Infography use to requirements specification for the design of the building

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Abstract. The study contributes to a growing body of research Transport infrastructure in construction object life cycle management and presents areas in which further investigation is needed. The object of study are Railway buildings and structures and the Employer's information requirements (EIR) for design of individual residential building. The task of the study was to determine necessary and sufficient scope of parameters which contained in infographic form of EIR comparing with traditional text form of EIR. Also, the task was to determine what categories of the traditional EIR are transferred to an infographic representation form and what categories are ignored in case of a relatively low complexity building. Methods that have been used in the study were infographical representation of text and further expert evaluation. Conclusions of the study present the necessary and sufficient scope of parameters for infographic form of EIR, the relations between infographic parameters and categories of the EIR traditional form and subcategories of the traditional EIR that are ignored in case of a relatively low complexity building.

1. Introduction.

The trend to consider the construction object (CO) within its full life cycle (LC) sets the task of allocating the necessary and sufficient data set for each stage of the CO LC that should be contained in the building information model (BIM) [1, 2].

There are several approaches to divide a life cycle of construction object into stages. One of them is on the base of a party which leading role is more significant during the lifecycle [3]. Another one such as the MacLeamy Curve, shows efforts and energy costs to develop and maintain the object of construction [4]. There is an alternative way to describe life cycle of a building [[5]].

There is a well-known approach based on quality forms and changes of CO during its LC. Therefore, LC could be divided on the stages as follows:

- Pre-design (concept design) stage
- Design stage
- Procurement and Fabrication stage
- Stage of Construction
- Operation and maintenance stage
- Retrofit and Renovation stage
- Demolition and Recycling stage [5]

It is proposed to allocate seven stages of a construction object life cycle, then to provide information support and management of the construction object by a specified set of databases that are connected
via product life cycle management (PLM) system that leads to the construction object domain knowledge base. [7] As seen in figure 1, there are 37 databases in 12 categories which contain information about CO during its LC. It has to be outlined that decisions made in the earliest stage of architectural design have the greatest impact on the construction, lifecycle cost and environmental footprint of buildings. Yet the building services, one of the largest contributors to cost, complexity, and environmental impact, are rarely considered as an influence on the design at this crucial stage. [8]

The earliest stage of architectural design refers to "Pre-design (concept design)" stage and of the database lists mentioned in figure 1.

**Stages of a construction object (CO) life cycle (LC)**

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![Diagram](image-url)

**Figure 1.** Pre-design stage of CO LC consists of 6 categories of databases.

One of the most crucial information at this stage is the employer's wishes and requirements toward a CO. Such an information could be found in Terms of Reference (TOR), in Requirements specification, in Employer's requirements (ER) and Employer's information requirements (EIR). This group of terms has been put as EIR further in the study.

The EIR defines the information that will be required by the employer from both their own internal team and from suppliers for the development of the project and for the operation of the completed built asset. Relevant extracts from the EIR are included in procurement documents for the appointment of each supplier appointed directly by the employer, which may include; advisors, consultants, contractors and so on. ER and EIR set out the information required by the employer, enabling suppliers to produce BIM execution plan (BEP) [7].

The level of detail in the employer's requirements and the extent of design required from the contractor is very variable. Employer's requirements can range from a very simple specification to a fully developed performance specification and concept design. There is no specific GOST (government standard) for these documents and every professional group or corporation has been working out its own set of data in accordance with state laws and GOST. Implementation of information technologies all over the world has started the process of collapsing traditional text into image. The tendency is occurring in all spheres of human activity including construction design. One of the name of the tendency: information visualization. [9].

In terms of EIR it gives: universalization of submitting the design documentation (the ability to submit it within different cultures and languages), reduction of time to familiarize and percept the data and unambiguous perception of information in global information society. The task of the study was to determine necessary and sufficient scope of parameters which contained in infographic form of EIR comparing with traditional text form of EIR. Also, the task was to determine what categories of the
traditional EIR are transferred to an infographic representation form and what categories are ignored in case of a relatively low complexity building (an individual residential house).

