Dieter Jacob / Clemens Müller (Eds.)

Estimating in Heavy Construction

Roads, Bridges, Tunnels, Foundations

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With a foreword of
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Cover: Tunnel Luise-Kiesselbach-Platz, München
Foto: © BAUER Spezialtiefbau GmbH, Schrobenhausen, Germany

Library of Congress Card No.:
applied for

British Library Cataloguing-in-Publication Data
A catalogue record for this book is available from the British Library.

Bibliographic information published by
the Deutsche Nationalbibliothek
The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data are available on the Internet at <http://dnb.d-nb.de>.

© 2017 Wilhelm Ernst & Sohn, Verlag für Architektur und technische Wissenschaften GmbH & Co. KG, Rotherstraße 21, 10245 Berlin, Germany

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Coverdesign: Sophie Bleifuß, Berlin
Production management: pp030 – Produktionsbüro Heike Praetor, Berlin
Typesetting: Reemers Publishing Services GmbH, Krefeld
Printing and Binding :

Printed in the Federal Republic of Germany.
Printed on acid-free paper.

Print ISBN: 978-3-433-03130-8
ePDF ISBN: 978-3-433-60624-7
o-book ISBN: 978-3-433-60623-0

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Foreword

There is no up-to-date English language textbook on heavy construction calculation/estimation, in contrast to building construction. This may be because this type of construction often involves heavy construction machinery from Germany and Asian countries. Therefore, I appreciate that such a textbook for contractors as well as clients has been provided.

This book can be used for US heavy construction, as well as heavy construction in Asia and developing countries. The examples are calculated in euros and can easily be changed into USD. The examples have to be adapted to the local/regional conditions with regard to wages and material costs. The sales tax/value added tax as used also needs to be adapted.

The book provides a good basis for estimation because all important cost categories are considered. The risks of different construction contracts are systematically evaluated with regard to risk distribution between owner and contractor. Specific risks, for instance for joint ventures, are also considered. A systematic scheme for the calculation of interim interest is provided as well.

The book differentiates between time-dependent and time-independent costs. This allows one to easily calculate the costs caused by delays. The initial strategy part of the book considers the effect of different levels of capacity utilization and the cost/profit consequences. The calculation/estimation is not presented as a deterministic process, but the book shows how this depends on strategic considerations, subjective factors and stochastic characteristics. The book also demonstrates the application of cost estimating software.

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Preface

In contrast to building construction, there are only a few available English books on estimating in heavy construction projects, such as roads, bridges and specialized foundation engineering works for buildings. This book is based on our German estimating book, in which we have collected German examples. These real projects can also be applied to the international market.

The estimating is based on specific construction methods which are dependent on the boundary conditions, the machinery available and the quality and training of personnel.

Be aware that estimating is always a stochastic process and cannot deliver a deterministic result. Reliable estimating is not only important for a contractor but also for a professional client who wants to have a rough overview of his cost situation, especially in civil engineering and underground construction. This is expensive, complicated work and one cannot simply measure square or cubic meters of living space as in standardized building engineering. One only has to think of related significant cost overruns in a few recent large-scale projects to understand the need for a publication written exclusively for heavy construction estimating.

We would especially like to thank all contributing heavy contractors such as Strabag Großprojekte GmbH, VINCI, Heijmans Oevermann GmbH, BAUER AG and Matthäi Bauunternehmen GmbH & Co. KG for their support.

Freiberg, September 2016 Dieter Jacob, Clemens Müller (Editors)

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List of Abbreviations

acc.	according
approx.	approximately
av.	average
AW	average wage
BIM	Building Information Modelling
BOT	build, operate, transfer
BR	boring rate
C	concrete
CA	compressed air
CAD	computer-aided design
calc.	calculation
CAPM	capital asset pricing model
Cf.	compare
contr	contractor
Dia.	diameter
div.	division
dist.	distance
DW	diaphragm wall
ea.	each
EDP	electronic data processing
e. g.	exempli gratia – for example
Empl.	employee
ER	employer
GMP	guaranteed maximum price
HPI	high-pressure injection
hol.	holiday
i. e.	id est – in other words
ID	Identity
IDC	indirect costs
ISO	International Organization for Standardization
ins.	insurance
JV	joint venture
LOC	letter of credit
MT	microtunnel
OCC	overhead construction costs

OP	order procurement
P	performance
PC	prime Costs
pos.	position
PPP	public-private partnership
proc.	procurement
pub.	published
QM	quality management
qty.	quantity
QU	quantity unit
RAP	risk and profit
resp.	respectively
RMS	risk management system
RN	record number
str.	strength
SUB	subcontractor
TBM	tunnel boring machine
tot.	total
TP	total price
TS	tunnel segment
UoM	unit of measurement
UP	unit price
VaN	value as new
VAR	value at risk
VAT	value added tax (sales tax)
WG	wage group
w/o	without

Selected terms to help international understanding

A	motorway
AG	incorporated company
B	federal highway
BAL	construction site equipment list
BGB	German Civil Code
BSt	rebar steel
DIN	German Institute for Standardization
e.V.	registered association

ERA	UCP: Uniform Customs and Practise for Documentory Credits
FGSV	Construction of the Road and Transportation Research Association
GmbH	Limited (Ltd.)
KonTrag	Control and Transparency for Areas in Business Act
RQ	standard cross section
RStO	Guidelines for the standardization of the superstructure
VOB	Public Construction Tendering and Contract Regulations

Units

a	anno
CD	calender days
cm	centimeter
CW	calender weeks
d	day
EUR	euro
g	gram
h	hour
KEUR	thousand euros
km	kilometer
kW	kilowatt
kWh	kilowatt hour
l	liter
m	meter
min.	minute
mm	millimeter
mo	month
pc	piece
Q	quarter
RM	running meter
t	tons
WD	working days
w/c	water/cement ratio

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1 Strategy and estimating

It is more important than ever to follow appropriate strategies to be competitive; even more so in difficult economic times. The implementation of the strategies must be supported by efficient management.

