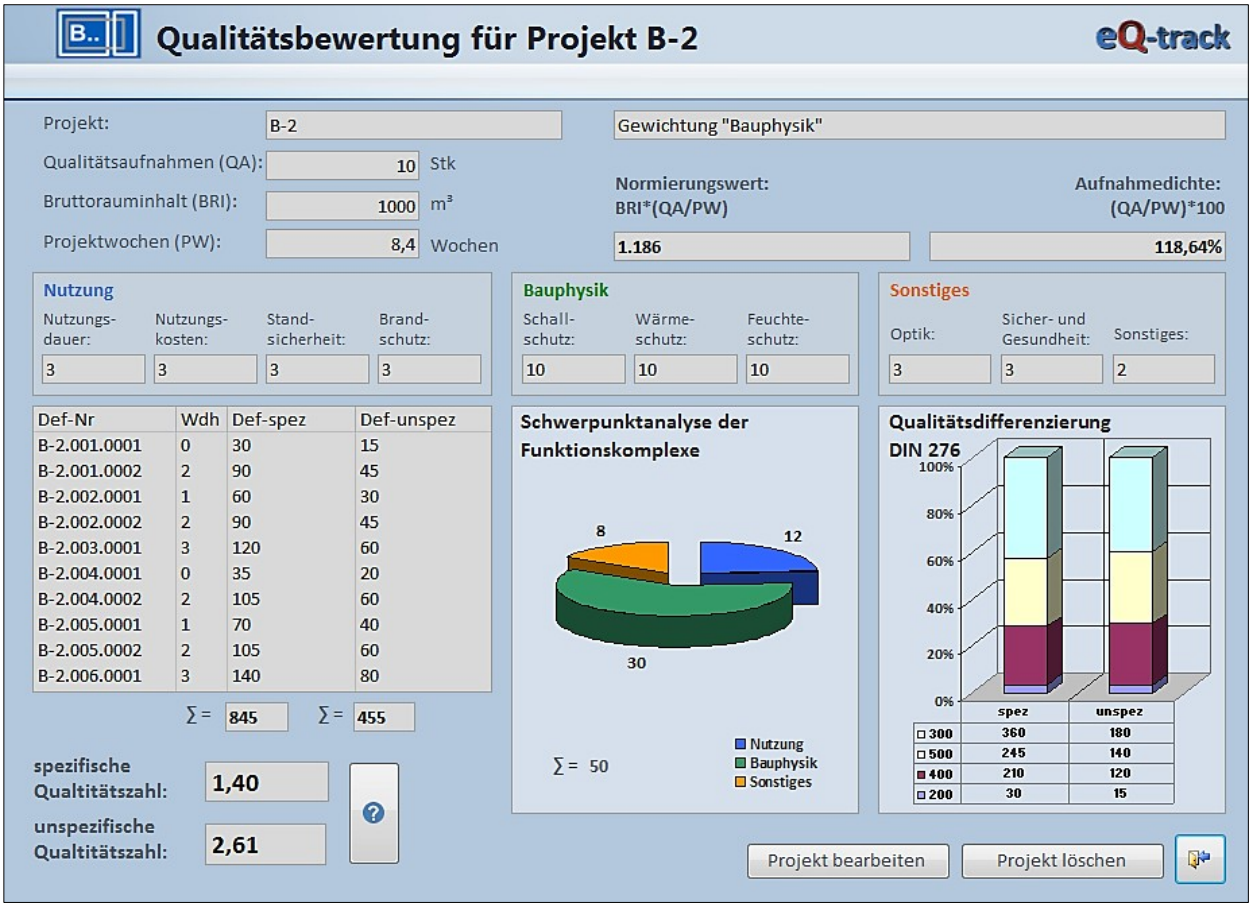

Fig. 1: Example of the results of a quality assessment

To record and evaluate construction defects the research group from the University of Siegen developed a special computer program called eQ-track (electronic quality track)

