Linking up versus Breaking down: Demands on Cost Estimating for Turn-key Construction Projects

P. Racky
Institute of Construction Management, University of Kassel, Gemany

ABSTRACT: The complete monetary valuation of interfaces between the various building elements or work packages is a substantial success factor for a correct estimate that takes account of all costs of turn-key construction projects. The estimating processes employed by construction contractors often neglect systematic interface analysis what leads to incorrect results. This paper sketches out an interface-oriented estimating approach. This approach will lead to a procedure in which the building elements to be costed are structured in a way that corresponds to their functional logic. As result a linked-up procedure, such as is necessary to cope with complex systems, will be achieved and a complete costing made easier.

1 INTRODUCTION

Turn-key construction projects show increasing complexity. There are several reasons for this. Firstly, the high interaction of the various work packages in planning and execution. Other reasons for this increasing complexity are the accelerated pace of the business processes as a result of increasingly shorter project durations, the rising number of project participants due to increasing specialization, the progressive individualization of construction designs and the extension of project-specific objective systems established by owners and users.

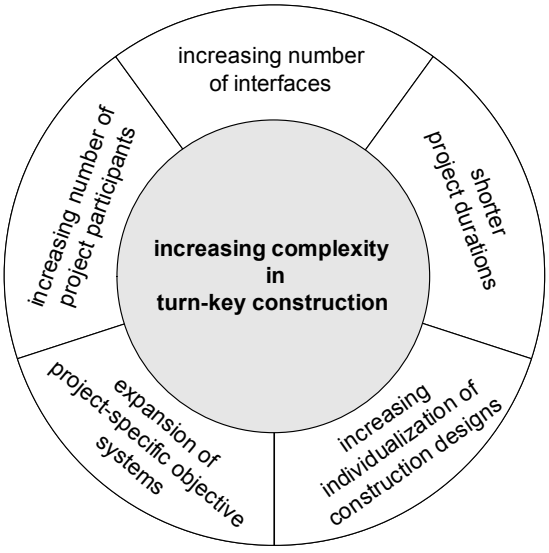

Figure 1. Reasons for the increase of complexity in turn-key construction

The increasing complexity of the product "building" in turn generates increasing complexity in the various processes in construction management, such as cost estimating, scheduling or planning coordination (cd. Gidado 1996). In this respect estimating is a process of particular importance for the contractor. The further development from classical contractor of structural works to contractor of turn-key building projects thus leads to sometimes drastically high requirements in terms of the handling of operational business processes in the construction companies. In recent years this has affected an increasing number of German companies, because the proportion of turn-key projects in the construction volume as a whole, especially in building construction, has increased continuously.

This paper describes an approach to modeling the interface valuation in estimating. This approach will be formulated from a construction management perspective with a focus on the organization of estimating in construction companies. These considerations will give rise to approaches for the future support of the estimating process by construction informatics. The aim is a process model strictly constructed on the functional logic of the turn-key construction work.

2 CURRENT PRACTICE IN ESTIMATING

A strong characteristic of current practice in estimating involves breaking down the entire system "building" into smaller elements or packages, for example structure, envelope, M&E, interior and analysing them. On the basis of this analysis, the bid price for the project is put together. The systematic synthesis of these elements, i.e. the recording and pricing of the interaction between them and the resulting consequences for the bid price is much less intensive. Without adequate synthesis, however, it is impossible to make an adequate estimate of production costs.

