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Assessment of Environmental Risks in the Civil Construction Sector. Note II: Risks Associated with Use, Decommissioning and Demolition Stages

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Abstract

In recent decades, the civil construction sector has undergone rapid growth, marked by an increase in both the number and complexity of infrastructure and building projects. Environmental risks in the civil construction sector pertain to the potential for construction activities to cause negative impacts on the natural environment. The aim of the study is to develop risk matrices for risks associated with use, decommissioning and demolition stages in civil constructions sector. The operation and usage phase of a building or infrastructure is crucial, as it involves a variety of risks that can impact performance, safety, and maintenance costs. Identified risks include structural defects, maintenance challenges, mechanical, electrical, and plumbing (MEP) system failures, environmental incidents, regulatory non-compliance, material degradation, changes in building usage, health and safety concerns, fire hazards, community impacts, and accessibility issues. The decommissioning and demolition phases are integral and interconnected steps in the process of land and civil structure reconfiguration. Significant risks during these stages include occupational accidents, exposure to hazardous materials, environmental pollution, and waste generation, all of which can negatively impact worker health and the environment, potentially leading to legal penalties.

Keywords: European directives, hazard, maintainance issues, safety and protection measures.

1. Introduction

In recent decades, the civil construction sector has experienced rapid development, reflected in the increase in the number and complexity of infrastructure and building projects. This expansion has brought numerous economic and social benefits, contributing to job creation and improving living conditions. However, construction activities have a significant impact on the environment, generating various risks that need to be assessed and managed effectively [3, 8]. Environmental risk in the civil construction sector refers to the likelihood that construction activities will generate adverse effects on the natural environment, including air, water and soil pollution, degradation of natural habitats and loss of biodiversity.

These risks can have long-term consequences on human health, quality of life and ecological sustainability [4, 5, 10, 11].

Environmental risk assessment is an essential process for identifying, analyzing and managing the negative impact of construction projects on the environment. It involves the use of specific methods and tools to determine the level of risk and to propose measures to reduce or eliminate it [1, 2, 10, 11].

In a global context marked by climate change and a growing awareness of environmental issues, environmental risk assessment is becoming an indispensable tool for the planning and implementation of sustainable construction projects [1, 6]. The main objective of this study is to analyze and evaluate the environmental risks associated with the civil construction sector, with a focus on identifying the main sources of risk and developing effective strategies for their management.

The study aims to provide a solid basis from which decision-makers, designers and builders can learn to integrate environmental considerations into all stages of the construction process. In order to achieve the proposed objectives, risk assessment models and knowledge from the field will be applied. Data and information from secondary sources, such as environmental reports, impact studies and specialized literature, will also be used [9].

The civil construction sector in Europe plays a crucial role in the continent's economy, contributing significantly to regional GDP and job creation. Civil construction includes a wide range of projects, from road and rail infrastructure to residential and commercial buildings. In the context of continuous urbanization and increasing demands for infrastructure modernization, the civil construction sector is vital for ensuring sustainable and sustainable development in Europe [9, 11]. In recent years, the focus on sustainability and reducing environmental impact has increased significantly in Europe. European directives and international agreements, such as the Paris Agreement, impose strict requirements for reducing carbon emissions and promoting energy efficiency. In this context, the civil construction sector is challenged to adopt greener practices, use sustainable building materials and implement innovative technologies to minimize environmental impact [7].

The aim of the study is to develop risk matrices for risks associated with use, decommissioning and demolition stages in civil constructions sector.

2. Material and Method

A risk matrix is a tool used to identify, evaluate, and manage risks by prioritizing control measures based on their probability and impact. It involves determining the likelihood of a risk occurring using a probability scale and evaluating the potential consequences of the risk on an impact scale [2, 10, 12].

Risks associated with the operation and use phase relate to resource consumption, greenhouse gas emissions and impacts on biodiversity. Built buildings and infrastructure can be high users of energy, water and other natural resources, contributing to resource depletion and climate change. Energy-inefficient buildings can generate significant greenhouse gas emissions, contributing to global warming. The siting and operation of infrastructure can continue to affect natural habitats and biodiversity, through land fragmentation and continued pollution.

