



Creative Construction Conference 2014, CC2014

Errors in the preparation of design documentation in public procurement in Poland

Michał Juszczak, Renata Kozik, Agnieszka Leśniak, Edyta Plebankiewicz, Krzysztof Zima^{a,*}

^a*Institute of Building and Transport Management, Tadeusz Kościuszko Cracow University of Technology
Warszawska 24 St., 31-155 Kraków, Poland*

Abstract

The system of construction design completion most frequently used in Poland is the traditional one. In this system, the client describes the subject of the order by means of design documentation and technical specifications of construction and commissioning of building works. The article analyses the most frequent errors that appear in design documentation, discusses the reasons for their occurrence and specifies their possible consequences.

© 2014 Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license

(<http://creativecommons.org/licenses/by-nc-nd/3.0/>).

Peer-review under responsibility of the Diamond Congress Kft.

Keywords: design documentation; public procurement; construction

1. Introduction

The basis of an appropriate bidding procedure concerning construction works is the correct preparation of documents describing the subject of the order. In the case of orders involving public funds, the client must obey the relevant regulations, especially ones specified in the Public Procurement Law [1]. Although the regulations came into force years ago and even though there exist numerous master documents, clients continue having problems with an appropriate preparation of design documentation describing the subject of the order. As a result, a number of issues ensue on both the bid preparation and project completion stage. In many countries extensive researches on problems with an appropriate preparation of design documentation were carried out [2-4].

* Edyta Plebankiewicz. Tel.: +0-048-628-2330; fax: +0-048-628-2330.

E-mail address: eplebank@izwbit.pk.edu.pl

The aim of the article is to analyse the errors that occur most often in describing the subject of the construction order when the client separates the design contract from the construction works contract.

2. The scope of design documentation

Construction works consist of two stages. The first involves designing the building, while the second embraces works execution on the basis of design documentation.

In the traditional form of construction works completion, the design stage is separated from the construction one. In this case, the investor first orders designing a project and then, when the design is ready, execution of works. In the other form, one contractor is entrusted with both design preparation and construction completion (Design & Build). Both systems are described in the Polish law [1], as the possible ways of contracting construction designs in the public sector.

The traditional system of completing construction works designs is the most popular and most commonly implemented one [5] In Poland as many as 99% of public investments are done within this system. Here the client describes the subject of the order by means of design documentation and technical specification of construction and commissioning of building works.

The scope and form of design documentation are regulated by the Regulation of the Minister of Infrastructure from 2nd September 2004, concerning the detailed scope and form of design documentation, technical specifications of construction and commissioning of building works and the functional-utility program (Journal of Laws No. 202, pos. 2072) as amended (subsequent amendments of 22nd April 2005, Journal of Laws No. 75, pos. 2075, of 23rd April 2010; Journal of Laws No. 72, pos. 464 and of 18th February 2011, Journal of Laws No. 42, pos. 217).

The scope of design documentation differs depending on whether or not it is necessary to obtain a building permit. In the case of the necessity of a building permit, design documentation consists of a construction design which includes the specificity of construction works, detailed designs, bill of quantities of the works, as well as the information about safety and health protection, when its compilation is required by separate regulations.

3. Errors in construction and detailed design projects

The content of a construction design, as it is required in Poland, was defined by the Act on the Construction Law. The Act mentions only the construction design, which is necessary to prepare when one needs to obtain a building permit. The construction design should contain the following: land or plot development plan, architectural and construction plan, specifying the function, form and construction of works in question, their energy and ecology performance, also including suggested technical and material solutions.

In accordance with the needs, the design may also contain declarations about ensuring a supply of energy, water, heating and gas, sewerage; statements about the conditions of connecting the building object to systems of water supply, sewerage, heating, gas, electroenergetic, telecommunication and roads; a declaration about the possibility to connect the plot to a public road; a geology engineering report and geotechnical conditions of foundation of a building object.

The aim of the detailed design is to complement and provide details to the construction design to the degree necessary to formulate the bill of quantities of the construction works, an investment cost estimate, to prepare a bid by the contractor (in the form of a tender cost estimate) and to facilitate the subsequent execution of the construction works. In sum, the detailed design is prepared in order to complete the works.

