

Keywords: errors; warehousing; modern solutions; strategy

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REDUCING ERRORS IN THE COMPANY'S WAREHOUSE PROCESS

Summary. Warehousing is a labour-intensive process, requiring warehouse operators to use different methods of work and various equipment and to be in constant motion. During this process, various types of warehousing errors can occur, which can be reduced with the introduction of a suitable strategy. A prerequisite for this is to have sufficient knowledge of the specifics of error prevention in the warehouse process that are mainly linked to how warehouse operators perceive the usefulness of modern technology, the introduction of modern work processes and their own accountability in work. This study aims to develop a strategy that takes into account these aspects and is an ideal solution for the prevention of potential errors in the warehouse process of the company.

1. INTRODUCTION

From a macro perspective, the warehouse process is primarily a link between the manufacturer and the buyer [1], whereas from the micro perspective, it represents the link between business functions within the company (sales, purchasing, production, logistics, etc.). What both perspectives have in common is the intensity of the operations and the constant motion of people and equipment [2]. Operations do not only add value to the logistics system of a company [3] because each additional activity in the warehouse increases costs and the potential for errors in the warehousing process. Errors can affect both the well-being of individuals through work-related injuries and a company's overall costs, both direct and indirect. According to estimates by HSE [4] - Great Britain's national independent watchdog for work-related health, safety and illness, indirect costs can be up to 50 times higher than the costs incurred by the insurance company upon reimbursing the company in case of an accident. Loss of reputation alone can lead to lower prices of goods, reduced business volume and deteriorating employee morale [5].

The warehouse process is particularly prone to errors because it involves the use of different work processes and equipment. In addition, elimination of errors through the introduction of modern technological solutions does not guarantee success in itself, not without taking into account the specifics of the warehouse process. In this process, warehouse operators play a fundamental role by planning, designing, managing, maintaining and controlling the various technologies and systems. The successful implementation of various error-prevention strategies therefore often depends on the perceptions of warehouse operators with respect to the usefulness of modern technology, the introduction of modern working procedures and their accountability in relation to their work.

The views of different authors [2, 3, 5-10] differ on whether the introduction of modern technological solutions in the warehouse process results in fewer mistakes. For example, those who are opposed to increased automation recognise that modern technology gives the system and its users new capabilities, but also inevitably brings a certain complexity: increasing demands for a faster, more powerful and precise system; adapting poorly to existing work processes and technologies; requiring additional training; and bringing new vulnerabilities that did not exist before.

The main objective of this study is to devise a strategy that would represent a systemic solution for the management of work processes in a company's warehouse taking into account the specifics involved in preventing warehousing errors. This can help achieve greater accountability by warehouse operators in their work and greater commitment to the use of modern technological solutions. By taking into account the technological, organisational and individual (human) reasons for errors, the proposed strategy represents an ideal solution for the prevention of potential errors in the warehouse process of the company. The strategy also sets an important starting point for the further development of systems aimed at ensuring reliability and safety in warehouse, logistics and other operational work processes.

2. THE SPECIFICS OF PREVENTING ERRORS IN THE WAREHOUSE PROCESS – LITERATURE REVIEW

The review of the literature in the field of error prevention addresses three aspects that have a significant impact on the quality of work, costs, organisation and safety in the warehouse. The first aspect focuses on the analysis of the effect of individual warehouse activities on the costs and errors in the warehouse process. The second aspect emphasises the importance of the role of warehouse operators in introducing modern technological solutions in warehousing and the third focuses on the factors that affect the mistakes committed by warehouse operators in their work.

2.1. The Effect of Individual Warehouse Activities on the Costs and Errors in the Warehouse Process

In terms of the safety and health of employees, the HSE - Health and Safety Executive [4] identifies the main causes of accidents in the warehouse (Figure 1). Serious accidents are mostly caused by manual handling and slips, which are also the cause of most absences from work.