The task was given to four groups of postgraduate students of Moscow State University of Civil Engineering. Total number of participants: 64 persons. They had to work out the EIR to design of individual residential house, acting as an employer. Then their works had been analyzed to find dispersion of EIR parameters and to determine the principal basis of Pre-design stage information of CO LC. The reference text form (traditional EIR) to compare results was the EIR for construction design taking from one of the government organizations.

2. Methods.
One of the methods is to change the modality of information while the task retains the same. It can be done with the help of infographics. Infographics is a general theoretic science on the life cycle of a document in reprographics. Also, infographics is a methodological foundation of designing systems and consulting technical means of image visualization in informational technologies. [[10], [11]]

Another method was an expert evaluation. Expert evaluation method utilizes the knowledge of user experience professionals in evaluating ER or EIR for the design of the building. Compared to user studies, expert evaluation is often easier to arrange. Experts can also evaluate “difficult” material such as product specifications or early prototypes with many technical problems. Basic problems can be avoided by conducting an expert evaluation before a more expensive user study. [[12], [13]].

3. Results.
The reference text form of the EIR contained 52 parameters in 3 categories on 19 pages of text: General data (16 parameters), Main requirements to design solutions (25 parameters), Additional data (11 parameters). As seen in the figure 2, the whole amount of parameters of the traditional EIR text form is counted as 100%.

![Figure 2](image)

**Figure 2.** The fluctuations of visual parameters of the infographic EIR.

From the infographic point of view, the optimal EIR for CO design is presented on the figure 3. It has contained 44.2% of parameters of the traditional EIR text form. The values of all EIRs ranged in the interval from 34.6% to 50.0% with the average figure as 42.8% (with the notice of trend line).
As seen in figure 3, there is no information about security, finance, energy-efficiency, ecology, legal base documents, names of contractors/subcontractors, tender matters, design management. However, parameters of security, finance and energy-efficiency are presented in other infographic EIRs made in the frames of the study.

Expert evaluation of the infographic EIR has determined there are the following relations between infographic parameters and categories of the EIR traditional form:

- General data contains 62.5% of traditional form
- Main requirements to design solutions contains 44% of traditional form
- Additional data contains 18% of traditional form

Information visualization of the EIR data on the base of infographic approach contains necessary and sufficient scope of parameters to fulfill design of CO and it can reduce the size of the EIR document up to 9.5 times comparing with traditional text form document. It helps to submit the EIR without translation within different international design teams and reduce time to familiarize and percept the data in the EIR for design of CO.

This approach corresponds with the Integrated Design Process (IDP). IDP is a method of intervention in early stages of the design process that supports the development and design team to avoid sub-optimal design solutions. IDP is not a new concept, and may in fact have been applied in the past by some design teams on an ad-hoc basis. [14].

Also, the same visualization approach might be applied to optimize other data of Pre-design stage of CO LC and determine necessary and sufficient set of parameters of databases structure. This would make future LC construction object domain knowledge base more sustainable. To confirm this assumption, further studies are needed [15, 16].

4. Conclusion
1. The necessary and sufficient scope of parameters which contained in infoaphic form of EIR has been determined as 42.8% of traditional EIR text form.
   Information visualization of the infographic EIR form can reduce the size of document up to 9.5 times comparing with traditional text form document.
2. The relations between infographic parameters and categories of the EIR traditional form are as follows: General data contains 62.5% of traditional form; Main requirements to design solutions contains 44% of traditional form; Additional data contains 18% of traditional form. If these conditions are met, it helps to submit the EIR without translation within international design teams, it gives the reduction of document size and of time to familiarize and percept the data in the EIR for design of CO.

3. The following subcategories of the traditional EIR were ignored in case of a relatively low complexity building (an individual residential house): ecology, legal base documents, names of contractors/subcontractors, tender matters, design management.

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