Research project

Lifecycle oriented planning, tendering and contracting processes – Piloting project supports of public building projects in structural engineering

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In the "ZukunftBAU"-project "Life cycle oriented planning, tendering and contracting processes in structural engineering – Methodological bases[1]" the spectrum of German guidelines regarding costing has – under the direction of the author – been surveyed in order to clarify their applicability for determination and optimisation of life cycle costs. As a complement and support has our research partner Prof. H. Franke compiled legal bases for life cycle oriented tenderings. In the present "ZukunftBAU"-project succeeded in the years 2011 - 2014 the piloting of our research results in simultaneous project supports of the following public building projects:

Project support of the new office building "UBA 2019" in Berlin (zero-energy building)

Client :	BBR Berlin
User:	Federal Environment Agency Berlin

Project support of the new building project "Walter Eucken School" in Karlsruhe (passive house)

Client :	Municipality of Karlsruhe, Office of Structural Engineering and Building Management
User :	Walter Eucken vocational school

Project support of the HVAC system replacement in the University Hospital Leipzig

Client:	University Hospital Leipzig, Planning and Building Management
User:	Dermatological Institute, University Hospital Leipzig

Guiding principle of the project supports

Which methods and instruments optimise life cycle costs of building-components along the project phases of a building project ?

During the supported projects emerged in regard to this question a complex methodological approach, which contains equally the optimisation of investment costs and follow-up costs and beyond that involves the building qualities after DGNB- / BNB-criteria.

[1] ZukunftBAU Balck (2012).

Building components and products – Life cycle costs and qualities are depending on industrial potentials of building

In building projects the industrial potentials of building are only on rare occasions identifiable already at the beginning of the project phase. Only after a sufficient concretisation alongside increasing detailed drafts they become the focus of implementation options. There are, therefore, especially the planning determinations on the component level that enable a solution of the interface problem between the industry and the sphere of the planners. This is also the fundamental experience of our project supports in the research project: Only when structural-technical solutions in the planning process – namely in the form of detailed *component-configurations* – can be displayed, also market- related corresponding *product-configurations* can be exhibited.

In terms of method, such configurations are likewise inventions of the draft-author – depending on his ingenuity, but also from the available knowledge. This means also that product-decisions are principally dependent on the context of individual drafts and that there are, regarding relevant product offers of the industry, numerous product alternatives. Here, it is now necessary to identify links between draft provisions in the form of construction parts and their feasibility through product applications, which are optimal in the evaluation of sustainability. So if it is possible to map draft-oriented knowledge of the planner in an appropriate rate of selectivity onto component knowledge – and then explore each relevant product knowledge of the manufacturer – can be found structural solutions that are in the market-potential optimally realised. So we are looking for "draft-driven" systems and products that qualitatively and economically cope with the aims of sustainability[2].

Non-energy follow-up costs

In the project supports for this point emerged in close collaboration with the research partners –- those responsible for the client organisation and commissioned planners – methodological approaches. They were tested by experimentally developed computational models for life cycle costs in connection with reviews of building quality in terms of their applicability. Object data were created on the component level in historical time scales for modelling. Thereto parallel building-related energy consumption were identified by using thermodynamic computer simulations. An extreme case is the supported

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[2] This relation has been examined in the "ZukunftBAU"-project „Life cycle oriented product information" in cooperation with industrial research partners – ZukunftBAU_Balck (2013).

UBA-project in Berlin in which the EU-directive for 2019, which requires a level of "zero-energy", was intended and achieved (commissioning in 2014) [3].

The evaluations of the life cycle oriented calculation models (LCC-models) showed that the component related identifiable follow-up costs of an established building in an observation period of 50 years range from 90 % (WES-project) to 100 % (UBA-project) amount of the overall follow-up costs of a building. This result surprised all those involved – and gave the impetus for the assessment of a trend:

The supported new construction projects are prime examples of the shift of the follow-up costs through energy optimisation. While building energy costs of non-residential buildings in the inventory of construction from the 1960s to 1980s account about 20 to 30 % of annual operational costs, this share goes because of the today attainable building energy efficiency to zero. In "Energy Plus" buildings even energy profits are achieved.

But there remain all non-energy follow-up costs: costs for cleaning, operating, costs of renewal and for the end of life cost of components at the end of their useful life – and these are component-generated follow-up costs. As a tendency can be said:

Follow-up costs of the future are non-energy costs – these are component-generated follow-up costs – especially for maintenance and renewal

Because all investment costs can also be displayed component-sharp, it can be generalised:

For zero-energy houses their life cycle costs are the sum of component-sharp determined investment costs and component-generated follow-up costs.