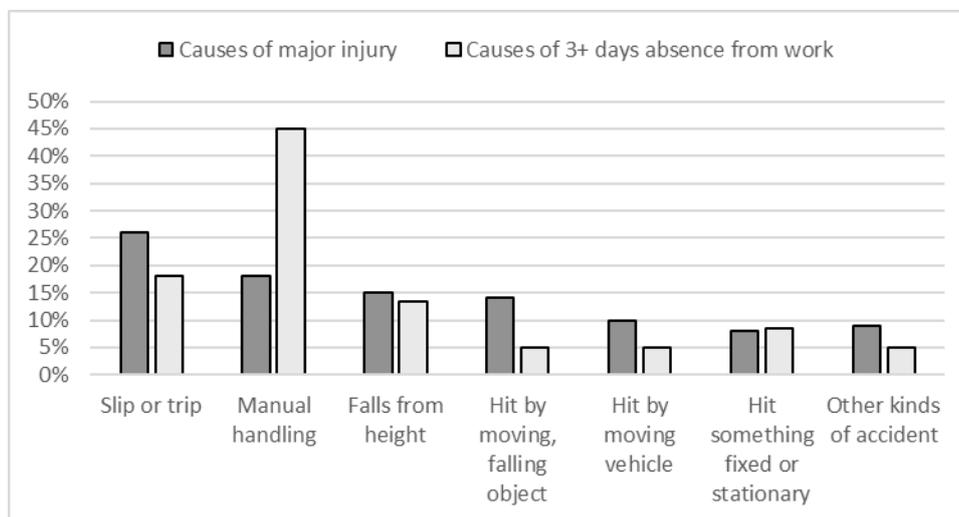


Fig. 1. The main causes of injuries in a warehouse [4]

The storage process as a support function to logistics comprises a series of activities: receiving, pre-packing, put-away, storing, order picking, packing, sorting and dispatching [1, 3, 10, 11]. Despite the interconnectedness of warehouse activities, each activity affects the total warehousing costs of a company differently. Figure 2 shows that the majority of the costs are attributable to the activity order picking, amounting to 36% of the overall structure of warehouse costs [10].

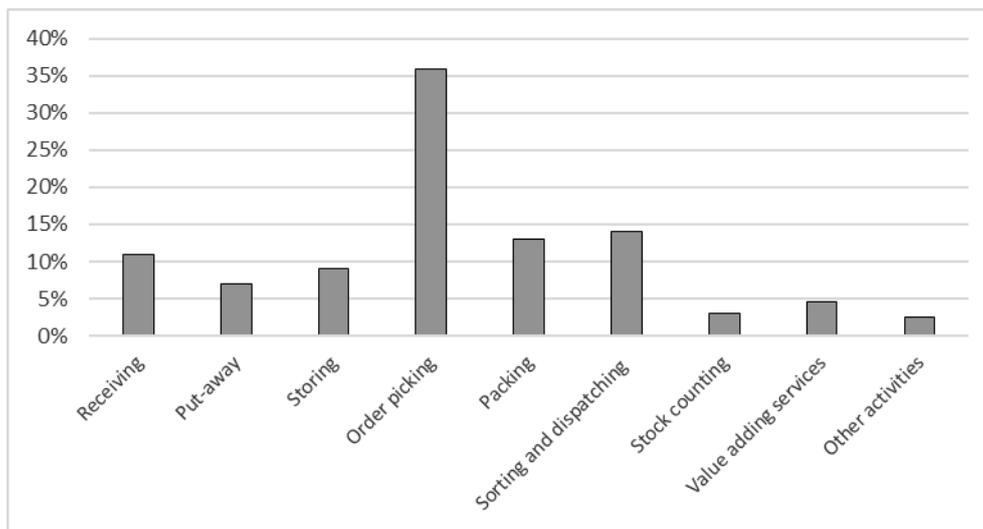


Fig. 2. Warehouse activities as a percentage of warehouse costs [10]

