FEATURES OF PREPARING OF SAFETY SOLUTIONS IN TECHNOLOGICAL PROJECTS AND POSSIBILITIES TO USE MULTI-CRITERIA DECISION MAKING METHODS IN CONSTRUCTION DESIGN STAGE

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Abstract Construction is one of the human activity fields, which are particularly closely related to the environment where the whole humanity exists in. That’s why there is a natural desire to take care of the environment creating it and actually using it. In order to determine the construction of technology projects the matching with the regulatory acts there has been visited 13 randomly selected construction sites to analyze the projects of construction technology. Article analyzes the construction technology project as a safety standard document for construction site, and the possibility of application of mathematical methods in construction design stage. As the construction project consists of technology (safety point of view) of the site plan and technological cards (notably those documents recorded safety design solutions), and the indicators making up the comparison, and plenty of indicators to evaluate site plan, work cards, the entire project may be very varied and diverse as well. To ensure the safety of workers at construction sites it is proposed to start to evaluate various construction projects of technological solutions quality and safety in terms of multi-criteria mathematical methods.

Keywords: dangerous factors in construction site, designing of safety in construction site, design of technology project of construction works, multi-criteria mathematical methods, technical-economical attributes, construction technology design.

Introduction

In the most general sense construction is one of the human activity fields, which are particularly closely related to the environment where the whole humanity exists in. In this case, there is a natural desire to take care of the environment creating it (construction and building design, construction stage) and actually using it (maintenance stage), while it is trying to manage such a way that its elements, including people, would be mutually coherent and all of this could be defined as harmonious development of the construction.

The business of the construction is rather specific, and this partly determines specifics of work safety in the enterprises (Dėjus 2009). Because of the construction specific features, as a business type, the work safety in construction enterprises is more complex and complicated than in other companies. The analysis of safety management systems in construction companies, which accidents probability depend on could also be very broad.

In this case, the projection of construction is gaining importance and construction technology design turns to multipurpose and more complicated.

In general, accidents at the construction sites can be classified also as a safety control system reject of the company which is determined of the various factors – technical, technological, organizational and other possible factors (Dėjus 2007, 2008), and any of adverse event associated with the construction design at the site in general sense and, particularly, preparation of the construction technology project and suitability for a particular site.

This article analyzes the construction technology project as a safety standard document in Lithuania, planning conditions and possibility of application of mathematical methods for safe work to the preparation of construction and design stage.

Safety solutions for construction technology work projects

Safety problems at construction sites are studied in works of Abudayeh et al. 2003; Beavers et al. 2006; Bentley et al. 2006; Choudhry et al. 2007; Fredericks et al. 2005; Fung et al. 2008; Hinze et al. 2006; Hsiao, Simeonov 2001; Husberg et al. 2005; Mohan, Zech 2005, Paine et al. 2004; Spielholz et al. 2006; Teo, Ling 2006;
To design the building construction technology in traditional methods it is normal to commit in the following sequence: one or more promising construction technologies and organization options are selected according to the designer's view; technical and economic indicators of each are determined which one of them, as a rule, is the project cost, and another – the duration of implementation, which is always important for the developer of the project while implementing project "rational" technological-organizational version; the specification of the selected "rational" version is performed or not.

An algorithm design which was described above is basically acceptable to the preparation of construction technology project as a main and a single safe work in a particular regulatory document on the construction site, and could be applied if to draw attention to several features of the project preparation.

Technology project of construction activities is regulated by the legal acts of the Republic of Lithuania, first of all – TCR „The construction works“ (Reglamentas 2002), the „Regulations of workplaces installation in construction“ (Nuostatai 1998), „Health and safety rules for construction“ (Taisyklės 2000) and use of „Working facilities regulations“ (Nuostatai 1999). The final project must be fully complied with the regulations and at their annexes where the safety requirements are shown.

If safety requirements are specified in those regulations (Nuostatai 1998, Taisyklės 2000, Nuostatai 1999), so project of the construction technology structure, composition and requirements for its preparation is governed by TC Regulation (Reglamentas 2002) and Rules (Taisyklės 2000) in the annexes.

