DSTU business center construction project management using energy-saving and information BIM technologies

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Abstract. The article is devoted to the analysis of the possible ways to implement the construction project of the DSTU business center within the framework of the DSTU development program as a “university of the future” using the energy-saving technologies and information modeling. The main goals and objectives of the project are outlined. The article presents the financial scheme of the project, as well as the ways of its successful implementation. The measures and technologies to improve the energy efficiency of the building at all life cycle stages are considered. The social and economic effects that can be obtained when creating a BIM model of a business center building at the operation stage and further use during the operation phase are given. The article contains an analysis of the financial costs associated with the operation phase of the building. The study presents the expected results from the project’s implementation, taking into account the energy-efficient and information technologies’ use.

Introduction
As a part of the Don State Technical University (hereinafter - DSTU) development program, an investment project of DSTU “Campus D4” (hereinafter - the project) was developed on the basis of the university. The goal of the project is to create a comfortable high-tech environment for the university functioning, contributing to the effective development of technologies in the production promising areas, training of highly qualified personnel for the labor market of the Rostov-on-Don city and the Rostov region.

The main objective of the project is to ensure that DSTU targets are in line with the best world higher education institutions and enter the list of 100 best universities (Ratings QS – World University Rankings, Times Higher Education, World University Rankings, Social Sciences Research Network). [1]

Materials and methods
The basis for the project’s development was the project proposal for the DSTU main campus site’s development, located in Rostov-on-Don (Gagarin sq., 1). The planned zoning of the campus includes a training, educational and scientific-innovative zone, a business zone, a socio-cultural, sports and recreational zone. [2]

According to the financial scheme of the project, the cost of its implementation is 8 billion rubles, the duration of the project is 4 years. The sources of project’s financing are the investor funds in the amount of 30%, which is 2,400 million rubles, 70% - creditor funds in the amount of 5,600 million
rubles. To obtain the credit funds from a budgetary educational institution within the framework of the project, it is necessary to create an SPV company (special purpose vehicle – a special-purpose company that serves exclusively for the purpose of implementing the project). The planned loan term is 10 years. An increase in the loan term will be followed by an increase in the borrowed resources by 0.5% per annum every 2 years.

1. CONCESSION AGREEMENT

2. SOURCES OF PROJECT FINANCING

3. BORROWER

4. LOAN TERMS

Figure 1. The financial scheme of the investment project

Thus, the obvious need for the funds availability that will pay off credit debt on time or earlier. To obtain the financial resources, the construction project for the DSTU business center is developing. The center is designed for practical work of students, and the free space allocated for rent will allow to earn income to pay off the credit debt.

In order to derive maximum benefit from the structures’ operation, it is necessary to increase its effectiveness, for example, by creating an information model of the building. The creation and use of the BIM-model makes it possible to speed up the development and design process, reduce the time it takes to complete the work, and also directly monitor the construction process: from the pre-design stage to the immediate work at the construction site. The model dynamically changes simultaneously with the building throughout the life cycle, including at the stages of operation and demolition. So, with the development of the model together with the object, it is possible to achieve the maximum benefit from its use at all stages of the building’s life cycle. [3,4]

The information model’s advantage is the possibility of applying an integrated approach to its use: the architectural, constructive, technological, estimated parts of the project are combined with the issues of providing the engineering equipment, transport infrastructure, logistics and other sections necessary for a particular project. Due to this, a number of errors in the design is reduced, the time for preparation and production of work is reduced. [5,6]

Figure 2 shows the building information model created for the project. BIM-model will save money on the operation phase, the most expensive stage of the building life cycle due to the reduction of the planning time for repair work, reducing the number of errors in the design and on the construction site. Time, labor and material resources are saved from 10 to 30%, which indicates the positive social and economic effects of the model’s implementation [7].

From the point of view of energy consumption, the operation phase is the most expensive: up to 90% costs are accounted for by operation, in the production of building materials and structures, about 8% of money is consumed, in the construction process - 2%. From the standpoint of a likely increase in the degree of energy efficiency in construction, the main role belongs to the design and construction stages, the final result of which is manifested in the socio-economic effect during the building’s operation [8].
Figure 2. Information model of the DSTU business center

Figure 3. DSTU cost structure for utility bills in 2019

The most expensive expense among DSTU utilities is the electricity payment, which implies that it is advisable to use energy saving technologies during the business center construction, which will save resources and help to reduce the cost of paying for electricity, which is necessary as part of the funds’ collection to pay off the loan debt.

