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Use of Industry 4.0 and Organisational Innovation Concepts in the Serbian Textile and Apparel Industry

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Abstract

Technological and non-technological innovations represent one of the most important and sustainable sources of competitive advantages for businesses. Industry 4.0, a new fundamental paradigm shift in industrial production and organisational innovation, as new management practices, are important issues for companies as they seek to upgrade their productivity, improve the quality of supply and retain competitiveness. Analysis of technological and non-technological innovations of the textile and apparel industry in Serbia became particularly important in the situation where the Serbian transitional economy opted to alter its growth model. This paper analyses the results of the European Manufacturing Survey conducted in manufacturing industries in a transitional economy – the Republic of Serbia. The current Serbian dataset of 2015 includes 280 observations of Serbian firms of all manufacturing industries. The empirical results indicate that textile and apparel manufacturing companies in Serbia utilise industry 4.0 and organisational innovation concepts on a very low level.

Key words: Industry 4.0, organisational innovation, EMS, textile, apparel.

■ Introduction

Enterprises operating in the manufacturing industry (i.e. textile, apparel) are increasingly forced to take measures directed towards elevating the effectiveness of the operation and implement innovative solutions [1]. Analysis of competitiveness issues regarding the textile industry in Serbia is particularly important in the situation where the Serbian transitional economy opted to alter its growth model [2]. The transition from a highly centralised planning system to an entrepreneurial knowledge-based economy requires knowledge [3] and innovation to adapt to new market conditions [4]. Innovation can be defined as technological innovations (i.e. product innovation, process innovation) and non-technological innovations (i.e. market innovation, organisational innovation) [5]. Industry 4.0, a new fundamental paradigm shift in industrial production [6], is a result of advanced digitalisation within factories, the combination of Internet technologies and future-oriented technologies in the field of “smart” objects (machines and products) [7]. Hence Industry 4.0 is considered to be technological innovation. Most of the studies focus on technological innovations in manufacturing companies, while non-technological innovations are being neglected [8].

In this respect, the objective of the present paper is to describe in detail the use, planned use and level of use of Industry 4.0 and organisational innovation, providing recent empirical evidence from

a comprehensive nationwide overview for Serbia using firm-level data covering 280 manufacturing establishments.

The paper is structured as follows: Section 2 summarises existing literature on the textile and apparel industry, Industry 4.0 and organisational concepts in manufacturing. Section 3 describes the data and methodology. Section 4 presents the results of our analyses. In addition, this section discusses the results and links the findings to the existing literature. Finally section 5 summarises the results, discusses their limitations and makes suggestions for further research activities.

■ Literature review

Textile and apparel manufacturing industry

Textiles and apparel are one of the most important sectors of the manufacturing industry [9]. Hence they play a vital role in the daily life of people and global economics [10]. Moreover textiles and apparel are decisive sectors for industrialised and lesser developed countries [9]. Throughout history, private sector manufacturing has been highly labour-intensive, and sectors like the textile and clothing industry have created employment opportunities for poor people in low-cost countries [11] European countries are in competition with low-cost countries such as China and India [12]. To reduce production costs, companies in the apparel industry from developed countries are outsourcing manufacturing plants to developing regions [13].

However, the European textile industry is trying to increase its innovative and competitive potential to achieve a significant role in the economic arena [12]. Moreover the European Union also has a positive impact on improving the competitiveness of the textile sector. Thus there is a clear interest from the member states and candidate countries in substantially strengthening the industry on the European and even global scale [12]. To increase competitiveness, it is necessary to produce fashion products which are strongly affected by the dynamics of esthetic and technological trends [14]. As the textile and apparel industry is characterised by seasonality, there is a need to seasonally launch new products in order to build the creativity and loyalty of customers [14]. Therefore the organisation of work, along with other organisational concepts, is vital.

The textile industry in Serbia still has a modest share of the global market [2]. The reason for this lies in the poor economic situation, reflected by transition in the last decade [2]. The relative share of textile and clothing products in the creation of the newly added value of the processing industry in Serbia is considerably lower than in other countries with a similar development level, which indicates structural discrepancies in its development [2]. For this reason, this paper seeks opportunities for improvement regarding the application of technological and organisational concepts in the textile and apparel manufacturing sector.

Industry 4.0

The term Industry 4.0 was firstly introduced in Germany at the Hanover Fair in 2011 [15]. It has emerged as a popular catchphrase in German industry to cover functional areas such as efficient, individual production at lot size 1 under the condition of highly flexible mass production in the emergence of cyber-physical systems and internet of things technologies in the production domain [16]. Similar terms were also introduced in other main industrial countries – “Industrial Internet” in the USA and “Internet +” in China [17]. One of the fundamental concepts of Industry 4.0 is the “smart factory” [7]. Industry 4.0 considers a factory as an autonomous system and includes the following technological concepts: software for production planning and scheduling (e.g. ERP) [18], systems for automation and management of internal logistics (e.g. RFID) [7], new systems in the development of products and services [19], Product-Lifecycle-Management (PLM) systems [20], mobile/wireless devices for programming and operation of equipment and machinery [6], and digital solutions in production (e.g. tablets, smart phones) [6]. With the use of technological concepts, companies reach higher targets [21]. Russmann et al. [22] found that smart factory Industry 4.0 concepts will make production systems as much as 30 percent faster and 25 percent more efficient. Manufacturing companies that have introduced and fully utilised smart factory technologies are continuously upgrading their performance [5]. 82 percent of organisations that claim to have implemented smart manufacturing say that they have experienced increased efficiency, 49 percent – fewer product defects, and 45 percent – increased customer satisfaction [23]. However, this research and the reports do not focus on textile and apparel industries, and, to our knowledge, research on the status of technologically innovative concepts is scarce. Therefore in this paper we concentrate on Industry 4.0 concepts and their impact on the textile and apparel manufacturing sectors and contribute to the theory by researching this under-investigated field.

