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APPLICATION OF ERGONOMICS IN SUPPLY CHAINS

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Abstract There is very few theoretical and practical research related to the possibility of using ergonomics to improve the supply chains management and the functioning of supply chains. In textbooks and other books in the field of supply chain, almost without exception, ergonomics is not mentioned. This paper has the main goal to highlight the importance of applying ergonomics in the design and implementation of supply chains. In connection with this, segments of supply chains have been identified in which ergonomics can provide significant material, safety and other contributions. In addition, several examples from practice are presented that indicate real gains from the application of ergonomics in supply chain management. The basic conclusion of this paper is that a multidisciplinary approach is required for the design and successful management of supply chains, which includes experts in the field of ergonomics.

Keywords: Ergonomics; supply chain; supplay chain management.

1. INTRODUCTION

A large number of business activities around the world in the domain of supply chains are carried out without any knowledge of the impact of ergonomics on the functioning of supply chains or with minimal knowledge of the possibilities of applying ergonomics in supply chains. In addition, from the theoretical point of view, only a few papers considered the possibility of applying ergonomics to the improvement of supply chains. Some of the papers dealt with certain specific problems of supply chains that were resolved from the ergonomic aspect. However, it seems that there is still not enough awareness of the effects that can be achieved by applying ergonomic knowledge, methods and solutions in supply chain management.

Bearing in mind the foregoing, the aim of this paper is to explicitly point out the connection between ergonomics and supply chains. In this regard, the paper will show how ergonomics can be incorporated into the organization and become an integral part of the thinking and practice of people (teams) dealing with supply chains management. The central part of this paper is dedicated to identifying various possibilities related to the application of ergonomics in the design, functioning and management of supply chains.

2. GLOBAL OVERVIEW OF THE RELATIONSHIP BETWEEN ERGONOMICS AND SUPPLY CHAINS

The connection between ergonomics, supply chains and supply chains management can be seen already on the basis of the definitions of these terms. There are many definitions of supply chains, supply chains management and ergonomics. Here we will present some of the definitions from which we can notice this connection. According to Quinn, supply chain are "all of those activities associated

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with moving goods from the raw-materials stage through to the end user" [1]. From this definition, it can be noticed that the supply chain includes the flow of material starting from its order, then through all stages of the process of production, storage, transport, servicing and sales. Stadler defines the supply chain management as "the task of integrating organizational units along a supply chain and coordinating material, information and financial flows in order to fulfill (ultimate) customer demands with the aim of improving the competitiveness of a supply chain as a whole" [2]. In addition, Zunjic defines Ergonomics as a "multidisciplinary science whose goal is to examine the impact of means of work, conditions of work, processes of work, and products as results of work on humans from the psychological, physiological, anatomical, biomechanical, sociological, organizational and physics aspect by applying the quantitative and qualitative research methods, as well as to adapt the design of the aforementioned elements to humans, with the aim of improving comfort, safety, efficiency and satisfaction, which are considered during their interaction with humans" [3].

From the above definitions, it follows that the application of ergonomics in supply chains and supply chains management on a global scale manifests (but does not limit) through:

- procurement of materials that are safe for manipulation, handling and use, and that which do not have negative effects on human health
- ensuring handling with the materials by the participants in the supply chain in a safe manner, when the nature of the materials is such that it could endanger the health of workers
- ergonomic designing of tools that can improve operator efficiency and safety
- designing auxiliary devices that allow reducing the physical and mental strain of operators to the lowest possible extent
- ensuring adequate environmental conditions in all segments of the space that includes the supply chain (noise, lighting, dustiness, thermal environment, vibrations), which should be harmonized with ergonomic recommendations and standards
- designing the operator's workplace in the supply chain in accordance with anthropometric and other ergonomic criteria
- adjusting the process of work to the operator (rhythm, shift work, the way of carrying out work tasks, workload) in accordance with ergonomic guidelines
- designing the interface of machines and workspaces for operators in transport means and means for manipulating materials (trucks, cranes, hoists, forklifts, etc.) on ergonomic principles, in order to increase comfort, reduce operational errors and increase the efficiency of execution of work tasks
- application of ergonomic criteria, recommendations and standards for designing safe manufacturing plants (entrances, exits, passages, warehouses, etc.)
- designing and evaluating the efficiency of protective measures and devices on machines in order to realize the safe work of the operator
- ergonomic design of final products tailored to customers, which is manifested through increased product demand, reduced stocks and increased flow in the supply chain
- ergonomic design of packaging and wraps
- designing information in accordance with ergonomic principles, in a usable form suitable for faster absorption, understanding and efficient execution of services (those services that are based on direct participation of users, such as online shopping)

