The Level of Influence of Human and External Risks on a Construction Company's Sustainability

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Abstract. The impact human and external risks in construction projects, which significantly affect the production activities and sustainable functioning of construction companies is very relevant. This article describes the human and some external risks affecting the sustainability functioning of construction companies. The authors examined internal risks staff can be exposed, as well as external risks that may affect the work of construction companies, how they are analyzed and evaluated, as well as identified there reasons to increase the competitiveness of contracting companies to manage any potential risks during construction and after operating facility, This will prevent losses and increase company's sustainability in the labor market. This research paper aims at analyzing the impact of human risks, on sustainability and assessing, as well as determining their frequency and the likelihood of occurrence of these risks, their impact on the construction project and on a company. Mathematical and statistical methods as well as algorithms were used in this research. This research indicates that risks of all kinds shall be accurately, determined in addition to indicating the importance of each of them and assessing the likelihood occurrence of these risks. To determine methods and procedures that could decrease the chances of these risks leading to increased construction company's sustainability in the labor market.

1. Introduction

The construction sector is important and can effectively contribute to national development and the fixed capital, GDP and national employment growth. However, the sector is sensitive to changes and influences of different characters. Foreign analysis and domestic experience in developing construction projects over the last 30 years suggests a clear dependence the volumes of production of construction products on the market demand. Nevertheless, as the economic situation of the Russian Federation gradually evolved into a systemic crisis, the industry witnessed a mass liquidation of large construction companies, which caused decline in the number of investment construction projects [1]. Investment conditions in construction projects constantly changing, adjusted constant stream of new conditions and requirements from the relevant government agencies, and the increased competition among companies to work at a decent level and win tenders for construction projects, companies to optimize the quantitative and qualitative characteristics of the labor force, that significantly affected by human and technical risks faced by a project in the implementation process, which requires analysis, the necessary researches and improving
existing approaches to the planning of production activities of labor resources, all this is necessary for the development of companies in the construction sector [2].

The construction and installation process is the key part of implementing a construction project. In terms of time and space, erection technology is key to determine exactly how the construction and installation work shall be organized. Just as a construction company can have capacity reserves or deficits when planning and developing averaged working conditions at various types of facilities, a construction crew can have reserves, since its headcount and skills may fall short of being optimum with respect to the work performed at this stage of work [3,4].

World statistics proved that the most of dangerous accidents at work causing death occur during construction. These accidents are related to many causes such as insufficient of staff experience and negligence of safety requirements, especially by young workers [5]. The staff assigned to construction shall have the necessary conditions to deal with and reduce the risks such as the risk of equipment and machinery to the staff and the company and try to prevent accidents or reduce them, as well as to provide the right atmosphere helping the staff to work. All these human and technical factors have a significant impact on project, sustainability of companies, and maintaining their reputation in the labor market.

A sustainable construction company is one efficiently in unstable, and uncertain competitive market conditions (technology sustainability, supply and sale sustainability, financial sustainability, etc.) [6]. To achieve this sustainability, there must be appropriate and scientific staff treatment and all the stakeholders from the Contractor to the Project manager and others to deal with the risks, whether technical or human risks or risks related schemes and specifications on the ground, that may arise during the project, which would affect the duration and cost of work, as well as its quality and the company.

2. Literature review

Previous research has shown a number of factors affecting the staff performance in the construction industry [7]. Among these factors, there is an insufficient knowledge of the amount of risks in the construction industry. Risk recognition has received a lot of attention recently, Specifically, new research has shown that staff is often unable to identify a large proportion of occupational risks [8].

In 2008, Hamid, A.; Majid, M.; and Singh, B. conducted a research of the occupational risk assessment, which revealed that accidents are caused by a wide range of factors such as unsafe tools, work site conditions, the specific industry problems, unsafe methods related of work, human factors, and management issues [9].

In 2009, Garrett, J. W.; and Jochen, T. revealed that some of the poor construction risks identification reasons include inherent uncertainty in projects from complex engineering including high-rise structures, bridges and power plants to small projects with hardly any maintenance and renovation conducted [10].

According to Toole’s [11] study in the USA, the causes of accidents include: unsafe methods or sequencing; deficient safety enforcement; lack of proper training; lack of modern safety equipment; unsafe site conditions; poor attitude toward safety; lack of and deviation from regular behavior.