Organisational concepts in manufacturing

In the previous two decades, organisational innovative concepts have gained the attention of researchers and practitioners [24]. Organisational or non-technical innovations play an increasingly

important role in a better understanding of innovation and its impact on a company’s competitiveness [25]. The empirical research reported by Llach et al. [24] indicates that companies that have adopted environmental management systems have been using organisational innovations. Koren and Palcic [5] argue that the use of organisational innovative concepts increases the proportion of complex products in manufacturing companies in transition countries (i.e. Slovenia). Since Slovenia and Serbia are similar in size and are both transitional countries, it could be concluded that the use of organisational innovative concepts increases the proportion of complex products in Serbian manufacturing companies as well. In addition, the use of organisational innovative concepts has a positive impact on launching new products on the market. However, it has turned out that the scope and level of organisational concept utilisation are not correlated with R&D expenditure in the Slovenian manufacturing sector [26]. Lalic et al. [8] claim that the implementation of organisational innovations improves innovation culture in manufacturing companies from a developing country (i.e. Serbia) and complements the development of new products and related services. Thus it is important to further investigate organisational innovative concepts, not only from the overall manufacturing perspective but also from that of a specific sector (e.g. textile and apparel).

Research methodology

Our analysis used a Serbian dataset from the European Manufacturing Survey

Table 2. Classification of manufacturing sectors according to share in the total sample. *Source:* own research results.

NACE Rev. 2	Manufacturing industry	Share in total sample, %
10	Manufacture of food products	18.2
25	Manufacture of fabricated metal products, except machinery and equipment	13.6
22	Manufacture of rubber and plastic products	8.3
28	Manufacture of machinery and equipment n.e.c.	6.0
14	Manufacture of wearing apparel	6.0
27	Manufacture of electrical equipment	5.3
23	Manufacture of other non-metallic mineral products	5.3
18	Printing and reproduction of recorded media	4.6
31	Manufacture of furniture	4.3
29	Manufacture of motor vehicles, trailers and semi-trailers	4.0
16	Manufacture of wood and products of wood and cork, except furniture	3.6
20	Manufacture of chemicals and chemical products	3.3
17	Manufacture of paper and paper products	3.3
13	Manufacture of textiles	3.3
	Others	10.9

Table 1. EMS database – distribution of firms by size. *Source:* own research results.

Firm size	n	%
20 to 49 employees	107	38.2
50 to 249 employees	141	50.4
250 and more employees	32	11.4

[27], a survey on manufacturing strategies, the application of innovative organisational and technological concepts in production, and on questions of personnel deployment and qualifications in the European manufacturing industry [4, 28, 29]. The written survey set has been carried out by the Fraunhofer Institute for Systems and Innovation Research (ISI) since 1995 [30]. The survey was conducted among manufacturing firms (NACE Rev 2 codes from 10 to 33) having at least 20 employees. The 2015 study included eight Industry 4.0 concepts and eighteen organisational concepts. Organisational concepts were divided into 5 groups: organisation of work (3 items), organisation of production (4 items), production management (4 items), energy and environmental control (3 items), and human resource management (4 items). We asked the companies to reveal information about use, planned use and level of use (high, medium, low).

In 2015, we sent 826 questionnaires and received 280 responses, representing 33.89%. About 38.2% of the firms in the sample are small, having between 20 and 49 employees, while another 50.4% of the firms have between 50 and 249 employees, and 11.4% – more than 250 employees. The largest industry in the sample is the manufacture of food products

Table 3. Use of Industry 4.0 concepts. *Source:* own research results.

Industry 4.0 technology concepts	Share, %	Rank	Planned use, %
Devices for programming and handling of machines	6.8	8	9.6
Product lifecycle management systems	8.9	7	8.6
Technologies for safe human-machine interaction	11.4	6	4.3
Digital visualisation	12.1	5	9.6
Systems for automation and management of internal logistics	18.6	4	10.7
Digital exchange of product/process data	21.4	3	9.6
Near real-time production control system	26.4	1	16.1
Software for production planning and scheduling	21.8%	2	11.4%

Table 4. Use of organisational concepts. *Source:* own research results.