1.1 Sales and marketing strategies

There are three different core area strategies available for the contractor, which can also be combined:[1)]

- Niche strategy (specialization): In this strategy, the main task is the concentration on niche markets. The company focuses on a specific, narrowly defined industry segment. These niches can include, for example, a specific purchasing group, a specific part of the performance program, or a geographically defined market.
- Cost leadership: This strategy aims at being the cheapest provider on the market. A comprehensive cost advantage should be reached within the branch by means of this strategy. This requires, for example, cost-cutting measures, strict cost control, and minimization of costs in certain areas, such as service or marketing.
- Comprehensive services (differentiation): The goal of this strategy is to offer services, which differ greatly in quality and variety from the services offered by the competition. By achieving a unique position against the competition (i. e. unique services), it is possible to overcome the cost-cutting strategies of the competition.

It is questionable whether a typical construction company can aim to make its sales entirely in niches. One does certainly strive strategically to save a certain share of revenue from the intense price competition.

In many cases a price war cannot be avoided. Cost-effective competitiveness can only be achieved through rationalization, utilization of the learning effect, and skillful procurement management (of construction materials and subcontractor services).

Niche and cost leadership strategies are particularly practicable for providers of individual trades. The differentiation strategy, on the other hand, is closely bound to the market presence of system providers[2)]. Table 1.1 describes both forms according to characteristics such as size of the company, depth of production, price margin etc.

1) Cf. the three types of competitive strategies: Porter (1999), pp. 70–85. To the topic of EU-eastward expansion: Jacob/Mollenhauer (2002), pp. 52–72 to the operational strategies of the domestic market penetration and Birtel (2002), pp. 73–82 to the operational strategies of the opening of the construction markets in the accession countries.

2) For the characteristics of the system provider cf. BWI-Bau (2013) p. 158.

Estimating in Heavy Construction. 1st Edition. Jacob, Müller (Eds.)
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Table 1.1 Characteristics of single trade and system providers[3)]

Characteristic	Single trade provider	System provider
Size of the company	Small and medium-sized enterprises	Medium-sized and large enterprises
Scope of operation	Regional and superregional	Superregional, international
Depth of production	High	Low
Price margin	Low to large	Middle
Range of services	Homogeneous	Heterogeneous
Service program	Single crafts	Complete solutions
Position in the market	(seldom) Awarded to subcontractors, or subcontractors themselves	General company, general contractor, project company, consortium leader
Indirect resource demands	Handcrafting, technical, economic, tax and legal know-how, innovation know-how, competence in problem solving	Moreover: coordination and organizational know-how; integration know-how

Not only is the definition of the strategy of practical relevance, but its execution is as well. Examples of the reduction or expansion of value added are provided in the construction business management working group, Schmalenbach-Gesellschaft[4)]. The balanced scorecard offers one possible instrument for the successful implementation of strategies in enterprises.[5)]

It is always important to know one's strengths and weaknesses. Which special benefits can one offer the customer in comparison to the competition? Where are the central needs of the market? Ultimately the question arises, where one can stand reasonably in regard to dependence on customer benefits and central market needs.

3) Stuhr (2007), p. 57.

4) Cf. optimizing the results with FOKUS and Reduction of real net output Adenauer (2005) pp. 25–36 and extension of added value in a mid-sized company Schmieg (2005), pp. 37–48.

5) Cf. construction-related application balanced scorecard Stuhr (2009), pp. 14–16.

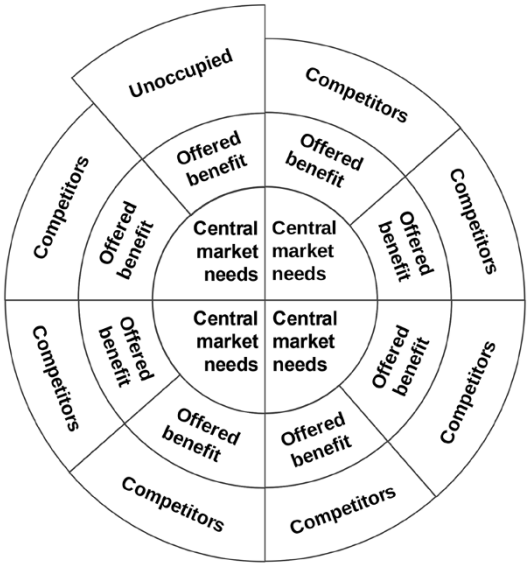

Figure 1.1 Optimal positioning in the sales market[6)]

The results of customer analysis, competitor analysis, analysis of one's individual situation and, finally, positioning in the market influence the preselection of bids. The preparation of an offer involves considerable time and effort. The calculation process requires personal and financial resources. In this way, the company faces order procurement costs:

Order procurement costs = ‰ Costs of volume of supply x hit ratio

Limit: Order procurement costs $\leq$ 2 %

The order procurement costs should not exceed two percent. Two strategies are conceivable (cf Figure 1.2):

1. The company always offers and calculates only superficially. The comparatively low bidding costs therefore result in a poor hit rate: approx. 20 inquiries must be processed in order to receive an order.
2. The company selects the inquiries that best correspond to the chosen enterprise strategy for the range of products and services. The offer is vetted and fundamentally calculated. The higher costs are thereby leveraged by a higher hit ratio (only approx. four cancellations per hit).

6) Cf. Weissmann/Schwarz (1997), p. 110.