An important result of the research is the methodological consequence: While the reduction of energy costs is possible only with the help of systemic building models – e.g. by thermodynamic computer simulations or calculation models according to DIN 18599 – have for the purpose of optimisation all relevant components to be considered indi-

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[3] The office building "UBA 2019" in Berlin-Marienfelde is the first net-zero-energy-house of the federal government. In operation of the building, the energy demand is fully covered locally by a sustained renewable energy generation in the balance sheet of a year (heat and electricity). Therefore the building implements already the EU-directive for 2019 regarding the energy efficiency (2010/31 / EU) of buildings as a standard for zero-energy buildings. The building was certified in 2015 in accordance with the BNB-system with "Gold".

vidually and have to be examined "component-sharp" in regard to alternative realisation opportunities. One focus are component-alternatives or product-alternatives of the entire building technology.

"Economic Strategic components" – Pareto-distributions in the structure of life cycle costs

In the office building project for the Federal Environment Agency in Berlin, as well as in school building project in Karlsruhe, has as a result of a detailed investment analyses been figured out that about half of the total construction costs are among such components that in all mathematical observation periods of the determined life cycle costs (time cuts all 10 years to 50 years) no component generated follow-up costs – due to the components useful life and use of durable materials (e.g. construction parts of the support structure). Further analyses revealed for both buildings in several time slices Pareto-distributions, where approximately 20 % of the total investment generated about 80 % of the component-generated follow-up costs: Such building components are defined by the author as "economic strategic components" or simply as "strategic components". These are components that cause due to their nature and functions follow-up costs – e.g. cleaning of floorings and glazing, maintenance costs of technical components, auxiliary power for fans and pumps, power consumption of shiners[4]. In the observed time sections the follow-up costs of each component are many times higher – up to 15 times (!) – than the original investment costs of these components.

In the project supports this empirical facts corresponded to the concentration of a few depicted component parts with corresponding cost groups of investment. This included exterior walls, windows, floorings, ventilation systems, shiners and lighting systems. In optimisation processes each investment costs and follow-up costs were identified and assessed "component-sharp" for structural and technical variants. The results were used in the decision-making process of the client / planner, to achieve the best-possible cost-qualities conditions for use and operation – through variants of constructions, materials and products-alternatives.

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[4] The by the author in the mid-1990s constructed hypothesis that about 20 % of the total investment relate only certain parts of a building, which due to their functions and operating conditions cause approximately 80 % of all follow-up costs in the first 2-3 decades, was a main hypothesis of the project supports described above. It was indeed confirmed by the present results in a number of respects, but still remains an object of empirical studies of Building Research – but on the condition that each installed system and component of the building will be fully taken into account.

Ecological-health Strategic components

In the project support of the new office building for the Federal Environmental Agency in Berlin, the selected methodological approach also proved to be a starting point, to define parallel to these strategic components in an economic perspective, ecological and hygienic criteria for focusing optimisation worthy components. In conclusion of such draft-optimisation processes they were termed "Ecological-health Strategic components". An important research result is the possibility that in any building project, both approaches – the orientation on economical strategic and ecologic strategic components – can be combined[5].

Life cycle oriented product selection – Procurement in the tension between market rules and benefits

One of the assignments of the research project was the development of an integrative model of proceeding, which facilitates within the project-related processes of procurement a high degree of coupling between draft-related knowledge of components and market-oriented knowledge of products. This approach was implemented in the carried out project supports with verifiable results. This, however, had the original focus of research, which was primarily aimed at the tendering and contracting procedures, to be extended. The aspired model of proceeding was therefore extended to the entire process chain of project-related processes – otherwise the dependence of life cycle oriented product choices of previous planning steps and subsequent life cycle phases would not be presentable. Therefore, in order to track requirements for sustainable building parts and components in the phases of the project course, have for the purpose of orientation to be observed the following questions simultaneously:

PLANNING ASPECT: Which are the methodological consequences of the life cycle focus on components in planning processes of construction projects ?

PROCUREMENT ASPECT: Which are the methodological consequences of the life cycle orientation on products in tendering and contracting processes ?