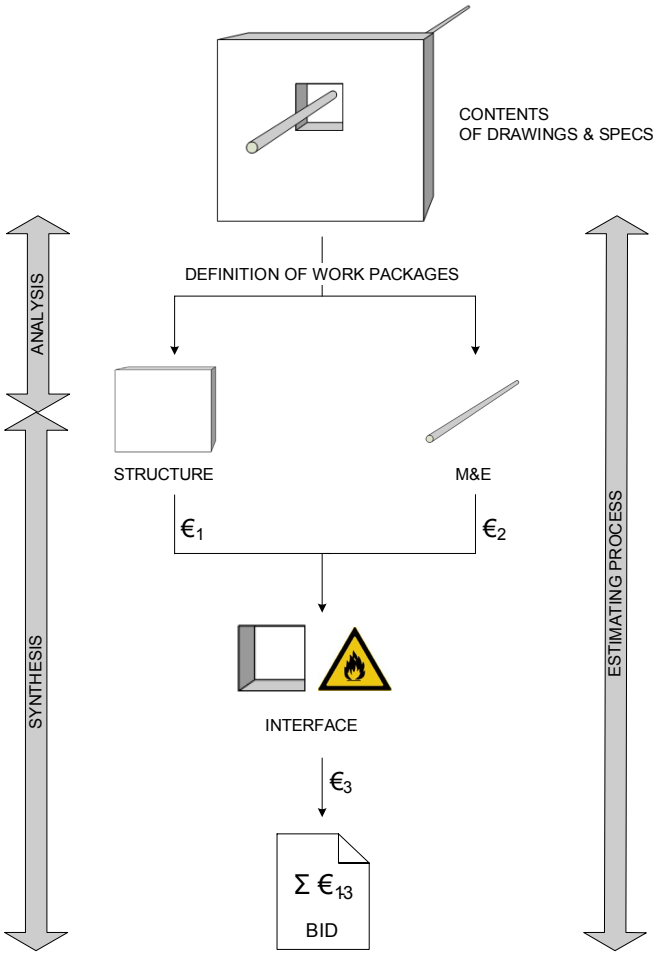

Figure 2. Analysis and synthesis of work packages in the estimating process

The reason for fragmenting the estimating process has largely to do with the historical development of construction companies from structural builders to turn-key builders. Existing expertise and resources in the area of estimating structural works have been supplemented by specialists for the other trades for which there was and still is no existing know-how in the company. These specialists are often from sub-contracting project-related external engineering companies which, spatially, organizationally and hierarchically discrete, contribute their share to costing. The networking of these various units is certainly a critical factor for the success of the process, but is often in practice, in our experience, underestimated. Thus, for example, a structural works expert calculates the wall openings required for the M&E pipings, and his colleague responsible for calculating the M&E trade itself calculates the appropriate pipings, but the costs for fire barriers that may be necessary at the intersection of structural and M&E works are often not systematically considered.

Without adequate synthesis, i.e. interface management, no satisfactory definition of the construction costs is possible. This is especially true in the case of functional technical specifications with completeness clauses. This sort of specification has become standard in turn-key construction. Unlike the specification with detailed bill of quantities it may be the case here that individual work packages belong to the works as a whole, although they are not explicitly specified, but are contractually required to deliver a building ready for occupation and use (cd. Kapellmann & Schiffers 2000). It is then that the complete linking of work packages for a correct costing becomes indispensable. Against this background and the current market-dependent influence factors on estimating depicted in Fig. 3, it becomes clear that optimizing estimating processes and methods is a fundamental success factor in construction management (cd. Seefeldt 2001).

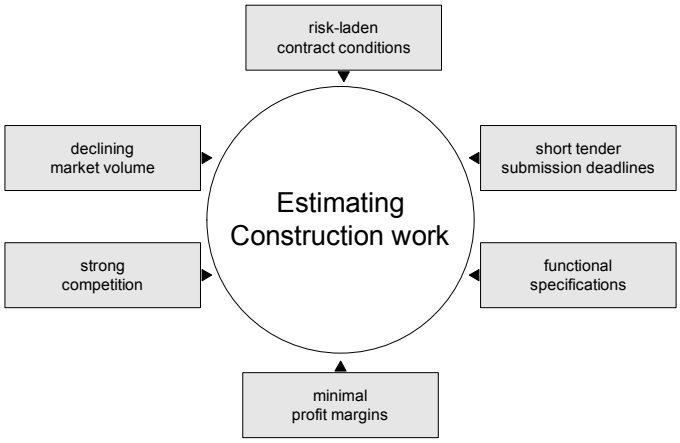

Figure 3. Current market-dependent influence factors on estimating

3 EXISTING SYSTEMS FOR STRUCTURING CONSTRUCTION WORKS AND COSTS

The hitherto normal systems for work and cost structures, e.g. the Standard Construction Work Code (Standardleistungsbuch =StLB) or German Industrial Standard (DIN) 276 – Costs in Building Construction are inadequate in taking into account the estimate-related needs of a general contractor. The