Organisational concepts	Share, %	Rank	Planned use, %
Organisation of work			
Method of 5S	50.7	5	16.8
Standardised working instruction	75.4	1	10.7
Integration of tasks	39.3	6	12.5
Organisation of production			
Measures to improve internal logistics	24.3	15	15.7
Customer- or product-oriented lines/cells in the factory	33.2	11	8.6
Production control by pull principles	27.1	13	10.7
Methods for optimising change-over time	39.3	7	15.0
Production management			
Visual management	36.4	10	13.6
Methods of assuring quality in production	57.9	3	11.4
Methods of operation management	21.8	16	13.2
Methods of continuous improvement of production processes	26.1	14	15.7
Energy and environmental control			
Certified energy management system	5.0	18	22.9
Instruments of life-cycle assessment	8.2	17	18.2
Impact measurements of social and environmental activities	38.6	8	19.6
Human resource management			
Instruments to maintain knowledge of elderly employees	63.2	2	6.8
Instruments for promoting staff commitment	32.9	12	8.9
Standardised methods of job design	37.1	9	12.5
Employee financial participation schemes	56.1	4	7.1

(NACE 10), followed by the production of fabricated metal products, except machinery and equipment (NACE 25), and the manufacture of rubber and plastic products (NACE 22). The share of companies from the textile (NACE 13) and apparel (NACE 14) manufacturing sectors in the total sample is 9.3%. *Tables 1 and 2* give an overview of the sample. The results of the survey will be presented with descriptive statistics.

■ Results and discussion

Overall manufacturing sector

First, using the frequency analysis, we presented the level of use and upgrade of specific Industry 4.0 and organisational concepts in Serbian manufacturing companies. Our research included eight Industry 4.0 concepts and eighteen organisational concepts. We asked the companies whether they use a specific

innovation concept and if they have upgraded it in the past three years. *Table 3* presents the level of use of Industry 4.0 concepts and their upgrade in Serbian manufacturing companies. The most widely used Industry 4.0 concept is the near real-time production control system, which is used in more than a quarter of the manufacturing companies (share of 26.4%). Other technologies are present in less than a quarter of the manufacturing companies. The results show that more than a fifth of Serbian manufacturing companies use software for production planning and scheduling (21.8%) as well as the digital exchange of product/process data (21.4%). Serbian manufacturing companies are still behind other European industries in the utilisation of digital factory concepts. For instance, the Slovenian manufacturing industry, on average, uses Industry 4.0 concepts in more than 30% of all companies [5].

Serbian manufacturing companies are increasingly realising the importance of digital factory concepts. The analysis shows that most of the companies (share of 16.1%) plan to use the technology of the near real-time production control system. The plan to use other Industry 4.0 concepts is below 12%. It is obvious that the implementation of any Industry 4.0 concept is a very complex project, therefore the small share of companies that are planning to use them is not surprising.

Figure 1 depicts the level of use of Industry 4.0 technology concepts. Companies estimated the degree of use as low (first contact with the concept), medium (partial use of the concept) and high use (full application of the concept, at least 70% of employees involved). If we classify Industry 4.0 technology concepts according to the share of high use, we can observe that the order of technologies is, to some extent, similar. Software for production planning and scheduling has been, according to the use frequency, in the second place, but it is in the top place among companies in terms of high utilisation of its potential. The share of high use for all other technologies is in the range from 20 to 50%.

The share of organisational concept use in Serbian manufacturing companies is presented in *Table 4*. All three concepts from the group “organisation of work” are ranked among the top ten most frequently used organisational concepts. Standardised working instruction is considered the most widespread method of organising work, since more than 75% of Serbian manufacturing companies use it. Standardised working instruction is followed by the instruments to maintain knowledge of elderly employees, present in more than 63% of the companies. The same applies to the methods of assuring quality in production. There are two more organisational concepts that are represented in more than half of Serbian manufacturing companies, namely the 5S concept (50.7%) from the group “organisation of work” and employee financial participation schemes (56.1%) from the group “human resource management”. The other organisational concepts are implemented in less than half of Serbian manufacturing companies.

We asked the companies which organisational concepts they were planning to implement in their systems by 2018. Most companies planned to introduce

