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Risk Analysis in Internal Transport: An Evaluation of Occupational Health and Safety Using the Fine-Kinney Method

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Abstract: The imperatives of occupational health and safety (OHS) are increasingly recognised as critical components of business operations, particularly within logistics where manual tasks such as item picking and transportation present notable hazards. This study employs the Fine-Kinney method to conduct a risk analysis of internal transport activities in logistics systems. Hazards associated with various internal transport mediums are systematically identified and categorised. An illustrative case study involves a logistics provider based in Serbia, scrutinising the risks prevalent within warehouse operations. Through application of the Fine-Kinney method, the analysis determines the predominant risk to be collisions involving pedestrians. In response, the study advocates targeted preventive and corrective strategies to diminish these risks. Theoretical and practical contributions arise from addressing these identified risks, offering valuable insights for logistics enterprises. The emphasis on preemptive safety measures underscores their significance in safeguarding worker welfare and enhancing the efficiency of logistics operations.

Keywords: Risk assessment; Occupational health and safety; Fine-Kinney method; Internal transport; Logistics; Preventive measures

1 Introduction

Technological advancements are reshaping logistical operations, particularly through automation and digitization. Despite such progress, the manual nature of many logistical tasks necessitates a rigorous analysis of OHS due to the high incidence of potential injuries and unsafe work conditions. It has been documented that health issues among logistics employees, including stress and physical strain, contribute to dissatisfaction and a diminished commitment to both the organization and its clients, subsequently degrading the quality of logistic services offered [1, 2]. A healthy work environment is paramount, one in which employees are safeguarded and motivated to perform optimally. The imperative of OHS is manifested in measures implemented by companies to mitigate adverse effects and guarantee a secure work setting. The right to safety and health protection stands as a fundamental human entitlement, underpinning productive work and quality of life. Furthermore, such protection is not solely for the employee's welfare; it also enhances productivity, quality of products and services, and employee motivation and satisfaction [3, 4].

The complexity of internal transport processes, characterized by an amalgamation of diverse technologies and tools, is noted. These processes remain semi-automated, necessitating employee involvement in their execution [5]. The confluence of employees in proximity to internal transport means inherently entails risk, exacerbated in the absence of appropriate protective measures and adequate training. The foundational approach to avert potential harm in such settings involves the identification of risk, its causes, and consequent outcomes. Risk assessment serves to recognize and quantify activities with accident potential and to stipulate preventive measures or, at a minimum, attenuate the aftermath of accidents.

The objective of this examination is to underscore the significance of workplace safety and health, pinpoint risks associated with various internal transport means, and delineate applicable control measures. The structure of this paper is as follows: a problem description and literature review are expounded in the subsequent section. The third section addresses the identification of risks and hazards inherent in internal transport, including an in-depth risk profile for each transport modality. The application of the Fine-Kinney method for risk assessment within internal transport is elucidated in the fourth section. A case study analysis is presented in the fifth section, followed by concluding observations and prospective research avenues in the final section.

2 Problem Description and Literature Review

OHS are defined by the establishment of conditions under which protective measures are enacted to safeguard the lives and health of employees, as well as other individuals entitled to such security. It represents a societal consensus, engaging all stakeholders in the pursuit of optimal safety and health standards within the workplace. The objective is the minimization of adverse outcomes, fostering an environment wherein employees achieve satisfaction from their tasks. This domain integrates a spectrum of measures, technical, health-related, legal, psychological, pedagogical, among others, aimed at hazard identification and elimination to ensure the welfare of individuals in their professional milieu.

Protection, considered as a societal function, manifests in both broad and specific contexts. Broadly, it is underpinned by labor and social insurance laws that confer rights related to working hours, earnings, and safe work conditions, encompassing a gamut of protections that extend social and material security in the event of occupational injuries. Specifically, protection involves a suite of measures and activities dedicated to the creation of safe work conditions and the preservation of worker health.

The imperative for occupational safety measures originated with the earliest forms of labor, but only materialized as an organized pursuit in the early 19th century. Post-industrial revolution, a stark escalation in workplace injuries was observed, culminating in worker protests demanding improved conditions. This catalyzed the evolution of protective legislation, the broadening of social rights, and the formation of international bodies committed to the stabilization of safety and health systems within workplaces.

