Are construction cost escalations a natural law?!

Relevance of cost certainty in the Construction and Real Estate Industry

Dipl.-Ing. Stephan Klamert
Institute of Construction Management, University of Stuttgart,
Pfaffenwaldring 7, D-70569 Stuttgart,
e-mail: stephan.klamert@ibl.uni-stuttgart.de

1. Introduction

Since primitive times of construction, construction costs and their compliance are essential for building owners and investors. But the daily press is reporting regularly about construction projects, which suffer from construction cost escalations. Often it is actually spoken about building cost explosions. Realising that, you can have the feeling that accurate construction cost estimation is a very tough challenge for the people involved in the construction business. Are cost escalations a natural law, which has to be accepted?

In contradiction to that, there is the keen wish of the private, as well as the public building owners to have construction cost accuracy. Building costs, which are predicted in an early project stage of a construction project are fundamental for the investment decision to realise a construction project or not. Furthermore, these predicted costs are within the cost control the basis for more project accompanying cost relevant decisions. It is essential for the building owner to keep the costs within the budget. This can judge about success or failure of the investment. The great difficulty concerning this is to make a decision for investment at an (very) early moment when a lot of cost relevant characteristics of the project are not defined yet. On the other hand, at this moment it is still possible to have great influence on the future building costs.

If and in which dimension construction cost escalations could be described by a natural law, should be discussed and answered within the following explanations.

2. What are construction cost escalations?

A general accepted and precise definition for “construction cost escalations” does not exist so far. Generally it is understanding that an early obligatory cost estimation as a cost objective will be exceed by the actual assessed costs. The obligatory cost objective is mostly determined from early cost estimation and is used as the foundation for the construction investment decision and the budgeting. Are the actual assessed costs corresponding to the cost objective; it can be talked about cost certainty. The cost objective is the result of an

estimation of future costs, and as a forecast it is basically characterized by fuzziness (Sander et al. 2010, 607). The challenge in estimating the cost forecast is to minimize this fuzziness, which results in an optimization of construction cost certainty.

The intrinsic difficulty is to forecast the later actual assessed costs exactly in a very early moment. To this moment, a lot of cost relevant characteristics of the later building are still undefined. Another difficulty for a precise cost forecasting is the very long duration for planning and realizing a construction project.

In this context of construction cost certainty, the understanding of “certainty” has to be enlarged. Within the decision theory, a decision under certainty is based on absolute information and the result can be expected securely. For construction cost estimation, a decision under “certainty” and a secure cost forecast is nearly not possible.

Künzler is defining „certainty“ as a state of affaire, “in which the risk is smaller than a borderline risk” (Künzler 2002:9). Generally, a risk is the possibility of a target misconduct, what is the discrepancy of a result from an expected reference value. This target misconduct can be positive (chance) or negative (danger) (Schelkle 2005:10). Related to construction costs, it is possible to speak about cost certainty when the assessed costs are conforming to the cost objective or the discrepancy from the assessed costs is within an acceptable scale of tolerance for the owner. What scale of tolerance is acceptable, strongly depends on the owners´ intensions for investment and his financial basic conditions.

The opposite of cost certainty is a cost escalation (synonym: cost increase, cost overrun). The actual assessed costs are deviating from the cost objective within a scale that is not acceptable for the owner any more. Finally, to avoid cost escalations, it is very important to consider a scale of tolerance by fixing the cost objective as a target costing or the budget definition. But is it possible to assess the necessary scale or amount of tolerance? The knowledge about the major cost increasing factors is essential in this context. But what are these cost increasing factors and which impact do they have on cost certainty? This question should be a part of this research.