Some authors [12, 13] point out that order picking is one of the most labour-intensive and time-intensive processes in internal logistics, accounting for more than 50% of the total warehouse costs. It is unsurprising, therefore, that several authors researching the field of logistics have focused on this particular warehouse activity [1, 3, 10, 11]. In addition, this activity has a significant impact on the safety of employees as it involves a great deal of manual handling. The errors that occur in the process by which products are retrieved from their storage locations in response to customers' orders [14] can result in an increase in costs due to [10]:

- accepting returns;
- labour costs due to the manual handling and checking of the returned item,
- picking the replacement item;
- re-packing;
- re-delivery;
- administration costs;
- reduced cash flow with reference to non-payment of invoice;
- possible stock write-off if the returned product is outside an acceptable time of delivery or has been damaged in transit.

Due to the large impact on costs and on the quality of logistics services to customers, most researchers as well as the handling industry are investing their energies in the introduction of modern technological solutions to facilitate easier picking for employees and to increase picking productivity and quality.

2.2. The Role of Warehouse Operators in Introducing Modern Technological Solutions in Warehousing

In the work process of a warehouse, the use of modern technological solutions includes a better use of space, savings in energy and manpower, improved control, fewer manual handling operations, the possibility of coordinating flows of products in order to avoid bottlenecks, reduced operational costs and fewer work-related accidents [1, 10]. A study carried out by the American Aberdeen Group in 2009 found that the most successful companies use advanced warehousing technologies as a long-term strategic advantage for improving human capabilities and process and business results. The purpose of modern technological solutions is to increase productivity and quality of work [11, 15, 16], which should lead to a reduction of errors in the warehousing process of the company [10, 17].

However, even those advocating the use of modern technology have differing opinions on the subject of the automation of the picking process. Grosse [18] pointed out that it is possible to achieve a

fully automated picking process, but there are quite a few manual activities that do not require automation. The author proves his argument with the statistics that show that manual handling still prevails in practice. In his study, he stresses the importance of focusing on the important human characteristics of the order pickers in the management of the picking process. De Vries et al. [12] also point out that in order for the use of modern technology such as PTL, PBV or RFID to be successful, warehouse operators should be involved in the process. This is why picking performance is still highly dependent on the extent to which pickers are able to use these technologies efficiently. Therefore, it is of interest to investigate the influence of individual pickers and their interaction with the picking technology used. Modern warehouses face increasing demands to deliver products as quickly as possible and without any mistakes, requiring pickers to consistently work productively and accurately under high time pressure and with various picking tools. It is unlikely that all individuals respond equally well to these demands. To improve the order picking process, it is therefore interesting to find out which individual pickers can perform particularly well in specific order picking contexts [12].

2.3. Factors Affecting Errors Committed by Warehouse Operators

Various authors, such as Norman [6], Hollnagel [7], Reason [5, 8] and Dekker [9], who study the sources of error in the work process, emphasise the fact that warehouse operators are often identified as the main cause of errors in the warehouse process. The authors mentioned above reject this notion and further explain that human error is a symptom of deeper problems within the system because the source of errors is structural in nature, rather than human. The authors also point to technological and organisational causes of errors.

Errors that are rooted in technology occur because the warehouse process is constantly changing as increased automation reduces the number of manual handling operations, while also increasing data processing. Warehouse operators are thus interacting with information more than with the physical movement of goods [3]. These changes in warehouse operations result in fewer mistakes in terms of the movement of goods, but produce errors of a different kind, which are rooted in an increased use of technology [5, 6, 9]. Reason [8] shares the same point of view by highlighting that, in an effort to mitigate the consequences of the uncertainty of human resources, the designers of automated systems have unwittingly created an environment in which new types of errors can occur, which can be even more detrimental than the errors they were attempting to avoid in the first place. Reason [8] points out that automation, which has led to a greater use of technology, also brought with it additional problems:

- with fewer less demanding tasks being performed by humans, the technology has made
- the more demanding tasks even more challenging;
- high-tech systems require operators only to supervise their operations - this raises the
- problem of maintaining vigilance for longer periods of time;
- the skills of the operators become more difficult to update;
- the high investment costs are not always justified, given the expected benefits.