To improve the energy efficiency of the DSTU business center building within the framework of the project development, a decision was made to install the energy-saving equipment.

1. Solar panels. The use of solar panels during operation will reduce energy costs by 30-40% [9].

2. Energy efficient elevators. Energy-efficient elevators reduce the cost of operating a building, significantly saving energy throughout the elevator operation. The drives help to reduce the two main factors affecting energy costs - peak load and power consumption. In fact, a fully loaded elevator car moving down can transfer a significant energy fraction to a nearby elevator lift. The amount of electricity saved due to the recovery depends on various parameters of the system, namely: cab loading, speed, lift height, passenger flow diagram and system efficiency.
The cost of installing the elevators with innovative solutions is 7.8% higher compared to the conventional two-speed elevators, but the resulting energy-saving effect covers the costs of the early elevator operation’s periods.

|                      | Conventional two-speed elevator | Frequency-controlled | Frequency-controlled and regenerative motor |
|----------------------|---------------------------------|----------------------|--------------------------------------------|
| Elevator Cost        | 720 000                         | 986 000              | 968 000                                    |
| Electricity consumption per year, kW / h | 11 680                          | 7 008                | 2 920                                      |
| Energy saving per year, kW / h | 0                               | 4 672                | 8 760                                      |
| Energy saving per year on 1 elevator (rubles) | 0                               | 19 155               | 35 916                                     |
| Energy savings per year per 100,000 elevators | 0                               | 1 915 520 000        | 3 591 600 000                              |

**Figure 4. Elevator Power Consumption**

3. Energy efficient double-glazed windows. The main feature of the profile, which is used for the energy-saving windows’ manufacturing, is the presence of more air chambers. It is the air in the chambers that plays the role of a heat-insulating material and prevents the passage of cold into the building.

4. Installation of luminaires with motion sensors. For the rational use of energy resources, the project proposes the use of LED lamps with light and noise sensors SA-700 for lighting stairs, corridors, toilets. The use of motion sensors saves energy by turning on the lighting devices only for the time when the room is not empty, which eliminates the need for wasting electricity. When using light and noise sensors, the lamp operating time is reduced from 24 hours a day to 5 hours a day [10].

Through the above-mentioned energy-saving measures use during the construction of a business center, as well as during the construction of other buildings as a part of the DSTU campus development according to the proposed scheme, it is planned to achieve the reduced costs for utility bills and, as a result, a quick credit’s repayment.

Thus, the result of the energy-efficient technologies use is the achievement of economically viable and reasonable consumption of energy resources based on the latest achievements of science and technology. Reducing heat loss and a reasonable consumption of heat energy gives a possibility to achieve maximum energy efficiency of the building.
**Figure 5.** Comparative dynamics of the DSTU costs while maintaining the existing property complex and with the commissioning of new energy-efficient buildings, rub

**Summary**

Thanks to the introduction of an information model for the DSTU campus business center construction project, there is a decrease in the timing of design work, a reduction in the planning time for repair work, a decrease in the number of errors in the design and on the construction site and the social effect of the introduction of technologies is noted. There is a saving of time, labor and material resources from 10 to 30%. The economic effect of the energy saving technologies’ introduction will save on utility bills, which will also help maintaining the financial resources received from the rental of premises for loan repayments [11].

So, from the above-described it follows that for the university’s investment project’s implementation it is necessary to use an integrated approach that will take into account both the daily needs of building users, comfort and efficiency of their work, and the types of new construction, modern engineering solutions. In particular, the analysis of financial opportunities, which are of prime importance in the project’s formation, should be included in the complex of the issues under consideration [12].

Thus, the positive effect achieved by increasing the efficiency of a single project with the global introduction of information modeling technologies will allow to qualitatively develop the construction field, improve the quality of ongoing reconstruction and construction projects and also lead to a positive effect in the general economic situation in the Russian Federation.

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