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ANALYSIS AND ASSESSMENT OF THREATS EXISTING IN SELECTED SMALL SPORTS AND RECREATIONAL INFRASTRUCTURE FACILITIES USING QUALITY MANAGEMENT TOOLS

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Marta Jagusiak-Kocik[1] – *orcid id: 0000-0001-6031-9169*
Czestochowa University of Technology, Department of Production Engineering and Safety, Armii Krajowej 19B, 42-201 Czestochowa, **Poland**

Abstract: The aim of the work was to determine the effectiveness of the use of the Ishikawa diagram and the Pareto-Lorenz diagram in the analysis and assessment of threats that occur in small sports and recreation infrastructure - playgrounds. After analysing the available literature, it can be concluded that there are studies in the field of safety on playgrounds, but there are no publications combining surveys with the use of quality management tools in relation to this topic. Through a direct survey conducted among parents and caregivers, information was obtained about the threats in playgrounds located near housing estates they meet most often. Using the Ishikawa diagram, this information was grouped and a brainstorming session was conducted to isolate the root causes of these threats. After conducting an analysis using the Pareto-Lorenz diagram, the threats that appeared most frequently in the respondents' responses were specified. The result of the work is to propose actions that can reduce or eliminate these threats.
Keywords: threat, small sports and recreational infrastructure facilities, playground, Ishikawa diagram, Pareto-Lorenz diagram, safety

1. INTRODUCTION

Small sports and recreational infrastructure facilities are facilities for people of all ages, intended for active leisure time. Such facilities include rope parks, skate parks, workout parks, outdoor gyms and playgrounds. The number of such facilities is regularly increasing in Poland. They play an important role in the life of local communities because they are not only places for physical activity, but alsoa meeting center. As the number of such facilities increases, more challenges arise related to the proper maintenance and management of such facilities. Safety of use also becomes crucial. The safety of such facilities is influenced by elements such as: equipment, design, acceptance before putting into use and maintaining the facility in proper technical, hygienic and sanitary condition.
The object selected for analysis are public playgrounds. It is a separate, in many cases fenced, place intended for children to play. The playground most often includes: a slide, a sandbox, a swing, a carousel, a spring rocker and ladders. There are often benches on

the playground for caregivers of children playing. Playgrounds are most often located in the vicinity of housing estates and on the premises of schools, kindergartens and nurseries. When designing a playground, factors such as: the needs of children and their caregivers, the landscape and climatic conditions, possible pollution and noise, and safety and functionality of devices should be taken into account.

A playground is a place of joy and rest for children and their caregivers, as well as a space for experimenting and developing creativity. It should be friendly, but above all safe for users and free from elements that may pose a threat, therefore the analysis and assessment of the most common threats become key elements in ensuring the safety and effective functioning of these facilities.

The aim of the work is to identify and prioritize the most common threats in selected small sports and recreation infrastructure facilities - playgrounds. This goal will be achieved by conducting a survey in which a representative group was to indicate what threats they encounter on playgrounds located near housing estates and by grouping and hierarchizing these threats using traditional quality management tools - the Ishikawa diagram and the Pareto-Lorenz diagram. The result of the work will be to propose practical solutions that can be implemented to effectively counteract the identified and most common threats.

The risk analysis presented in this article can also be valuable in other management areas where risk factors exist, such as the automotive industry (Mazur, 2018) and forging industry (Ulewicz et al., 2019). In each of these cases, it is necessary to consider engineering expertise and the so-called "common sense" (Kuzior and Zozul'ak, 2019). Risk reduction methods, besides structural solutions, involve the use of appropriate materials with enhanced properties, including steels (Ulewicz and Novy, 2015; Ulewicz et al., 2016; Dudek et al., 2017), lightweight alloys (Szewczyk-Nykiel, 2023), and plastics (Mazur et al., 2021; Franta and Zając, 2022). Appropriate actions aimed at risk reduction and the development of new materials can inspire the advancement of analytical methods such as image analysis (Gądek-Moszczak and Żmudka, 2013), DOE (Pietraszek et al., 2020), and risk assessment (Frontczak and Hachaj, 2022; Ulewicz et al., 2023). The consequences of risk reduction are significant not only socially (Kuzior, 2022), educationally (Radek et al., 2023) but also environmentally (Bajdur et al., 2016; Djokovic et al., 2022).

2. SAFE PLAYGROUND - REQUIREMENTS, REGULATIONS

All devices installed on playgrounds must meet the requirements of the Act of December 12, 2003. on general product safety (consolidated text: Journal of Laws of 2021, item 222), implementing Directive 2001/95/EC of the European Parliament and of the Council of December 3, 2001 (Yearley and Berliński, 2022).