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- designing means for displaying information (displays and other information carriers) in accordance with ergonomic recommendations, which improves the way of communication and increases the awareness of all participants in the supply chain
- training of workers, operators, repairers for safe and comfortable work
- ensuring hygienic working conditions
- increasing the satisfaction of all participants in the supply chain as a result of ergonomic optimization of all factors that affect the life and work of people involved in the supply chain.

3. ERGONOMICS AND NEW TECHNOLOGIES IN THE FUNCTION OF SUPPLY CHAINS

Below are examples showing how ergonomics and new technologies in the function of ergonomics have been applied in order to improve supply chains. Ergonomic knowledge was also applied to the development of such technological solutions and their application. Such solutions enable a more comfortable work of the operator, the level of safety increases, with some tasks being performed in a shorter time.

The Nova Scotia Liquor Corp. (NSLC) serves 60 agency stores and 106 retail stores, generating more than one half billion dollars annually [4]. More than ten years ago, the NSLC was operating with many different marks of materials handling equipment. Then, the NSLC management prioritized taking the operators' wants and needs into consideration. They invited its workers to play an active role in testing the new equipment and choose a new training program through their dealer community. The new fleet has used cameras installed on all narrow aisle reach trucks to assist operators to identify, place and retrieve pallets at greater heights to reduce neck strain. The suspension isolates impacts. In addition, the three operating stances support visibility. A sensor system in the operator section enables proper operating procedures. As a result, employees were happier and the crew was also able to reach 100% compliance.

Next successful example comes from Cummins, which is a global power leader that is involved in design, manufacturing, selling and servicing diesel engines and similar technology around the world. They have network of 600 company-owned and independent distributor facilities,107 manufacturing plants, and more than 5,000 dealer locations. The company covers more than 160 countries and regions [5]. Now, the company uses a Humantech software-as-a-service (SaaS) application for managing ergonomics in the production, montage, distribution and service environments at many of its plants. This new system helped the company to become one of the leading [5]. In the domain of safety, the company began with the prediction which events could occur and they also have been engaged in the risk assessments. In addition, they developed preventive programs, such as providing ergonomics training to their employees. The applied solution allows Cummins' employees to attend online training comfortably and when they need it. For example, a new employee can attend ergonomics training during the first week of his/her employment, and in the second week be on the shop floor identifying and assessing high-risk jobs. The ability of the system to identify and gather global MSD risk data has transformed the way they prioritize and alleviate MSD risks. Based on the application of this system, it is achieved a saving of more than $12 million in injury cost avoidance and more than $4 million in efficiency and productivity. Today, the system is used in more than 190 countries and regions and at more than 230 Cummins facilities.

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Another successful example of the application of ergonomics and new technologies in supply chains comes from Ferris Industries. This is a company that produces movers for over 100 years. The management of the company has decided to reduce cycle times by 50%, while also to improve operator ergonomics and productivity. To achieve this goal, Ferris installed an automated towline conveyor assembly system. Ferris's assembly line involved 12 stations [6]. Since installing this towline system, they have been able to cut their cycle times in half, by systematically pacing the production and by balancing workstation assignments. In addition to the improvement of the productivity, they were able to balance all the 12 stations, they achieved much better control of the assembly process and also they have had less fatigued workers.

4. CONCLUSION

In a large number of books in the domain of supply chains, for example in [7,8], ergonomics is not mentioned at all. In this paper, segments in which ergonomics can make a significant contribution to the design and functioning of supply chains are identified. Practical examples that are presented clearly indicate that significant financial gains are possible when ergonomics is applied in supply chains. These examples also point to the benefits of application of ergonomics for employees working in the supply chain system. Some ergonomic solutions can also successfully contribute in solving various problems of supply chains, including certain problems that are described in [9]. All this indicates that a multidisciplinary approach is needed for designing and implementation of supply chains, which includes the area of ergonomics. The application of such an approach can reduce certain material and other losses in supply chains and provide significant profit when ergonomic knowledge is applied in an appropriate way, starting from the phase of designing supply chains.

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