The growing demand for increasing efficiency and large construction volumes gradually introduced new building and construction techniques. In parallel with this development, increasing standards were applied to the quality and safety of operations, in particular to management and logistics. Safety depends on the proper staff management and the equipment operation, as well as their relationship to safety measures [11].

Safety of any construction projects is affected not only by natural properties of new materials, climate conditions, etc., but also to by serious mistakes made during development and construction (see Table 1). Verifying structure reliability based on permitted load or various methods, whether empirical,
probabilistic, or on partial factors etc., significantly increases the complexity of calculations and the economic burden[12,13].

Table 1. Failure causes.

| Draft | Implementation | Operation | Other | Human failure | Load |
|-------|----------------|-----------|-------|---------------|------|
| 20%   | 50%            | 15%       | 15%   | 80%           | 20%  |

The risks management process shall be carried out continuously at all construction stages. To do this, risks shall be identified and assessed in a timely manner, as well as measures to reduce the risks identified need to be developed. To actively implement this plan, the implementation results with project monitoring shall be systematically analyzed [14]. Therefore, it is necessary to know and identify the risks to which construction workers may be exposed and which have a significant impact on the sustainability and effectiveness of companies.

3. Types of risks that the staff may be exposed to during the project

Professional risks affecting the staff in the working environment are divided into several groups:

3.1. Physical risks: the risks affecting an organization and representing inappropriate natural influences varying according to the working environment and nature, such as [15]:

3.1.1 Excess heating: climatic conditions or thermal emissions resulting from operating activities, machinery, equipment, factories, etc.
3.1.2 Moisture or excessive cold: staff is exposed in areas, where the temperature is very low.
3.1.3 Improper lighting, noise, working at heights, and falling objects [16].

3.2. Mechanical, electrical and occupational Injury risks: these risks come from electrical connections and operating machines, machines and work tools, including technical and industrial workshops, electricity rooms, electric panels, lighting poles, etc.

3.3. Structural risks: the risks that construction staff may be exposed to as a result of non-application of occupational health and safety procedures during construction, in addition to the lack of exits, corridors, escape ladders, safety equipment, etc.

3.4. Chemical risks: the risks occurring from inhalation of toxic vapors, toxic gases, dust, pesticides, solvents and smoke, or contact with the surfaces of these substances. The exposure degree to chemicals depends on the substance concentration degree, the exposure duration and chemical pollutants in the air, whether in the form of solids (dust, asbestos) or gases and vapors.

3.5. Health risks: these may affect the construction staff due to germs or microbes produced by the environment because of the lack of enough number of health facilities and there poor quality, including water tanks, toilets, restaurants or due to the accumulation of waste in the environment surrounding workplace, as well as work-related musculoskeletal disorders (WMSDs) among construction staff [16], and the staff efforts as a result of work pressure.

3.6. Fire risks: fire may endanger the life the staff at different facilities, lead to loss and damage to property due to the lack of safety precautions or come from smoking by the staff in places with combustible materials, as well as if the staff is not aware how to act in case of fire.

3.7. Risks of negative behavior: these affect the staff engaged in construction exposed to damage due to lack of the rules of optimal use occupational safety and health measures, due to theft or intentional damage as well as lack of awareness due to the lack of experience and awareness programs and the laws criminalizing negligence.

3.8. Risks of psychological and social: stress, human relations, social and family support.

3.9. Financial risks: lack of salaries and non-payment of overtime wages, etc.
There are also many external risks affecting the surrounding microenvironment or facilities functionally related to a construction companies (banks, investors, suppliers, tax authorities, etc.), the overall construction industry and the sustainability of construction companies as follows in Figure.1:

**Figure 1. External construction risks.**

**4. Research methodology**

The research methodology depends on the analysis of the human risks affecting the sustainability of construction companies consisting of three main parameters (Figure.2), and evaluates the risks acceptance or limitation (Figure.3).
Figure 2. Human risks analysis elements.