In the appendixes of Regulation (Reglamentas 2002) there is provided that the contractor prepares the technology project of the construction before construction work begins. Project preparation, as it was mentioned, must be guided by the technical design solutions of a project, also the specific safety assurance solutions must be submitted, but links or excerpts of occupational safety and health regulation cannot be used as solutions kinds.

In general, the project of construction technology consists of the notes, the construction scheme of the situation, site plan, a vertical cross-section of construction with a crane, timetable of construction and technological cards (TC) and those cards the sixth point consists of safety solutions, along with the collective and personal protective means.

In the fifth annex of the Rules (Taisyklės 2000) there is stated that the specific design solutions, determining the technical means, work methods which ensure the safety and health must be made in technology project of the construction. These design solutions cannot be replaced by references or excerpts from the safety and health legislation, regulation, technical documentation, which refers just an appropriate design solution.

To prepare design solutions it is necessary to clarify the dangerous and harmful factors which are associated with the work technology and conditions of constructions, specify their operational areas and identify hazard.

The changing in building conditions which affects the safety and health, the technology project of construction should be modified and / or adjusted.

In order to prevent workers falling from a height in the technology project of the construction there must be referred the temporary fencing installation location and types of ropes, safety belt, technological equipment and tools to carry out work at a height, also the means and ways how to get workers to their working places.

In order to avoid material of construction falls from height in the construction work technology project there must be shown the suspended ways to ensure the storage and transfer elements mounted to the location, equipment (the pyramid, cassettes) to ensure storage stability of structural elements, the methods how to store the materials, equipment and products; the mantle (dismantled) construction temporary and permanent mounts, temporary mounts of the prefabricated elements, the methods of waste and garbage disposal; protective overlay (decks) or natural shelter installation position and construction.

As machinery and construction mechanics are used, in the technology project of construction measures to eliminate harmful and / or high-risk factors for the operator and for employees working near it must be included; the measures which restrict the work area of construction machinery, also the fencing.

Working in excavations or trenches shall be referred to the safe excavation of slope gradient or slope excavation reinforcement method and technology of installation; inputs and outputs to the way of excavations or trenches; if it is necessary, water disposal methods.

In order, to protect workers from the hazardous effects of electric current it is necessary to provide temporary electrical equipment installation procedures, voltages, temporary electrical power and lighting networks of roads, stream of fencing techniques and introduction – distribution systems and appliances; the metal parts of electrical equipment grounding techniques; additional safety measures working in very dangerous and hazardous facilities; also safe methods of works near power transmission lines and near existing power plants.

From given information it can be concluded that the safety of technology solutions for construction project is very clearly and unambiguously defined, and all the attention on safety at work preparing is concentrated on the five risk factors – a fall from a height, structures and products falls, injury of mechanisms, prevention of electrocution falling soil, what is completely connected to conclusions (Déjus 2009) about the hazard factors.

Thus, the quality of the projects in specific constructions sites was analyzed with full certainty on construc-
tion technology project structure, the scope and level of solutions details.

There is indicated (Dėjus and Viteikienė 2003) that for comparative analysis there were randomly selected (from different construction companies rather different construction objects) the projects of construction technology – totally 20 units. Survey results are presented in the Table 1.

Doing the analysis of construction technology project there is no possibility to avoid completely the subjective factor affecting its performance. However, such an investigation has a strong indication that the majority of construction firms in preparation of construction work technology projects with its quality and content, design solutions of specificity, particularity and completeness – does not meet the requirements of normative acts, which is attributable with employees, who prepare project, competence in the field of occupational safety.

In order to determine the construction of technology projects the matching with the regulatory acts there has been visited 13 randomly selected construction sites to analyze the projects of construction technology. Partial details of the analyzed construction technology projects and building sites are in Tables 2 and 3.