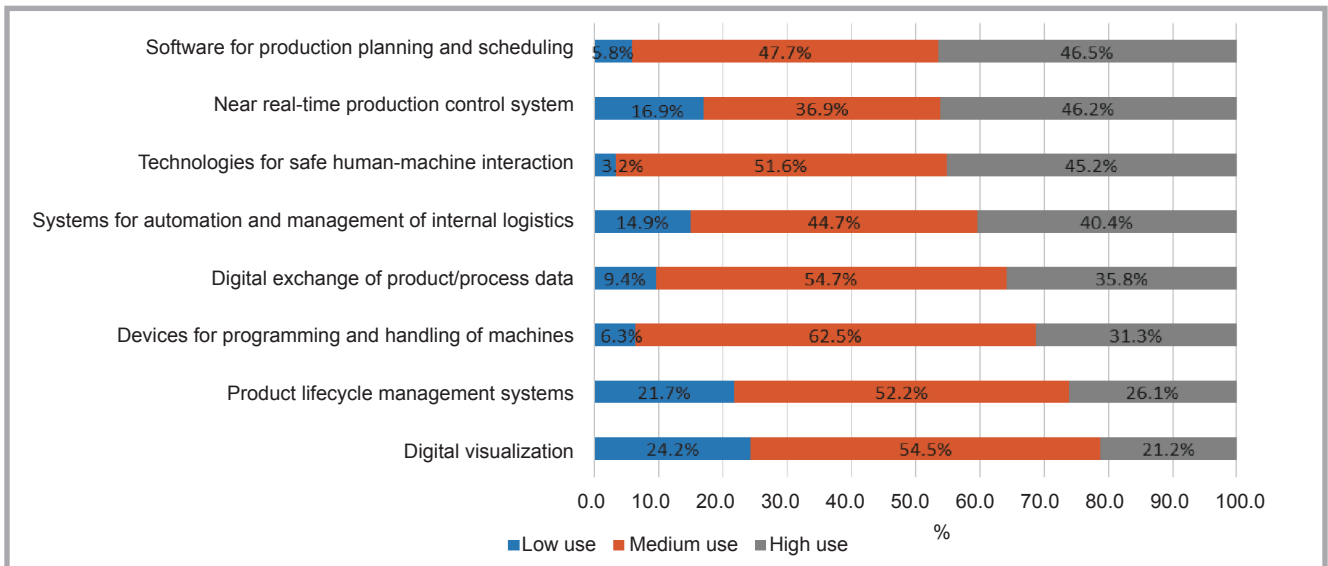


Figure 1. Rate of use of Industry 4.0 concepts. Source: own research results.

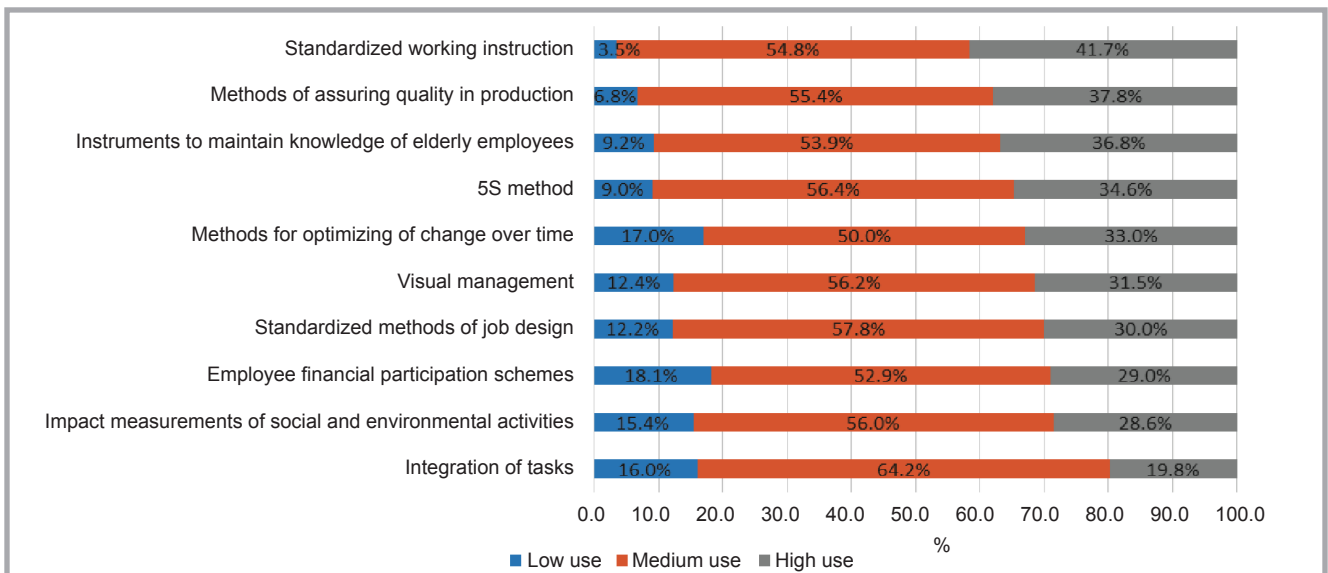


Figure 2. Rate of use of the ten most commonly used organisational concepts. Source: own research results.