Initial efforts in occupational protection prioritized technical measures, such as rudimentary protective devices on machinery to prevent physical injuries. However, the maturation of mechanization rendered many such measures obsolete. The advent of automation and information technologies at the close of the 20th century, replacing manual labor with automated systems, necessitated novel approaches to workplace safety and protection due to the emergence of new hazards and risks.

Presently, alongside traditional workplace injuries and recognized occupational diseases, there is an increasing prevalence of work-related illnesses, stress, and psychological afflictions. These contemporary concerns, pervasive across all work activities, demand heightened vigilance concerning risks associated with work process organization, worker psychophysical capacities, social interactions, and employee behavior both within and beyond the workplace.

The influence of team leaders on safety within warehouse environments was investigated, with a focus on the practices of a Logistics Service Provider (LSP) company [6]. Concurrently, the Hazard Identification, Risk Assessment and Risk Control (HIRARC) method was employed in maritime warehouse settings to identify potential hazards, with the research underpinned by interviews and observations, culminating in the determination of twelve risk factors [7].

The assessment of warehouse risk has been approached through the use of an interval-valued intuitionistic fuzzy Analytical Hierarchy Process (IVIF-AHP), categorizing OHS risks into tiers of significance ranging from insignificant to catastrophic [8]. The introduction of new technologies, such as drones, into warehouse operations and their implications on safety were also examined, applying a fuzzy Failure Modes and Effects Analysis (FMEA) to evaluate ten identified risks within warehouse operations [9, 10].

The ergonomic risks in warehouses have been quantified using the Cornell Musculoskeletal Discomfort Questionnaire (CMDQ), which informed the implementation of potential preventive and corrective measures [11]. Further, the integration of Fine-Kinney with Fuzzy Analytic Hierarchy Process-Fuzzy Višekriterijumsko kompromisno rangiranje (FAHP-FVIKOR) methods was adopted for risk assessment, leading to the proposition of risk mitigation strategies [12].

Evaluations of OHS risks have also been conducted using Pythagorean Fuzzy Proportional Risk Assessment (PFPRA), which encompasses Fine-Kinney, Pythagorean fuzzy AHP, and a fuzzy inference system (FIS), in conjunction with Pythagorean Fuzzy FMEA (PFFMEA) [13]. A hybrid methodology combining Kemeny Median Indicator Rank Accordance (KEMIRA-M), Quality Function Deployment (QFD), and Fine-Kinney has been proposed for risk assessment, with its efficacy tested using data from a manufacturing company [14, 15]. The literature frequently references the FMEA method for risk assessment, notably in managing risks in international commodity flows and goods distribution, where a fusion of FMEA and QFD methods was applied [1, 5]. Such methodologies have led to the development of preventive and corrective measures post-implementation. In the domain of freight forwarders, the FMEA methodology has identified primary risks in international commodity flows, such as erroneous loading addresses, documentation lapses, informational deficits, and traffic congestion at borders [2]. Labor safety in warehouses has been evaluated through logistics field audits (LFA), and frameworks for safety improvement in warehouse settings have been proposed [3, 4].

2.1 Role and Significance of OHS

OHS extend beyond the mere preservation of employee well-being, significantly enhancing productivity, service quality, work motivation, and employee satisfaction. It is imperative to align the highest standards of health and psychophysical protection with statutory and regulatory frameworks. Conditions and environments must be conducive to employee performance, with motivation fostered to ensure tasks are conducted actively and correctly.

The import of OHS is evaluated from humanistic, social, and economic lenses. Humanely structured work conditions engender individual contentment, corporate success, and societal pride. Socially, the focus is on the reduction of workplace incidents, occupational diseases, and the subsequent care extended to affected employees and their families. Economically, the repercussions of workplace injuries are significant, entailing costs related to work cessation, medical expenses, and compensations that impact both employer and social insurance budgets. Thus, OHS are intricately linked to the productivity, cost-efficiency, and market competitiveness of business operations.

Managing OHS is critical for several reasons. Ethically, it is incumbent upon employers to guarantee a secure work setting. Statistically, safe environments correlate with heightened worker efficiency and lower absence rates, thus reducing potential financial liabilities. Strategically, robust health conditions are pivotal in attracting investment and securing competitive edges through trust and reputational enhancement. Conversely, inadequate health standards can erode profitability and precipitate poor business outcomes, potentially leading to the attrition of top-tier employees. Legally, adherence to OHS regulations is not merely advisable but often compulsory, with non-compliance attracting severe penalties. At the corporate level, investment in a quality work environment yields long-term benefits, with ramifications that extend to national economic parameters, influencing national income levels and the allocation of social insurance funds [16].