3. Construction cost escalation: yesterday and today

The prediction of construction costs and their compliance is not just a problem of modern times and is of high relevance for owners and further involved people in the construction business through all ages of construction. To keep the budget was and is of crucial importance and a challenge for all involved people since the first days of construction

realization. A prove for this can be find within all eras of history. Already 2.000 years ago, it is reported that it would be self-evident for the owner to calculate the future construction costs approximately to know if it is possible to finance all the construction works. If not, the owner must fear to bring the construction activity to an end during the construction realization process and will become a fool for everyone (The Bible, Luke 14, 28-30). About the importance of cost predicting accuracy, there is an historic report of the Roman architect and engineer Vitruvius Pollio (Vitruvius Pollio 2009:485) 25 B.C., about a tough but fair law of the Greece city of Ephesus. The master builder was responsible to make an estimate of the future final construction costs. For this cost prediction he was responsible and was liable with his entire assets. Are the actual costs corresponding to the cost estimation, the master builder was awarded. Are the actual costs increasing the cost estimation by a maximum of 25%, the cost overruns were financed by the public fund. Are the cost overruns more than 25%, the additional costs was financed by the private assets of the master builder.

In 1494 Sebastian Brand reported in his book “Das Narrenschiff” (engl.: The Ship of Fools) about the failure of a cost forecast. Penther (Pfarr 1994: 556) in 1765 was the first who described a cost estimation as the written notification of all construction costs mentioning the costs of material, carriage and wages specially. Within his explanations, Penther notes critically that the best cost estimate is useless if it is faulty. 60 Years later, Huth (Pfarr 1994: 557) pointed out, that the most cost estimations are insufficient. As the most causes he mentioned the following four reasons:

- Problems with the subsoil,
- Price increase of construction materials and carriages during construction realisation,
- Alterations of the planning by the owner,
- Defective cost estimation calculation.

In the book “Der Baucontract” (engl. The Construction Contract) of Mertens (Pfarr, 1994: 556), in 1863 he described the characteristic of cost estimation as “major completeness” and a “customary in a place unit price” and warned of the consequences of an underestimated costing for the owner. In the worst case this could result in the economic ruin of the owner.

By reading the daily press, journals or other publications, there are many reports about construction projects which are faced by huge construction cost escalations. As a highlight, it is often reported about the realisation of the Suez Canal, the Sydney Opera House, the Channel Tunnel or as an example of our times the realisation of the Boston Central Artery/Tunnel Project (“Big Dig”). Current examples for construction projects in Germany which are faced with cost escalations are the “Elbphilharmonie” in Hamburg or “AirRail-

Center in Frankfurt a.M.. In the context to the cost estimation for the rail project “Stuttgart 21”, Chancellor Merkel expressed that it will not be bad “if the cost estimation of megaprojects would be correct tolerably”.

Project	Cost overrun [%]
Suez Kanal	1.900*
Sydney Opera House	1.400*
Concord supersonic aeroplane	1.100*
Bosten Central Artery/Tunnel (Big Dig)	470
Elbphilharmonie	280
Panama Canel	200*
Channel Tunnel	80*
AirRail	51

*(Flyvbjerg et al, 2006:19)

Table 1: Construction cost increase of selected famous construction projects

It became apparent, that construction cost forecasts are calculated in all eras of construction and were, as the foundation for financing and decision-making of great importance for the owner. But also it became apparent, that to keep the costs within the budget/cost objective, it was and is a great problem and challenges for all responsible involved people of the construction business all the times.

4. Quantitative examination of cost escalation

Are cost escalations a crucial problem of construction realization or is it just the one-sided perception of single “Black Sheeps”? To answer this question qualitative respectively quantitative, because of less significant facts, it is not easy to answer. As to the different availability of data material, it is to distinguish between private and public construction owners. Information about grievances and cost escalations of public construction projects are basically available and the reporting is more or less based on facts. Otherwise, information about construction cost escalations of private owners are kept under secret and are just available sporadic. Although cost information about public construction projects could be available basically, the problem is that these information are documented and administered by the regional / local building authorities in a very local and unstructured way. A data preparation on higher ranking just happens on special order, e.g. parliamentary enquiry.

About frequency and amount German construction projects are faced with cost escalations, this could not be answered easily, because there is neither quantitative nor based on scientific research evidence in Germany. It is a fact, that no significant publication is existing

concerning this topic in Germany. But among German experts, there is the assumption that the final construction costs regularly are over the beginning budget in a range of 15% to 20% (Immobilienzeitung, 2011, No. 4, 27.11.2007: 7). As to an international publication, approx. 50% of all construction projects are over budget between 40% and 200% (Hartman/Ashrafi 2004: 500)

To compensate this gap in scientific as well as practical knowledge in Germany, there was and is some research at the Institute of Construction Management at the University of Stuttgart. The following table gives an extract about research activities to the subject of cost escalations and cost certainty in Germany, executed and supervised by the author.