Every manufacturer, importer and distributor is obliged to introduce safe products to the market. This is specified in the relevant standard: for equipment and surfaces, it is the PN-EN 1176 playground equipment standard and surfaces. Owners of public playgrounds (housing cooperatives and communities, city and commune offices, as well as directors of teaching and educational institutions: schools, kindergartens and nurseries) should purchase devices that comply with this standard (compliance confirmed by a certificate or declaration of conformity).

In addition, they are responsible for maintaining playground equipment in good technical and aesthetic condition and in a way that prevents excessive deterioration of their

functional properties and technical efficiency. Owners or managers are obliged to pay special attention to the hygienic and sanitary condition of playgrounds, in particular the condition of the sand in sandboxes to prevent infections and infectious diseases, before and during the spring season.

Every playground should be inspected regularly (Yearley and Berliński, 2022):

- daily inspections should take place on playgrounds that are intensively used and exposed to vandalism,
- functional inspections should be carried out every 1 to 3 months with the frequency indicated by the manufacturer in a given playground device,
- a basic inspection takes place once a year and should take into account the condition of the surface and all playground equipment. In addition, the effects of weather conditions are checked, as well as the symptoms of corrosion or rotting, as well as any changes in the safety level of devices resulting from replacement or repair,
- once every 5 years, an inspection of the technical condition and suitability for use of the playground, its aesthetics and surroundings is carried out by a person with construction qualifications and knowledge of the PN EN 1176 standard.

There should be an information board on the playground that specifies the rules for the safe use of sports equipment and devices and informs about the prohibition of bringing animals onto the playground (Yearley and Berliński, 2022). The board should also include contact details of the person/entity responsible for the safety of this place and the emergency number for emergency services.

3. RESEARCH METHODOLOGY AND ANALYSIS OF RESULTS

An analysis of threats occurring in playgrounds located near housing estates was carried out in the second quarter of 2023. The first stage of this analysis was to conduct a short survey among parents and caregivers who come with their children to playgrounds located near housing estates. The research was carried out directly, through conversations with respondents on playgrounds. The survey consisted of two parts: the first part consisted of questions about age and education, while in the second part respondents answered the question what threats they most often encounter on playgrounds they visit with their children? Surveys were conducted near 10 playgrounds in 3 districts of Częstochowa. Based on the 120 responses obtained, a representative group of 60 people was created. To create a representative group, the answers were divided into three groups (from each district of Częstochowa) and 20 answers were selected from each of these groups. A similar method of distinguishing a representative group was presented in the (Jagusiak-Kocik, 2021, Jagusiak-Kocik, 2022) papers. The representative group was dominated by women, aged 25 to 35, with secondary and higher education. After conducting the survey, they were separated the 10 most frequently repeated answers regarding threats encountered on playgrounds. These responses are presented below:

1. Unsuitable surface.
2. No fence.
3. Sharp objects (glass, stones) on surfaces.
4. Incorrect fence construction.
5. Devices poorly attached to the ground, unstable.
6. Poor technical condition of playground equipment.
7. Gaps and holes in devices.

8. Location of the playground (too sunny, no shade).
9. Location of obstacles too close, e.g. garbage bins or benches next to equipment.
10. Unfenced, dirty sandbox.

The next step of the analysis was to present the relationships and group them using one of the 7 traditional quality management tools - the Ishikawa diagram. This diagram was used in the (Chądzyńska and Klimecka-Tatar, 2017, Ciecińska and Oleksiak, 2023, Czerwińska et al., 2020, Czerwińska and Piwowarczyk, 2022, Knop and Ulewicz, 2022, Krynke et al, 2021, Luca et al., 2017, Mizuno, 2020, Siwiec and Pacana, 2019, Siwiec and Pacana, 2021, Urbaniak, 2004, Ulewicz, 2014) papers. The Ishikawa diagram, also known as the fishbone diagram, fish diagram, tree diagram or cause and effect diagram, allows to identify groups of causes that influence a given problem. Brainstorming allows to look at a specific problem from many sides and isolate many causes influencing it.

The work grouped the answers of the surveyed parents and caregivers regarding the threats they most often encounter on playgrounds, and groups of causes influencing these threats were created. Using the Ishikawa diagram, it can often discover the root cause of a given problem. The constructed Ishikawa diagram, presented in Figure 1, presents 5 groups of causes influencing threats on playgrounds. 4 of them are the cause groups related to the 5M principle (Man, Method, Machine, Material), while 1 group is Environment.