The errors that occur in the warehouse process are also an organisational problem because the problems are created within an organisation where people work. Identification of the sources of human error is therefore essential because of the accumulation of procedures and changing nature of work, production pressures, conflicting goals and the safety culture within the organisation [9].

Despite the fact that the source of errors in the warehouse process is structural in nature, rather than human, the fact remains that every individual contributes towards the work process different know-hows, abilities and skills as well as varying levels of motivation [19, 20]. From the point of view of managing the warehouse work process, a warehouse manager should possess the following nine critical attributes [10]: excellent communication skills, the ability to delegate effectively, motivational skills, problem-solving skills, flexibility, comprehensive knowledge of the processes and procedures of the company, the ability to train others, being customer oriented and teamwork skills. In addition to the personal attributes that are crucial for managing the warehouse process, there are several typical factors that can affect human performance in a negative way [9]: cognitive fixation, plan continuation,

stress, fatigue, buggy or inert knowledge, new technology, computerisation and automation surprises and procedural adaptations.

Personal characteristics, work experience and the factors that affect human performance have a significant impact on the level of human error in the warehouse process. Due to the nature and tendency to regulate the warehousing process, there are many routine work operations, which, in certain situations, can cause problems in mental perception, performance of work and decision-making. Betsch et al. [21] examined the issue of relapse errors in routinised decision-making. The study showed that individuals working under severe time pressure maintain their routines even when they are intent on choosing a more appropriate alternative. The source of human error can therefore also be found in the internal functioning of the individual. Reason [5] pointed out that each system has two types of control: external control, which is ensured by rules and procedures, and internal control, which stems from the knowledge and principles acquired through work practice and the employees' experience.

3. THE STRATEGY FOR REDUCING ERRORS IN A COMPANY'S WAREHOUSE PROCESS

The proposed strategy takes into account the specifics of error prevention in the warehouse process, identified in the literature review. Since most authors, i.e. Norman [6], Hollnagel [7], Reason [5, 8] and Dekker [9] argue that the reasons for errors are not exclusively human in nature, the strategy also takes into account the technological and organisational aspects of errors in the warehouse process of a company. The proposed strategy therefore consists of three phases. The first phase deals with the organisational aspects of managing the warehouse process of a company, whereas the second and third stages deal with the technological and human aspects.

The first phase of implementation of the strategy, which addresses the organisational aspects of warehouse process management, begins with the company's top management and is divided into the following five steps:

STEP 1: Analysis of the Company's Strategy

The development of a strategy is the main responsibility of the top management of a company. Management must clearly define the role of logistics in the company. In doing so, they must not focus solely on the costs, but also on the positive effects brought about by logistics in managing the flow of goods and information in the company's supply chain.

STEP 2: Building an Internal Team of Interdisciplinary Experts

Management builds an internal team of interdisciplinary experts in the fields of sales, purchasing, storage, production, logistics and controlling, which will play a key role in developing and setting up a strategy for the reduction of errors in the warehouse process.

STEP 3: Analysis of the Company's Logistics System

The internal interdisciplinary team of experts carries out an analysis of the entire logistics system of the company from the point of view of each individual's area of work. The goal is to obtain a material flow analysis with the purpose of showing the flow of value from the supplier, production, customer and reverse logistics.

STEP 4: A Description of Warehouse Processes and Designing the Warehouse Function

Each department enters all the steps of the receiving and distribution process pertaining to their own field of activity into the diagram. Based on the data, we can determine the role of the warehouse function within the company (whether it is an independent function or a subordinate function of another business function).

STEP 5: Management Training on the Source of Human Error

In order to understand the issues surrounding managing human error, it is crucial to educate the management staff through seminars or workshops. In the initial phase, training should be carried out by qualified professionals, while in the long term, setting up a system of knowledge transfer with internal instructors is a sensible solution. Understanding the source of human error requires more than

a single, one-time-only process, but a series of related activities that contribute towards understanding and eliminating human errors at all levels of the company.