Errors in the preparation of designs, in both the construction design and the detailed design, are an inseparable part of preparing a construction investment and, unfortunately, they tend to occur frequently. A simple definition of a design error is "a deviation from the plans and specifications" [6].

An analysis of errors committed in designs reveals a possibility of dividing them into categories according to the place of their occurrence: technical description, engineering drawings, calculations. Another categorisation is one according to the person: investor, architect, discipline-specific designer. Categorisation according to the type of error includes: discrepancy in the design, discrepancy within design documentation, lack of information, incorrect or incomplete information, errors in designing. The most frequent errors in construction and detailed designs in public procurement in Poland were included in Table 1. All the errors were categorised in accordance with the type of error, its place of occurrence and the person responsible for the appearance of the error.

Table 1. The most frequent errors in designs.

Error groups	Person responsible			Place of error in a design
	Investor	Architect	Discipline-specific designer	
<i>Discrepancy in the design</i>		Discrepancy between technical description with drawings		<i>Technical description</i>
		Discrepant information in individual design disciplines		<i>Technical description, drawings</i>
<i>Discrepancy within design documentation</i>	Discrepancy between the design's bill of quantities			<i>Drawings</i>
		Discrepancy between the design's technical specifications		<i>Drawings</i>
<i>No information</i>		No information required		<i>Technical description</i>
		No dimensions in drawings		<i>Drawings</i>
		No detailed information about technology or materials		<i>Technical description, drawings</i>
		No design assumptions	Excluding data, i.e. load, ground conditions	
<i>Incorrect or incomplete information</i>		Incorrect or incomplete description of elements		<i>Technical description</i>
		Incorrect dimensions in drawings		<i>Drawings</i>
		Incorrect design assumptions		
<i>Errors in designing</i>		Incorrect description of materials		<i>Technical description, drawings</i>
		Discontinuity of the elements designed		<i>Drawings</i>
		Lack of required elements		<i>Drawings</i>
		Discrepancy between elements designed and law, standards, rules of art		<i>Drawings, Calculations</i>
		Errors in calculations		<i>Calculations</i>

There exist a few main factors which cause errors to occur in designs. They include the following: designers' lack of construction knowledge or experience, lack of time to prepare a high-quality design documentation, working on two-dimensional documentation which hinders design verification, lack of coordination between subjects, wrongly defined or imprecise scope of duties, human errors.

4. Errors in bill of quantities

The requirements concerning the bill of quantities, which constitutes the description of the subject of a public procurement on construction works, are specified in the Regulation of the Minister of Infrastructure of 2nd September 2004 on the detailed scope and form of design documentation, technical specifications of construction and commissioning of building works and the functional-utility program (Journal of Laws No. 202, pos. 2072 as amended). According to article 6, section 1, "A bill of quantities of construction works should contain a list of basic works predicted to be completed in the technical order of their completion together with their detailed description or

indication of the basis establishing a detailed description and indication of appropriate technical specifications of construction and commissioning of building works, with the calculated and listed bill of quantities items of basic works". As the article states, the bill of quantities of construction works should include the following: the title page, an index of the sections of the bill of quantities and a table of the bill of quantities. The information that should be included in the individual sections of such a compilation is listed in Table 2.

Table 2. The contents of the bill of quantities (BOQ) of construction works

elements of BOQ	Information required in the given element of the bill of quantities (BOQ)
Title page of BOQ	1) name of the order given by the client; 2) depending on the scope of construction works specified by the subject of the order – names and codes: a) works groups, b) works classes, c) works categories; 3) address of the construction object; 4) name and address of the client; 5) date of the BOQ completion.
List of BOQ sections	1) division of all works in a given construction object into work groups according to CPV; 2) further division of the BOQ according to the taxonomy established individually or taxonomy employed in publications concerning standard cost-estimates of non-cash outlays; 3) in the case of works involving multiple construction objects, the list of sections should additionally include the division of the whole investment into construction objects – the work group concerning ground preparation should constitute a separate section of the BOQ for all of the objects.
Table of BOQ	1) BOQ items related to basic works; 2) numbers of the BOQ items; 3) codes of BOQ items, specified according to the taxonomy of works established individually or on the basis of publications concerning standard cost-estimates of non-cash outlays; 4) numbers of technical specifications of construction and commissioning of building works including the requirements for individual BOQ items; 5) names and descriptions of BOQ items, and calculations of the number of units of measure for BOQ items; 6) units of measure concerning the particular BOQ items; 7) number of units of measure for the particular BOQ items.

