Investments in digital technology advances in textiles

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ABSTRACT – REZUMAT

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The investments in digital technologies are expected to soon have a major impact on the textile and fashion companies' sustainability and competitiveness. Motivated by these trends empirical research on investments of the fashion and textile companies in ICT technologies-based advancement in the Serbian case was provided in 2022. Representatives of 423 textile and fashion companies were asked about their investments in various digital technologies in the previous three years and their digital transformation status. The research findings show that investments in cloud computing, IT, energy management, automation, robotics, and machine learning technologies have a significant impact on the digital transformation of companies. Most of them reached a medium level of transformation, fewer than a high level, with many textile and fashion companies just defining digital transformation. The contribution of the research findings to the investments in the companies' digital transformation can be seen in the significance of the textile's digital technology implementation, which enables manufacturers and retailers to respond directly to market demand by reducing product lead time and cost, increasing supply chain efficiency and profitability, and promising in terms of ensuring competitive advantage in the risk and challenging business environment.

Keywords: *artificial intelligence, cloud computing, digital technologies, innovation, textile and fashion industry, sustainability*

Investiții în progresul tehnologiei digitale în domeniul textil

Este de așteptat ca, în curând, investițiile în tehnologiile digitale să aibă un impact major asupra sustenabilității și competitivității companiilor din domeniul textil și de modă. Având motivația dată de aceste tendințe, în 2022 a fost furnizată o cercetare empirică asupra investițiilor companiilor din domeniul textil și de modă în progresul bazat pe tehnologii TIC în Serbia. Reprezentanții a 423 de companii din domeniul textil și de modă au fost chestionați despre investițiile lor în diferite tehnologii digitale, în ultimii trei ani și starea lor de transformare digitală. Rezultatele cercetării arată că investițiile în cloud computing, IT, managementul energiei, automatizare, robotică și tehnologii de învățare automată au un impact semnificativ asupra transformării digitale a companiilor. Majoritatea au atins un nivel mediu de transformare, câteva dintre acestea un nivel ridicat, multe companii din domeniul textil și de modă doar definind transformarea digitală. Contribuția rezultatelor cercetării la investițiile în transformarea digitală a companiilor poate fi văzută în importanța implementării tehnologiei digitale în domeniul textil, care permite producătorilor și comercianților cu amănuntul să răspundă direct la cererea pieței, prin reducerea timpului de livrare și a costului produselor, creșterea eficienței și profitabilității lanțului de aprovizionare, promițătoare în ceea ce privește asigurarea unui avantaj competitiv în mediul de afaceri riscant și provocator.

Cuvinte-cheie: *inteligență artificială, cloud computing, tehnologii digitale, inovație, industria textilă și de modă, sustenabilitate*

INTRODUCTION

The most significant technology trend that is changing the economy and society today can be identified as digitalization [1, 2]. Looking at the EU production of clothing and textiles whose turnover reached over 169 billion euros, it can be evident that the industry increases its investments in new digital technologies implementation, by 4 billion euros last year (Eurostat, 2022). The results can be seen in already 23% of the global online share of revenues, with only a fashion segment of the $2.5 trillion global industry [3–6]. By 2022, worldwide online apparel and accessories sales are forecasted to reach $765 billion, expecting around a 7.3 percent growth rate by 2025 (eMarketer, 2022).

94% of EU enterprises used a fixed broadband internet connection, and 78% had a website in 2021, providing, online ordering, order tracking, description of goods or services, price lists, and links to their enterprise's references to social media. E-business integration in the EU is increasing, 22% of firms had e-commerce sales, 38% of EU enterprises used ERP software applications (Enterprise resource planning), and 31% to 65% used software applications for CRM (Customer Relationship Management) [7, 8].