No.	Title	Finishing
1	Analysis of Construction Cost Estimation Methods concerning the Obtaining of Cost Certainty	02/2010
2	Construction Cost Increases in the Public Sector	03/2010
3	Construction Cost Development in the Stage of Realization - Development of a Systematic to Display	07/2010
4	Relevance of Cost Certainty in the Construction and Real Estate Industry	08/2010
5	Construction Costs Accuracy in the Development Investment Analysis	05/2011
6	International Scientific Publications of Construction Cost Escalations and its Causes	05/2011
7	Empirical Study of Cost Escalations in Building Construction	06/2011

Table 2: Extracts of research activities concerning cost escalation and cost certainty

The results of the study no. 4 “Relevance of Cost Certainty in the Construction and Real Estate Industry” are presented in chapter no. 5.

In contradiction to Germany, international, there are a small number of publications about empirical studies concerning this subject. But these studies are almost exclusively concentrating on public (infrastructure) projects and are partly based on few data.

The most comprehensive and significant research about frequency and amount of construction cost escalations in the moment is a study from Flyvbjerg et al (Flyvbjerg/Holm et al, 2002). Subject of this study is a research of 258 transportation infrastructure projects about their cost escalations. The sample was sub-divided according to the kind of project into rail, fixed links (bridges, tunnels) and roads. The results of this research could be summarized as follows:

- 9 (86%) of 10 projects are faced with construction cost escalation.

- Underestimation of construction costs is occurring more frequently and with higher amount than an overestimation of costs.
- The average overrun of predicted construction costs are 28%.
- Depending on the kind of project, there are different cost escalations (rail: 44,7%, fixed-links: 33,8%, roads: 20,4%). Technology and geology could be a reason for different cost escalations.
- Cost escalations are a world-wide phenomenon across 20 nations and 5 continents. There is no observation that cost escalations are depending on the geographical position.
- The level of cost predicting accuracy is independent of time and never became more precise within the last 70 years.
- Other kinds of construction megaprojects (e.g. dams) or projects of other industrial sectors (e.g. aerospace, pipelines, power plants, information technology) are faced with cost escalations in the same or even in a stronger way as transportation infrastructure projects.

5. Relevance of Cost Certainty in the Construction and Real Estate Industry

Based on the fact, that there is less information about frequency, amount and causes of construction cost escalations of private owners in the German-speaking area available, previously to this research some experts were interviewed about the actual research relevance of cost certainty in the Construction and Real Estate Industry.

All 23 experts have got responsible functions in different fields of activity within famous enterprises of the German construction and real estate industry.

Scope of function and position status of the experts is shown in the following table.

Field of Activity / Position Status	CEO / Directorate	Divisional Head	Consultant / Official in Charge	Total	
Architecture Office	1			1	**4%**
Project Controler	4		3	7	**30%**
General Contractor	3	3	1	7	**30%**
Project Developer	1		1	2	**9%**
Client / Owner		2		2	**9%**
Lawyer in Construction Law	2			2	**9%**
Others	2			2	**9%**
Total	**13 (56 %)**	**5 (22%)**	**5 (22%)**	**23**	**100%**

Table 3: Function and position status of the experts

The interviews are based on a questionnaire, which was given to the experts previously to the interview. The questionnaire served as a guideline for the conversation. The aim was to achieve a deeper insight and overview about the complexity, relevance and the problematic issues of cost planning accuracy and the danger of cost escalations within an unceremonious dialogue. The results (extracts) of the expert interviews will be presented accordingly the following thematic structure:

How important is construction cost certainty for the construction and real estate industry?

During the construction realization, costs and time are the central topics and of fundamental relevance. Architects and project controller are responsible for cost estimation and cost monitoring. The knowledge about the precise future costs in an early project stage is essential for the investment decision and for the financing. That´s why this topic is of high relevance and significance for the owner.
A project realization within the budget is an argument for the professionalism and the reputation of the architect or cost controller.

Are construction costs escalation a problem?