StLB, in its structuring system, assumes a unit-price single trade based bid procedure. This form does not correspond to practice in turn-key construction. DIN 276 considers the building costs from the point of view of the owner and the architect and not from that of the contractor. Identification systems such as, for example, DIN EN 61346-1 have so far played no part in estimating for turn-key projects. The existing systems all break down the building works into elements independent of each other - in the systems theoretical sense of analysis - or into single trade work packages. In practice, however, a strictly single trade consideration contributes to an incomplete understanding of mutually dependent interfaces, with all of the resulting discrepancies that emerge in the course of the project.

4 INTERFACE MANAGEMENT

The importance of interface management has grown in recent years as the importance of turn-key building has grown (cp. Buysch 2002). Essentially, there is an interface when co-ordination between two elements of a system is necessary. Applied to the calculation of turn-key buildings, the interfaces are cost-relevant points of contact between two or more work packages. These may involve spatial, chronological or technological interfaces. A spatial interface, for example, is the opening in a wall for a sprinkler pipe. Chronological interfaces are the result of mutual dependence of work packages during the execution phase. An example for this is the time needed for the screed to dry before the interior works can be started. Technological interfaces may for example be between the sun protection function of the facade and the efficiency required of the ventilation system. Furthermore, interfaces also occur as result of the division of work made in the course of the estimating process. These are organizational interfaces between various people.

It is the task of the interface management to guarantee the complete cost valuation of all interfaces. This is a co-ordinating function within the estimating organization. Among the principal tools that support and document this co-ordination are interface matrices, interface co-ordination plans and interface specifications.

These tools however are usually discrete isolated applications. Lists or specifications of interfaces are, so far, not generated automatically from the CAD data during the planning process. Similarly, the usual estimating software has no functions that provide automatic indications of possible specific interfaces when processing individual work packages. These are possible starting points for common research projects in co-operation between construction management and construction informatics.

5 INTERFACE-ORIENTED ESTIMATING

The building elements represented in Fig. 2 are intended to clarify the approach of interface-oriented estimating. The three building elements are a reinforced concrete wall, a M&E piping that passes through this wall and a fire barrier in the wall opening. These three elements are dependent of each other in terms of location and measurements. In abstract terms, there are three objects (wall, piping, barrier) whose respective versions are interrelated. In terms of interface definition this a spatial interface.

In the course of a trade-oriented estimating process the building elements are divided between the work packages structural works and M&E works. The wall, including the opening, is allocated to the reinforced concrete works, the piping to a one of the M&E trades, e.g. sprinkler installation, and the fire barrier usually to a separate work package. In practice our experience is that at least two people from the estimating department of a construction company are involved in calculating these building elements – the structural works estimator and the M&E works estimator. The complexity of this planning detail then becomes clear if one takes into account that, in the planning phase, three parties are involved (the architect, the structural engineer and the M&E engineer), in the estimating process the two estimators previously mentioned, and in the execution phase altogether three specialist firms for structural works, M&E works and fire protection works. Because planning details often change in the course of a project and these changes have to be co-ordinated with each other, the result is an even more intensive need for co-ordination among all parties involved.