A review of the literature on the drivers of digital investments shows new efficiencies enabled by bottom-line and top-line growth of industrial companies, higher customer experience outcomes, and better addressing market needs with a combination of new

and existing data and technologies. Key investment areas are automation of the entire value chain, from decision-making to operations, efficient use of resources, such as time, energy, raw materials, and assets, and initial specific efficiency objectives with the potential to expand to new business models and customer experiences rooted in privacy and trust, customer relationship management. Also, digital marketing and building a better understanding of the scalability potential of the value chain challenges [9–11].
IoT (Internet of Things), and robotics to automate processes and collect data, AI (Artificial Intelligence), 3D vision, and digital platforms to analyze data to identify incremental efficiencies, personalization by big data analytics, cloud to reinforce data management, mobile technologies, and social networks to improve engagement, are some of the most used and implemented enabling technologies by industrial and service companies. The Internet of Things is digital technology mostly used by EU enterprises, 29% used IoT devices, (Eurostat, 2022), for keeping their premises secure, cost reduction or efficiency increase, and radio frequency identification to monitor or automate the process of textile production. 3D digital printing is now widely used for roll-to-roll fabric printing, garment printing, and even electronic textile printing [12], and digitally printed fabric as banners is increasing the investments of these companies in IoT technologies implementation. Using IoT for customer service considers most often the smart cameras or sensors to offer customers a personalized shopping experience [13, 14]. The Internet of Things in the textile industry helps autonomously collect, evaluate, and send data in the textile industry. The new textile industrial transformation includes more now data management to support building efficient, predictive, and profitable models. Artificial Intelligence digital technologies are used by 8% of firms in the EU, most often for robotic process automation. AI with its branch of computer vision in textile manufacturing has increased. AI uses input images to make a computer understand and predict the real world based on the given data and applies probabilistic neural network (PNN) models, a system for detecting knitted fabric defects such as holes, oil stains, fallen-out stitches, and knots using image processing techniques and feature extraction and fabric defect detection with CNN using real images of printed fabrics, as more effective in detecting defects in real-time than conventional classification algorithms such as Support Vector Machine.
The higher productivity impact of robotics and mobile-social media could be explained by their higher maturity compared to IoT and cognitive technologies. They have better-defined use cases and clearer expected returns, and companies in the EU seem to have been more effective in translating bottom-line efficiencies from robotics and mobile/social media into higher operating margins. The less mature technologies appear to start creating value only when associated capabilities, such as data infrastructure, skills, and other intangible investments, are in place. The return on digital investments varies by industry, and industry leaders achieve a greater productivity increase from investments in new technology than followers. Asset-heavy industries realize more value from robotics; asset-light industries realize greater value from mobile/social media. Asset-heavy industries make greater investments in hardware-based technologies, such as IoT and robotics. Asset-light industries make greater investments in software-based technologies, such as mobile/social media and cognitive technologies. They have achieved greater productivity gains from mobile/social media than cognitive technologies.
Digitized production techniques in textiles include more and more computer-aided design (CAD), the usage of digital files, and computer-aided manufacturing (CAM), with the support of programming languages, sensors, servers, and electronic signals. Robotics and artificial intelligence have been widely adopted in weaving and preparation machinery compared to knitting and nonwoven. The application of intelligent robotics in technical sectors such as Robolap, Roboload, Robodoff, and Aerobotic is becoming more useful as AI is also making its way into technical sectors such as cotton colour sorting, weaving defect analysis, synchronization defect classification, knitwear hand development, intelligent design aids, and computer-aided instruction. Robots, as reprogrammable, multifunctional manipulators that move materials, parts, tools, or other devices through variable, programmed motions to perform a variety of tasks, are becoming very important to digitization in the industry. Machine vision technology is the key to the textile industry as it enables accurate analysis and control of fabric lay down. Apart from this, image processing technology has also found its application in the following sectors: colour grading of cotton, manual evaluation of knitted fabrics, virtual fitting systems for garments, classification of dyeing defects, analysis of blending irregularities in yarns, and classification of fabric defects [15–17]. Textile developments would include big data collection, improving reaching the better, smart flooring, for example, that accurately measures shopper movement in a store and from which could be learned how best to set up the store. With AI methods, it is possible to automatically classify body shapes and thus improve the development of perfectly fitting clothing. Or it enables trainable methods for automated visual quality control when it comes to detecting and classifying defects in textile surfaces. AI also offers a new dimension of individualized.
According to McKinsey (2022), fashion companies consider investing in digital marketing capabilities a top priority in the last years. Social media use is expanding by around 25% annually, with nearly 70% of users active on Instagram (in 2021, 59% of EU enterprises used social media). 86% of businesses utilize influencer marketing. 17% of brands had either implemented shoppable galleries or planned to do so in the following year (Statista, 2022). E-commerce marketplaces, and in general online platforms, may facilitate economic growth by enabling sellers to