Construction cost escalations are, without doubt, an actual and big problem for all people, involved within the construction process. But it is possible to handle this problem by regular cost monitoring and controlling. As to a subjective assessment, 2/3 of all construction projects are faced with cost escalations.
A big problem is mainly the appraisal and control of cost estimations, which were estimated by external consultants, e.g. for building services or land development.
The costing of building law related specifications is challenging as well.

Which consequences have construction cost escalations?

It is to distinguish if the owner belongs to the public or private sector. For a private owner, the consequence could result in the economic ruin. In the case of the public owner the cost overrun will always be equalised by supplementary financial assistance. As a consequence, this money could not be spending to otherwise and necessary investments and the cost effectiveness, based on a cost-benefit-analyse, could turn into negative.

What are the causes of cost escalations?

The causes of construction cost escalations are very multifarious and the topic is assessed of high complexity. The following aspects were mentioned as possible causes of cost escalations:

Requisition:
- The owner's requirements on the project are not defined clearly
- Particularly technical specifications aren´t defined clearly
- Modification of scope of work and planning, additional scope of work
- Modification of already defined space program (increase of quality and quantity) because of new user/tenant → new user requirements, new production conditions.
- Technical innovation/progress, quality improvement

Owner and other Project Participants (Architects, Consultants)
- Separation of financing (owner) and user specifications (tenant/user)
- Missing owners discipline
- Missing owners decision making
- Bad quality of planning (e. g. technical mistakes, missing cost consciousness)

Cost Planning / Budget Determination
- The owner's budget for the wished construction works is too small (aware / unconsciously)
- Bad quality of cost estimating and cost monitoring, lacking experience in cost estimation, cost estimation based on wrong assumptions (e.g. cost index)
- Difficulty in cost estimation of special trades (e. g. building services trades)
- Cost planner is inexperienced
- Faulty cost estimation because of insufficient project information / definition
- High complexity, technical innovation

Project Organisation
- Inefficient project organisation
- Too many project participants and unclear definition of interfaces
- Insufficient project preparation (e. g. Investigation of the subsoil)
- Project accompanying planning because of temporal demands

Market Impact
- Building material price increase
- Market price development

Building/ plot of land
- Subsoil / foundation
- Building licensing requirements (building law, fire protection etc.)
- Technical complexity of the project
- Technical innovation (new for the first time)

Building Law
- Requirements of building law
- Requirements of fire protection

Construction Contract
- Bad quality of tender and contract documents

Risk
- Subsoil
- Act of God

How to reach construction cost certainty?

Estimating a significant cost forecast is depending strongly on the planning quality (project information and definition), effort of estimation and the expert knowledge of the cost planner. The expert knowledge is particularly shown by his skill to generate appropriate cost indices from past reference projects and adapt them to actual market conditions. Still the moment of signing the contract, the costs for the contractual construction activity is fixed.

A maximum of cost certainty can be guaranteed by an undisturbed construction progress (e.g. planning alterations). In this context, the quality and the degree of the planning maturity (information and definition), in the moment of concluding the contract is very important for the contractual quality. To avoid alterations of planning, all in future relevant project participants should be ask for advice as soon as possible. Based on regular cost monitoring, the compliance with cost objectives must be observed. In the case of cost overruns, it is possible to interfere in the planning and realization process by alterations of quality and quantity (target costing, design to cost, cost control). Concerning the steering possibility to interfere, the individual awarding of contract to sole traders is more convenient than a turnkey lump sum award.

Basic observations concerning the appearance of construction cost escalations

a. The owner's budget is financially insufficient. There are no or minimal funds for risks or cost tolerances (contingency). Often, it is overseen that the architect's cost estimation does not comprise all owner relevant construction costs.
b. The certainty of a cost forecast is determined by the following factors:
    - Basis for estimating (status of project information/definition),
    - Estimating experience of the cost planner (personal, availability of cost data),
    - Effort of estimating (status of differentiation, number of cost data).
c. Cost forecasts in early project stages are nearly exclusive based on cost indices, which are generated from already accounted reference projects or can be acquired from construction data providers (e.g. building cost information service of the German Chamber of Architects). The predicting accuracy depends on the number and comparability of cost indices (effort of estimating), on which the cost forecast is based on. As to the Gaussian error compensation law, the total error is less than the single error of a data indice. The application and adaption of appropriate cost indices on the special characteristics of a construction project is either based on multiplicity, quality and availability of appropriate cost indices and of course on the experience of the cost planner.