The second phase of implementation of the strategy starts with managing human aspects and is divided into the following five steps:

STEP 1: Employee training

The role of a leader in the transfer of theoretical and practical knowledge onto other employees is instrumental in establishing a safe warehouse system. The leader transfers knowledge first and foremost through his/her response to human error, and then by using the appropriate language (without judgement, but by showing understanding of the reasons for the error). The leader should transfer knowledge to all employees and not just to the individuals who have potentially caused the error. This part is crucial if an organisation is attempting to implement a culture of reporting errors.

STEP 2: Implementing the 5 S Method into the Warehouse Process

The leader introduces the employees to the principles of the 5S Method with the purpose of implementing the method into the warehouse process of the company. The 5S Method is the basis of a disciplined approach to work. It can be divided into five successive phases: sort, set in order, shine, standardise and sustain. In the first phase, we remove from the warehouse all the things that we never used before. The items that are necessary on a daily basis and occasionally should be arranged so that they can be accessed easily in terms of work and safety. All items should be properly marked. The next phase consists of cleaning the warehouse. By defining standards, we ensure uniform procedures and measures throughout the operation. This also promotes the interchangeability of work processes. The system is sustained through reporting on the progress at periodic meetings and through controls, which are more stringent in the initial phase. The 5S Method fosters a culture of continuous improvement, which is the basis for introducing a system of innovation.

STEP 3: Implementing a System of Innovation, Improvement and Rewards

With the introduction of the 5S Method, the working environment is tidier and orderly, and the working conditions in a warehouse are safer and free of any unnecessary equipment and tools. The next step that modern companies are familiar with is the introduction of a system of innovations, improvements and rewards. The purpose is to push employees to strive for progress every day in terms of security, reducing costs and improving the quality of the warehouse process. Small daily improvements are important as they can in turn lead to greater innovations. The rewards policy can involve monetary remuneration, which would be based on the calculation of the monetary benefits of the improvements or practical rewards (vouchers, excursions, etc.). The purpose of the rewards is to encourage employee innovation.

STEP 4: Implementing an Error Reporting System

The most demanding part of building a culture of safety in the warehouse is implementing a system for reporting errors. It can be difficult for employees to report their own errors; thus, this is a lengthy process that requires the systematic engagement of the company's management. This should start with the management receiving training on the source of human error and on the methods for eliminating it, followed by daily training of the employees and by encouraging them to foster a safe working environment.

The third phase of implementation of the strategy starts with managing technological aspects and is divided into the following four steps:

STEP 1: Development of Key Criteria

Based on the analysis, the team of interdisciplinary experts develops the key criteria that will be the basis for measuring the performance of the warehousing process to achieve the following:

- the reduction of errors,
- the reduction of waiting,
- the reduction of unproductive work,
- better efficiency of equipment,
- better use of space
- the reduction in storage costs.

STEP 2: Choosing the Right Warehouse Management System

The purpose of implementing a warehouse management system is to improve human performance in terms of planning and executing warehouse operations. The authors agree that the introduction of modern warehouse information system improves the warehouse process, provided that all business functions within the company are involved in the implementation process. A warehouse management system should have the following characteristics [1-3, 10, 16, 22]: the ability to connect with other systems, high performance, flexibility, accessibility, ease of use and the ability to support modern storage solutions.

STEP 3: Measurement of the Criteria

Warehouse management systems are based on criteria measurement. The base data must be accurate and clearly interpreted. Each company determines the criteria that are important for its own operations. From the viewpoint of the warehousing process, the following measurable criteria may be defined: proper utilisation of man-hours, storage space use, equipment use, goods waiting for receiving or shipping, etc.

STEP 4: Reporting on the Results and Implementing a Plan of Action

Measurable results should be presented to the employees at periodic meetings. Any deviation from the set objectives should be analysed and a plan of measures should be made, which would enable progress in the warehouse system.