Table 1. Analysis of construction technology works project (Dėjus and Viteikienė 2003)

<table>
<thead>
<tr>
<th>Current No.</th>
<th>Attributes</th>
<th>Projects matching attributes, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Project solutions partly or fully changed by links or fragments from regulations of safety and health</td>
<td>95</td>
</tr>
<tr>
<td>2.</td>
<td>Project solutions are not specific or detailed enough to be understood and realized unambiguously</td>
<td>80</td>
</tr>
<tr>
<td>3.</td>
<td>Project was modified on circumstances change in a construction site</td>
<td>5</td>
</tr>
<tr>
<td>4.</td>
<td>While organizing the project, a dangerous factor was found out and later an accident occurred because of it</td>
<td>40</td>
</tr>
<tr>
<td>5.</td>
<td>Dangerous zones that appear when disusing lifting mechanisms are pointed out in the project</td>
<td>10</td>
</tr>
<tr>
<td>6.</td>
<td>Collective and personal safety means defending from specific factor were predicted in the project</td>
<td>25</td>
</tr>
<tr>
<td>7.</td>
<td>Safety and health protection signs were not prescribed in the project</td>
<td>90</td>
</tr>
<tr>
<td>8.</td>
<td>Workers were introduced the ready project and they signed</td>
<td>5</td>
</tr>
<tr>
<td>9.</td>
<td>Project was organized with reference to lapsed regulation(s)</td>
<td>75</td>
</tr>
<tr>
<td>10.</td>
<td>Works were performed differently from indications in the project</td>
<td>85</td>
</tr>
<tr>
<td>11.</td>
<td>The collective prevention from workers falling from heights was prioritized when organizing the project</td>
<td>30</td>
</tr>
<tr>
<td>12.</td>
<td>Safety belts and other personal (preventing workers from falling from heights) safety equipment that was prescribed in the project fully matches its safety requirements</td>
<td>5</td>
</tr>
<tr>
<td>13.</td>
<td>Project was not organized at all or its composition or any part does not fit the requirements</td>
<td>40</td>
</tr>
<tr>
<td>14.</td>
<td>Project was organized considering construction works preparation and organization solutions of technical project</td>
<td>10</td>
</tr>
</tbody>
</table>

Table 2. Attributes of quality of construction works technology projects (Dėjus 2008)

<table>
<thead>
<tr>
<th>Construction site No. \ Attributes</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
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<tr>
<td>Site No. 1</td>
<td>30</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>20</td>
<td>15</td>
</tr>
<tr>
<td>Site No. 2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Site No. 3</td>
<td>60</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Site No. 4</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Site No. 5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Site No. 6</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Site No. 7</td>
<td>10</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Site No. 8</td>
<td>20</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Site No. 9</td>
<td>75</td>
<td>yes</td>
<td>no</td>
<td>not needed</td>
<td>no</td>
<td>not needed</td>
<td>60</td>
<td>45</td>
</tr>
<tr>
<td>Site No. 10</td>
<td>30</td>
<td>no</td>
<td>not needed</td>
<td>not needed</td>
<td>-</td>
<td>-</td>
<td>30</td>
<td>-</td>
</tr>
<tr>
<td>Site No. 11</td>
<td>60</td>
<td>no</td>
<td>not needed</td>
<td>not needed</td>
<td>-</td>
<td>-</td>
<td>15</td>
<td>20</td>
</tr>
<tr>
<td>Site No. 12</td>
<td>15</td>
<td>no</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Site No. 13</td>
<td>60</td>
<td>no</td>
<td>no</td>
<td>yes</td>
<td>not needed</td>
<td>not needed</td>
<td>70</td>
<td>45</td>
</tr>
</tbody>
</table>

393
Attributes, which were used:
1. Project structure and scope of the TCR requirements (0–100 points, none)
2. Worksite plan meets the situation on site (yes, no)
3. In the technological card 1 there is the temporary location and types of runs (yes, not needed)
4. In the technological card 2 there is the temporary location and types of runs (yes, not needed)
5. In the technological card 1 there is the safety belt and rope attachment site (yes, no, not needed)
6. In the technological card 2 there is the safety belt and rope attachment site (yes, no, not needed)
7. Technological card 1 quality (5–95 points)
8. Technological card 2 quality (5–95 points)

Briefly commenting on table 2 and 3 there should be noted that although the indicator in table 1 and 2, 3 is not the same, but the data in these tables do not give reason to assert that the construction technology project preparation and their quality has changed in a positive way – in some cases projects are even not prepared and quality of those which are prepared apparently low.