Risks associated with the decommissioning and demolition phase relate to the management of demolition waste, soil and water pollution, recycling and reuse of materials. Demolition of structures generates large amounts of waste, including hazardous materials that require appropriate treatment and disposal. Demolition activities can lead to soil and water contamination with toxic substances. Lack of an adequate plan for recycling and reuse of construction materials can lead to waste of resources and pollution.

3. Results and Discussions

Risks associated with the operation and use phase in the civil engineering sector. The operation and use phase of a building or infrastructure refers to the period during which it is used for its intended purpose, after the completion of construction. This phase involves various risks that can affect the performance, safety and maintenance costs of the building.

The following risks have been identified as risks associated with the operation and use phase in the civil engineering sector: structural defects, maintenance issues, mep system failures, mep system failures, environmental incidents, regulatory compliance, material deterioration, changes in building use, health and safety issues, fire risk, community impact and accessibility issues. The risk matrix and the risk level value matrix are presented below in Table 1. This can be useful in identifying and assessing the potential risks that buildings and infrastructures may encounter after construction is completed and put into use.These risks are assessed based on likelihood and impact to prioritize mitigation actions. For structural defects that consist of problems related to the structural integrity of the building, such as cracks or weakening of the foundation, the risk level is low, and recommended mitigation measures consist of periodic inspections, preventive maintenance, and prompt repairs.

Table 1. Probability, Impact and Risk Level Values for the Risk Matrix Associated with the Operation and Use Phase in the Civil Construction Sector

Risk	Probability	Impact	Level
Structural defects	2	5	10
Maintenance issues	5	4	20
MEP systems failures	3	5	15
Safety and security issues	4	5	20
Environmental incidents	2	5	10
Regulatory compliance	3	3	9
Material wear	5	3	15
Changes in building use	2	5	10
Health and safety issues	3	5	15
Fire hazard	3	5	15
Impact on the community	2	3	6
Accessibility issues	3	3	9

For maintenance problems that consist of deficiencies in maintenance activities that can lead to building damage, the risk level is high, and recommended mitigation measures consist of preventive maintenance plans, maintenance contracts with specialized companies, continuous monitoring preventive maintenance plans, maintenance contracts with specialized companies, continuous monitoring.

For MEP (mechanical, electrical, plumbing) system failures that consist of problems with the heating, ventilation, air conditioning, electricity, or plumbing systems, the risk level is moderate, and recommended mitigation measures consist of regular maintenance, use of quality components, monitoring, and prompt intervention.

For safety and security issues consisting of the risk of intrusion, vandalism, or other incidents that may compromise the security of the building and its occupants, the risk level is high, and mitigation measures consist of modern security systems, video monitoring, security personnel.

For environmental incidents consisting of negative environmental impacts due to the operation of the building (e.g. pollution), the risk level is low, and mitigation measures consist of eco-friendly operating practices, environmental certifications, and efficient waste management.

For regulatory compliance consisting of non-compliance with updated regulations and standards, the risk level is low, and mitigation measures consist of continuous monitoring of regulations, internal audits, and adjustment of operations. For material wear and tear consisting of the deterioration of construction materials and finishes over time, the risk level is medium, and mitigation measures consist of periodic maintenance, use of durable materials, and prompt repairs. For changes in building use that consist of modifying the original purpose of the building and may require structural or functional adjustments, the risk level is low, and mitigation measures consist of flexible planning, impact assessment before change, and infrastructure adaptability.

For health and safety issues that consist of risks to the health and safety of occupants, such as poor air quality or toxic materials, the risk level is medium, and mitigation measures consist of monitoring air quality, using safe materials, implementing safety measures. For fire risk that consist of the possibility of a fire breaking out that causes major damage to the building and occupants, the risk level is medium, and mitigation measures consist of effective fire detection and extinguishing systems, evacuation plans, and occupant training. For community impacts consisting of negative impacts on the surrounding community, such as increased noise or traffic, the risk level is low, and mitigation measures consist of community consultation, implementation of impact reduction measures, environmentally friendly design. For accessibility issues consisting of deficiencies in the accessibility of the building for people with disabilities or mobility difficulties, the risk level is low, and mitigation measures consist of compliance with accessibility regulations, adaptation of infrastructure, provision of necessary facilities. The problems that may arise and that may generate risks are presented below. The materials needed for construction do not arrive on time at the construction site and delays in the execution of the works and cost increases may occur. The materials or execution do not meet quality standards and the need for repairs arises, increasing costs and decreasing the durability of the construction.