access new markets and reach new customers at a lower cost [18, 19].

Based on digital technologies implementation of powerful devices is going to be developed: clothing technology, intelligent, wearable, smart clothing. Emerging textile areas like beauty and cosmetic textiles based on microparticles; health textiles that monitor vital signs or are available to third parties for care purposes; safety clothing with an integrated indicator in the sleeve, working clothes with active lighting elements, textiles that generate energy, Adaptive Products, and connectivity improvement are further benefits of these investments [20–22].

The aim of the research and significance of the use of digital technologies in textiles are given in the first part of the study structure, digital transformation, and specific digital technologies used in the operations of the textile and fashion companies in Serbia as a case in the second section. After that are presented the methodology, key findings, and discussion are. Conclusions with the contribution to the theory and practice, possible future research, and the literature are given at the end of the article.

MATERIALS AND METHODS

The textile industry in Serbia is taken as the case sector for empirical research. The total gross value added (GVA) generated by the textile industry was 397.5 million EUR in 2020, which is 1.0% of the total GVA of the country and 0.9% of Serbia's GDP. Observed by activities, 219.4 million EUR was created by the manufacture of wearing apparel (55.2%) and 110.5 million EUR by the manufacture of textiles (27.8%). From 2016 to 2020, the GVA share of the textile industry in total GVA and GDP of the Republic of Serbia shows a downward trend. Export of textile products in 2021 amounted to 1.3 billion EUR which is 6.0% of total export but despite the negative effects caused by the pandemic, export of these products are around 0.7% higher than in 2019 (pre-pandemic level). The textile industry is hiring 61.9 thousand workers (2.8% of total employment) while most are employed in the manufacture of wearing apparel (36.2 thousand). The textile industry in 2021 was operating 1.9 thousand active companies and 6.2 thousand entrepreneurs, which is in total nearly 8.1 thousand (figure 1).

For this paper, empirical research was conducted on the attitudes of representatives of 423 companies from the textile industry in Serbia in 2022. The main goal of the research is to determine the level of digitalization of these companies based on their previous investments in new digital technologies (% of total revenues for the period, 2019–2021).

According to the profile of surveyed companies in the textile sector, 42.00% are engaged in production, 38% in services and trade in the field of textiles, and 20% in marketing and design. Most are micro and small companies, with revenues of up to 150,000 euros. The medium companies are 12.19% (17.00% with over 2 million euros of revenue per year in 2021). About 90.00% of the surveyed companies are private companies, entrepreneurial shops, and agencies. About 7.00% of them are part of an international chain, and about 2.40% have mixed capital. Most of the representatives of the surveyed companies who answered the interview questions were the owners and managers, which supports the credibility of the research results.

All surveyed companies have invested in the last three years in the digitalization of their business, products, and services but with different dynamics and different technologies. Thus, up to 10.00% of total revenues in the last three years, 24% of them allocated for the application of digital technologies, from 11–30.00%, 27.66% of them, and over 31.00%, and over that percentage, 7.09% of the interviewed textile and fashion companies.