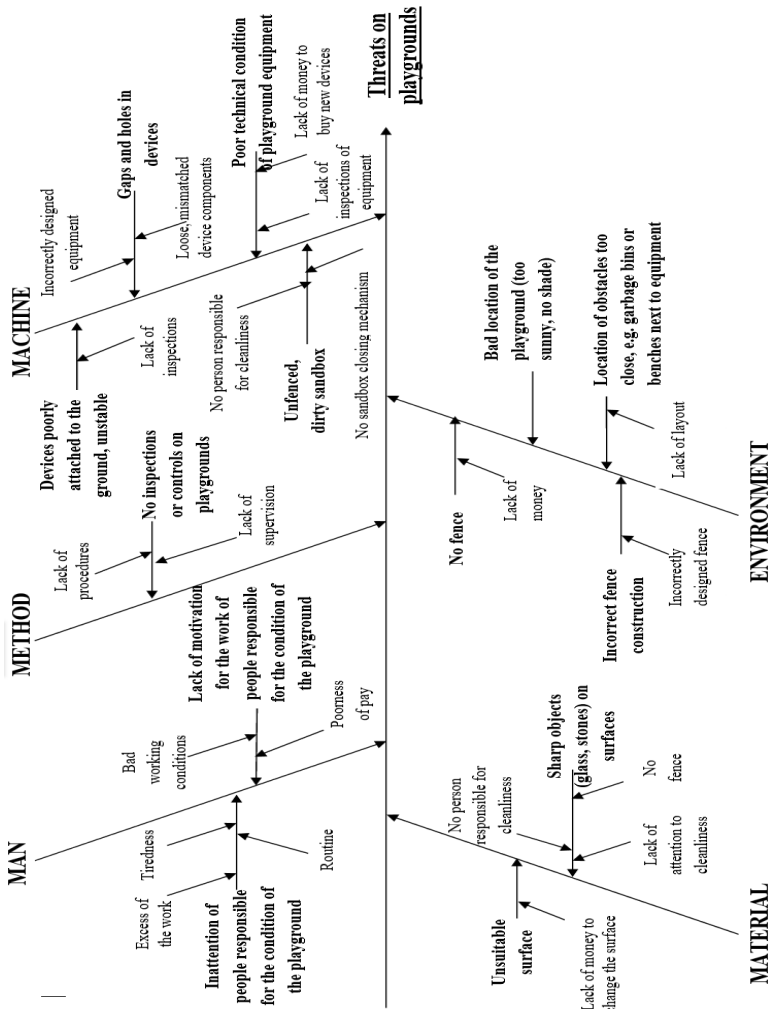

Fig. 1. Ishikawa diagram for playground threats

The Ishikawa diagram presented in Figure 1 shows that most threats are related to the machine and the environment. In machines, these are threats related to, among others: with the poor technical condition of playground equipment and an unfenced, dirty sandbox, while the environment group includes threats that concern, among others, the location of the playground or the lack of a fence.

The next part of the analysis is the hierarchy of threats on playgrounds that were indicated by the respondents as a result of the direct survey. This hierarchy will be made using another traditional quality management tool - the Pareto-Lorenz diagram. The practical use of this tool can be found in the papers of (Czerwińska and Piwowarczyk, 2022, Knop and Ulewicz, 2022, Mizuno, 2020, Pacana and Czerwińska, 2020, Pacana and Czerwińska, 2019, Urbaniak, 2004, Ulewicz, 2014). This diagram allows to determine which threats occur most often in the examined research period and which should be eliminated first. The Pareto-Lorenz diagram is based on the "20-80" rule, which means that usually a small number of causes (from 20 to 30%) are responsible for a significant part (from 70 to 80%) of the effect.

For the purposes of this work, the 10 most frequently repeated answers regarding threats encountered on playgrounds in the second quarter of 2023 indicated in the survey were marked with symbols from Z_1 to Z_{10}. These threats were ranked according to the number of respondents' answers, from the most common to the least frequent (how many times a given threat appeared in the answers). The existing threats along with the adopted symbols and the frequency of their occurrence in the respondents' answers (after ranking) are presented in Table 1.

Table 1
The structure of the respondents' answers regarding threats on playgrounds in the research period

Threat designation	**Threat name**	**Ranking the number of respondents' answers**
Z_1	Unsuitable surface	114
Z_2	No fence	110
Z_{10}	Unfenced, dirty sandbox	75
Z_3	Sharp objects (glass, stones) on surfaces	53
Z_6	Poor technical condition of playground equipment	26
Z_5	Devices poorly attached to the ground, unstable	24
Z_7	Gaps and holes in devices	19
Z_9	Location of obstacles too close, e.g. garbage bins or benches next to equipment	12
Z_8	Location of the playground (too sunny, no shade)	5
Z_4	Incorrect fence construction	4

The percentage share and the cumulative percentage of the number of threats in the survey responses are presented in Table 2.

