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Use of ergonomic principles in manual order picking systems

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Abstract **- Successful companies are continually striving to streamline costs and optimize processes, enabling them to grow progress, develop and ensure competitiveness on the market. A large part of the costs arises in warehouses, where up to 55% of total costs are generated by order-picking, which makes it important and interesting in terms of research. The paper explores "picker to part" order-picking concept, which enables flexible work and is the optimal choice for most companies. The concept is associated with a high level of work-related injuries and work-related illnesses. Work requires physical efforts resulting from handling heavy goods, performing repetitive movements and using manipulative means. Human as the main actor of the concept affects the costs caused by picking and the quality of work done, which depends on technological support, physically and psychologically capable and motivated people. Due to the high costs of service, the focus on time planning and productivity increases. Contrary, the lack of attention is paid to the working conditions and the health status of the pickers. To overcome this gab, a review of scientific and professional literature on ergonomic principles in picking concept »picker to part« was carried out, followed by a quantitative survey of ergonomic properties in warehousing activities. Results revealed that more than 60% of the surveyed order-pickers associate problems with health with the characteristics of work, about 24% of them associate health problems with the use of a particular means of transport, and all agree that provided measures to reduce physical effort and greater support of technologies influence on increased speed of work and better health status of order-pickers.**

Key words **- injuries, picker-to-part, ergonomics, picking, productivity, costs**

I. INTRODUCTION

The complete technological sophistication of the warehouse enables the optimization of processes with automation, where human performs a minimal, urgent part of the process. However, studies show that 80 % of the work in picking systems and warehouses is still handled by hand, where pickers walk or collect goods through manipulative means (De Koster et al., 2007; Napolitano, 2012; Grosse, Glock & Neumann, 2015). This fact proves that the picking process is labour intensive with a high level of human work. At the same time, picking is the most costly process that makes more than half of total costs in storage (Tompkins et al., 2010; Richards, 2012; Grosse, Glock & Neumann, 2015). Consequently, it is understandable that employers and researchers are striving to find ways to achieve a greater number of picks per time frame. These efforts clearly do not affect the reduction in musculoskeletal disorders that are not decreasing over the years and are significantly higher in logistics than in other sectors. As stated by Grilec (2015): »According to the US Office of Labour Statistics, the proportion of musculoskeletal disorders and accidents at work throughout the private sector is 33.5 cases per 10.000 workers. Of this, in agriculture, forestry and fishing, the maximum of 41.5 cases per 10.000 workers are reached. In the meantime, in the service sector, especially in transport and storage, the level of MSD and injuries rises to 80,3 cases per 10.000 workers. If we compare the level of damage in the entire private sector and in the area of transport and storage, we can quickly assume that the damage is twice as high in the latter. Furthermore, we can say from the above that there are certainly many possibilities and room for improvement in this area in an ergonomic sense.« Ergonomic is a science that generally connects human and the working environment in order to create optimal working conditions for a particular worker, thus enabling the worker to do his job well.
The next indicator that highlights the importance of dealing with workers is a demographic picture that indicates that the population is aging. »The share of the work contingent (20 - 64 years) is projected to decline in the future from 64 % this year to 59 % in 2024 and to 56 % in 2034. If we

compare these two age groups, we find out that on 100 people in the labour contingent are currently around 27 people aged 65 and over. Average age of the population is expected to rise from 42 to 46 years in the next two decades.« (Sambt, 2014). Companies must, not only because of their responsibility to society, but also due to long-term goals, integrate their employees into strategic planning and take care of the operational capability of their staff. Therefore, it makes sense for companies focus also on reduction of the physical and mental burden on employees and not solely to rise of productivity.

The paper contributes to the understanding of order-pickers' health problems researching correlations between the degree of intensity of the observed type of health problem and:

(1) frequency of certain movements,

(2) type of means of transport used.

