Risks on Optimization of Life Cycle of Technology of Installation of Transformed Low-rise Buildings from Sandwich Panels

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Abstract. One of the main issues of development of organizational and technological solutions for the rapid construction of transformable low-rise buildings of sandwich panels (transformable low-rise buildings) is to improve the methods of industrial production through the use of high-performance mechanization. Increase of working capital efficiency, which makes prefabricated transformable buildings of sandwich panels the most attractive technical solutions for the investor-customer and allow you to quickly recoup the investment. Traditional measures of improvement of the organization of processes and specific directions of development of the organization of construction production of (transformable low-rise buildings) in modern conditions are given. We highlight the technological component of sustainability, and the specifics of security in the modern conditions of technological development and increasing innovativeness.

1 Introduction

For such a large country as Russia, with an economy with prospects for development, construction risk issues play a particularly important role. New construction can be viewed as a new product for various purposes, in particular the development of organizational and technological solutions for the rapid construction of transformable low-rise buildings from sandwich panels (transformable low-rise buildings) [1,2]. Raising capital for the implementation of construction projects requires the validity of all financial indicators and the involvement many individuals in the implementation of the investment construction project. Construction is closely related to investment activities given that construction projects require significant start-up capital, and generate future cash flows. Both the investor and the construction company are interested in ensuring that the project brings maximum profit and is expedient for implementation on a number of financial indicators. However, there may be a number of issues on which the interests of participants in the investment process will differ [3-5], potentially resulting in agency conflicts manifesting into construction risks.

Today, in Russia, the risks of investing in the construction of (transformable low-rise buildings) production are characterized by increased complexity of diagnosis, and the risks are much higher than investments in many other sectors of the economy. This puts the

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problem of optimizing the risks of the product life cycle at the forefront in the implementation of many investment projects [1-10].

Despite the importance of the problem of risk optimization, there is no generally accepted definition of the essence of the risk of interaction of participants of the investment process in construction [11-13].

Initially, it is necessary to find out who and at what stage of the life cycle of the construction production project (transformable low-rise buildings) does the risk need to be properly optimization.

In modern Russian construction, some projects are complex and intricate. The introduction of new complex mechanisms of financing the construction projects, there do not see to be a corresponding reduction in the investment and financial risks. Financial and credit mechanisms link the final consumer of housing with the supplier of funds for construction with builders. At the same time, all three parties have their own interests in risk optimization and the authority to deal with this issue [14,16].

Planning determines the order, sequence and timing of risk optimization activities. The risks involved are those that can be identified and assessed prior to the start of the project. Such risks constitute a risk optimization plan, which contains a list of identified project risks, their assessment and processing strategy. In addition, the risk focuses on responsible persons and other control processes that will help optimize the risks [15,17].

Focusing on the methods of risk identification, we can identify many approaches to the classification of risks. According to the common approach of Construction Risk Management System (CRMS) in foreign countries, proposed by American researchers and analysts, the process of risk identification consists of six stages:

- 1) identification of uncertainties;
- 2) preparation of a preliminary checklist;
- 3) consequence scenarios;
- 4) a reflection of risks;
- 5) systematic list of risks;
- 6) total risk.

Optimization of risks includes steps for the selection and implementation of various measures to reduce to the acceptable levels of risks on each dimension of risk. We focus mechanisms to manage risks: 1) acceptance, 2) transfer, 3) mitigation, 4) evasion [18]. The choice of the risk optimization method is based on the qualitative and quantitative assessment of the project risks.

2 Methodology

The methodology of the research is a systematic approach that focuses on the methods of analysis and comparative efficiency of decisions made by the enterprise. We combine methods from mathematics and statistics to develop measurable indicators based on statistical modeling and qualitative expert assessments.

The research methods allow us to rank enterprises based on their capacity for innovative development. The effective optimization of risks and the proper implementation of enterprises help with the critical need to address: 1) increasing demand for transformable low-rise building products, and 2) increasing competitiveness [19-21].

2.1. Development of a new generation of pre-fabricated transformable low-rise buildings

Development of a new generation of pre-fabricated transformable low-rise buildings from sandwich panels should take into account the full life cycle of the system, consisting of: economic calculations, design documentation, organizational and technological solutions, development of capacity, return on investment, and economic impact [22, 25].

Table 1 illusrtates the life cycle described above (from origin to decline) in a graph. Each life cycle phase can be described mathematically depending on the nature of external and internal processes that occur at a particular time interval [23-26].

Table 1. Mathematical functions describing the dynamics of life cycle phases.