Assessing the level of application of digital technologies based on these investments, the representatives of the surveyed companies made the following observations: most of them, 279 companies have partially implemented new digital technologies in their business and are in a medium stage of digital transformation.

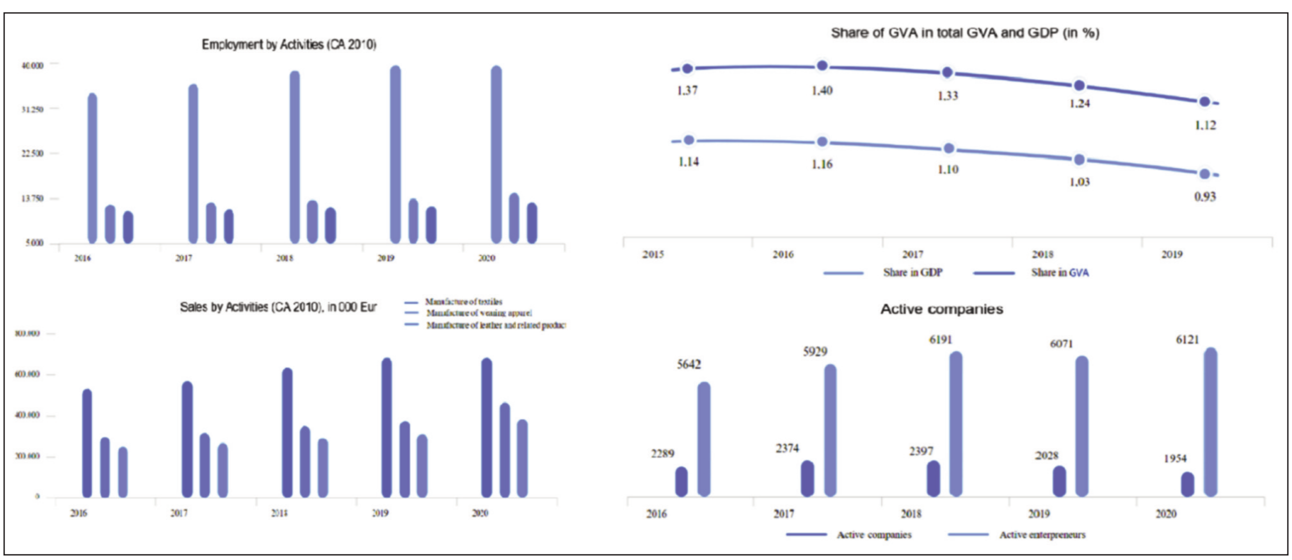

Fig. 1. Serbian textile industry indicators, 2016–2020

18.91% are on a high level of digital transformation with full use of implemented technologies, and 15.13% have just initiated the digital strategy, and are at the beginning of the implementation of digital technologies and their transformation process.

By technologies: Cloud technology is used by surveyed companies, 56.97% of them partially apply it, 13.47% are among those with advanced implementation, and 29.55% of them did not start using it at all or are in the early beginning phase. Technologies of automation, process optimization, and interoperability of functions are applied by surveyed companies so that, 70.00% of them partially apply, 14.89% are at the beginning, and 14.42% riched advanced implementation. Energy management technologies are popular, many companies have these technologies planned in their digital strategy. In practice, 30.26% of companies from the sector applied them on a high level, partially applied by 43.49%, and not 26.24% are at the beginning of the implementation. Algorithms and sophisticated machine learning technologies are generally applied in the practice of the digital transformation of textile companies, 25.76% of them partially apply them, 64.06% of them did not start using them at all, and 10.16% of surveyed companies applied this digital technology. IT technologies for managing business functions are the most 5 popular digital technologies in the digital transformation of textile companies, so 49% of them partially apply them, 29.07% are advanced in their implementation, and 27.42%, are at the beginning of the application.