Note that in almost all cases, designers were prepared to the relevant part of TP. However, even in this case construction technology projects were not always prepared.

The investigation has shown no sign that multipurpose selection method for the construction work development technology projects have been applied, while exactly variable design can give competitive advantage in much shrunken construction market now.

**Indicators to be used for comparing options of construction projects technology in a view of safety**

Šarka et al. 2008 claims that the multipurpose mathematical methods in various areas were begun to be regarded in the middle of the twentieth century, when the first works were published (Churchman and Ackoff 1954; Churchman et al. 1957; MacCrimmon 1968; Paenick 1976; Hwang and Yoon 1981). The chosen topic (Zavadskas 2008) was developed later (Fiedler et al. 1986; Kaplinski 2008a,b, 2009; Peldschus 2008, 2009), both to improve or develop new multipurpose methods (Kaklauskas 1999; Ustinovichius et al 2007; Zavadskas et al. 2009; Zavadskas et al. 2008b; Braurers and Zavadskas 2006) and their application in individual tasks (Zavadskas et al. 2008b; Zavadskas and Antučevičienė 2007) or analysis of the methods in the various fields (Ustinovichius and Kochin 2008; Banaitienė et al. 2008), including ones related to the construction business (Turskis 2008; Mitkus and Šostak 2008).

As the construction technology project consists of the site plan and technological cards (safety design solutions are recorded in these documents), and the attributes making up the comparison, and plenty of attributes to evaluate site plan, work cards, all the project may be very varied and diverse.

**When designing the plan of the construction site** danger zones are determined (in accordance with Regulation (Reglamentas 2002), Section 1.1.3 p.) the areas of hazardous zones are calculated.

Really dangerous areas on the construction site are in areas where (Déjus 2009):
1. Height difference of over 1.3 m. That is why there is a risk of workers falling from a height – high ceilings (all the perimeter) and the roof structure around the periphery of the stairs on all floors of the building structures

**Table 3.** Data about the construction sites, where technology projects of construction were analyzed

<table>
<thead>
<tr>
<th>Construction site No. \ Attributes</th>
<th>1 Technical project of construction works organizing is included (yes, no)</th>
<th>2 Works number in design schedule</th>
<th>3 TC number in the technology project of construction works</th>
<th>4 Price of works (million Lt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Site No. 1</td>
<td>yes</td>
<td>108</td>
<td>15</td>
<td>59</td>
</tr>
<tr>
<td>Site No. 2</td>
<td>yes</td>
<td>93</td>
<td>2</td>
<td>29</td>
</tr>
<tr>
<td>Site No. 3</td>
<td>yes</td>
<td>300</td>
<td>30</td>
<td>157</td>
</tr>
<tr>
<td>Site No. 4</td>
<td>yes</td>
<td>200</td>
<td>1</td>
<td>80</td>
</tr>
<tr>
<td>Site No. 5</td>
<td>-</td>
<td>70</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Site No. 6</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.5</td>
</tr>
<tr>
<td>Site No. 7</td>
<td>yes</td>
<td>10</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Site No. 8</td>
<td>yes</td>
<td>60</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Site No. 9</td>
<td>yes</td>
<td>87</td>
<td>10</td>
<td>30</td>
</tr>
<tr>
<td>Site No. 10</td>
<td>yes</td>
<td>22</td>
<td>3</td>
<td>54</td>
</tr>
<tr>
<td>Site No. 11</td>
<td>yes</td>
<td>200</td>
<td>30</td>
<td>40</td>
</tr>
<tr>
<td>Site No. 12</td>
<td>no</td>
<td>74</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Site No. 13</td>
<td>yes</td>
<td>130</td>
<td>10</td>
<td>20</td>
</tr>
</tbody>
</table>
(flight, and landings around the periphery), the openings in overlays (holes on each floor all around the perimeter) and near openings in vertical structures, where there is a risk of falling from a height (such as doors for a balcony) – horizontal projection of the length of a dangerous area.

It should be noted that the above-mentioned dangerous zones width (occupational safety and health regulatory acts) is not regulated; only a boundary with different altitudes in the worksite area is dangerous (in most cases – the building).