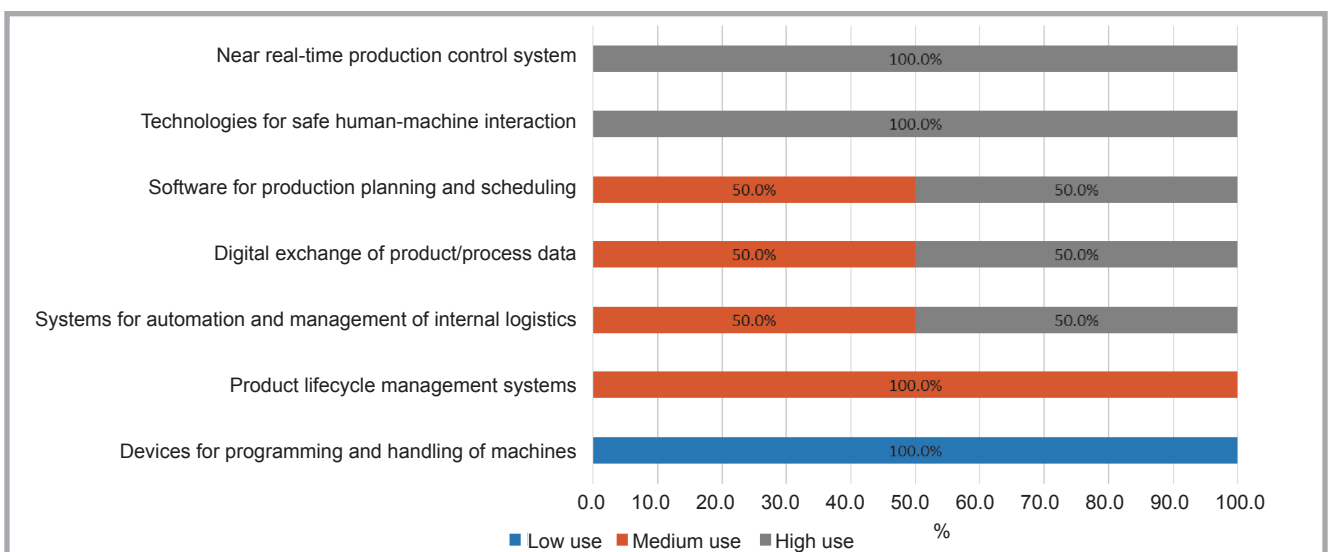


Figure 3. Rate of use of Industry 4.0 concepts in textile companies. Source: own research results.

Table 5. Use of Industry 4.0 concepts in textile companies. *Source:* own research results.

Industry 4.0 technology concepts	Share, %	Planned use, %
Devices for programming and handling of machines	11.1	22.2
Product lifecycle management systems	11.1	11.1
Technologies for safe human-machine interaction	11.1	0.0
Digital visualisation	0.0	22.2
Systems for automation and management of internal logistics	22.2	0.0
Digital exchange of product/process data	22.2	0.0
Near real-time production control system	22.2	0.0
Software for production planning and scheduling	22.2	0.0

Table 6. Use of organisational innovation in the textile industry. *Source:* own research results.

Organisational concepts	Share, %	Rank	Planned use, %
Organisation of work			
5S method	55.6	2	11.1
Standardised working instruction	88.9	1	0.0
Integration of tasks	44.4	3	11.1
Organisation of production			
Measures to improve internal logistics	0.0	16	22.2
Customer or product-oriented lines/cells in the factory	11.1	11	11.1
Production control by pull principles	11.1	12	11.1
Methods for optimising change-over time	11.1	13	11.1
Production management			
Visual management	22.2	8	11.1
Methods of assuring quality in production	33.3	5	0.0
Methods of operation management	11.1	14	22.2
Methods of continuous improvement of production processes	11.1	15	11.1
Energy and environmental control			
Certified energy management system	0.0	17	22.2
Instruments of life-cycle assessment	0.0	18	22.2
Impact measurements of social and environmental activities	22.2	9	11.1
Human resource management			
Instruments to maintain knowledge of elderly employees	33.3	6	11.1
Instruments for promoting staff commitment	22.2	10	11.1
Standardised methods of job design	33.3	7	11.1
Employee financial participation schemes	44.4	4	11.1

concepts from the group “energy and environmental control”. The largest share of planned use can be seen in the field of the Certified energy management system (22.9%), followed by accounting for social and environmental impact (19.6%) and instruments of life-cycle assessment (18.2%). The share of planned use of the other organisational concepts is below 17%. It is a fact that none of the organisational concepts proposed is applicable to all companies (size, production type).

Figure 2 shows the level of use of the ten most widely used organisational concepts. The analysis shows that only standardised working instruction is highly used in more than 40% of the manufacturing companies in Serbia. Only 3.5% of the companies considered the use of standardized working instruction as low. The share of all other highly used concepts in companies is less than 40%. The smallest share

of the highly used concepts is linked to the group “energy and environmental control” and “organisation of work” iImpact measurements of social and environmental activities 28.6% and Integration of tasks 19.8%). These results are not unusual since the largest share of planned use concepts can be seen in the group “energy and environmental controlling”. These results are in line with the previous research. Koren and Palcic [5] found that the standardised working instruction concept is highly used in more than 46.4% of the manufacturing companies in Slovenia. Managers should view the adoption of concepts from the “energy and environmental control” group as an opportunity for the implementation and use of organisational innovations [24].

Textile manufacturing sector

The next stage of the research was to determine the use of Industry 4.0 and or-

ganisational innovation concepts in the Serbian textile industry. **Table 5** shows the level of use of Industry 4.0 concepts and their upgrade in textile manufacturing companies. The level of utilisation of Industry 4.0 concepts in textile companies in Serbia is very low (less than 25%). However, in comparison with the whole manufacturing sector, it could be argued that the utilisation of digital factory concepts in the textile industry is above average. The most widely used concepts are systems for automation and management of internal logistics, digital exchange of product/process data, the near real-time production control system, and software for production planning and scheduling (share of 22.2%). The digital visualisation concept was not used in any Serbian textile manufacturing company; however, most of the companies were planning to use it by 2018. It could be argued that the textile sector in Serbia is in a difficult phase but is slowly getting out of the crisis. This condition is similar in the neighboring countries (i.e. Croatia) [12].