2.2 ISO 45001

Prior to the establishment of the ISO 45001 standard, the Occupational Health & Safety Assessment Series (OHSAS) 18001 standard prevailed. This precursor delineated requirements for a health and safety management system, necessitating organizations to assimilate and fulfill stipulated health and safety legislative mandates. Designed for compatibility with the ISO 9001 and ISO 14001 standards, OHSAS 18001 facilitated the integration of quality management, environmental protection, and health and safety management systems. In April 2018, a transition was observed from OHSAS 18001 to the ISO 45001 standard [17].

ISO 45001 articulates the criteria for an OHS management system, targeting organizations cognizant of the paramount importance of employee well-being. It mandates a thorough examination of processes, identification of actual and potential impacts, and assessment of associated risks. The crux of this standard's implementation lies in its proactive approach to safeguarding employee health and safety. It prescribes the meticulous documentation of employee health incidents and injuries, the execution of pertinent training, the analysis of data, and the adoption of measures for the continual enhancement of the safety system. Responsibilities and authorizations are distinctly delineated to ensure steadfast application, safe work procedures and instructions are formulated, and employee training is conducted. Moreover, drills for managing emergency situations are periodically executed. Benefits reaped from the implementation of ISO 45001 encompass a reduction in workplace injuries, proactive injury prevention, organizational alacrity in hazard mitigation, legal compliance of work processes, and the bolstering of corporate reputation, potentially augmenting investor and partner engagement [18].

3 Identification of Risks and Hazards in Internal Transport

Transport is pivotal in logistics, occupying both the initial (raw material conveyance) and terminal (final product delivery to consumers) stages of the production process. Adequate management of transport is imperative, with safety being a paramount concern to prevent material damage and safeguard individuals. Transport bifurcates into external and internal segments. External transport encompasses the movement of materials between distinct locations, while internal transport pertains to material movement within a company's premises, linking various production and storage areas. Internal transport, a critical component of production, pervades all economic sectors, facilitating the progression of the technological process and connecting disparate production operations. A variety of internal transport means are utilized within logistic systems, including but not limited to trolleys, pallet trucks, forklifts, cranes, automated guided vehicles (AGVs), conveyors, and elevators.

The assessment of risks in workplace transport is a systematic process aimed at evaluating potential dangers to the safety and health of individuals stemming from vehicles or equipment utilized within the workplace by employers, employees, or visitors. This comprehensive examination encompasses all work aspects influenced by workplace transportation, taking into account specific hazards associated with the use of such vehicles and equipment. The primary goal of this risk assessment is to mitigate risk, forming part of the overarching legal obligations that employers and workplace controllers have to evaluate risks posed to the health and safety of employees. A three-step process is followed for the risk assessment related to workplace transportation [19]:

• Hazard identification. This initial phase involves recognizing all potential causes of injury or damage. Hazards may include materials, equipment, work methods, or exposure to harmful agents such as chemicals, noise, or vibrations. Identification of the types of transport means used is imperative (e.g., employee vehicles, forklifts, delivery vehicles, large trucks, etc.).

• Risk assessment for injury or damage. The subsequent phase seeks to determine who could be injured, the mechanism of injury, and the potential severity. All risks associated with each identified means of transport and activity, the individuals at risk, and the frequency of their exposure to these risks must be identified.

• Risk control. The final phase introduces measures to either eliminate or mitigate risks to the lowest reasonable and feasible extent. It involves an appraisal of existing control measures to ascertain their efficacy or the need for modification. Strategies may include: avoiding risks by altering workplace practices; assessing unavoidable risks and devising measures to manage them; addressing risks at their source through spatial reorganization and regular vehicle maintenance; tailoring the work environment to individual needs; substituting hazardous means of transport with safer alternatives; implementing collective protective measures for the benefit of all personnel; developing a comprehensive preventive policy that includes documentation of transportation management systems and introduction of risk-reducing work practices; provision of instructions for safe operations, including information dissemination about transportation-related hazards, appropriate attire, equipment, and visitor advisories.