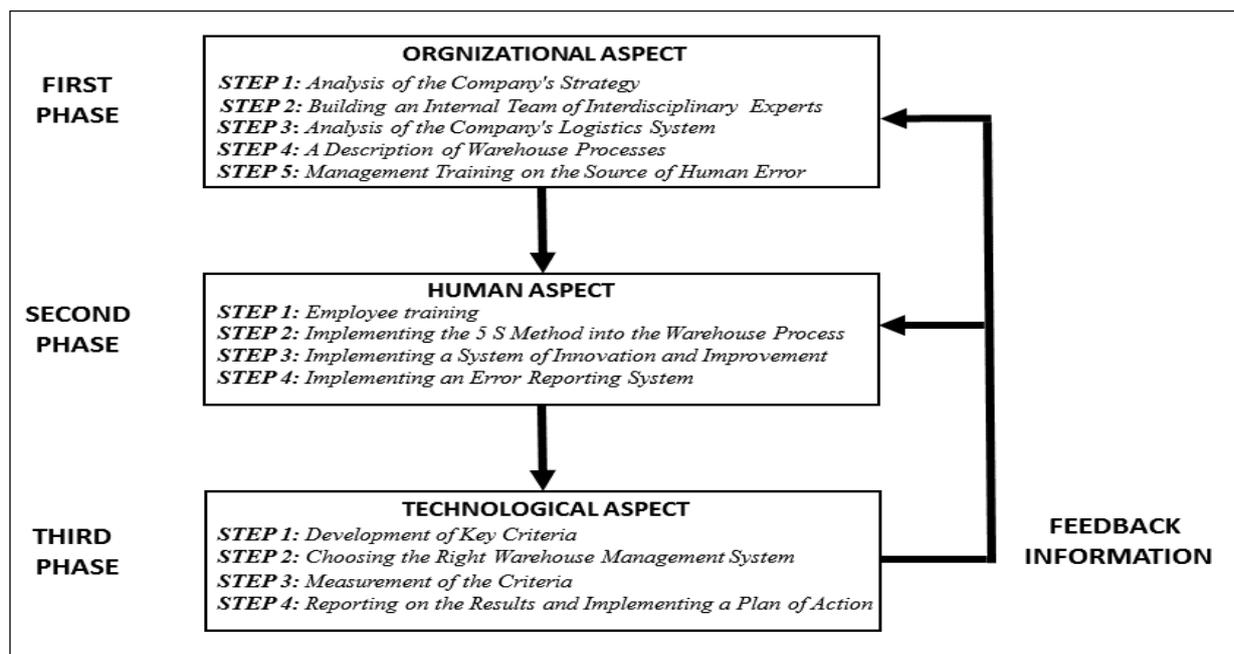


Fig. 3. The strategy for Reducing Errors in a Company's Warehouse Process

4. DISCUSSION

The implementation of the strategy should promote closer cooperation between company employees since the process of reducing errors in the warehouse process also involves departments that are part of the logistics system of the company. The company's management team is involved in the implementation of the strategy from its initial (first) phase, followed by a team of interdisciplinary experts in the fields of sales, purchasing, warehousing, production and logistics, who all play an important role in implementing the error-reduction strategy in the warehouse process. In this phase, the company carried out an analysis of its logistics system and warehouse processes, which will improve the control and organisation of work processes in the warehouse in the long term.

The final part of the first phase (Step 5) is focused on educating the management staff on the issue of the source of errors. The strategy then enters into its second phase, which focuses on training warehouse operators, as the analysis of the literature review clearly indicates that warehouse operators play a crucial role in ensuring an efficient and safe warehouse process. In this phase, the strategy focuses on dealing with the factors that affect the occurrence of errors in the work of warehouse operators. The first and second steps are aimed at creating the right conditions for the prevention of human reasons for errors in the warehouse process. The third and fourth steps involve some of the measures to be adopted at the organisational level of the company in order to improve the system for innovation and improvement and safety culture. This part of the strategy is aimed at creating the right conditions for the prevention of organisational reasons for errors in the warehouse process.