Figure 3 depicts the level of use of Industry 4.0 concepts in the textile sector. If we classify technologies according to the share of high use, we can observe that the order of technologies is very different. Technologies for safe human-machine interaction and the near real-time production control system have a 100% high use share. Systems for the automation and management of internal logistics, the digital exchange of product/process data and software for production planning and scheduling have a 50% medium use share and 50% high use share. Devices for the programming and handling of machines have a 100% low use share, and product lifecycle management systems have a 100% medium use share.

The share of organisational concept use in Serbian textile companies is presented in **Table 6**. Like with the state of the overall manufacturing sector in Serbia, all three concepts from the group “organisation of work” (standardised working instruction 88.9%, 5S method 55.6%, and integration of tasks 44.4%) are ranked among the top ten most frequently used organisational concepts in textile companies. The share of use of other organisational concepts is below 50%. These results may suggest that Serbian enterprises operating in the textile industry primarily count on improving internal processes, such as work organisation. Aspects related to energy and environmental control

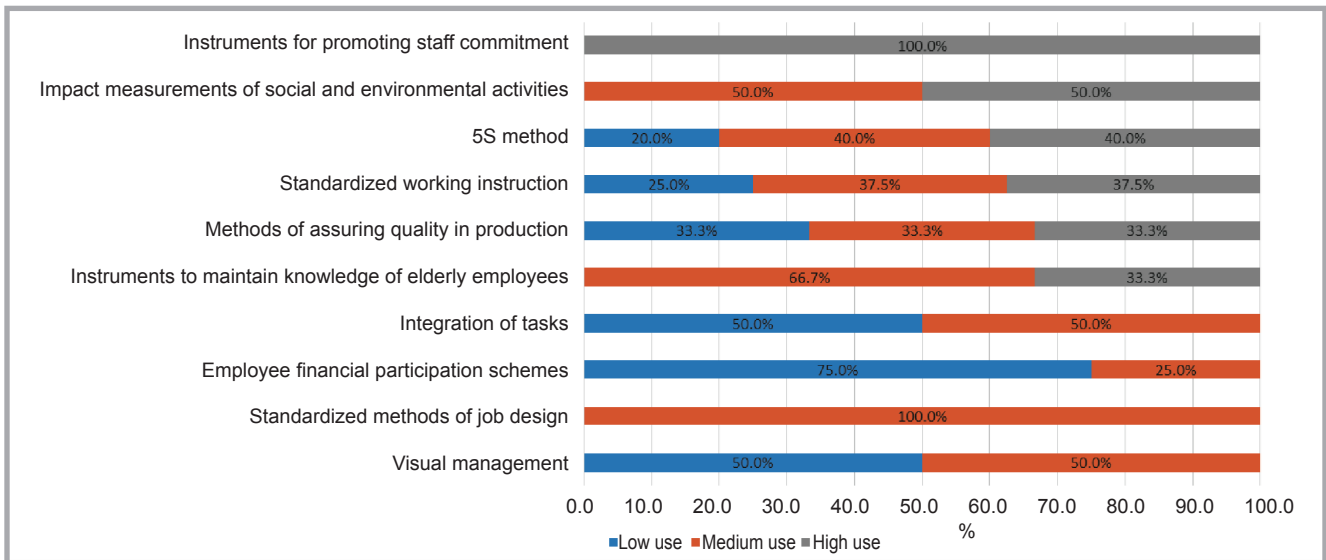


Figure 4. Rate of use of the ten most commonly used organizational concepts in textile companies. Source: own research results.

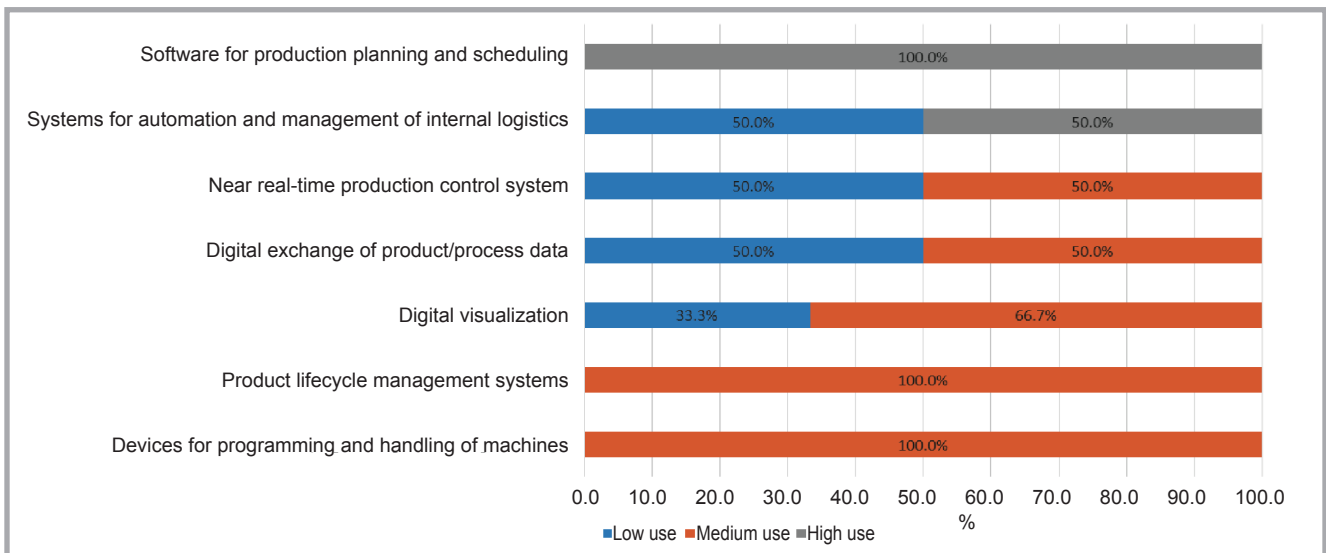


Figure 5. Rate of use of Industry 4.0 concepts in apparel companies. Source: own research results.