Errors committed in the bill of quantities can be classified as follows: formal errors and calculation errors. Formal errors – relating to the discrepancy between the bill of quantities as part of the design documentation describing the subject of the public procurement for construction works and the requirements of the Regulation mentioned above. A synthetic compilation of formal errors that occur in the bill of quantities are presented in Table 3.

When considering the reasons for which formal errors occur, one needs to take into account such aspects as: lack of knowledge or experience of the people preparing the bill of quantities documentation, especially their poor knowledge of public procurement laws and regulations concerning the bill of quantities of construction works; incoherency of construction designs, detailed designs and technical specifications of construction and commissioning of building works.

Table 3. The content of the bill of quantities (BOQ) of construction works

Elements of BOQ	Formal mistakes
Title page of BOQ	1) providing erroneous CPV codes of works;
List of BOQ sections	1) a free division of all construction works into BOQ sections, failing to divide works into groups according to CPV;
Table of BOQ	1) no reference to technical specifications of construction and commissioning of building works containing requirements for the particular BOQ items; 2) erroneous reference to technical specifications of construction and commissioning of building works containing requirements for the particular BOQ items; 3) lack of calculation formulas – providing only the final numbers of BOQ units of works.

Calculation errors occur in the discrepancy between the number of works calculated and included in the bill of quantities and the actual numbers that result from the technical documentation. When considering the reasons for which calculation errors occur, one may distinguish the following factors: the quality of construction designs and detailed designs – design errors are transferred to the bill of quantities; human errors – resulting from a large number of necessary calculations, the complexity of the calculation formulas and their laboriousness.

The bill of quantities should be in the form of a document that, to a large extent, facilitates the preparation of a bid compatible with the Regulation article 4 section 3, if the order for construction works “is granted as a single source procurement or, in the essential decisions of the contract, a lump-sum remuneration was agreed on, design documentation may not include the bill of quantities of the construction works”. As a result, the risk involved in the

preparation of the bill of quantities and the possibility of errors which may occur in the calculation of the number of works is taken by the potential contractors, not the client.

5. Errors in the information about safety and health protection

The duties of the designer involve, according to the Act of 7th July 1994, Art. 20, sec. 1, pt. 1b of the Construction Law, Journal of Laws of 2003 No. 80, pos. 718, preparation of the information concerning safety and health protection (referred to as “information”) related to the specificity of the building object’s design which will be included in the safety and health protection plan. Thus the information in question is essential to prepare such a plan by the construction manager, whose duty is to prepare it himself or to have it prepared in such a way that the plan contains the specificity of the building object and the conditions of conducting the construction works, including the planned simultaneous construction works and industrial production.

The designer’s duty also includes the preparation of information for each investment for which a construction design is done. The safety and health protection plan is indispensable to be granted a building permit or a separate decision approving a construction design (Art. of 35 sec. 1 pt. 3 of the Construction Law). In addition, information concerning safety and health protection must be prepared in the case of the need to obtain the final decision about a demolition plan when the application includes a plan of the building object demolition.

The relevant authority that issues building permits, before granting permission or approving on a construction design, has to verify the completeness of the design, the required opinions, agreements, permits, verifications and the information about safety and health protection.

To preparation of the information is based on the construction design. The scope of the information is specified by article 2 of the Regulation of the Minister of Infrastructure of 23rd June 2003 on the information about safety and health protection, as well as the safety and health protection plan (Journal of Laws of 2003 No. 120, pos. 1126). The information about safety and health protection consists of the above-mentioned Regulation, a title page and a descriptive section.