Correlations were researched by the survey based on 126 valid questionnaire, which were returned from order-pickers in several logistic companies around Slovenia. The research contributes to understanding the importance to use ergonomic principles in the order-picking process and provides a guide for further research.

I. PRODUCTIVITY AND ERGONOMIC PRINCIPLES IN MANUAL ORDER-PICKING

Picking is a process that is regardless of the technological sophistication of the warehouse physically demanding. It is one of the essential processes of intra-logistics where the order-picker prepares goods according to customer orders. The picking process "picker-to-parts" is considered as the most labour-intensive process in warehouse, resulting in up to 55 % of the total costs of storing goods, which represents the potential and challenge to reduce costs. The costs are caused by the traveling, searching, picking and set-up. Approximately 55 % of the total order-picking time is spent for traveling (Tompkins et al., 2010). Due to the large impact of traveling on the total costs, different authors identify that the determination of the shortest route is the key goal of optimization efforts and the most common way to increase productivity. Warehouses are seen in the eyes of owners as cost centres that combine high capital and require a high level of human work that is physically tiring. Although automation seems to be the right solution, manual work remains and the morbidity of employees is increasing in relation to order industries. The important competitive advantage of manufacturing companies is seen mostly in the productivity of employees and the organization of the process (Hompel et. al., 2011; Günthner et al., 2014) while good working conditions are still neglected.

Order-picking system »picker to part« is flexible and requires minimal investment costs compared to automated solutions. Productivity in such systems largely depends on order-pickers who carry out risky work such as raising or lowering loads by twisting or bending the upper part of the body. The availability of a worker depends on the number and severity of injuries, just as the availability of the machine depends on the number and severity of defects. The productivity of order-pickers is closely linked to fatigue, which can be reduced by rest. Productivity, injuries and fatigue are affected by ergonomic conditions. Musculoskeletal disorders are the most reported causes for absence from work and account for over 52% of all work-related illnesses and more than 2% of the gross national product in the European Union (Schneider & Irastorza, 2010; Grosse et al., 2015), where low back disorders are the most costly of the musculoskeletal disorders (Marras, Da-vis, Kirking & Bertsche, 1999). For this reason and in light of demographic changes and an increasing work lifetime, human factor issues at work have gained importance (Gajšek et al., 2017). This is paralleled by legal initiatives in many countries, which leads to an increase in regulations that enforce occupational safety in logistics (Grosse et al., 2015). However, the changes are very slow and employers are very conservative and insist that improved conditions of work cannot return financial contributions within a reasonable time (Gajšek et al., 2017).

II. LITERATURE REVIEW

Chapter presents findings from scientific and professional research in the field of ergonomics in manual order-picking.

Picking tasks in order to increase productivity, as well as the separation of production and logistics activities, led to an increase in the physical burden on employees. Permanent execution of manual picking tasks increases the pressure on the joints and the spine, especially in the lumbar spine, causing degenerative, permanent defects. For this reason, the injury of the lumbar spine is known as a recognized occupational injury caused by long-standing upsets, the carrying of heavy loads or long-term activities in extreme situations (Günthner et al., 2014). Mentioned activities have negative impact on the spinal cord of order-pickers that includes pain, illness, injury, and temporary or permanent incapability for work. Musculoskeletal disorders and injuries of the skeletal system are the main causes that employees permanently or temporarily leave the labour market, followed by a decline in productivity (Goldscheid, 2008; Bokranz & Landau, 2006; Günthner et al., 2014). Musculoskeletal disorders characterize health problems of muscles, whales, skeletons, cartilage, vascular system and ligaments. Excessive and repetitive tasks in the order-picking process increase the risk for order-pickers who largely suffer from musculoskeletal disorders (Punnett & Wegman, 2004; Grosse et al., 2015). In 2005, 35 % of Europeans who suffered from musculoskeletal disorders worked at work with heavy loads. The most common diseases and / or injuries are back pain and work-related damage of the upper limbs, known as the »repetitive movements« failure. Treatment and recovery are often ineffective. The result can be permanent inability to work and loss of employment. Absenteeism causes high costs for manufacturing companies, logistics service providers, the national economy and the economy in general (European Agency for Safety and Health at Work, 2010). The economic impact of musculoskeletal disorders, compensations for absenteeism and loss of employment are measured to be up to 2 % of GDP in Europe, which is approximately € 23.9 trillion in Germany alone (Schneider & Irastorza, 2010; Grosse et al., 2015).
Table 1 summarizes the scientific articles that are relevant for understanding the discussed topic.

