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Early estimation of building construction speed in Germany

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Abstract

One of the major tasks of construction project management, in addition to determining costs, is an early determination of the construction duration. Construction speed indicators (e.g. m^2 gross external floor area/month) can serve as the basis for this determination.

The use of a series of independent variables for early estimations of construction speed indicators of German building construction projects is proposed. Based on 200 properties, these variables serve as the speed drivers of a project, and the regression model, tested against the 200 properties, has a mean absolute percentage error of 20%. The identified speed drivers are: project size, number of winters, and planning duration.
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1. Introduction

Construction duration and costs are relevant factors determining construction project performance (cf. for example [1]). A construction duration that is too long, as well as one that is too short, can have a negative impact on the project's economic success. For this reason, construction duration forecasts play an important role in early project phases, as do cost forecasts. Construction speed indicators support early construction duration forecasts, which are one of the major tasks of construction project management. The following equation is used in this connection:

Construction speed (m^2 gross external floor area/month) * Area (m^2 gross external floor area) = Construction duration (month)

Only a few resources to support planning the construction duration, similar to those used for cost planning for example, have previously been available in the German-speaking area. The lack of indicators and models supporting an early estimate of the construction speed is particularly serious. The present study deals with this deficit. Using the analyzed data as a basis, the relevant drivers, as well as indicators based on them, are clearly articulated and a regression model for estimating construction speed indicators is derived.

These analyses are based on primary data from 216 properties from the BKI database (Baukosteninformationszentrum Deutscher Architektenkammern – Information Center on Construction Costs of Architects' Associations in Germany). On this basis, indicators and their drivers can be designated. Thus the remarks of this paper are based on concrete construction projects whose data are available on a uniform basis.

In addition to the data pool, however, this study also builds on studies which hitherto have not delivered a uniform and thus a conclusive picture of important drivers. Prominent emphasis must be given to the work by Bromilow et al. [2], which considers the connection between

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construction duration and building construction costs. In addition, however, the advanced studies by Chan and Kumaraswamy [3] and Love et al. [1] must be mentioned, which primarily examine project-specific characteristics, such as project size and type of façade construction, and their influence on construction duration. But what is still lacking in spite of this work, above all for the German-speaking area, are indicators and models that build on a wide data pool.

The research described here proposes an initial approach for attaining the objective set forth above. In the first two sections of this paper, the authors present the definition of construction speed and the results of their study of the secondary literature. They primarily address the question of the various relevant drivers influencing construction speed. The following sections are devoted to the data pool, which is introduced briefly. Additionally the characteristics of the proposed model and their drivers are presented in detail. In the concluding section the results of the data analysis are summarized and aspects are identified that are relevant for further investigation.

2. Definition of construction speed

A construction project passes through several phases. It begins with a concept and continues though the preliminary studies, planning, the construction process, and on to the new facility's start of operations. This study deals exclusively with the project's construction process, which is defined as the construction duration from the start of work at the construction site until the entire work is completed.

The construction speed defines the average progress of construction over the construction duration. Normal units of measure are revenue (€ revenue/month), area completed (m^2 gross external floor area/month), or volume completed (m^3 building volume/month). This study defines construction speed using floor area, i.e., the study's functional unit parameter (m^2 gross external floor area/month).

3. State of the art

There are already studies available that evaluate drivers of construction duration and, in part, of the construction speed of new construction projects. Table 1 summarizes these studies. For reasons of scope, no consideration has been given here to studies that are concerned, for example, with civil engineering projects or the reasons for construction delays (for example Al-Khalil and Al-Ghafly [4]).

One of the first works dedicated to the empirical investigation of construction duration comes from Bromilow [5]. Above all, he highlighted the connection between construction duration and building construction costs. A later study by Bromilow et al. [2] was based on 395 construction projects and identified three construction duration drivers:

- Building construction costs.
- Client (government/private).
- Building age (for example before 1969 or after 1969).

Table 1
Related studies and their relevant drivers

Study	Data pool (country)	Relevant drivers
Bromilow et al. [2]	395 (Australia)	Building construction costs Building age Client (government/private)
Chan and Kumaraswamy [7]	111 (Hong Kong)	Client (government/private) Project type (building/civil engineering works) Building construction costs Gross floor area Number of levels
Walker [6]	33 (Australia)	Building construction costs Work type (fit out, etc.) Client objectives Management style Communication (between architect/engineer and contractor) Use of information technology
Chan [12]	110 (Hong Kong)	Building construction costs Client (government/private)
Chan and Kumaraswamy [8]	56 (Hong Kong)	External wall area Number of levels above ground Average floor size Frame type (presence/absence of precast façades) Type of foundation Communication (between architect/engineer and contractor) Type of scheme (rental/purchase)
Boussabaine [10]	230	Building construction costs Type of call for tenders Tender type Contract type
Chan [13]	51 (Malaysia)	Building construction costs
Ng et al. [14]; Skitmore and Ng [15]	93 (Australia)	Building construction costs Type of use (education/residential, etc.) Type of call for tenders Tender type Client (government/private) Building age
Chan and Kumaraswamy [3]	71 (Hong Kong)	Building construction costs Frame type (presence/absence of precast façades) Building volume Average floor size Type of scheme (rental/purchase)
Love et al. [1]	161 (Australia)	Gross floor area Number of levels

Walker [6] analyzed the interrelations between drivers and construction duration based on construction projects and surveys. He came to the conclusion that in addition to "hard" factors such as project size, "soft" factors also play a significant role. Thus, for example, according to Walker the structure and capability of management is hidden behind the client factor (government/private). In addi-

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