d. Cost escalations could be connected with extended construction activities, e. g. an optimization of the consequential costs or of the revenues by extending the construction activities. This would be a positive side of construction cost escalations.
e. An extension of construction time causes cost escalations.
f. Frequency and amount of construction cost escalations are significant depending on the kind of construction project and its complexity. The precise cost estimation for a system building, factory building or a simple residential building is more easy than the precise cost estimation for a hospital or some alterations.

6. Are construction cost escalations a natural law?!

Well, are construction cost escalations a natural law or not? Because of the predicting character of cost estimation, absolute cost certainty could be guaranteed only for the fewest construction projects. On the other hand, it is a fact, that the phenomenon of construction cost escalation perceives regularly in the construction business and the consequences of a cost increase could result in a serious problem for the owner and all involved people in planning and building construction. A natural law describes the necessary and probable progression or relationship of two facts (Armstong, 2004: 218). In the case of cost escalation, not every construction project is experienced by construction cost escalations, and if so in a very different amplitude. But by shifting the focus to construction cost escalations and its causes, there can be observed an interrelationship. It is possible to conclude from some indicators, which are known as cost increasing factors, to a qualitative assessment of the cost certainty of a cost estimate. If, for example, the planning quality or the knowledge about the subsoil isn´t good enough, these are two possible indicators for, maybe, additional costs. Between the relationship of cost escalations and its causes, it is definitely possible to talk about a natural law.

As a result of this paper, the following basic principles and interrelationships regarding construction cost escalations could be summarized:

Basic principle no. 1:
Cost estimation is a prediction of costs, which is basically afflicted with “fuzziness”.

Basic principle no. 2:
The real construction costs can be kept within an acceptable scale of tolerance or be under- or overestimated. There is evidence that the actual construction costs are underestimated for many times and rarely be overestimated.

Basic principle no. 3:

Cost accuracy is essential depending on the data basis , the effort for cost estimation and the experience of the cost planner. The appraisal of project risks belongs to the experience of the cost planner.

Basic principle no. 4:

The quality of the data basis for the cost estimation is essential influenced by the degree of project information and the degree of project definition done by the owner. The degree of project information and project definition is in the beginning of a project very small and became more concretised within continuing the project phases of conception and planning. The degree of project definition describes scale and quality of the owner's decisions.

Basic principle no. 5:

As higher the degree of definition is, as lower is the possibility to have influence on the costs.

7. Subject of Research

Within this paper, it was demonstrated that:

- There is less available information about frequency and amount of construction cost escalations in Germany.
- Nevertheless, there is much evidence, that construction cost escalations are a big problem and of high relevance for the construction and real estate industry.
- The consequences of construction cost escalations could be decisive for success or failure of a construction investment.
- Construction cost estimation is afflicted with fuzziness. By creating the budget, the intention must be to assess this fuzziness as exactly as possible.
- There is a natural interrelationship between construction cost escalation and its causes.
- To know cost increasing factors, it is possible to avoid or assess them.

The objective of this research is to develop a systematic to evaluate the accuracy of different building construction cost estimations from project initiation to completion of construction. Subject is the building construction with a focus on office and administration buildings of a private owner. User of this systematic could be all construction involved people, which are responsible for construction cost planning – owner, architect, project controller. As a practical result, the application of this evaluation systematic is to have a statement about the accuracy of a cost estimation. The user will have an overview, which special components (cost increasing factors) of his cost estimation are of (high) potential for cost increases. On the one

hand, this would be a guideline by a precise budget definition. On the other hand, it would be possible, to force up cost certainty by appropriate counteractive measures.

First step of this research was to explore the causes of construction cost escalations and to specify the essential cost increasing factors. This was and is done by an analysis of national and international literature; examination of approx. 30 already assessed construction projects in Germany and expert interviews. Based on the knowledge about the causes and their influence to construction cost escalations, a systematic to evaluate these cost increasing factors must be developed.

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