Table 1: Scientific papers with summaries

Authors:	Keywords:	Summary of the article:
Christmanssona, Medbob, Hanssonc, Ohlssonc, Unge Bystromc, Mollerd & Forsman (2002)	assembly of goods, picking, productivity of systems, manual handling of goods, case studies, time consumption, physical work	The research was carried out on the case of four order-pickers who were filming during their work. With laboratory equipment, computerized measurements of muscle strain, work posture and movements were performed. The order-pickers used the carts and the forklift truck without the possibility of personal transport, so they had both hands free for picking. Pickers rated work as physically stressful. The results indicate that the picking was very burdensome for the hands, as the movements were constantly repeated.
Motmans (2012)	Full body vibration, forklift driver, running surface, air suspension seat, travel speed	Research has shown that the main cause for lower back pain is driving with a forklift truck. 63 % of Japanese forklift drivers suffer from pain in the lower part of the spine. Research has also shown that forklift drivers have 2 times more chance of having pain in the lower part of the spine than others. Permanent or prolonged exposure to the overall body to vibration increases the risk to damage the lumbar spine and the associated nervous system.

Battini, Persona & Sgarbossa (2014)	Real-time assessment of ergonomics, motion detection system, storage processes, industrial applications	The research is based on an innovative system for evaluating ergonomic effects on the body in real time. The collected data was used to redeploy the warehouse and to train pickers for the proper handling of goods in terms of ergonomics. This integration makes it possible to achieve the final win-win result in terms of optimizing the process with employee productivity and ergonomics.
Grosse, Glock & Neumann (2015)	Picking, picker to part, warehouse, human factors, ergonomics, literature, content analysis	The paper reveals a systematic literature review on order- picking planning models and their relation with order-pickers. The paper proposes a conceptual framework for integrating human factors into planning models of order-picking activities and hypothesises that doing so improves the performance of an order-picking system and workers' welfare.
Battini, Calzavara, Persona & Sgarbossa (2015)	Picking, human availability, injuries, ergonomics, cost models	The paper analyses the impact of ergonomic working conditions on the availability and productivity of the labour-intensive warehouse system with the aim of assessing how ergonomics affect the total cost of systems. Authors have shown that the improvement of ergonomic conditions has an important, positive impact on the total cost of the warehouse system.
Gajšek, Đukić & Opetuk (2015)	Ergonomics, forklift, musculoskeletal disorders, lower back pain	The paper presents a review of scientific literature published between 2001 and 2013 on the health problems of forklift drivers. Authors revealed that the most frequent injuries of forklift drivers are: in 67 % pain in the lower part of the spine, in 25 % discomfort, in 17 % problems with the neck and in 8 % back injuries / pain, musculoskeletal disorders, injuries and pain in the arms.

The literature review revealed that order pickers work is associated with a high level of injuries and work-related illnesses. The problem of the incurred risks in order-picking is the use of various types of technology that require a certain type of order-pickers' movement and influence with specific factors on the order pickers and their health. It is therefore important to find out the links between the type of means of transport and the health status of the order picker. Companies which want to be competitive on the market within the limits of the available resources and offer the best to the buyers must achieve high productivity of the employees. The literature highlights the impact of ergonomic working conditions on the speed of order pickers' work, which we believe is the one of the most convincing reason for implementation of ergonomic principles into the work processes for the managers. On the basis of the stated reasons and the reviewed literature, we posed 3 theses presented in the next chapter.