To assess the statistical significance of the level of digitalization of textile companies in Serbia, the Hi test method was used, and further basic and alternative hypotheses were set:

- H_{01} = There is no statistically significant difference in the application of modern technologies in the digitalization of business operations concerning the level of investment, and that
- H_{a1} = There is a statistically significant difference in the application of modern technologies in the digitalization of business operations about the level of investment.

Besides that, five auxiliary hypotheses are defined concerning investments in a specific technology (H01/Ha1, H02 /Ha2; H03 /Ha3; H04 /Ha4; H05 /Ha5; H06/Ha6).

The hypotheses were tested on a sublimated example of research results related to the financial resources allocated to the total income of enterprises for investments in new digital technologies, individually by technologies, and the total impact of these technologies on the achieved level of digital transformation of enterprises (tables 1 and 2).

Table 1

CROSSTABULATION INDICATORS												
Indicator	**Level of digital transformation**											
The firm's investments	At the beginning of the implementation			Partially implemented			Advanced implementation			Total		
	N	Column (%)	Row (%)	N	Column (%)	Row (%)	N	Column (%)	Row (%)	N	Column (%)	Row (%)
≤ 10%	42	65.63	15.22	213	76.34	77.17	21	26.25	7.61	276	65.25	100.00
11% – 30%	14	21.88	11.97	52	18.64	44.44	51	63.75	43.59	117	27.66	100.00
≥ 31%	8	12.50	26.67	14	5.02	46.67	8	10.00	26.67	30	7.09	100.00
Total	64	100.00	15.13	279	100.00	65.96	80	100.00	18.91	423	100.00	100.00
The firm's investments	Claud technology											
	Level of digital transformation											
	At the beginning of the implementation			Partially implemented			Advanced implementation			Total		
	N	Column (%)	Row (%)	N	Column (%)	Row (%)	N	Column (%)	Row (%)	N	Column (%)	Row (%)
≤ 10 %	107	85.60	38.77	153	63.49	55.43	16	28.07	5.80	276	65.25	100.00
11% – 30%	11	8.80	9.40	79	32.78	67.52	27	47.37	23.08	117	27.66	100.00
≥ 31%	7	5.60	23.33	9	3.73	30.00	14	24.56	46.67	30	7.09	100.00
Total	125	100.0	29.55	241	100.0	56.97	57	100.00	13.48	423	100.00	100.00
	Automation, robotization, process optimization, interoperability of functions											
	Level of digital transformation											
	At the beginning of the implementation			Partially implemented			Advanced implementation			Total		
	N	Column (%)	Row (%)	N	Column (%)	Row (%)	N	Column (%)	Row (%)	N	Column (%)	Row (%)
≤ 10 %	43	68.25	15.58	206	68.90	74.64	27	44.26	9.78	276	65.25	100.00
11% – 30%	13	20.63	11.11	83	27.76	70.94	21	34.43	17.95	117	27.66	100.00
≥ 31%	7	11.11	23.33	10	3.34	33.33	13	21.31	43.33	30	7.09	100.00
Total	63	100.00	14.89	299	100.00	70.69	61	100.00	14.42	423	100.00	100.00

Table 1 (*continuation*)