The title page includes: the name and address of the building object, the full name or name of the investor, together with their address, and the full name and the address of the designer who prepared the information. The descriptive section, according to article 2 pt. 3, contains the following:

- the scope of the works for the whole construction project and the order of completing individual objects;
- a list of the existing building objects;
- indication of the elements of land or plot development that may pose a danger to people’s safety and health;
- indication of possible danger existing during works completion, specifying the degree and types of danger, its place and time of occurrence;
- indication of the way employees are instructed before the beginning of particularly dangerous works.
- indication of technical and organizational means preventing the risks that result from the conduction of construction works in places posing particular danger or in their neighbourhood, including those that ensure safe and efficient communication facilitating quick evacuation in case of fire, breakdown or other dangers.

The basis of an appropriate preparation of the information is the knowledge of the requirements concerning safety and health protection as described by the law, in particular, in the act of 26th June 1974 Labour Code (Journal of Laws of 1974, No. 24 pos. 141), the Regulation of the Minister of Labour and Social Policy of 26th September 1997 on the general health and safety regulations (Journal of Laws of 2003, No. 169 pos. 1650), the Regulation of the Minister of Infrastructure of 6th February 2003 on health and safety on construction sites (Journal of Laws of 2003, No. 47 pos. 401), the Regulation of the Minister of Economy and Labour of 20th September 2001 on health

and safety while working with machines and other technical devices for earth, construction and road works (Journal of Laws 01.118.1263) and a number of other health and safety regulations.

The lack of knowledge of the health and safety regulations, lack of experience and inaccuracy may be the source of errors in the prepared safety and health protection information. The particular errors that may occur include the following:

- failure to indicate all the elements of land development which may endanger people's health and safety;
- incomplete specification of possible risks which may arise during construction works;
- incorrect specification of the degree and types of danger, or the place and time of its occurrence;
- incomplete specification of technical and organizational means preventing risks that result from the construction works in places posing particular danger or in their neighbourhood.

6. Errors in technical specifications of construction and commissioning of building works

Technical specifications of construction and commissioning of building works are the basic document describing the subject of the order on construction works. Public investors are required to prepare it in accordance with the Act on Public Procurement Law (article 31). The scope and the general rules of its preparation are included in the Regulation of the Minister of Infrastructure of 2nd September 2004 on the detailed scope and form of design documentation, technical specifications of construction and commissioning of building works and the functional-utility program (Journal of Laws No. 202 pos. 2072). The Regulation defines technical specifications of construction and commissioning of building works as documents containing sets of requirements which are essential to specify the standard and quality of construction works, the way the works are completed, the performance of a construction products and the evaluation of the execution of individual works.

Correctly prepared specifications are used as:

- tender document – specifying the scope of activities and works indicated in the particular bill of quantities item, allowing to correctly establish the unit price of this item, as described by the tenderer taking part in the bid;
- contractual document – which is an appendix to the contract signed by the client and the contractor (specifies what the investor expects from the contractor as the end result and the way correctness can be verified at building commissioning);
- detailed design document – which holds for the contractor and the investor's supervisor while inspecting and commissioning of works.

According to the above-mentioned Regulation, each technical specification should contain at least 10 items:

1. the general part;
2. requirements concerning the performance of the construction product;
3. requirements concerning the equipment and machines used for construction works;
4. requirements concerning means of transport;
5. requirements concerning the qualities of the execution of works.
6. inspection, testing and commissioning of construction products and works;
7. requirements concerning the bill of quantities and the quantity survey;
8. commissioning of works;
9. works settlement;
10. reference documents.

This way of creating a specification allows to embrace all the basic issues that are essential to the correct process of construction and commissioning of works.

Technical specifications of construction and commissioning of works have been present on the Polish market for a considerable amount of time, and in the domain of public procurement there is an obligation to prepare them regardless of the value of the order. Yet despite the existence of guidelines regarding their preparation, numerous ready-made master documents or the availability of computer software, such as the SEKO-spec, which facilitates the preparation of the specifications, irregularities and errors continue to be committed by designers preparing this part of documentation. Table 4 depicts the most frequent errors occurring during the preparation of the specifications.