III. METHODOLOGY

An important part of every research work is the determination of the research problem and the good preparation and implementation of the research. In order to obtain quality and relevant data, we have carried out a systematic overview of scientific and technical literature, which we

have found with the help of Internet browsers that access the online scientific journals such as ScienceDirect, Logistics journal, research works of universities and other organizations. We rely on recent literature, published after year 2002. We searched papers with key words "ergonomics" and "order-picking". Papers were divided into relevant papers and these, which did not relate to the field of research. With the descriptive method we defined important terms for understanding our research. Using the synthesis method, we summarized the writings of various authors and brought them together and gained general knowledge about the research topic. Using the compilation method, we summarized the scientific and professional findings of various authors.
In the second phase of the research included survey, which was conducted to verify 3 theses. Following theses were proposed on the basis of previously described literature review:
• There are correlations between the frequency of various types of order pickers' movement and the degree of intensity of the observed type of order pickers' health problem.
• There are correlations between the type of means of transport used by the order picker and the degree of intensity of the observed type of health problem.
• Order picker's height of rate of the impact of a particular characteristic of his/hers work on his/hers health correlates with his/hers height of rate of the impact of a particular characteristic of his/hers work on the speed of his/hers work.
Three relevant persons tested the content of the questionnaire to make sure that the questionnaire is comprehensive and meaningful. We also tested the comprehensibility of the content of the questionnaire on 3 order pickers who have been working as order picker for more than 5 years. It turned out that the questionnaire is understandable and meaningful. Data were collected from September 2015 to August 2016. We provided the questionnaires to the order pickers in person. At that time, out of 21 Slovene companies, 126 valid survey questionnaires were collected, of which 119 or 94.4 % from men and 7 or 5.6 % from women. It was important for us to include order pickers who spend more than 80 % of their working hours for order-picking. The obtained data were copied into the Statistical Product and Service Solutions (SPSS) database. Using the program, descriptive static analysis were carried out.

IV. RESULTS

We verified three theses. For the sake of better transparency, the variables are written in abbreviations in Table 2. Legend of abbreviations is given in Table 5.

Table 2: Correlations between specific health problem and the frequency of specific movement

Way of working / Health problems		C1	C2	C3	C4	C5
	3,4,5 v %	59.6	80.1	63,5	61.9	84.2
D1	76.2	.349**	.337**			.290**
D2	68.2	.213 *	.201 *		.232 **	.351 **
D3	63.4	.307 **	.321 **			.398 **
D4	59.5	.260 **	.280 **			.345 **
D5	61.9	.343 **	.229 *			.232 **
D6	54.8	.350 **	.218 *			.237 **
D7	38.8				.248 **	.335 **
D8	42.1	.240 **	.276 **			
D9	59.6			.186 *	.320 **	.319 **

Legend: ** - Significant correlation p<.001, * - Significant correlation p<.005

The first verified thesis is:
• There are correlations between specific health problem and the frequency of specific movement.
In Table 2, we present the values of correlations between specific health problems (D1-D9) and the frequency of specific movement (C1-C5). The first thesis can be partly confirmed.

Thesis 1 confirms the linear dependence between bilaterally dependent phenomena, indicated by the coefficient of correlation. Correlations are significant for the following relationships:

- intensity of pain in the lower part of the spine (D1) significantly correlates with the frequency of:
  - lowering the load from the height above the shoulder and head height (C1) (τ=.349, p<.001);
  - lifting the load from the height below the knee height (C2) (τ=.337, p<.001);
  - walking between the places from which the goods are taken (C5) (τ=.290, p<.001).
- intensity of pain in the neck part (D2) significantly correlates with the frequency of:
  - lifting the load of the height above the shoulder height (C1)(τ=.213, p<.005);
  - lowering the load lifting from the height below the knee height (C2) (τ=.201, p<.005);
  - entering the forklift (C4) (τ=.232, p<.001);
  - walking between the places from which the goods are taken (C5) (τ=.351, p<.001).
- intensity of shoulder pain (D3) correlates with the frequency of:
  - lowering the load from the height above the shoulder and head height (C1) (τ=.307, p<.001);
  - lifting the load from the height below the knee height (C2) (τ=.321, p<.001);
  - walking between the places from which the goods are taken (C5) (τ=.398, p<.001).
- muscle pain intensity (D4) correlates with frequency of:
  - lowering of the load from the height above the shoulder height (C1) (τ=.260, p<.001);
  - lifting of the load from the height below the knee height (C2) (τ=.280, p<.001);
  - walking between the places from which the goods are taken (C5) (τ=.345, p<.001).
- intensity of pain in the leg muscles (D5) correlates with the frequency of:
  - lowering of the load from the height above the shoulder height (C1) (τ=.343, p<.001);
  - lifting the load from the height below the knee height (C2) (τ=.229, p<.005);
  - walking between the places from which the goods are taken (C5) (τ=.232, p<.001).
- intensity of pain in the wrists (D6) correlates with the frequency of:
  - lowering of the load from the height above the shoulder height (C1) (τ=.350, p<.001);
  - lifting the load from the height below the knee height (C2) (τ=.218, p<.005):
  - walking between the places from which the goods are taken (C5) (τ=.237, p<.001).
- intensity of worsened vision (D7) correlates with the frequency of:
  - entering the forklift (C4) (τ=.248, p<.001);
  - walking between the places from which the goods are taken (C5) (τ=.335, p<001).
- intensity of swelling of the legs (D8) correlates with the frequency of:
  - lowering the load from the height above the shoulder height (C1) (τ=.240, p<.001);
  - lifting the load from the height below the knee height (C2) (τ=.276, p<.001).
- intensity of mental fatigue (D9) correlates with frequency:
  - rearward driving (C3) (τ=.186, p<.005);
  - entering the forklift (C4) (τ=.320, p<.001);
  - walking between the places from which the goods are taken (C5) (τ=.319, p<.001).

The second verified Thesis is:

- There are correlations between the type of means of transport used by the order picker and the degree of intensity of the observed type of health problem.

Table 3 presents the correlations between specific health problems (D1-D9) and the type of mean of transport, which is used by specific order-picker (A1-A8). The second thesis can be partly confirmed.

Table 3: Correlations between health problems and the types of mean of transport

Means of transport / Health problems		A1	A2	A3	A4	A5	A6	A7	A8
	3,4,5 v %	39.7	34.1	50.7	45.2	50.9	11.1	18.2	8
D1	76.2	.417 **				.185*	- .223 *		-.248 **

D2	68.2	.374 **							
D3	63.4	.340 **							-.197 *
D4	59.5	.370 **							-.200 *
D5	61.9	.318 **							
D6	54.8	.224 *					-.200 *		
D7	38.8	.304 **							
D8	42.1	.310 **	.192*						
D9	59.6	.316 **		-.221 *					

Legend: ** - Significant correlation p<0.001, * - Significant correlation p<0.005

The second Thesis can be partly confirmed. Correlations are significant for following relationships:

- intensity of lower back pain (D1) correlates with the following types of used transportation technology:
  - goods are carried in the hands (A1) (τ=.417, p<.001);
  - pallet truck with possibility of personal transport (A5) (τ=.185, p<.005);
  - pallet truck with possibility of lifting the order picker (A6) (τ=-.223, p<.005);
  - order picker forklift (A8) (τ=-.248, p<.005).
- the intensity of pain in the neck part (D2) correlates with carrying goods in hands (A1) (τ=.374, p<.001);
- intensity of pain in shoulders (D3) correlates with the following types of used transportation technology:
  - goods are carried in the hands (A1) (τ=.340, p<.001);
  - order picker forklift (A8) (τ=-.197, p<.005).
- intensity of muscle pain in hands (D4)correlates with the following types of used transportation technology:
  - goods are carried in the hands (A1) (τ=.370, p<.001);
  - order picker forklift (A8) (τ=-.200, p<.005).
- intensity of muscle pain in legs (D5) correlates with carrying goods in hands (A1) (τ=.318, p<.001).
- intensity of pain in wrists (D6) correlates with the following types of used transportation technology:
  - goods are carried in the hands (A1) (τ=.224, p<.005);
  - pallet truck with possibility of lifting the order picker (A6) (τ=-.200, p<.005).
- intensity of decreased vision (D7) correlates with carrying goods in hands (A1) (τ=.304, p<.001).
- intensity of swelling of legs (D8) correlates with the following types of used transportation technology:
  - goods are carried in the hands (A1) (τ=.310, p<.001);
  - trolley (A2) (τ=.192, p<.005).
- intensity of mental fatigue correlates with the following types of used transportation technology:
  - goods are carried in the hands (A1) (τ=.316, p<.001);
  - hand pallet truck (A3) (τ=-.221, p<.005).

The third verified Thesis is:

- Order picker's height of rate of the impact of a particular characteristic of his/hers work on his/hers health correlates with his/hers height of rate of the impact of a particular characteristic of his/hers work on the speed of his/hers work.

Table 4 shows correlations between impacts on work speed (F1-F7) and impacts on order picker's health (E1-E7). The thesis 3 can be confirmed. Correlations are observed for all proposed relationships.

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Table 4: Correlations between impacts on work speed and impacts on order picker's health

Impacts on order picker's health / Impacts on work speed		E1	E2	E3	E4	E5	E6	E7
	3,4,5 v %	68.3	74.6	60.3	65.9	75.3	74.6	81.7
F1	70.6	.508**						
F2	75.4		.566**					
F3	68.2			.413**				
F4	68.3				.610**			
F5	75.4					.658**		
F6	81.8						.560**	
F7	78.6							.763**

Legend: ** - significant correlation p<.001, * - significant correlation p<.005

Table 4 presents correlations between impacts on work speed (F1-F7) and impacts on order picker's health (E1-E7). We note that respondents have identified all options with more than 60 % agreeing on the impact of proposed measures on work speed and order picker's health. Measures include different ways of physical effort reduction and use of different technical or technological support. When examining Table 4 diagonally, we notice that these measures, according to order pickers, have a disproportionate effect both on the work speed and on the order picker's health status. It can be concluded that order pickers agree that reduction of needed physical effort, better technical equipment and use of technological solutions reduce health risks and increase order-picking productivity.

Correlations are significant for following relationships:

- measure 1: reduced amount of work that requires stretching above shoulder; impact on health (E1) correlates with impact on work speed (F1) (τ=.508, p<.001);
- measure 2: reduced amount of work that requires lifting from height under the knees; impact on health (E2) correlates with impact on work speed (F2) (τ=.566, p<.001);
- measure 3: use of pallet truck with mounted aerial platform for employee for order picking in the first floor of the storage rack; impact on health (E3) correlates with impact on work speed (F3) (τ=.413, p<.001);
- measure 4: use of pallet truck with option of lifting the pallet to the height of goods disposal; impact on health (E4) correlates with impact on work speed (F4) (τ=.610, p<.001);
- measure 5: use of pallet truck with possibility of personal transport; impact on health (E5) correlates with impact on work speed (F5) (τ=.658, p<.001);
- measure 6: use of barcode or RFID tags reader / terminal / smartphone; impact on health (E6) correlates with impact on work speed (F6) (τ=.560, p<.001);
- measure 7: introduction of automation in the sense of "goods-to-order picker"; impact on health (E7) correlates with impact on work speed (F7) (τ=.763, p<.001).