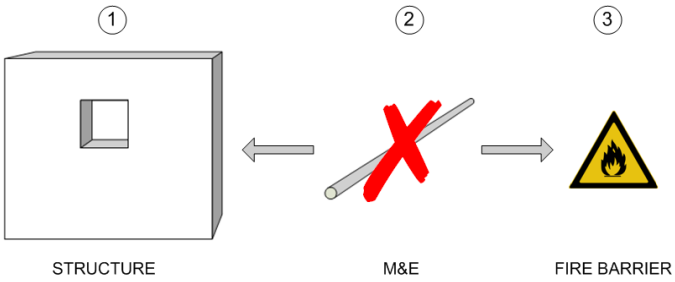

Figure 4. Trade-oriented structure of work packages

In the trade oriented calculation process the procedure is as follows: in estimating the costs for the construction of the wall, the costs of the opening are included and spread among the m² of wall surface. The costs of the piping and fire barrier are estimated separately. If in the course of a planning change the piping becomes unnecessary, there is no further need

to build a wall opening and a fire barrier. In this case all three packages would be affected by changes in costs and would have to be re-estimated. In the case of reinforced concrete works this leads, because of the previous cost spreading, to a change of the costs per m² of wall surface.

In the case of an interface-oriented estimating process another procedure is used. This approach leads to a separate estimate of the interface costs. In the example considered, these are the costs for the wall opening and the fire barrier. The costs of the opening are consequently are not spread among the m² of wall surface. If the piping is not necessary, the estimate of the wall does not have to be revised. In comparison with the trade-oriented procedure, one co-ordination point less is necessary.

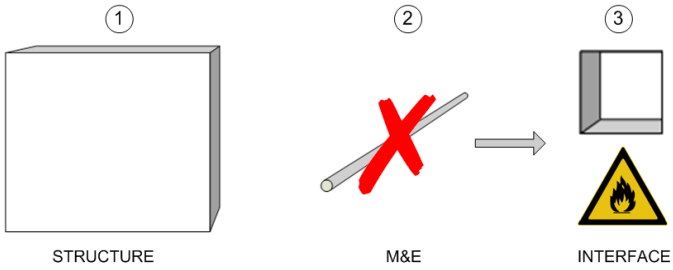

Figure 5. Interface-oriented structure of work packages.

This procedure is logical inasmuch as the opening and the barrier are necessary only because of the cross-over point between wall and piping and are otherwise dispensable. The interface-oriented approach is based strictly on the functional logic of building elements. This means that estimating and cost structuring basically follow the cost-relevant links between the work packages and not necessarily the traditional cost structuring systems and company-specific organizational structures. As a result, a estimating process that follows the inherent logic of the construction process becomes the model. This process model helps to prevent interface costs - as can be observed very often in practice - from being incompletely calculated.

The reduction of the co-ordination points required leads to reduction in complexity. Consequently the interface-oriented calculation approach helps to cope with the complexity of turn-key building projects. In the opinion of the author it is worthwhile pursuing this approach in construction management and economics research.

In the construction phase of the building the interface-oriented approach does not mean any alteration in the allocation of the building elements to the subcontracting single trade contractors. In the example cited the wall opening would still be part of the work package of the structural works contractor. The difference is, that the allocation of building elements to the work packages takes place after the calculation of the interface costs and not before.

6 APPROACHES TO RESEARCH CO-OPERATION BETWEEN CONSTRUCTION MANAGEMENT AND CONSTRUCTION INFORMATICS

A necessary basis for implementing the interface-oriented approach in estimating is the existence of a complete interface model for the construction project. Fig. 6 shows an extract from the design of a corresponding model, in which the possible spatial, chronological and technological interfaces have to be represented. The drawings and technical specifications can then be examined at the appropriate interfaces. Thus, from a general model a project-specific one can be generated. The project-specific model can then be used to make a correct allocation of the costs to the building elements and interfaces. The cost structure here has to be so flexible that both interface and trade cost allocation is possible by means of a sort function. The trade allocation for the general contractor is necessary, among other things,