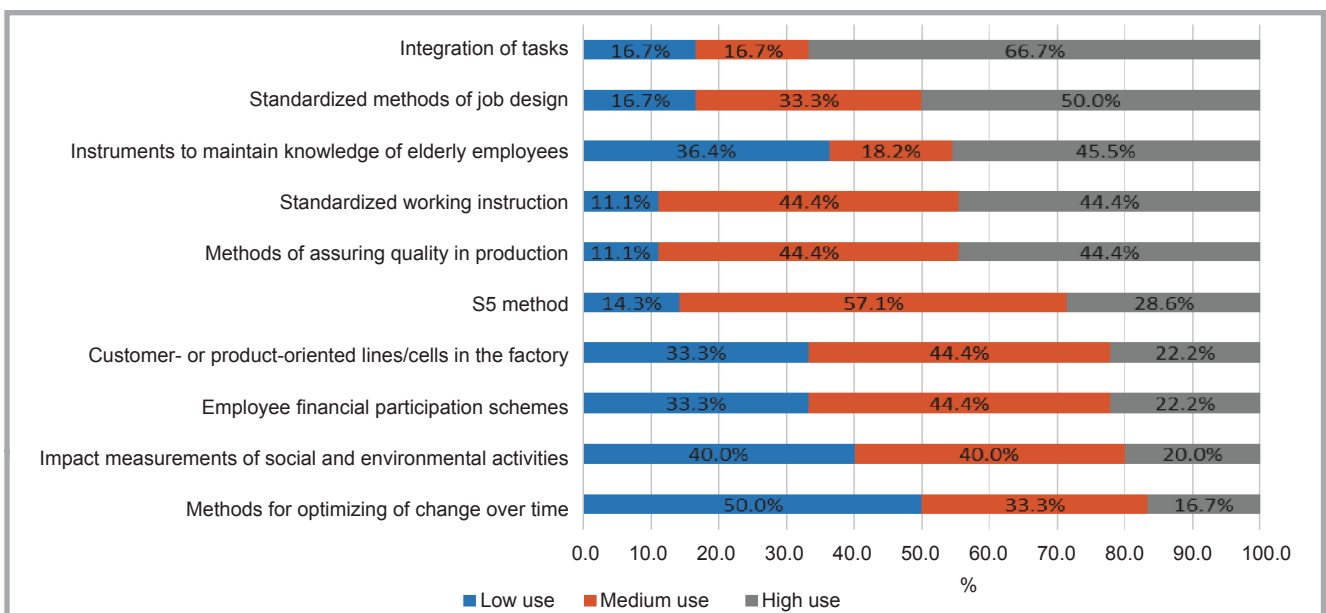


Figure 6. Rate of use of the ten most commonly used organisational concepts in apparel companies. Source: own research results.

Table 7. Use of Industry 4.0 concepts in apparel companies. *Source:* own research results.

Industry 4.0 technology concepts	Share, %	Planned use, %
Devices for programming and handling of machines	5.9	0.0
Product lifecycle management systems	5.9	0.0
Digital visualisation	17.6	0.0
Systems for automation and management of internal logistics	11.8	5.9
Digital exchange of product/process data	11.8	11.8
Near real-time production control system	11.8	17.6
Software for production planning and scheduling	5.9	11.8

Table 8. Use of organisational concepts in apparel industry. *Source:* own research results.

Organisational concepts	Share, %	Rank	Planned use, %
Organisation of work			
5S method	41.2	6	23.5
Standardised working instruction	52.9	2	11.8
Integration of tasks	35.3	7	11.8
Organisation of production			
Measures to improve internal logistics	11.8	16	11.8
Customer or product-oriented lines/cells in the factory	52.9	3	5.9
Production control by pull principles	23.5	12	5.9
Methods for optimising change-over time	35.3	8	11.8
Production management			
Visual management	17.6	13	11.8
Methods of assuring quality in production	52.9	4	5.9
Methods of operation management	17.6	14	0.0
Methods of continuous improvement of production processes	17.6	15	5.9
Energy and environmental control			
Certified energy management system	5.9	18	0.0
Instruments of life-cycle assessment	11.8	17	5.9
Impact measurements of social and environmental activities	29.4	10	11.8
Human resource management			
Instruments to maintain knowledge of elderly employees	64.7	1	5.9
Instruments for promoting staff commitment	29.4	11	11.8
Standardised methods of job design	35.3	9	5.9
Employee financial participation schemes	52.9	5	5.9

are the least important. Similar results can be found in Poland and Slovakia [1].