Incidents may occur in which workers are injured or there is material damage, which may lead to the cessation of works and legal and financial penalties. Severe weather may affect the progress of construction works, which may cause delays in execution and additional costs. Legislative changes may be recorded that affect the conditions for the construction work and, as a consequence, the need to adapt the project and increase costs may arise.

Delays in the funds necessary to continue the works may lead to delays or the cessation of works and possible bankruptcies. Construction equipment and machinery may break down, resulting in delays in execution and repair or replacement costs.

In order to adequately manage the risks associated with the planning and design phase in the civil construction sector, specific solutions are proposed for each identified problem (Table 2).

Table 2. Risk management solutions associated with the planning and design phase in the civil construction sector

No.crt.	Identified problem	Proposed actions
1.	Delays in delivery of materials	Careful supply planning and supplier diversification
2.	Construction quality issues	Regular inspections and strict quality control
3.	Work accidents	Compliance with safety regulations and regular training of workers
4.	Adverse weather conditions	Compliance with all local and international regulations and standards.
5.	Changes in legislation	Continuous monitoring of regulations and prompt adaptation of plans Securing multiple sources of financing and maintaining a healthy cash flow
6.	Equipment failure	Regular maintenance of equipment and facilities

Risks associated with the decommissioning and demolition phase in the civil construction sector. The decommissioning and demolition phase in the civil construction sector involves various risks and challenges that need to be carefully managed to ensure safe, efficient and regulatory compliant execution.

These risks can range from occupational safety and environmental issues to logistical and financial issues. The following risks have been identified as being associated with the decommissioning and demolition phase in the civil construction sector: work accidents, exposure to hazardous materials, environmental pollution, logistical and transport issues, delays in the demolition schedule, unforeseen costs, compliance with legal regulations, waste generation, impact on existing infrastructure, community complaints, dust and noise control and site security.

The risk matrix and the risk level value matrix are presented below in Table 3.

Table 3. Probability, Impact and Risk Level Values for the Risk Matrix associated with the decommissioning and demolition phase in the civil construction sector

Risk	Probability	Impact	Level
Work accidents	3	5	15
Exposure to hazardous materials	3	5	15
Environmental pollution	3	5	15
Logistics and transportation issues	3	3	9
Delays in the demolition schedule	3	3	9
Unforeseen costs	3	5	15
Compliance with legal regulations	3	5	15
Waste generation	5	5	25
Impact on existing infrastructure	3	3	9
Community complaints	3	3	9
Dust and noise control	5	3	15
Construction site security	3	5	15

Work accidents are incidents that can injure workers on the construction site, affecting worker safety, leading to work stoppages and possible legal penalties. The proposed mitigation measures consist of regular training of workers, implementation of strict safety measures. The proposed mitigation measures consist of prior assessment and protection of surrounding infrastructure.

In order to adequately manage the environmental risks, specific solutions are proposed for each identified problem (Table 4).

Table 4. Risk management solutions associated with the decommissioning and demolition phase in the civil construction sector

No.crt.	Identified problem	Proposed actions
1.	Evaluare detaliată a riscurilor	Identification and early assessment of specific risks associated with decommissioning and demolition, including analysis of their potential impact and likelihood of occurrence.
2.	Proactive planning and management	Develop a detailed risk management plan that includes clear procedures and well-defined steps for each aspect of the decommissioning and demolition process.
3.	Compliance with safety regulations and standards	Ensuring compliance with all local, national and international regulations relating to demolition, waste management, environmental protection and occupational safety.
4.	Adequate staff training and preparation	Ensuring that all those involved in the decommissioning and demolition process are well trained in the legal, technical and safety aspects specific to their activities.
5.	Use of modern technologies and equipment	Adopting advanced technologies and specialized equipment to increase work efficiency and minimize the impact on the environment and the community.
6.	Continuous monitoring and reporting	Implementing a system for continuous monitoring of work progress and compliance with established plans, transparent reporting of any problems and implementation of necessary corrective actions.
7.	Waste and hazardous substance management	Planning and implementing an effective waste management program, including identification, classification, transportation, temporary storage, and proper disposal of hazardous or recyclable materials.
8.	Effective communication with stakeholders	Maintaining open and transparent communication with all stakeholders, including the local community, local authorities and other organizations involved in the project.
9.	Implementation of safety and protection measures	Ensuring the implementation of appropriate safety measures to protect workers, other people and surrounding infrastructure from the risks associated with demolition.
10.	Proper financial planning	Conducting a detailed financial assessment and planning an adequate budget to cover all estimated costs and potential additional costs that may arise during the decommissioning and demolition process.