Stage of the life cycle	Of a function Symbol	The function Equation	Of the curve that describes the function
Origin	Combined exponential-power function	$Y = e^{at} \times S t^B$
The acceleration of growth	Of the Exponential function	$Y = a \times Se^t$
The slowdown	In the Second function Tornquis	$Y = k (t+a) / (t+B)$
The Maturity	Of The Parabola	$Y = a + Bt - ct^2$
The Decline	Video	$Y = a - Bt$

The life cycle model of the developed systems of a new generation of (transformable low-rise buildings) is presented in the (see table 2).

Table 2. A generalized version of the process life cycle construction of modern transformable low-rise buildings made of sandwich panels

1	Scientific research
2	Concept development
3	Technical study
4	Economic feasibility studies
5	The rationale for the techno-economic estimation
6	Develop a requirements specification
7	The design of the prototype
8	Prototype manufacturing
9	Prototype test
10	Project adjustment
11	Production of a series of samples
12	Test lots of samples
13	Project adjustment
14	Serial production

Concrete measures to create transformable low-rise buildings of a new generation can be solved through folding and sliding structures with unified nodes, with lighter-weight bearing and enclosing structures [27-30].

To optimize the process of installation technology of the transformed low-rise building from sandwich panels, we first develop the option of improving the manufacturability of all construction operations. This option is proposed as a system of high-tech solutions, and is considered not only at the stage of construction, but also in the process of operation, repair, and dismantling, at all stages of the life cycle (LC):

$$M = f (S_{\text{life-cycle}}) + \{S_{\text{ctr}}\} > \max, \tag{1}$$

M - is a model of increasing the technological effectiveness of the construction process,
S_{life-cycle} - stages of the life cycle of the house (transformable low-rise buildings),
S_{CTR} - stages of development and implementation of advanced design and technological solutions.

Such basic technological parameters of fast construction of the transformed low-rise building from sandwich panels as, labor costs and machine-time, cost and duration of works can be considered and estimated as the sum of costs, at the stages of preparation and maintenance, design (C_{pr}) and construction (C_{con}), and at the stages of the life cycle of the maintenance (C_{maint}), repair (C_{rep}), reconstruction (C_{rek}), by means of the following modeling [23]:

$$M(C_{lcc})=C_{\text{prep.design. constr.}}+ C_{\text{cost during. oper. rep. reconst}} + CTR_{\text{des.const. tran.}} \rightarrow \min, \tag{2}$$

where,
C_{lcc} - life cycle costs,
C_{prep.design. constr.} - costs at the stages of preparation, design and construction,
C_{cost during. oper. rep. reconst} - costs during operation, repair and reconstruction,
C_{costs at the stages of dismantling, transportation of} (transform low-rise building).

Taking into account the above on schemes 1, and 2, the scheme of development of the approximate variant of technology of installation of the transformed low-rise building from sandwich panels is shown in Figures 1 and 2).

Fig. 1. Development of an approximate installation technology transformable low-rise building of sandwich panels.

Fig. 2. An exemplary embodiment of parameters of technological schemes for installation of the transformed low-rise building of sandwich panels.

3 Results and Discussion

In the present work, the peopoaws algorithm of formation of the optimal model of technology of rapid construction of low-rise buildings transformed from sandwich panels, improved design and technological solutions for installation of (transform low-rise building) sandwich panels, although not without risks [15-19].

As in the case of design, there are problems in the construction of transformation of low-rise building; for example, the rise in price in the presence of a complex site and the need to install panels with a crane in a small area in the presence of electric wires above the ground presents significant risk.

Transportation of some panels requires special transport, which affects among other things, the budget and requirements for access roads.

4 Conclusions

Compliance with technology to guarantee and facilitate expansion and future scaling of operations, and the complex technology the add to greater risk of any deviations from the standard practice [28-30].It is critical to identify key factors and patterns that affect the risk on the optimization of the technological mode transformable prefabricated low-rise buildings of industrial sandwich panels. These include reducing the complexity and cost of installation from increasing the size, degree of prefabrication and weight of the panels, reducing the complexity of the device joints, reducing the duration of building the number and skills of workers in the unit, and shifting and level of mechanization.

Pre-fabricated technologies are in demand in the developed stable market in the construction of large volumes of standard housing. Taking into account the cultural norms and Russian mentality, today the use of pre-fabircated technologies is more likely possible only in the case of construction of social housing and similar programs with state-dictated conditions. Buyers of business class houses are likely to choose classical construction technologies and are ready to experiment only at the level of finishing, but less likely to compromise on basic building materials.

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