3.1 Risks and Hazards Associated with the Use of Sack Trolley

Trolleys, as rudimentary transport means, are designated for the conveyance of light loads across short distances, not exceeding 50 meters, and are typically employed in operations of low intensity. Their utility is primarily as auxiliary transport within various settings, with variations ranging from one to four wheels as illustrated in Figure 1.

Figure 1. Sack trolley [20]

Incidents have been recorded where injuries were sustained due to the lack of comprehensive awareness regarding safety protocols associated with sack trolley usage. While not classified among the most hazardous equipment, the incidence of injuries or material damage associated with their use is not negligible. Adherence to basic procedures is essential to mitigate risks such as toe crushing, tripping, abrasions, and musculoskeletal injuries. The risks inherent in the use of sack trolleys include [20]:

• Compression injuries to fingers and hands, which may occur when they are caught between the trolley and stationary objects.

• Foot injuries, resulting from the trolley's wheels traversing over feet or from loads slipping off the trolley.

• Slips and falls, which may happen if the trolleys are improperly loaded, maneuvered at inappropriate angles, or operated on uneven surfaces.

• Overloading risks, which can cause a variety of injuries, particularly to the back, shoulders, and arms during the loading, unloading, or transit process.

• Falls attributed to unsuitable ramps or inclines.

3.2 Risks and Hazards Associated with the Use of Forklifts

Forklifts, which are vehicles equipped with a fork for lifting and transporting materials, are integral to operations within loading areas, warehouses, and distribution centers. They enable the horizontal and vertical movement of various types of cargo, from larger items to smaller goods on pallets and bulk items in containers. Adaptations with different attachments allow for the handling of diverse cargo forms, such as pipes, rolls, and barrels. Despite their utility, forklifts are associated with significant risks and hazards, as depicted in Figure 2.

Figure 2. Forklift accidents [21]

While forklifts are instrumental in material handling, they are not without associated risks that can lead to severe injuries or fatalities. It is recognized that through effective management and preventive measures, the incidence of forklift-related mishaps can be substantially reduced. A collaborative effort between employees and employers is essential to enhance health and safety measures at work [22]. Risks identified include [22, 23]:

• Overturning: The instability of forklifts, particularly when carrying loads, presents considerable danger to operators. Overturns may result in severe injuries or fatalities and are likely to occur under conditions of improper load balance, abrupt movements, or when navigating uneven terrain. Unloaded forklifts, which are less stable than their loaded counterparts, are particularly prone to overturns.

• Musculoskeletal strain: Operators may experience sprains, strains, and other soft tissue injuries, with potential long-term health implications. Hazards include repetitive movements, constant operation on uneven surfaces, and ingress and egress from the forklift.

• Pedestrian injuries: Forklift operations in shared spaces put pedestrians at high risk. Contributing factors to pedestrian injuries encompass driver inattention, inadequate signage, and lack of spatial separation between forklifts and pedestrian paths.

• Falling loads: Improperly secured loads pose a risk to both pedestrians and operators if they fall from the forks, which may occur due to overloading, incorrect loading practices, or abrupt movements.

• Falls from forks: Instances of employees standing on and being lifted by forklift forks, despite being unsafe, are reported. Falls from height can lead to serious injuries, often attributed to disregard for safety, the urgency of task completion, or lack of appropriate equipment.

• Harmful emissions: The use of internal combustion forklifts, though declining due to technological advancements, still poses a risk, especially in poorly ventilated or confined spaces.

• Collisions: Forklift collisions can occur with other vehicles or objects and may be caused by factors such as narrow working spaces, driver fatigue, poor visibility, or excessive traffic within the work area.

3.3 Risks and Hazards Associated with the Use of AGV

AGVs are vehicles outfitted with autonomous navigation systems that follow predetermined paths, as depicted in Figure 3. In the context of internal logistics, AGVs present a reduced risk profile due to the minimization of human-related factors, such as inattention or non-adherence to operational procedures, which traditionally contribute to accidents. The automation of AGVs mitigates such risks, with these vehicles being capable of autonomous obstacle detection, velocity regulation, and communication with other systems and personnel. AGVs are integrated with an array of sensors, actuators, and control systems, with sensor data being crucial for environmental navigation and interaction. AGVs can operate singularly or in conjunction with a fleet [24].