Table 4. The most frequent errors occurring in technical specifications (own study)

Type of error	Description
Incorrect layout of the specification	Failing to adjust the specification to the form imposed by the Regulation. Authors often fail to include the 10 obligatory items, intentionally omitting some or changing their order, names and contents.
Incompatibility of the specifications with the standards and other documents	Invoking outdated standards and laws. Incompatibility between the general detailed specifications caused by the lack of communication between their authors. Incompatibility of specifications related to activities and works included in the particular bill of quantities items.
Copying the records of other documents and of open-access information	Copying parts of the binding standards, technical approvals, records of master specifications or other public materials. Providing irrelevant information concerning, for example, the function of an element, while it is the method of its construction that is important.
Indicating particular products, brands of products, etc.	Providing the names, brands or too detailed descriptions pointing to the producer hinders competitiveness of bids from several tenderers basing on different but fully equal materials and technologies of works execution. Only the parameters and conditions relevant to the elements predicted in the design should be mentioned.
Failing to indicate the requirements that a constructed element should meet	This error might suggest that the contractor is not responsible for the end result, but should only ensure that works execution is conducted according to the technology indicated in the specification, using the relevant materials mentioned there.
Unclear and imprecise wording	Such wording as "it is advised" or "it is desired" may lead to a disagreement between the contractor and the orderer, consequently causing problems at works commissioning.

Errors frequently make specifications unreadable and, in some cases, useless. They definitely hinder any practical application of the specifications. An erroneous specification, instead of complementing the design documentation with essential detailed descriptions of the required execution, commissioning or works settlement, may convey unclear, unnecessary and often misleading information. This may lead to contractors' protests which often delays the beginning of works. Correctly prepared specifications are extremely helpful not only at the contractor selection stage, but also at the stage of investment completion and works commissioning. However, investors too often underrate their importance, treating them as an additional formal requirement.

7. Consequences of errors in the subject of the order

The consequences of errors in the description of the subject of the order are taken by the client as early as at the bidding procedure stage. Contractors willing to prepare their bid correctly ask many of questions. Therefore, in order to receive an insight into the problems associated with the preparation of the bid, the results of construction works contracts announced by the authorities of chosen cities in 2010-2011 were analysed [7]. The analysis involved the structure of questions based on the proceedings conducted in Krakow and Szczecin (in total 270 questions). Figure 1 presents the structure of the questions.

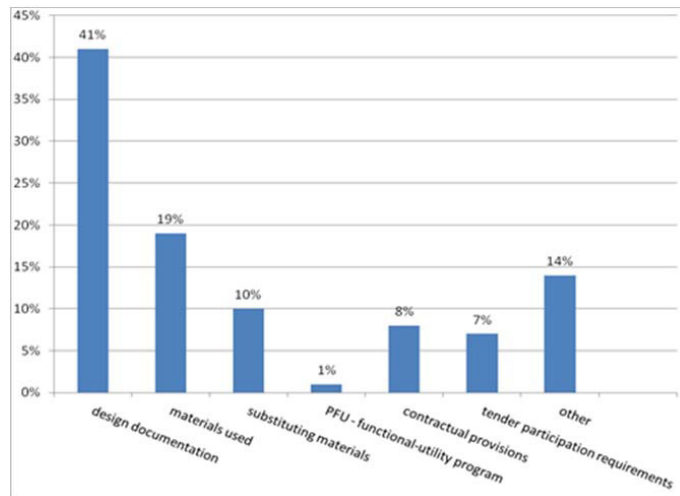


Fig. 1. The structure of the questions (proceedings conducted by the Municipality of Krakow and the Municipality of Szczecin)

A significant number of questions involved project designs (41% of questions). Many of them asked about the building materials to be used. They included requests for more precise statements about the client's requirements concerning materials and questions about possibilities of using substitutes, which may be seen as the consequence of imprecise descriptions of these elements in the documentation.

Since the majority of questions were connected with design documentation, Figure 2 presents the scope of bidders' most frequent doubts associated with the design.