If the second phase is successfully implemented into the warehouse process of the company, employees will be able to perceive the use of modern technology as an opportunity to increase productivity, reduce costs and avoid errors. Therefore, the third phase establishes modern technological solutions as a means to facilitate the transfer of knowledge and enable effective communication and integration within the company.

4.1. Basic Findings

The study yielded the following basic findings:

- The strategy provides a systemic approach to the prevention of errors in the warehouse industry as it establishes a link between the organisation, the employees of the company and the technology, and as such can be used by all companies irrespective of their main activity. This link allows for the process of solving errors to begin at the top levels of the company (strategic level), and then be transferred to the employees through training and stimulating progress, starting with everyday warehouse tasks. The goal is to create a safe system and establish a flexible and learning culture of the company.
- The strategy enables the participation of employees from different hierarchical levels and business functions in the process of preventing warehousing errors, which can improve control over work processes.
- The strategy emphasises targeted employee training, which can improve safety in the warehouse process.
- The study could have an impact on the engineering profession in practice owing to its transfer of knowledge from various multidisciplinary fields (organisational, safety and technological) that are necessary to manage the warehouse process.
- The study synthesises and analyses the literature that relates to the specifics of preventing errors in the warehouse process, which represents an important framework for future empirical studies.

4.2. The Weaknesses and Risks Connected with the Implementation of the Proposed Strategy

The proposed strategy is a new strategy for preventing errors in the warehouse process, which requires testing in different types of companies. This would enable us to further define the benefits of the strategy as well as to identify areas that need improvement. Error prevention in the work processes of companies is a lengthy process, which means that the results of the implementation of the strategy would only be visible in a few years. Although the strategy would result in a number of benefits, it is important to keep in mind that it would be impossible to devise a strategy capable of completely preventing the occurrence of all errors in the warehouse process of a company. Warehousing is a dynamic process that is also affected by constantly changing factors outside of the company, such as the relocation of production to countries with cheaper labour and various technological and organisational customer demands. The success of the proposed strategy is also contingent on the introduction of modern managerial methods for managing work processes, which may affect the mentality and the engagement of employees in establishing a safe working environment.

5. CONCLUSION AND GUIDELINES FOR FUTURE RESEARCH

The warehouse process is constantly changing as increased automation reduces the number of manual handling operations, while also increasing data processing. Warehouse operators are thus interacting with information more than with the physical movement of goods [3]. Changes in warehouse operations result in fewer mistakes in terms of the movement of goods, but produce errors of a different kind, which are rooted in causes that are human, technological and organisational in nature [5, 6, 8, 9].

Warehouse operators play a crucial role in this system because the successful implementation of an error-prevention strategy often depends on their perceptions with respect to the usefulness of modern technology, the introduction of modern working procedures and their accountability in relation to their work. By taking into account these perceptions, the strategy provides a systemic approach to the prevention of errors in the warehouse industry as it establishes a link between the organisation, the employees of the company and the technology, and as such can be used by all companies irrespective of their main activity. This link allows for the process of solving errors to begin at the top levels of the company (strategic level) and then be transferred to the employees (operational level) through training and stimulating progress, starting with everyday warehouse tasks. Thus, the process of preventing warehousing errors involves the participation of employees from different hierarchical levels and from different business functions, which allows for better control of work processes.

The proposed strategy is a new strategy for preventing errors in the warehouse process, which requires testing in different types of companies. This would enable us to further define the benefits of the strategy as well as to identify areas that need improvement, keeping in mind that it would be impossible to eliminate errors altogether because of the ever-changing nature of the environment in which an organisation operates. The desire to prevent errors also stems from the need to control the majority of future outcomes. In reality, life presents us with a multitude of unforeseen circumstances, which we are incapable of directly affecting.

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Received 12.10.2015; accepted in revised form 15.02.2017