The firm's investments	Energy management											
	Level of digital transformation											
	At the beginning of the implementation			Partially implemented			Advanced implementation			Total		
	N	Column (%)	Row (%)	N	Column (%)	Row (%)	N	Column (%)	Row (%)	N	Column (%)	Row (%)
≤ 10 %	90	81.08	32.61	157	85.33	56.88	29	22.66	10.51	276	65.25	100.00
11% – 30%	15	13.51	12.82	17	9.24	14.53	85	66.41	72.65	117	27.66	100.00
≥ 31%	6	5.41	20.00	10	5.43	33.33	14	10.94	46.67	30	7.09	100.00
Total	111	100.00	26.24	184	100.00	43.50	128	100.00	30.26	423	100.00	100.00
The firm's investments	Sophisticated machine learning algorithms											
	Level of digital transformation											
	At the beginning of the implementation			Partially implemented			Advanced implementation			Total		
	N	Column (%)	Row (%)	N	Column (%)	Row (%)	N	Column (%)	Row (%)	N	Column (%)	Row (%)
≤ 10 %	201	74.17	72.83	51	46.79	18.48	24	55.81	8.70	276	65.25	100.00
11% – 30%	63	23.25	53.85	49	44.95	41.88	5	11.63	4.27	117	27.66	100.00
≥ 31%	7	2.58	23.33	9	8.26	30.00	14	32.56	46.67	30	7.09	100.00
Total	271	100.00	64.07	109	100.00	25.77	43	100.00	10.17	423	100.00	100.00
The firm's investments	IT technologies implementation in business operations											
	Level of digital transformation											
	At the beginning of the implementation			Partially implemented			Advanced implementation			Total		
	N	Column (%)	Row (%)	N	Column (%)	Row (%)	N	Column (%)	Row (%)	N	Column (%)	Row (%)
≤ 10 %	93	80.17	33.70	152	82.61	55.07	31	25.20	11.23	276	65.25	100.00
11% – 30%	17	14.66	14.53	22	11.96	18.80	78	63.41	66.67	117	27.66	100.00
≥ 31%	6	5.17	20.00	10	5.43	33.33	14	11.38	46.67	30	7.09	100.00
Total	116	100.00	27.42	184	100.00	43.50	123	100.00	29.08	423	100.00	100.00

Table 2

HYPOTHESIS TESTING						
Level of digital transformation						
Test	ChiSquare (o)	Prob>ChiSq (o)	df	ChiSquare (t)	Prob>ChiSq (t)	Hypothesis H_{01}
Pearson	75.855	0.0001	4	9.488	0.05	not accepted
Claud technology						
Test	ChiSquare (o)	Prob>ChiSq (o)	df	ChiSquare (t)	Prob>ChiSq (t)	Hypothesis H_{02}
Pearson	75.238	0.0001	4	9.488	0.05	not accepted
Automation, robotization, process optimization, interoperability of functions						
Test	ChiSquare (o)	Prob>ChiSq (o)	df	ChiSquare (t)	Prob>ChiSq (t)	Hypothesis H_{03}
Pearson	31.696	0.0001	4	9.488	0.05	not accepted
Energy management						
Test	ChiSquare (o)	Prob>ChiSquare (o)	df	ChiSquare (t)	Prob>ChiSq (t)	Hypothesis H_{04}
Pearson	155.125	0.0001	4	9.488	0.05	not accepted
Sophisticated machine learning algorithms						
Test	ChiSquare (o)	Prob>ChiSq (o)	df	ChiSquare (t)	Prob>ChiSq (t)	Hypothesis H_{05}
Pearson	74.572	0.0001	4	9.488	0.05	not accepted
IT technologies implementation in business operations						
Test	ChiSquare (o)	Prob>ChiSq (o)	df	ChiSquare (t)	Prob>ChiSq (t)	Hypothesis H_{06}
Pearson	127.542	0.0001	4	9.488	0.05	not accepted

KEY RESULTS AND DISCUSSION

In this paper, one basic hypothesis, with its alternative (H01/Ha1), and five auxiliary hypotheses (H01 /Ha1, H02 /Ha2; H03 /Ha3; H04 /Ha4; H05 /Ha5; H06/Ha6, are tested by comparing it with the null hypothesis.

The null hypothesis is only rejected if its probability falls below a predetermined significance level, in which case the hypothesis being tested is said to have that level of significance. According to the results of the research, the exceptional importance of investments of companies from the textile and fashion industry in modern technologies, their application in business, and the modernization of functions for digital transformation is confirmed [2–6]. Also,

- H01: There is no statistically significant difference between the level of investment of a textile/fashion company in new technologies and the achieved level of digital transformation of its business.
- Ha1: There is a statistically significant difference between the level of investment of a textile company in new technologies and the achieved level of digital transformation of its business.