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[5] The result of this methodological approach emerged in cooperation with the BNB-auditor Nicolas Kerz. It had its origins in the objectives of the client (BBR) and user (Federal Environment Agency). The BNB-rating system was expedient in all project phases. In the so extended project support it was also confirmed that economic and ecological draft marks can be pursued at the same time and do not have to contradict.

At the focal point of these questions is the technological fact that buildings are produced by products – and that the decision of products is linked to previous decisions of "components", which is the result of draft and planning processes. The component orientation is in a methodological perspective the connecting link between conceptual specifications of architects and planning engineers and execution processes by product suppliers and implementing companies.

The applied products and depending follow-up processes of the realised building parts and components – and their reflection in follow-up costs – are a subject defined by the facility management in the construction and real estate industry, that received increasing attention in recent decades and is now also a planning content in construction projects in the course of the orientation of the building on sustainability requirements. This means methodologically that procurement processes related to construction projects – and therefore also tendering and contracting procedures –, can be as little separated from the preceding draft and planning phases as of the subsequent processes of the operation and management up to processes of renewal, disposal and recycling.

"Component-product-scenarios" in the planning process

In the preliminary planning and design planning phases, but not later than in the phase of implementation planning, can the determination of component properties be made dependent on product information. For this purpose, the method of "component- product-scenarios" were developed in the research project. The entry point are market analyses and the inclusion of product knowledge, which is offered by product manufacturers. These in planning practice common approach is a scenario so extended, that alternative draft solutions with regard to the anticipated follow-up processes with detailed follow-up costs can be studied "component-sharp". According to criteria of sustainability products – and especially alternative product solutions – are evaluated. The result is a product-neutral guideline in service specifications for a "product-corridor" in which bidders select and pricing out concrete products.

Participation of bidders to the optimisation of component

If bidders have component-related knowledge, which is not or only insufficiently available for planning architects and engineers, the observance of follow-up costs in connection with the product choices can be left to the bidders to a limited extent. Such a case has been exemplified for the tendering process of ventilation equipment in the "UBA 2019" project. In contrast to the previously described "component-product-scenarios" with estimated costs for both investment as well as projected follow-up costs – i.e. cost-dipoles – bidders were asked to link prices with efficiency calculations for the components chosen by the bidder in its own process. Therefore offers include price-cost-dipoles. Such by the bidder completely to be carried out coupling of calculated prices with product-specific "systemic follow-up costs" is always advantageous for builders and planners, when at the same time economically attractive solutions are linked with higher costs certainty associated with follow-up costs[6]. At the end in the offer counts each fixed price of each item consisting of "product + maintenance" with a in the LV established weighting of 60 % and efficiency-related costs of energy consumption of the components used by the bidder with 40 % weighting. In this way incentives are anchored for the bidder for the selection and interaction of best possible products within the tendering phase.

Legal bases of life cycle oriented tendering and contracting phases

The transition from planning services to construction is legally regulated by principles of competition: planning and draft decisions for "components" lead to "product-neutral" provisions. Product decisions are made by clients after submission of offers, in which implementing companies submit products. This market transition has the status of a matter of course. But it is by no means self-evident that the combination of component choices by planners and the product selection by bidders as a chain of subsequent processes can be planned as "legal pathway" and must be made low in risk.

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[6] For the indicated ventilation units the bidder had the possibility to calculate with algorithms (only accessible for him) selected product parameters in the interaction of the components. Three loading conditions were prescribed for the tendering (30 % / 50 % / 100 %). The bidder could compare and arithmetically evaluate on this basis several liable differences in efficiency of alternative components.

By the research partner Prof. Horst Franke[7] and his expert team were the legal bases and regulations in German law relevant to the life cycle approach – with integrations of EU law – recorded in a detailed compilation. On this basis, his team has supported tendering processes in the project supports. But doing so, the well-known fact manifested, that there is still little experience with life cycle requirements for products and services in today's market situation – with resulting complications and settlement risks in the processes of award and procurement.

However, the documentation of the legal aspects and the applicable rules (Part 3 of the report) also confirm that sustainable building – to the introduction of consistent life cycle oriented procurement channels – has become in the last 5 years a vast political programme. The realignment of tendering and contracting processes in the life cycle perspective is therefore inseparable from the overall reorientation of planning and construction phases[8].

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[7] Prof. Horst Franke, HFK Lawyers.

[8] Vgl. Hegner (2010) – Development and revision of the BMVBS-guideline for sustainable building, in particular the introduction of the status of the policies and corresponding developments of certification systems (www.Informationsportal NachhaltigesBauen.de).