Figure 3. Human risks assessment flowchart.
4.1. Frequent exposure to risk:
a computational element included in a business risk analysis, which is evaluated as an indicator:

| Frequent exposure to risk | Values |
|---------------------------|--------|
| Continuous                | 10 - 8 |
| Frequent                  | 8 - 6  |
| Average occurrence        | 6 - 4  |
| Seldom occurrence         | 4 - 2  |
| Rare                      | < 2    |

4.2. Probability of risk occurrence:
this element depends on the assessment of an accident occurrence probability, so we find that there is a question of how many times the incident occurred in the past? To answer this question, we assess that the risk occurrence probability depending on the recording of occupational accidents, Therefore, an evaluation of this component (as indicators) is as follows:

| Probability of occurrence | Values       | Probability |
|----------------------------|--------------|-------------|
| Mostly                     | 100% - 80%   | 1 – 0.8     |
| Possible                   | 80% - 60%    | 0.8 – 0.6   |
| Potential                  | 60% - 40%    | 0.6 – 0.4   |
| Poor probability            | 40% - 20%    | 0.4 – 0.2   |
| Improbable                 | < 20%        | < 0.2       |

4.3. Risk consequences:
this element assesses potential risk consequences, if there are certain expected risk consequences resulting in loss of life, injuries and damage to property and buildings are deemed tragic. If there is loss of life and damage to property, it is fatal. If there are several serious injuries and some occupational diseases, these results are serious, etc.

| Results                  | Values |
|--------------------------|--------|
| Tragically               | 20 - 18|
| Deadly                   | 18 - 13|
| Seriously                | 13 - 8 |
| Not seriously            | 8 - 3  |
| Almost existentially     | < 3    |
Table 5. Risk matrix.

| Frequent exposure to risk (A) | Probability of risk occurrence (B) | Consequences of risk (C) |
|------------------------------|-------------------------------------|--------------------------|
| Probability | Probability assessment | Probability | Probability assessment | Probability | Probability assessment |
| Continuous | 10 - 8 | Mostly | 1 – 0.8 | Tragically | 20 - 18 |
| Frequent | 8 - 6 | Possible | 0.8 – 0.6 | Deadly | 18 - 13 |
| Average occurrence | 6 - 4 | Potential | 0.6 – 0.4 | Seriously | 13 - 8 |
| Seldom occurrence | 4 - 2 | Poor probability | 0.4 – 0.2 | Not seriously | 8 - 3 |
| Rare | < 2 | (Improbable) | < 0.2 | Almost existentially | < 3 |

To evaluate the risk ratio by the following equation:

\[
\text{Risk ratio} = A \times B \times C \quad (1)
\]

If (risk ratio) > 12 the risk is high.
If (risk ratio) 12 – 6 the risk is medium.
If (risk ratio) < 6 the risk is low.

5. Conclusion

Construction projects in general are related to the risks and uncertainties, since they are of a special nature, and the most important feature is the length of the period leading to changing conditions, making them contain multiple risks. The main risks are the human risks faced by those engaged in construction, and, as well as the inability of construction companies to implement projects on time and ensure the required quality and specifications agreed upon.

The essential priorities of companies trying to maintain sustainability and good reputation in the labor market are to analyze and assess the risks in general and human risks in particular, and to know the consequences of these risks to be properly treated to ensure the least losses during the projects through a statistical matrix of risk, through which the impact of those risks is learned on the sustainability and effectiveness of companies at work. After evaluating and obtaining the results, one reaches the phase of risks control or reduction, which may include the following:

1. Removal, replacement or isolation of risks from the workplace.
2. Use of engineering controls to find solutions preventing or reducing occupational risks.
3. Following safety procedures before, during and after work.
4. Use of personal protective equipment.
5. Training and awareness of staff on the site about the occupational risks.
6. Intensification of tours at sites and writing risks reports to control them.

External risks, not considered usually when solving the organization and construction technology tasks, can have a significant impact on the sustainability of construction companies. They are also considered to minimize consequences of their occurrence. The necessary regulatory and technical measures will be developed and researched in the following papers, which will be examining in more detail the impact of external risks on the sustainability of construction companies.

It worth noting that the production burden of construction companies (building volumes) can be related to external risks, for instance: decrease in the exchange rate, breaking contractual obligations with counterparties, logistical-related errors, political decisions, production of construction items stopped due
to an accident or for other reasons. This may result in a company not having the volume required and production stopped.

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