Table 5: Legend of abbreviations

Variable	Legend
Transport means	

A1	goods are carried in the hands
A2	use of cart
A3	use of hand pallet truck
A4	use of electric pallet truck without possibility of personal transport
A5	use of pallet truck with possibility of personal transport
A6	use of forklift with lifting platform for picking on 1st floor shelves
A7	use of forklift with ability to adjust the height of the pallet on which goods are placed
A8	use of order picking forklift
Characteristic of work	
C1	lowering loads from the height above the shoulder and head height
C2	lifting loads from the height below the knee height
C3	looking back while driving forklift
C4	entering in the forklift
C5	walking between places where goods are taken
Health problems	
D1	lower back pain
D2	pain in the neck part
D3	pain in shoulders
D4	muscle pain in hands
D5	muscle pain in legs
D6	pain in wrists
D7	decreased vision
D8	swelling of legs
D9	mental fatigue
measures to improve order picker's health status	
E1	reduced amount of work that requires stretching above shoulder
E2	reduced amount of work that requires lifting from height under the knees
E3	use of pallet truck with mounted aerial platform for employee for order picking in the first floor of the storage rack
E4	use of pallet truck with option of lifting the pallet to the height of goods disposal
E5	use of pallet truck with possibility of personal transport
E6	use of barcode or RFID tags reader / terminal / smartphone
E7	introduction of automation in the sense of "goods-to-order picker"
measures to improve work speed	
F1	reduced amount of work that requires stretching above shoulder
F2	reduced amount of work that requires lifting from height under the knees
F3	use of pallet truck with mounted aerial platform for employee for order picking in the first floor of the storage rack
F4	use of pallet truck with option of lifting the pallet to the height of goods disposal
F5	use of pallet truck with possibility of personal transport
F6	use of barcode or RFID tags reader / terminal / smartphone
F7	introduction of automation in the sense of "goods-to-order picker"

V. FINDINGS AND POSSIBILITIES FOR FURTHER RESERCH

The thesis 1 assumes the existence of links between the various types of order pickers' movement and the intensity of the observed health problems. The thesis 1 can be confirmed with our empirical research with 60.32 %. From 59.6 % of respondents who frequently lower loads from the height above shoulder and head height, 47.6 % of them answered that they were lowering loads that weigh more than 10 kg. From 80.1 % of respondents who frequently raise loads from the height below the knee height, 57.2 % of them raise loads that weigh more than 10 kg. The variables correlate with all the listed health problems, except in case of decreased vision and mental fatigue. We find out that identified respondents are exposed to high health risks. Interestingly, work characteristic, namely looking back when driving a forklift, has been confirmed by 63.5 % of the respondents, but it does not correlate with any health problem, except with mental fatigue. In scientific literature authors frequently state looking back as key cause for occurrence of work-related lower back pain, uneasiness, neck and muscular pains. The scientific literature also states that lower back pain is the main consequence of lifting from standing position, carrying of heavy loads and situations in extreme conditions. The cause for our surprising result can be found in modern ergonomic solutions for forklift users, such as ergonomic seats, moveable commands and a like. 84.2 % of respondents frequently walk between places where goods are taken. This work characteristic correlates with all proposed health problems, except with swelling of legs.

Thesis 2 assumes the existence of correlations between the type of means of transport used by the order picker and the degree of intensity of the observed type of health problem, which can be confirmed by empirical research with 23.6 %. Survey identified approximately 50 % of order pickers who use pallet trucks without ability to pallet and 39.7 % of order pickers who frequently carry goods in their hands. Observed situation indicates high level of order pickers' physical activity. Survey revealed correlations between lower back pain and (1) use of pallet truck with possibility of personal transport, (2) use of pallet truck with possibility of lifting the order picker, and (3) use of order picking forklift. Those forklifts, when transporting loads, mostly require reversing and looking back by turning head Similar findings are also confirmed by scientific literature presented in the theoretical part. The findings are incompatible with observed correlations from the thesis 1, where viewing back while driving does not correlate with any health problem, except with mental fatigue. We assume that the cause for described health problem is in inappropriate type of used forklift and lack of proper education for forklift operators.