The greatest number of doubts found in questions concerning design documentation occurred in relation to the differences between the design and the bill of quantities of construction works. Bidders also noticed differences between technical specifications and the design. In some cases, the lack of dimensions in the design documentation hindered appropriate pricing and caused bidders' doubts whether the pricing should include those elements. Moreover, bidders indicated the lack of a particular item in the bill of quantities or the lack technical specifications, as well as incomplete information in the detailed design.

It must be emphasised, though, that questions do not necessarily mean gaps or improperly prepared documentation. Questions may just as well result from contractor's ignorance or the willingness to enforce the postponement of tender submission. What indicates that contractors' questions are valid and that the proceedings have been correctly prepared is, to a large extent, the necessity to introduce changes to the documentation. On the other hand, the need to introduce numerous changes to the documentation may cause tender submission postponement or, in extreme situations, cancelling the proceedings.

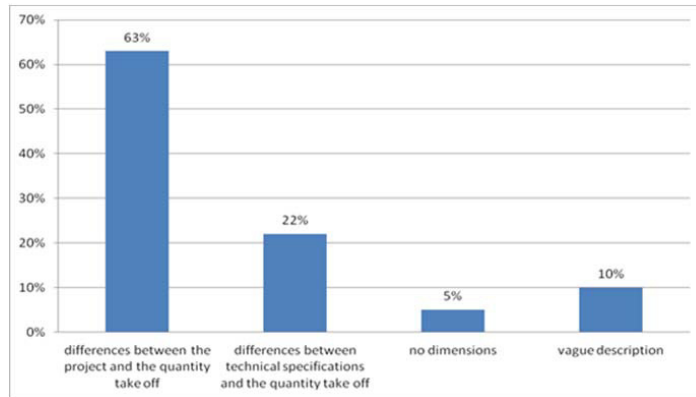


Fig. 2. The structure of questions concerning design documentation

Changing or complementation of documents took place in about 31% of all proceedings and in about 90% of those in which questions were asked. This indicates that contractors' questions almost always lead to the introduction of changes. Changes in tender documentation involved completing the bill of quantities, adding drawings, changing and completing technical specifications, changing and completing significant terms and conditions of the tender, and changes in contractual provisions.

The most frequent and the most serious consequences of mistakes in design documentation at the stage of completion of the investment include the following:

- suspension of works until design changes are ready or discrepancies in technical documentation are clarified;
- increase in the contract value due to additional and complementary works when the scope and type of works have changed;
- a threat to workers' health and life.

8. Summary

A correctly prepared documentation that bidders receive in tender proceedings is a condition of the contractor's submission of a tender that fulfils the client's requirements.

The article indicates the errors that appear most frequently in design documentation and technical specifications of construction and commissioning of building works. An attempt has been made to evaluate the reasons of error occurrence and enumerate their possible consequences. When more attention is paid to the preparation of the documents by reliable designers, the client may avoid spending time and resources on the introduction of necessary corrections.

References

- [1] Act on Public Procurement Law of 29th January 2004.
- [2] Love, P.E.D., Lopez R. & Kim J.T. (2014). *Design error management: interaction of people, organisation and the project environment in construction*, Structure and Infrastructure Engineering: Maintenance, Management, Life-Cycle Design and Performance, 10(6), pp. 1-10.
- [3] Lopez, R. & Love, P. (2012). *Design Error Costs in Construction Projects*, Journal of Construction Engineering and Management, 138(5), pp. 585 -593.
- [4] Dosumu O.S. & Adenuga O.A. (2013). *Causes, effects and remedies of errors in nigerian construction documents*, Organization, Technology and Management in Construction. An International Journal, 5(1), pp 676-686.
- [5] Harris, F., McCaffer R. & Edum-Fotwe F. (2006). *Modern Construction Management*, 6th ed., Blackwell Publishing.

- [6] Suther, G. N. (1998). Evaluating the perception of design errors in the construction industry, University of Floryda.
- [7] Kozik, R. & Plebankiewicz, E. (2013). *Bid documentation in public procurement in Poland*, Organization, Technology and Management in Construction - An International Journal, 5(1), pp. 712 – 719.