Despite the reliability of AGVs, they are not impervious to incidents that can result in significant repercussions. Should a braking system malfunction occur, an AGV's inability to halt upon obstacle detection can lead to collisions with infrastructure, machinery, or personnel, potentially resulting in injuries or fatalities. Technical malfunctions in speed and location sensors can also lead to a loss of AGV control, causing environmental damage or personal harm. Furthermore, the failure of obstacle detection systems complicates obstacle localization and may culminate in collisions. In instances of power loss, AGVs are programmed to deactivate, ceasing operation [24].

Figure 3. AGV [25]

To ensure the safe operation of AGVs, a variety of safety measures are employed. Constant monitoring of vehicle condition is vital, with pathways designated for AGV movement distinctly marked to delineate high-risk zones for employees. Traffic routes must be equipped with adequate warning signals, and safety gates and barriers installed where necessary. AGVs must be equipped with auditory and visual alerts, and an emergency stop feature should be readily accessible. Training for personnel operating in the vicinity of AGVs, as well as for those within the AGV operational area, is imperative to foster a safe working environment [9, 24].

3.4 Risks and Hazards Associated with the Use of Cranes

Cranes, utilized for moving bulk and individual goods within the confines of a specified workspace, are contingent upon their structural design. They are categorized by their power source, electric and internal combustion engine motors, and structural form, such as overhead, gantry, and portal cranes. An exemplar of an overhead crane is provided in Figure 4. Despite the implementation of safety measures, the operation of cranes is fraught with hazards. Between 1997 and 2006, data from the U.S. Bureau of Labor Statistics indicate an annual average of over 80 fatalities attributed to crane-related incidents, with 90% of these incidents ascribed to human error [26]. The risks associated with crane operation include:

Figure 4. Overhead crane [27]

Load drop: The peril of a falling load is among the most severe, with potential for injuries, fatalities, and extensive damage to infrastructure and equipment. Drops may result from operator error, improper load securing, or mechanical defects.

Electrical hazards: Approximately half of crane-related incidents involve contact between the crane and power lines, posing electrocution risks to those in contact with the crane and nearby personnel. Such incidents generally stem from inadequate planning and the absence of appropriate preventive measures. When avoidance of electrical lines is unfeasible, cranes should be equipped with physical barriers to prevent contact with live wires.

Crane overload: Crane malfunctions often occur due to overloading, surpassing the crane's operational capacity, which can lead to mechanical failure or collapse. While many cranes possess safety mechanisms to prevent overloading, not all are thus equipped. Excessive loading may induce load sway or cause abrupt drops, destabilizing or overturning the crane.

3.5 Risks and Hazards Associated with the Use of Belt Conveyors

Belt conveyors are utilized predominantly for the horizontal or inclined movement of bulk and individual goods. Characterized by a looped and tensioned belt between two drums, their fundamental components encompass frames, rollers or sliding surfaces for support, along with tensioning and driving mechanisms. They are acknowledged as the most prevalent transportation means within industrial settings.

Despite their efficiency, conveyors can present considerable dangers if safety protocols are not rigorously enforced. The importance of safety in conveyor operation has been increasingly recognized. Potential incident and accident locations have been categorized into four groups as illustrated in Figure 5 [28]:

• Hazards from the movement of conveyor drive components;
• Hazards associated with goods and stationary objects;
• Hazards from moving parts of the conveyor itself;
• Mechanical hazards.

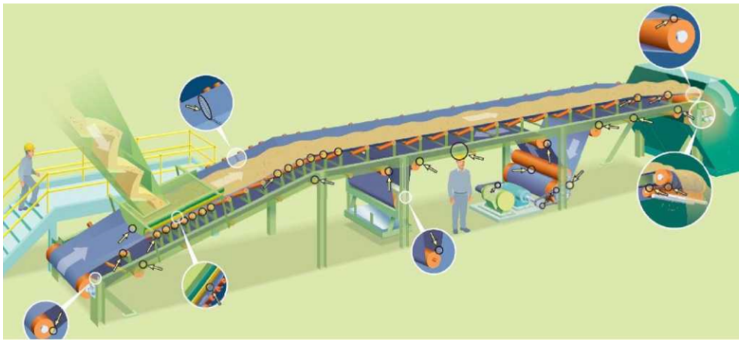

Figure 5. Possible injury locations on belt conveyors [28]

Risks associated with the operation of belt conveyors include [28]:

• Entrapment of limbs during handling or servicing, and while cleaning the conveyor belt;
• Crushing injuries caused by insufficient clearance when passing by the conveyor;
• Inhalation of airborne dust during conveyor operation;
• Falls from the conveyor during maintenance or interventions or due to unauthorized activity on the conveyor belt;
• Material falling from the conveyor onto workers at lower levels;
• Electrical shocks from electrically powered conveyors;
• Entrapment of limbs during the cleaning of the drum while the belt is in motion;
• Entrapment at material transfer points;
• Belt breakage or detachment during operation.