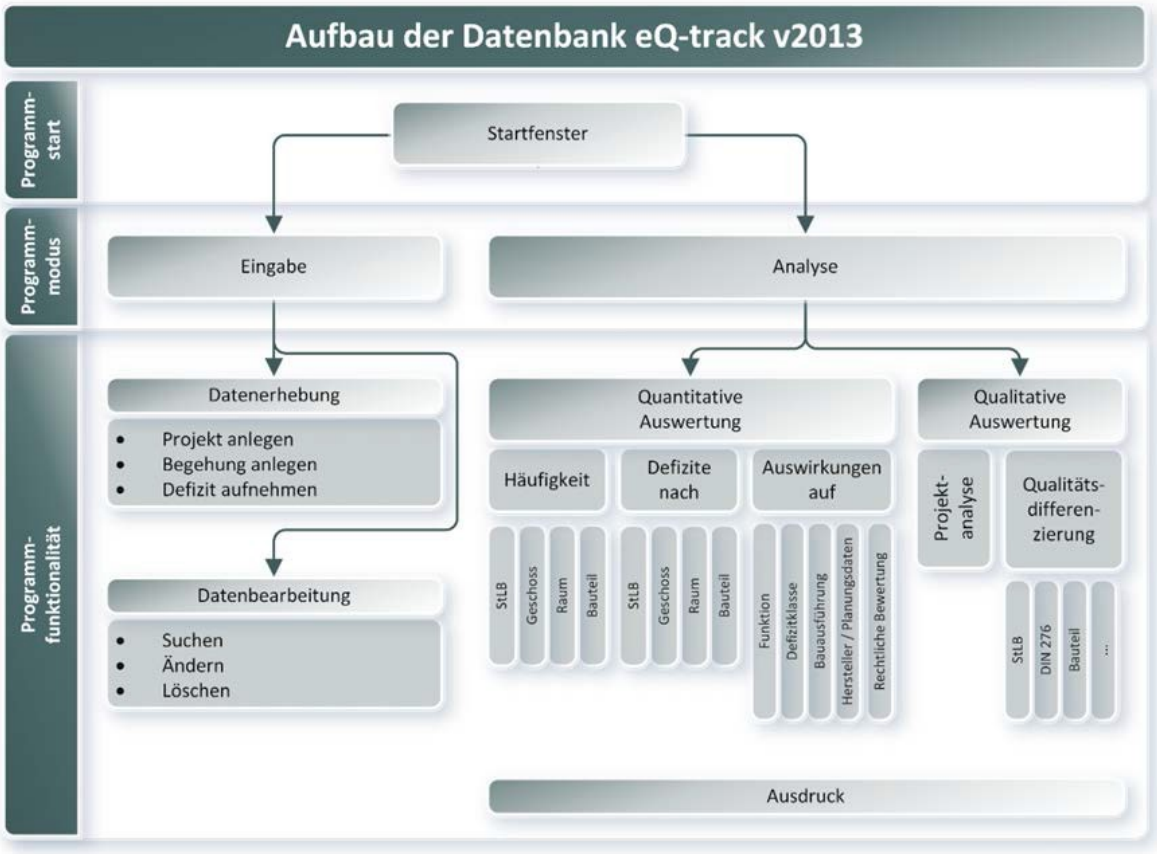

Fig. 2: Functions of the eQ-track software

The development of a program to record and evaluate construction defects also acknowledges the fact that many construction firms do not possess a program for recording defects. As a survey has revealed, particularly small and medium construction firms (SMEs) overwhelmingly record defects manually in writing. This methods makes it impossible to carry out cross-project analyses of defects and hence a systematic improvement in quality.

As a comprehensible, quantitive parameter, a quality index can be used in various areas of project management. For example, it can be used as a performance standard for the quality-dependent component of the salary of site or project managers. In fact, the focus of the research project is the application of the quality index in the context of a quality-dependent agreement between the employer and the contractor.

There is a special incentive for the contractor if, in addition to the usual building contract remuneration, good quality is specially rewarded with a bonus, and on the other hand, poor quality is penalised by a contractual deduction. This incentive will cause the contractor to carry out quality assurance methods more intensively in the project planning and project realisation phases than otherwise would be the case. The dependency of the quality bonus on the quality index leads to a so-called reward function.

$$QP = f\,(QZ,\ PB) \qquad \text{with } QP[€] \leq PB[€]$$

The general form of the reward function is represented in Fig. 3. It is open to the parties to the contract to specify the precise arrangements of the reward function. Obviously, the higher the quality bonus, the greater is the incentive to achieve quality.