Exposure to hazardous materials consists of exposure to asbestos, lead or other toxic materials with health risks for workers and the environment. The proposed mitigation measures consist of prior assessment of materials, use of protective equipment.

Environmental pollution consists of the release of harmful substances into the environment, which can lead to legal sanctions and ecological damage. The proposed mitigation measures consist of waste and contamination management plans.

Problems of delays and additional costs. The proposed mitigation measures consist of rigorous planning and contracts with reliable logistics providers.

Delays in the demolition program consist of non-compliance with the established deadlines and have a potential impact translated into increased costs and the impact of other projects. The proposed mitigation measures consist of efficient project management and continuous monitoring.

Unforeseen costs consist of expenses that were not anticipated in the initial budget and can lead to budget overruns and financial problems. The proposed mitigation measures consist of the accumulation of financial reserves and detailed planning of the expected costs. These costs include a detailed financial assessment of the project, including a contingency fund, clear contracts (signing clear and detailed contracts with suppliers and subcontractors to avoid additional unforeseen costs) and continuous review (continuous monitoring of costs throughout the project and adjusting the budget according to the progress of the works).

Compliance with legal regulations is an aspect that addresses non-compliance with applicable rules and regulations, which results in sanctions and delays in the project. The proposed mitigation measures consist of consulting with the authorities and obtaining all necessary approvals.

Waste generation consists of the accumulation of large quantities of waste resulting from demolition, which has a negative impact on disposal costs and environmental impact. The proposed mitigation measures consist of recycling materials and effective waste management plans.

The impact on existing infrastructure consists of damage to adjacent infrastructure, which may lead to repair costs and litigation.

Community complaints consist of complaints from residents in the adjacent area, which may result in conflicts and possible work stoppages. Proposed mitigation measures consist of active communication with the community and minimization of discomfort.

Dust and noise control consist of dust and noise emissions during demolition, which may have a discomforting impact on the community and legal sanctions. Proposed mitigation measures consist of the use of appropriate equipment and techniques for dust and noise control.

Site security refers to the risk of intrusion or theft on the site, which may result in material losses and delays. Proposed mitigation measures consist of the installation of security systems and video monitoring.

4. Conclusions

The operation and use phase of a building or infrastructure is critical, involving numerous risks that can affect performance, safety and maintenance costs.

Among the risks identified are structural defects, maintenance issues, MEP (mechanical, electrical, plumbing) system failures, environmental incidents, non-compliance with regulations, material deterioration, changes in building use, health and safety issues, fire risk, community impact and accessibility issues.

To manage these risks, mitigation measures such as periodic inspections, preventive maintenance plans, use of quality components, modern security systems, eco-friendly practices, continuous regulatory monitoring, use of sustainable materials, flexible planning, air quality monitoring, effective fire detection and suppression systems, community consultation and compliance with accessibility regulations are recommended.

Both decommissioning and demolition are essential and interdependent stages in the process of reconfiguring land and civil structures. Occupational accidents and exposure to hazardous materials are significant risks in the construction industry, with serious consequences for workers' health and the environment. Environmental pollution and waste generation are also environmental issues that can lead to legal sanctions.

Delays in the demolition schedule and unforeseen costs can cause budget overruns and affect other projects.Effective management of these issues includes preventive measures such as worker training, the use of protective equipment, rigorous planning and the implementation of effective waste management plans.

Compliance with legal regulations and active communication with the community are essential to minimize conflicts and ensure the smooth running of projects. In addition, site security must be guaranteed by adequate measures to prevent intrusions and theft.

The correct implementation of these processes not only facilitates sustainable and responsible development, but also contributes to maintaining a safe working environment and compliance with environmental and construction regulations.

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