Injuries may arise from inadequately guarded or misplaced conveyor belts, where protective elements are essential to prevent workers' attire, hair, or limbs from being caught. Increased belt speeds, intended to enhance productivity, can lead to worker injuries. Regular maintenance is necessary to ensure conveyor belts' proper functioning. Overloading the conveyor belt may result in objects falling and causing injury, particularly if the machine is also unprotected. Comprehensive training regarding risks and safe handling practices for conveyor belts is a crucial preventive measure.

The spectrum of injuries from conveyor accidents extends from minor scratches to severe trauma, including amputations, traumatic brain injuries, burns, and, in certain cases, fatalities. Common injuries involve amputations due to entrapment, burns or electric shocks from faulty wiring, crush injuries, and fatal accidents owing to crushing, falls, hemorrhage, or related complications.

4 Fine-Kinney Method for Risk Assessment in Internal Transport

The Fine-Kinney method is a systematic approach employed for risk assessment in the domain of internal transport. This method quantifies risk by evaluating three factors: probability, frequency, and severity. Probability is the likelihood of a risk eventuating, frequency denotes the rate at which the risk is encountered, and severity gauges the extent of harm to humans or the environment upon the risk's occurrence. Each factor is assigned a numerical value using established scales, with probability ranging from 0.1 to 10, frequency from 0.5 to 10, and severity from 1 to 100. These values are derived from the criteria delineated in Table 1. A risk score is subsequently calculated using Eq. (1):

$$\text{Risk} = \text{Probability}\ (P) \times \text{Frequency}\ (F) \times \text{Severity}\ (S) \tag{1}$$

The resulting risk score is utilized to classify the risk into one of five categories, which range from 'acceptable' to 'very high' risk, as outlined in Table 2. Risks classified as 'very high' or 'high' warrant immediate attention, with priority given to the formulation of risk mitigation strategies.

Table 1 and Table 2 provide a classification framework for the risk score, guiding the identification and implementation of necessary preventive and corrective measures aimed at risk reduction or elimination.

Table 1. Classification of risk factors [15, 29]

Probability (P)	**Linguistic Definition**	**Frequency (F)**	**Linguistic Definition**	**Severity (S)**	**Linguistic Definition**
0.1	Virtually impossible	0.5	Very rare (yearly)	1	Noticeable (minor first aid accident, or $>$ \$100 damage)
0.2	Practically impossible	1	Rare (a few per year)	3	Important (disability, or \$$10^3$ damage)
0.5	Plausible, but unlikely	2	Unusual (monthly)	7	Serious (serious injury, or \$$10^4$ damage)
1	Only remotely possible	3	Occasional (weekly)	15	Very serious (fatality, or $>$ \$$10^5$ damage)
3	Unusual, but possible	6	Frequent (daily)	40	Disastrous (few fatalities, or $>$ \$$10^6$ damage)
6	Quite possible	10	Continuous	100	Catastrophic (many fatalities, or $>$ \$$10^7$ damage)
10	Predictable- might well be expected				

Table 2. Risk score values [15]

Risk Score	**Linguistic Definition**
> 20	Perhaps acceptable risk
$20 - 70$	Possible risk (attention required)
$70 - 200$	Substantial risk (corrections/measures required)
$200 - 400$	High risk (immediate corrections/measures required)
> 400	Very high risk (maybe operation should be discontinued)

5 Case Study of an LSP

In the ensuing analysis, the internal transport risks at a leading LSP in Serbia were scrutinized. This LSP, with an extensive warehouse footprint exceeding 200,000 m^2, adheres to all pertinent industry standards. Table 3 enumerates the potential hazards and their ensuing consequences. Utilizing the Fine-Kinney method, a comprehensive risk assessment was conducted, drawing on insights from interviews with five experts from the LSP. The evaluation results are presented in Table 4.