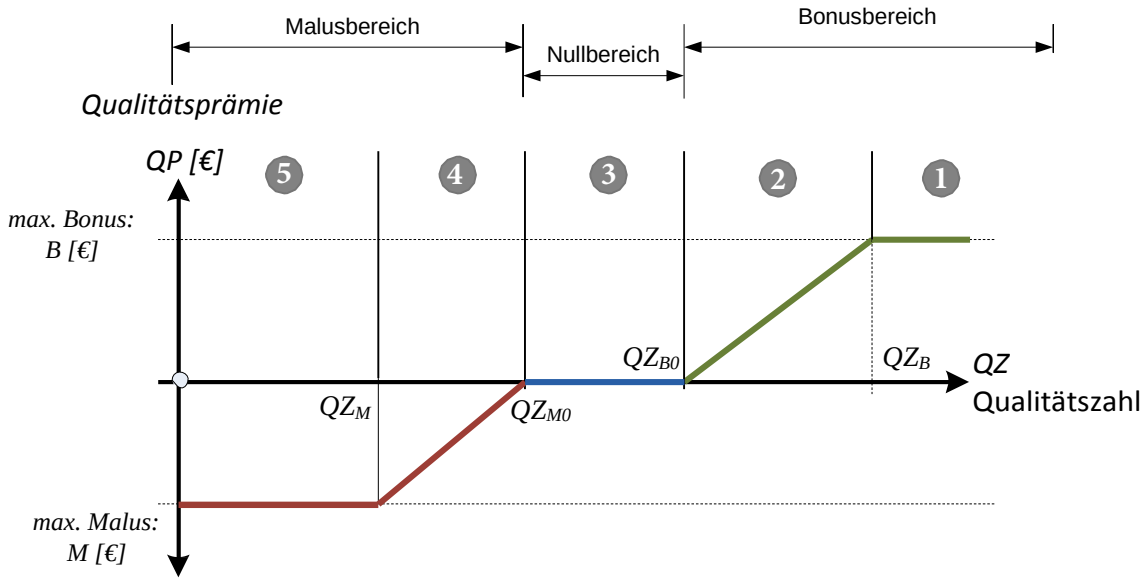

Fig. 3: Reward Function
(Dependency of the quality premium QP on the Quality Index QZ)

The provision of the premium budget by the employer and the carrying out of the quality surveys on site are parts of the project costs. The extent to which this represents additional costs has to be judged in relation to the benefits of applying a quality-bonus system. The following advantages which accrue from an improvement in construction quality should be taken into consideration.

- Lower rectification costs for defects, as these are discovered earlier in the course of quality surveys during the construction phase. (contractor's benefit)
- Reduction in the cost of site inspections or property surveys by the employer. The normal site inspections can be partly replaced by the quality surveys. (employer's benefit)
- Reduction of site management costs for defect rectification (de-snagging) works. (contractor's benefit)

- Less risk of delays to the programme or out of sequence working due to defect rectification works. (benefits to contractor and employer)
- Reduction in the number of disputes through the employment of an independent expert (benefits to contractor and employer).
- Reduction in property management costs, especially repair costs, through better quality of build. (employer's benefit)
- Fewer warranty claims (contractor's benefit)
- Enhancement of property value (employer's benefit)
- Increased confidence and improved reputation of subcontractors, especially in tendering and sales negotiations (benefits to contractor and employer)

Divergences from the required construction quality are determined during the process of site visits (quality surveys). According to the assessment model, building defects which are determined at handover are not included in the quality index. The distinction between construction deficiencies based on ongoing quality assessments and defects determined on completion or handover is fundamental for understanding the developed quality model. This distinction leads inevitably to the creation of a new contractual instrument, the quality agreement, which is in addition to the construction contract (Fig. 4).