In this case, if you don’t know the danger zone width (it could be the equivalent to about 2–2.5 m) it cannot be named as the danger zone area and, therefore, one of the comparison of indicators can be dangerous zone perimeters or protective enclosure length to protect workers falling from a height.

2. There is a risk that the workers could be injured by *falling materials and construction* – those zones are about 5–10 meters width (depending on building height) all around the building and near the openings of laps – the open area and 3 meters width. The above-mentioned risk can be controlled by collective security means – roofs, protective overlays or decks. Therefore, options can be compared both by the hazardous areas, as well as by how the area should cover the above-mentioned collective security means.

3. Working (or moving) the *construction machinery* is the risk of damage to employees. In this case, mechanism which can injure the employee may be of two types – which injure moving or when an employee is injured by a mechanism which affects the object – the lifting load, pushing a soil.

The danger zone near the moving mechanism is limited to 5 meters, if the manufacturer has not established in another way the danger zone (because of the crane load) is simply counted and it is of the circle (not always) shape while mobile cranes or not running tower cranes work, and prolonged circle shape (a circle is extended in the way under the crane direction).

It should be noted that in the sites there are the danger zones where there is a risk of being affected by electricity. However, mentioned factor (this is essentially the subject of electrical engineering) is not analyzed in the article.

Because there are many technological processes at the same time in a construction site and there are many working mechanisms there is a zone where a person can be injured not only by one but by several mechanisms. Therefore comparative indexes can be calculated not only for one mechanism dangerous zone, but for several mechanisms danger in one zone.

4. There are such variants of construction plan, when there is a *risk to injure people who work not in construction site*, but near it. In that case construction site fence is used which means not only the minimal price but lower risk of injuries of people who are near a construction site as well.

Theoretically smaller number of strangers can appear near the fence at the same time so the risk of strangers appearing on construction site is lower and injuries of strangers are less as well.

The safety in the construction site is outlined by attribute such as an area of building or structure where several workers work in one vertical at the same time and they are separated by one floor. In that case the index lets completely estimate the quality of calendar schedule from the point of view of safety.

The matter of the offered model (Déjus, Viteikiene 2003) is that the risk is estimated just by only one attribute in the construction company – finding dangerous factor in particular work place or means, how to be protected from it, the comparison of the regulations and real situations is done and it is found out if means meets the safety requirements. If one requirement is not appropriate the risk is accepted as unacceptably large, however, there is a way of risk reduction – it is necessary to perform the requirement of standard which was mentioned above. In general case, the estimation of any object by one index is not comprehensive, and the results of this estimation could distort realistically existing setting. However, if the attribute content were completed mentioned problems would be avoided. So the professional risk which appears in construction company could be estimated by performance of safety standard requirements, i.e. by only one attribute which is the answer for the question – if law acts requirements which regulate the organization of safety and its performance in construction site (further – *rate of standard requirement performance* – SRPR) are performed or not. Complexity of the attribute is hidden in the set of safety standard acts which involves absolute majority activity directions of construction workers.

Therefore estimating plan of construction site or all project of building works technology rate of standard requirements performance (SRPR) which allows estimating available standard law acts is applied.

Applying SRPR while estimating of the project of building work technology or arrangement of it’s part the advantage over the other applied rates are defined – all standard requirements which are indicated in the regulated standard law act of safety are known and unambiguous and identifying SRPR there are only two possible – positive and negative and it significantly reduces time of calculation.

*Application of SRPR* has also a disadvantage – it is relatively difficult to select “the most important” requirements of standard acts and to do work which is essential for the appropriate quality of both the construction and safety.

Explaining the concept of “the most important” standard law requirements it is possible to use the scheme of security of safe work in construction site (Déjus 2009).

Evaluating construction plan from the point of view of safety other attributes can be applied (hardness of a construction site which is quite subjective index because it is evaluated in points and which can depend on such special factors as a number of working mechanisms in the construction site, maximum height of means used at one time, vertical or horizontal projection of such means, cargo lifting by two cranes, used power of electrical tools
an equipments, technological width of cellar floor, number of different collective means of safety from falling, movement roads and length of roads of construction mechanisms, etc.