Table 3. Identification of hazards and consequences

Dangerous Scenarios	Consequences
Instances of forklifts overturning	A quarter of forklift overturning incidents result in fatalities; fractures and minor injuries are also reported, along with psychological impacts from fear and stress.
Collisions involving forklifts, whether with other vehicles or stationary infrastructure	Collisions between forklifts, or with other vehicles or stationary equipment, pose direct threats to operators, potentially resulting in a range of injuries from minor to severe. Impacts against stationary infrastructure, such as racking systems, can lead to catastrophic outcomes, including structural collapse and consequent endangerment to the workforce. Contact with electrical systems may incite fires, presenting widespread risk within the facility.
Situations where visibility is compromised due to elevated loads or obstructed sight lines	Occurrences of forklifts striking employees who are unaware or have their backs turned are noted, often resulting in injury.
Occurrences where loads become dislodged from forklift tines	Unsecured loads pose a risk of falling and causing harm to personnel in the vicinity or beneath. Furthermore, forklifts carrying hazardous materials may contribute to explosions if the load is compromised.
Events of personnel descending from forklifts	Consequences of these hazards span from lethal outcomes to significant physical trauma among employees.
Incidents where forklifts come into contact with pedestrian workers	Hazards of this nature are frequently associated with severe outcomes, including fatalities and fractures, which in turn lead to serious injuries among employees.
Cases of musculoskeletal injuries attributed to unfavorable ergonomic positions	Musculoskeletal injuries such as sprains, and injuries to the neck, back, and shoulders are attributed to repetitive or awkward movements and working on uneven surfaces.
Episodes of harmful emissions and the risk of explosions linked to refueling practices	Refueling and battery charging operations introduce risks related to flammable materials, with potential respiratory damage or poisoning to personnel in close proximity. The presence of an ignition source can escalate to a severe fire hazard.
Accidents where individuals are entrapped or compressed by forklifts or their loads	Employees situated near forklifts are at risk of injury from falling loads or overturning vehicles.
Circumstances leading to falls while operators mount or dismount forklifts	Drivers face the danger of slipping and sustaining serious injuries, including those to the back and head, fractures, and abrasions.
Conditions of forklifts being laden beyond their operational capacity	Overloading forklifts heightens the risk of loads falling and causing injury to nearby workers.

Table 4. Risk evaluation results

Dangerous Scenarios	Probability (P)	Frequency (F)	Severity (S)	Risk Score	Possible Risk Control Measures
Forklift overturning	6	2	15	180	Stability of the load on the forklift forks should be verified, and the load should be secured before movement. Caution should be exercised on inclines, and the alteration of fork height during motion should be avoided. Speed regulation is crucial, particularly when navigating curves. Comprehensive employee training programs should be instituted to cover operational safety. Ample space for maneuvering should be ensured to facilitate safe. forklift operation

Dangerous Scenarios	Probability (P)	Frequency (F)	Severity (S)	Risk Score	Possible Risk Control Measures
Collisions between forklifts, as well as between forklifts and other transportation vehicles or stationary objects	6	3	15	270	Two-way traffic should be established where feasible, with clear signage on fixed objects to enhance visibility. Signaling systems at intersections and mirrors at blind spots should be installed to improve navigational safety. A safe distance should be maintained between forklifts and other transport vehicles, especially when overtaking or circumventing obstacles. Forklifts should be parked exclusively in designated areas to prevent unregulated traffic and potential collisions.
Visibility compromised often due to heavily loaded cargo, elevated forks, or the presence of blind spots	6	2	3	36	Operation of forklifts shall be conducted only when the path of egress is unobstructed and visible. It is recommended that a spotter external to the forklift provides guidance to the operator. The forks should be maintained at a low elevation to ensure unimpeded visibility for the driver. Vigilance should be heightened during maneuvers such as turning and reversing.
Instances of loads falling from forklifts	10	2	15	300	Forklifts should be inspected for maintenance, focusing on the integrity of the forks before loading.
Employees falling from forklifts	10	3	7	210	The use of lifting cages and appropriate equipment should be employed for tasks involving height.
Pedestrian collisions with forklifts	10	3	100	3000	Traffic between forklifts and pedestrians should be segregated, with marked pathways and lanes. Speed limits for forklift movement should be enforced, and barriers installed where necessary. Forklifts should be equipped with lighting systems to enhance visibility to pedestrians.
Workers suffering from back and neck injuries attributed to unfavorable body positions	10	10	3	300	Swivel seats on forklifts should be used to reduce ergonomic strain, and the condition of road surfaces should be regularly assessed. Control layouts should be ergonomically arranged to prevent repetitive strain.
Emissions of harmful gases and risks of explosions arising from inadequate refueling practices	1	10	100	1000	Awareness regarding the hazards of indoor emissions should be raised among employees, and adequate ventilation systems should be installed. Regular maintenance of forklifts should be conducted to prevent mechanical failures.