Table 2
Percentage and cumulative share of respondents' answers regarding threats on playgrounds in the research period

Threat designation	Threat name	Percentage share	Cumulative share
Z_1	Unsuitable surface	25,79	25,79
Z_2	No fence	24,89	50,68
Z_{10}	Unfenced, dirty sandbox	16,97	67,65
Z_3	Sharp objects (glass, stones) on surfaces	11,99	79,64
Z_6	Poor technical condition of playground equipment	5,88	85,52
Z_5	Devices poorly attached to the ground, unstable	5,43	90,95
Z_7	Gaps and holes in devices	4,30	95,25
Z_9	Location of obstacles too close, e.g. garbage bins or benches next to equipment	2,71	97,96
Z_8	Location of the playground (too sunny, no shade)	1,13	99,10
Z_4	Incorrect fence construction	0,90	100,00

Based on the data presented in Table 2, a Pareto-Lorenz diagram was created, shown in Figure 2.

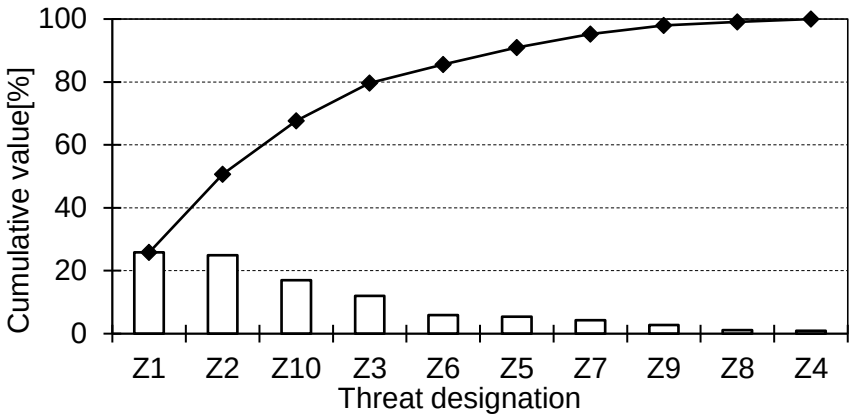

Fig. 2. Pareto-Lorenz diagram for threats on playgrounds

The diagram in Figure 2 shows that 30% of the causes cause almost 70% of the effects (67,65%). Moreover, it can be stated that 3 threats are responsible for 67,65 % of all threats on playgrounds indicated by the respondents: unsuitable surface, no fence and unfenced, dirty sandbox. The remaining 7 threats are responsible for 32,35% of the effects.

4. CONCLUSION

The playground is a place where every child likes to spend time. Creative and interesting play in such a place contributes greatly to the child's development, but it should be safe and risk-free, both in terms of construction and hygiene.

The paper presents the threats most often encountered by parents and caregivers of children attending public playgrounds near housing estates in Częstochowa. Based on a direct survey, the 10 most common threats were identified. These threats were grouped and presented in the form of an Ishikawa diagram, and then they were hierarchized using the Pareto-Lorenz diagram.

Analyzing the respondents' answers, it can be seen that the vast majority of parents and caregivers indicated unsuitable surfaces on playgrounds as the most common threat. On playgrounds, while playing, children often fall or fall from swings or carousels onto the surface, which is often hard and not adapted to the prevailing conditions. Playground surfaces should be safe and preferably made of synthetic materials such as rubber. Natural materials such as wood chips, bark or sand are also suitable. In the event of a fall, they will provide proper cushioning. Parents and caregivers also pointed out that playground surfaces often contain, in addition to garbage, various sharp objects, which also pose a threat to children playing. The owner or manager of a given playground is responsible for maintaining order on playgrounds. The respondents' responses often also included the threat of a lack of fencing and a dirty, unfenced sandbox. Each playground should be fenced and the fence should be free of sharp edges and ends. An unfenced, unclosed sandbox poses threats related to pollution and zoonotic diseases. The Chief Sanitary Inspectorate recommends replacing sand in sandboxes at least before and during the summer season, and each time the presence of visible contaminants is detected. In addition, parents and kindergarten teachers should make sure that children do not enter the sandbox with food and wash their hands and face after playing in the sandbox.

The presented work, despite presenting research that has not been previously carried out in this form, has certain limitations. The first is the small amount of data that was collected from respondents only in certain parts of one city. The survey did not ask about the number of children. It happens that a parent of one child perceives safety differently than a parent who has more children. By conducting more detailed surveys, covering more districts of the city and asking questions about the number of children, it can obtain information that will certainly allow to take a broader look at the analyzed issue. Another limitation of the work is the use of the Ishikawa diagram, which only presents cause-effect relationships, but does not include cause-to-cause relationships. The solution may be to use one of the modern quality management tools - a relationship diagram that shows such connections.

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