According to Pearson's test: the significance threshold is 0.05; the degree of freedom is 4, and the limit value for χ^2 = 9.488. The value for χ^2 = 75.855 was obtained. The obtained value is greater than the tabular χ^2 = 9.488, and the obtained significance of 0.0001 is less than the 0.05 threshold. Based on these parameters, the null hypothesis is not accepted, but an alternative one is that there is a statistically significant difference between the amount of investment of a company in new technologies and the achieved level of digital transformation of its business. Like all other hypotheses, an alternative was also accepted, according to which the levels of digital transformation of textile companies' business are distinguished based on the amount of invested funds (measured % of total revenue in the last three years, 2019–2021), in technological modernization of functions, production, and business, communication with consumers, market, supply chain, data. In all tested digital technologies applications in the textile companies, the significance threshold is 0.05, the degree of freedom is 4, the limit value for χ^2 = 9.488, and as follows:

- ***Cloud technologies (Ha2***), the obtained value is for χ^2 = 75,238 and is higher than the table χ^2 = 9,488, and the obtained significance of 0,0001 is less than the threshold of 0.05, so the null hypothesis (H2) – that there is no statistically significant difference between the amount of investment in technology cloud and reaching the level of digital transformation of his business is not accepted.
- ***Automation, robotization, process optimization, and interoperability of functions (Ha3***), the obtained value is for χ^2=31,696 and is higher than the table χ^2=9,488, and the obtained significance of 0,0001 is less than the threshold of 0,05, so the null hypothesis (H3), is that there is no statistically significant difference between the amount of investment in Automation, robotization, process optimization, interoperability of functions and reaching the level of digital transformation of its business is not accepted.
- ***In energy management (Ha4),*** the obtained value is for χ^2 =155.125 and is higher than the table χ^2 = 9.488, and the obtained significance of 0.0001 is less than the threshold of 0.05, so the null hypothesis (H4), is that there is no statistically significant difference between the amount of investment in energy management and reaching the level of digital transformation of its business is not accepted.
- ***Machine learning (Ha5),*** the obtained value is for χ^2=74.572 and is higher than the table χ^2 = 9.488, and the obtained significance of 0.0001 is less than the threshold of 0.05, so the null hypothesis (H5), is that there is no statistically significant difference between the amount of investment in Sophisticated machine learning algorithms and reaching the level of digital transformation of its business is not accepted, and
- ***IT (Ha6),*** the obtained value is for χ^2 = 127.542 and is higher than the table χ^2 = 9.488. The obtained significance of 0.0001 is less than the threshold of 0.05, so the null hypothesis (H6), is that there is no statistically significant difference between the amount of investment in IT technologies implementation in business operations and reaching the level of digital transformation of its business is not accepted.

CONCLUSIONS

The findings of this research on investments in digital technologies of companies in the textile sector and the achievement of different levels of business digitalization can contribute to the theory, support of knowledge, and benefits from the digital strategy of textile companies' implementation. Primary:

- *Automation technologies*, conversion of analogue to digital information in business in the initial phase of digitalization, with digital resources, the standard organizational hierarchy from top to bottom, growth strategy based on market penetration, metrics KPIs, ROI, and ROA, saving costs and resources for existing activities [2–4].
- *Robotization technologies,* the addition of digital components to products and services of textile companies, introduction of digital distribution and communication channels for medium-level business digitalization, with agile digital resources in the supply chain, organizational structure of separate agile units, digital growth strategy based on market penetration platform and its joint creation with other interest groups, metric-digital KPIs, and goals, which are primarily reflected in reducing costs and increasing revenue, reengineering business processes of the company and strengthening the user experience [7, 8] and

- *IT technologies* for introducing new business models in an advanced phase of digital transformation of textile companies, such as production and service digital platforms, business models based on big data and analytics, with organizational structure, flexible forms, IT internationalization, and analytically functional business areas, digital development strategies based on platforms, metrics; digital KPI, and new business model development [2].