Dangerous Scenarios	Probability (P)	Frequency (F)	Severity (S)	Risk Score	Possible Risk Control Measures
Workers at risk of being caught or crushed by forklifts or their loads	6	6	15	540	Prior to forklift activation, it is imperative to verify the absence of personnel in the vicinity. Operators are required to remain seated during forklift operation,and the stability of the load must be ensured. It is prescribed that workers abstain from positioning themselves beneath elevated forks.
Workers falling while entering or exiting forklifts	10	3	7	210	Adequately illuminated parking zones for forklifts must be provided to detect any ground surface irregularities, such as spills or debris. Handlebars should be ergonomically situated to facilitate optimal grip and accessibility. Comprehensive training in safe forklift entry and exit protocols is essential, with an emphasis on minimizing the frequency of these transitions.
Overloading of forklifts	10	2	7	140	The transport of cargo of indeterminate weight is strictly prohibited. Operators must be informed of the cargo's weight limits, ensuring all loads are securely fastened before transport.

The data in Table 4 indicate that no risk falls within the 'acceptable' category; each necessitates at least monitoring measures. Risks such as forklift overload and reduced visibility during operation are deemed small and can be mitigated through enhanced driver vigilance without substantial control measures. Medium risks, including forklift overturning, collisions, cargo falls, employee falls, and back and neck injuries due to poor ergonomics, necessitate the implementation of specific measures. These risks could result in outcomes requiring medical intervention or, in more severe cases, may lead to multiple fatalities, as could occur with explosions resulting from improper fueling. The most significant risks, those of workers being crushed by forklifts and forklift collisions with pedestrians, demand considerable effort and resources to manage.

For each identified risk, potential control measures have been proposed. These range from operational adjustments, such as load checking and maneuvering space enhancement for forklift operation, to infrastructural changes, including traffic route modifications and the installation of barriers. Training and procedural updates, particularly in high-risk zones, are critical components of the risk mitigation strategy.

In summary, while extremely high risks were not identified, the assessment underscores the necessity for interventions of varying degrees to address the risks present. These interventions, which could require significant financial investment, aim to eliminate or at least significantly reduce the identified hazards.

6 Conclusions

In the domain of logistics, the foundational role of safety is increasingly recognized, given the escalating incidence of injuries, fatalities, and material damages across diverse subsystems. This study underscores the direct impact of health risks on the social sustainability within companies. It is observed that injuries precipitate not only absences from work but also contribute to delays, diminished efficiency, and consequent reductions in revenue and profit margins. These findings underscore the necessity of comprehensive risk analyses, which are integral for mitigating potential hazards to personnel and the environment during various logistic operations.

The intricacies of OHS demand a multidisciplinary approach, engaging experts across various fields. The simplistic view that safety systems depend solely on the application of protective measures is now outdated. The human element emerges as a critical factor, incorporating mental and physical health, job satisfaction, hygienic conditions, contentment with work equipment, and other variables that influence the likelihood of workplace injuries.

The principal objective of risk assessment is to understand the dimensions of risks that precipitate undesirable events. The choice of a risk analysis method is informed by the complexity of the process, the organizational structure, and specific problem familiarity. In this research, the Fine-Kinney method was employed, applied to a LSP in Serbia, with a focus on forklift-related hazards. The probability, frequency, and severity of these hazards were evaluated, and a risk score was computed. Subsequently, measures were suggested to either eliminate or mitigate the identified risks, from enhancing employee vigilance to implementing advanced safety technologies and systems.

For future research, alternative risk assessment methods should be explored and compared across diverse real-world scenarios. Simulations also present a promising avenue for future studies. Furthermore, quantifying the costs associated with risk management could provide valuable insights. The primary limitation of this research was the unavailability of specific injury and damage data due to the company's confidentiality policies.

Data Availability

The data used to support the findings of this study are included within the article.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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