Thesis 3 assumes that order picker's height of rate of the impact of a particular characteristic of his/hers work on his/hers health correlates with his/hers height of rate of the impact of a particular characteristic of his/hers work on the speed of his/hers work. Correlations can be fully confirmed. The ergonomics of the workplace affects both the health status of order pickers and the work speed. From practice we know, that majority of managers still do not recognize ergonomics as factor that could help them to improve productivity. 63.5 % of respondents report that they are not educated about ergonomics and the preservation of health. 87.3 % of respondents report that daily program of recreational activities at workplaces is not allowed in their company. Managers often follow only legal requirements and do not act preventively (Gajšek et al., 2017):

- managers take into account only what is written in the laws;
- order pickers exposed to severe health risks should not be informed about possible measures for health protection, as this would disrupt day-to-day work;
- humanization of work is cost-related;
- improving working conditions does not increase profit.

CONCLUSION

The use of the term sustainable development in organizations has expanded into many areas of business over the past decade. It affects many logistics activities, including storage. Beyond limiting the impact of organizations on the environment, an important part of sustainable development is an economic and social aspect (Gajšek, Đukić & Opetuk, 2015). By reviewing the literature, we found that order-picking concept "picker-to-part" is an important and problematic area precisely

because of economic and social influences. At the local level, the order-picking concept has on the one hand an influence on the order pickers from the health point of view and on the other hand, on the quality of the service provided by the company. Quality is difficult to define as a term that means the same for all services and products. It is important to understand the role of quality at different levels of organization and the various aspects from which it can be addressed. Therefore, the quality of the spectrum of definitions, which is usually, even in the case of picking, is related to costs (Koblar, 2010). During the review of existing quality definitions Piskar and Dolinšek concluded that (Koblar, 2010): "The quality of the product or service is often dependent on the price and the costs incurred during the use of the product or the provision of the service; Include people, tools and time." In this context, the use of factors that influence the level of ergonomics in picking is crucial in ensuring a quality service. One of the main reasons for the introduction and observance of ergonomic principles and the key problem on which businesses cannot influence is the aging of the population. Data on the aging of the population indicate a problem that will affect the business of the companies in the future. It is therefore important that companies provide to employees such work conditions under which they will be able to perform their work actively and reliably until retirement.

We believe that it would be interesting and meaningful to expand the survey with a comparative analysis of productivity, frequency of errors and psychological impacts on order pickers in the order-picking system, where ergonomic principles are applied and introduced with a system where ergonomic principles are not taken into account. Ergonomics is a multidisciplinary discipline, therefore it is necessary to involve experts from various fields who can influence the development of their knowledge and research in order to fully assess the identification of ergonomic characteristics.

On the basis of theory and research with the help of surveys, we found that compliance with ergonomic principles in the organization of order-picking work is insufficient. The effects of integrating ergonomics into the order-picking system in the literature are not given enough attention, which influences the recognition of the needs for introducing ergonomic principles into the picking process, the control of the current situation of the pickers working environment and the development of further ergonomic measures in order-picking. To summarize the findings from the field of researching the use of ergonomic principles in order-picking on the concept of »picker-to-part«, we found out that the ergonomics of the workplace in order-picking:

- affects the quality of the service provided and consequently, the reputation of the company;
- affects the state of health of order pickers and consequently their productivity;
- affects the costs of the service, the cost of compensation payments, and other costs associated with order pickers' absence from work.

We conclude that taking into account ergonomic principles has a positive impact on working conditions that are directly reflected in the health status of order pickers and the quality of their work. In order to extend ergonomic principles and introduce them into the order-picking process, logistics managers need to recognize the purpose and importance of ergonomics in the context of workplace, which is to create easy traceable steps in the work environment, resulting in fewer errors and a balance between the productivity of order pickers and the impact on their health which, with initial investments, has a long - term impact on cost reduction.

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