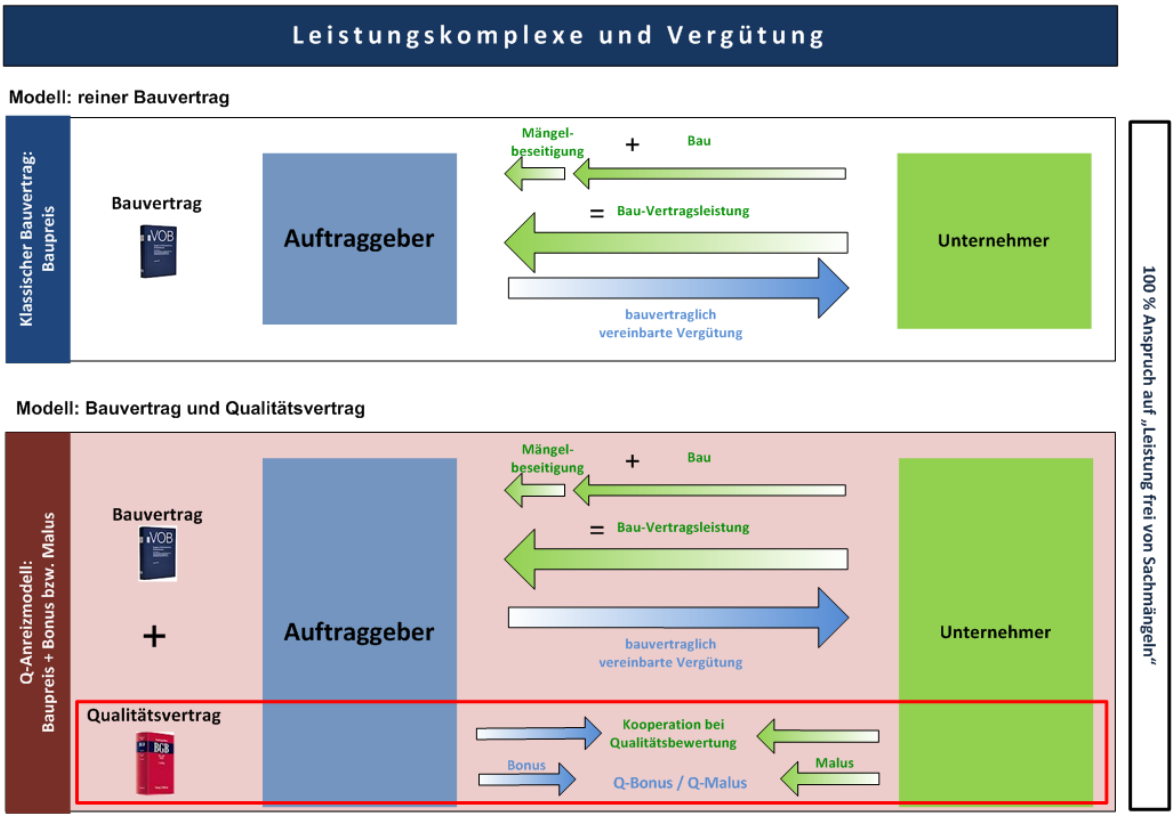

Fig. 4: Comparison of services in traditional building contracts and those of a quality incentive model (with quality agreement)

In order to facilitate the use of a quality system in practice, a model quality agreement was drawn up by the law firm Kapellmann & Partner of Düsseldorf. Users can adapt this to the given project conditions.

A quality agreement between the employer and main contractor is, to a certain extent, an unusual measure because the building contract itself represents an agreement on quality. However, the proposed provisions of the quality contract do not change the rights and obligations of the parties to the building contract, particularly in regard to defective performance or claims for defects. It is much more about the quality assessment and the premium – as a bonus or penalty – which becomes payable upon achieving a particular quality index. It is a precondition for the operation of the quality agreement that the contracting parties cooperate with each other, which also applies to the construction contract (main contract).

The large number of defects arising in construction projects is an indication that the usual contractual provisions and project management tools are not adequate to ensure the agreed quality level. This justifies the introduction of new quality assurance tools, such as those developed within the scope of this research project. These provide those participating in the construction project with new opportunities for quality management. The quantification of the quality level is seen as being particularly important for providing an objective assessment of the normally opposing positions of employer and contractor as to the achieved level of construction quality.