Construction work technological cards design happens at the same time with projection of a construction site or after it and safety at work problems are solved in technological card in much more details than making a construction site plan. At the same time there is certainty in technological cards. There should not be alternative solutions for safety at work. Because of all mentioned circumstances there can be used other attributes of comparison.

Also TC are prepared for separate works performance, and construction works are different in their technology and difficulty and of course safety at work factors which influence employees at their work places and work places preparation peculiarities. That is why TC solutions are made for a certain work place or work area.

Following solutions of safety at work are suggested:

1. Number of safety belts fastening places in one work area. The number should be as less as possible because while choosing technical safety equipment the priority is given for collective means of safety. Safety belts are kept as an individual means of safety which is divided to defend a worker from the falling from height and it is irrational to make a collective safety means at the place. The usage of safety means at the place of safety belts usage should be short and the danger is only for one worker or similar cases.

2. Technical accuracy of platforms (ladders, planked floors, etc.) usage. Such index is complex because while finding out its significance it is necessary to evaluate maximal number of factors which are connected with equipment technical accuracy – from manufacturer documentation to workers instructing at the work place about individual safety means and work on the platforms.

Mentioned index of technical accuracy is closely related to used platform means spoilage (and to individual and collective safety means) which should be marked in TC. It is important to mark certain activities of workers even when there is any suspect that used equipment is not technically in good working order.

3. Comparative attribute is expressed by dangerous factors acted in certain work area with number of used technical safety means which defends from mentioned factors. The mentioned attribute should not be less than 1 and it should be looked at while choosing scale of attributes meanings.

4. Number of electrical and simple tools used at work area. The index could be minimized having in mind that each tool generates even one dangerous factor. There should be certain safety means for each of the factor which cost so at that case a principle of rational minimum is used.

5. Evaluation of safety of construction plan and prepared TC quality SRPR is used which allows finding out TC compliance to legislative regulations and foreseeing probability of accidents.

Prepared TC solutions presentation influences TC realization in real construction site. In that case we should use regulations (Dėjus 2009) on using 3D principle representing safety solutions in construction work project. 3D should be used when projected solutions are presented on work place plan, the same work place cut and 3rd drawing where safety means installation or part used are presented. Understanding of technical documentation could be one of subjective evaluation indexes of TC quality.

The quality of construction work technological project can be evaluated according to relationship of TC with quantity of construction work in construction object calendar. Every work must be designed. This can be done in appropriate way only after preparing appropriate TC.

Practice shows that construction work technological project or its parts are evaluated according to attributes 5–7 because if there is bigger number of attributes the meaning of each attribute becomes less (Zavadskas et al. 2007) and it influences forming of priority line.

Mathematical meanings of above mentioned attributes could be used to make solutions matrix which would let to find out rational variant of construction work technological project or its parts.

Conclusions

Performing review of literature, there were stated, that author could not find such sources where the quality of construction technical-technological documentation from the point of view of safety would be analyzed and where multipurpose mathematical methods for evaluation of construction works technology projects or other construction technical documents would be suggested to apply.

Summarizing performed project we can claim that there is not any basis to state, that preparation of works technology project and its quality changed to the positive side during last five years – in some cases projects are even not prepared, quality of prepared projects is apparently low, safety solutions is not used in the project of construction works technology when construction is being projected.

In order to secure the safety of workers in construction author suggests:

1. To use varietal projecting of construction work technological projects, start to evaluate safety quality in construction work technological projects, use multifunctional mathematical methods.

2. Applying multipurpose methods to use suggested efficiency attributes of work safety solutions, firs of all – regulations of norms acting (SRPR), dangerous zones length, width of the zones where there is a risk to be injured by several operating mechanisms, width of the zones where collective safety means from materials or equipments injures should be used.

3. Estimating the quality of construction plan from the point of view of safety applying attributes such as an area of building or structure where several workers work at the same time in vertical and they are separated by only one floor, number of automotive mechanisms working in the same time in the construction site.
4. Evaluating work safety solutions projected in TC such attributes are used: number of places with safety belts fittings in one work area, technical accuracy of platforms (it is complex attribute), and number of electrical and simple tools used in work area.

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