Figure 4 shows the level of use of the ten most widely used organisational concepts in textile companies. The results show that the instruments for promoting staff commitment have 100% high use. However, this concept is only implemented in 22.2% of textile companies. Impact measurements of social and environmental activities have 50% high use. Other companies have below 50% high use. The smallest share of the highly used concepts is linked to human resource management (standardised methods of job design and employee financial participation schemes), which is quite concerning.

Most companies (22.2%) planned to introduce measures to improve Internal logistics, the certified energy management system, and instruments of life-cycle

assessment by 2018. This is a logical plan since none of these organisational innovative concepts were used in the Serbian textile companies. The results provide strong support to managers to reconsider the current strategy and to invest more resources in energy and environmental control concepts since they can significantly increase innovative potential.

Apparel manufacturing sector

At the end of the analysis process, an attempt was made to become familiar with and systematise the state of use of Industry 4.0 and organisational concepts in the apparel industry. **Table 7** presents the level of use of Industry 4.0 concepts and their upgrade in Serbian apparel companies. The most widely used Industry 4.0 concept in Serbian apparel companies is digital visualisation (17.6%). This is followed by systems for

automation and management of internal logistics, the digital exchange of product/process data, and then the near real-time production control system with (11.8%). The results from textile and apparel companies are very different. The majority of companies from the apparel sector use the digital visualisation concept. However, this concept is least used in textile companies. Most (17.6%) of the apparel companies are planning to use the near real-time production control system.

Figure 5 depicts the level of use of Industry 4.0 concepts in the apparel sector. Software for production planning and scheduling has 100% high use and the system for automation and management of internal logistics – 50% high use. Other companies from the apparel sector did not report a high use of Industry 4.0 concepts.

The share of organisational concept use in Serbian apparel companies is presented in **Table 8**. The most frequently used organisational concept is from the group “human resource management” (instruments to maintain knowledge of elderly employees). This organisational innovative concept is considered as the most widespread in the apparel sector since more than 64% of Serbian apparel companies use it. It is followed by the standardised working instruction, customer or product-oriented lines/cells in the factory, methods of assuring quality in production, and finally employee financial participation schemes (52.9% share of use). The other organisational concepts are implemented in less than 50% of Serbian manufacturing companies in the apparel sector. Compared to the results of the textile industry, organisational concepts from the group “energy and environmental control” have the lowest level of utilisation (below 30% share of use).

Figure 6 shows the level of use of the ten most widely used organisational concepts in Serbian apparel companies. The results indicate that the integration of tasks has 66.7% high use. This is followed by the standardized methods of job design (50% high use), and finally by instruments to maintain knowledge of elderly employees (45.5% high use). It could be argued that there is a small difference among the ten most commonly used organisational concepts in apparel companies, unlike in the textile industry.

Table 9. Correlation between Industry 4.0 innovation and organisational innovation. **Note:** ** Correlation is significant at the 0.01 level (2-tailed).

		Number of organisational innovations
Number of Industry 4.0 innovations	Pearson Correlation	.786**
	Sig. (2-tailed)	.000

Correlation between Industry 4.0 innovation and organisational innovation

We performed another test to find out how the number of Industry 4.0 innovation concepts is related to that of organisational innovation concepts. The results are presented in **Table 9**.

It can be seen that there is quite a significant positive relationship ($r = 0.786$) between the number of Industry 4.0 and organisational concepts used (significance value is under 0.01). It can be concluded that the use of Industry 4.0 innovation concepts usually requires the use of organisational innovation concepts in order to utilise them at a higher level.

Conclusions

This study examines the prevalence and use of Industry 4.0 and organisational concepts in the Serbian manufacturing industry. Moreover this paper provides theoretical and practical suggestions of how and in what way the use, planned use and level of use of different technology and organisational concepts in textile and apparel companies should be pursued to utilise innovative potential. The results show that companies that have introduced specific technologies of the digital factory are continuously upgrading their performance. Unfortunately the majority of companies admit that they do not fully utilise Industry 4.0 technologies to their full potential. The empirical results indicate that among the eight Industry 4.0 concepts, the most widely used in the overall Serbian manufacturing sector is the near real-time production control system (share of 26.4%). However, only 22.2% of Serbian companies from the textile industry and 11.8% from the apparel industry use it. Software for production planning and scheduling is the highest used concept since most of the companies reported its full application. Among the eighteen organisational concepts, the most frequently used are from the group “organisation of work”. The results indicate that the standardized working instruction is used by 88.9% and 52.9% of textile and apparel companies, respectively. Companies from the tex-

tile industry tend to implement concepts from the group “energy and environmental control”. However, the apparel industry is planning to use concepts from the group “organisation of work”. The results indicate that textile and apparel manufacturing companies have a lot of room for improvement in their performance and utilisation of innovative potential by applying innovative technology and organisational concepts.

The limitations of this study are in the areas of sampling. The focus of the study is exclusively on the Serbian market. For this reason, the validity of the evidence presented in this study is limited to the Serbian market situation. Accordingly future studies should compare the results with other european manufacturing survey [27] countries, both developed and developing. While the current study examines the use of currently implemented technological and organisational concepts in textile and apparel sectors, future studies should consider a longitudinal approach to the measurement of these constructs, thereby measuring the use of different concepts every three years.

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