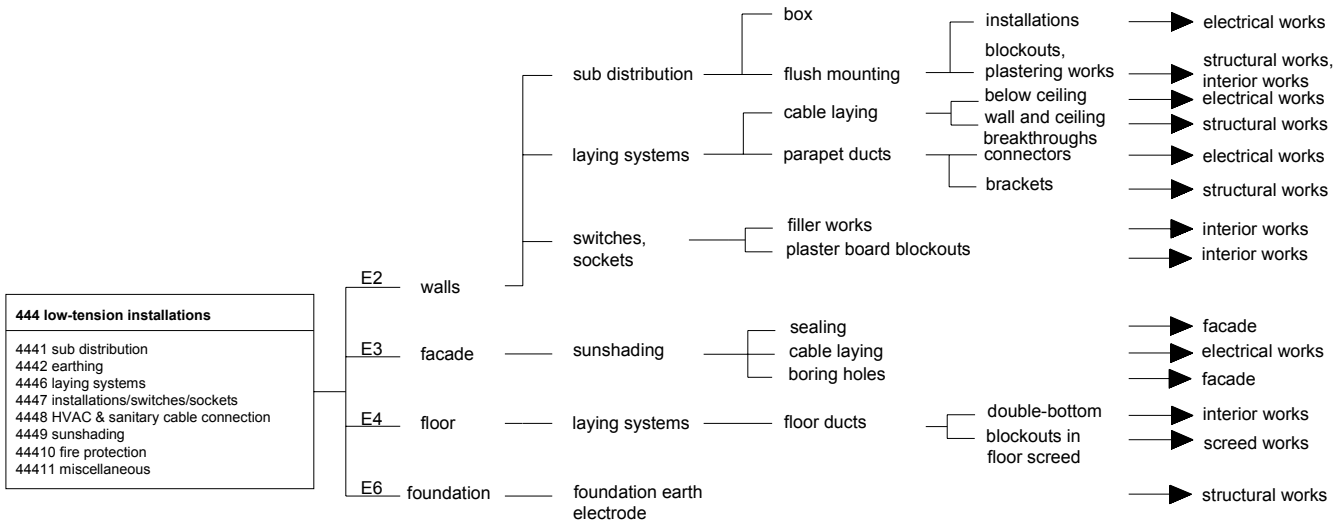

Figure 6: Interfaces of low-tension installations with other compound units and trades

to prepare the contract awards to the subcontractors. The interface allocation is, in turn, the basis for change order management in the further course of the project.

From the point of view of construction management research it is necessary to examine, in co-operation with construction informatics, to what extent project-specific interface models can be generated directly from the CAD documents of the architect and specialist planners and engineers. The aim of concrete research co-operation in this area could be to link tools for interface management with existing CAD tools. It is conceivable that the contributions of the individual planners (architect, structural planner, M&E planner, facade planner and others) could be integrated in one CAD model of the building and that spatial interfaces then ca be detected by means of clash detection. A further field of investigation must also deal with the extent to which general interface models can automatically be updated and extended with project-specific new knowledge. The interface model would thus be a tool of knowledge management in the company that would contribute to the transformation of person-related implicit knowledge into generally accessible explicit knowledge. It supports individual and organizational learning processes and provides, besides estimating, additional approaches to optimizing further management processes in turn-key construction.

7 CONCLUSIONS AND OUTLOOK

Estimating processes for turn-key projects have to be adjusted to the complexity of the building project. The individual building elements have to be considered in their functional context. For this reason the linking-up of individual partial processes and those people working on them is of major importance for a correct estimate. The interface-oriented approach leads to the necessary linking-up of the process structures.

The approach presented could be a starting point of future joint research projects involving construction management and construction informatics. It sketches demands for the further development of IT estimating tools. Construction management practice urgently needs innovations in this area.

REFERENCES

Gidado, K. I. 1996. Project complexity: The focal point of construction production planning. Construction Management and Economics: 14, 213 – 225, London: Taylor & Francis.

Kapellmann, K. D.; Schiffers, K.-H. 2000. Vergütung , Nachträge und Behinderungsfolgen beim Bauvertrag, Band 2: Pauschalvertrag einschließlich Schlüsselfertigbau. Düsseldorf: Werner.

Seefeldt, M. 2001. Projektmanagement im Auf-Bau. Hamburg: hansebuch Verlag.

Buysch, M. 2002. Schnittstellenmanagement für den schlüsselfertigen Hochbau. Diss., RWTH Aachen.