Previous works on the impact of the ICT investments on the company's results)confirm the findings of the study emphasizing the further importance of these technologies in achieving strategic objectives of the textile enterprises in applications of digital technologies and achieving business and content metrics [1, 2, 16, 17].

The coverage of work limits does not include the elaboration of each phase of digitalization achieved by introducing certain digital technologies [2, 10, 11, 21].

The paper points to the need for new research related to fostering digital transformation in the Serbian textile sector, which would address the external guides of this transformation: digital competitiveness, the needs of digital consumers, and stakeholders, especially online distribution, and the interdependence of factors within the supply chain [4–7].

REFERENCES

[1] Tech4i2 and Leicester University, *Understanding country performance in digital indexes*, 2019, Available at: https://www.itu.int/en/ITU-D/Regional-Presence/Europe/Documents/Events/2019/Regulatory%20Forum/Tech4i2%20Explaining%20variance%20in%20digital%20indexes.pdf [Accessed on May 23, 2022]

[2] Radocchia, S., *How Will Blockchain Change The Economy*, 2018, Available at: forbes.com [Accessed on May 23, 2022]

[3] Technology Vision, *IoT Platforms: Enabling the Internet of Things*, Accenture, 2016

[4] Engleson, S., *The Future of Voice From Smartphones to Smart Speakers to Smart Homes*, 2017, Available at: Comscore.com, [Accessed on May 23, 2022]

[5] Bloomberg Intelligence, *Big Data – Market Size*, Bloomberg Intelligence, 2018

[6] Grozdanic, R., *Klasteri u turizmu, International Monograph: Tourism & Hospitality Industry*, In: Tourism, and Hospitality Management. 2006, 12, 1, 119–130

[7] Milosević, P., *Developing Greenway Corridors in Serbia – Case Study of the Danube Region's Cultural Historical and Natural Resources' Potentials,* In: Architecture Civil Engineering Environment, 2015, 8, 1, 21–34

[8] Gardašević, J., Ćirić, M., Carić, M., *Understanding the motives for using social networks in the function of improving communication with consumers*, In: Marketing, 2018, 49, 4, 311–320

[9] Ljubojević, Č., Ćirić, M., *Maketing usluga,* Fakultet za ekonomiju i inženjerski menadžment, Novi Sad, 2017

[10] Ashton, K., *That "Internet of Things" thing*, RFID Journal, 2009

[11] Mingde, B., Zhigang, S., Yesong, L., *Textural Fabric Defect Detection using Adaptive Quantized Gray-level Co-occurrence Matrix and Support Vector Description Data*, In: Information Technology J., 2012, 11, 6, 673–685, https://doi.org/10.3923/itj.2012.673.685

[12] Korger, M., Bergschneider, J., Lutz, M., Mahltig, B., Finsterbusch, K., Rabe, M., *Possible Applications of 3D Printing Technology on Textile Substrates*, In: IOP Conf. Ser, Mater. Sci. Eng., 2016, 141, 012011, https://doi.org/10.1088/1757- 899X/141/1/012011

[13] Parsons, J.L., Campbell, J.R., *Digital Apparel Design Process: Placing a New Technology Into a Framework for the Creative Design Process,* In: Clothing, and Textiles Research Journal, 2004, 22, 1–2, 88–98, https://doi.org/10.1177/0887302X0402200111

[14] Kornit, *Shoe printing applications*, Kornit Digital, 2021, Available at: https://www.kornit.com/application-category/shoes/ [Accessed May 16, 2021]

[15] Choi, T.M. *Pre-season stocking and pricing decisions for fashion retailers with multiple information updating*, In: International Journal of Production Economics, 2007, 106, 1, 146–170, Available at: 10.1016/j.ijpe.2006.05.009

[16] Miletić, V., Ćurčić, N., *Građenje strateških alijansi – faktor internacionalizacije poslovanja nacionalnih preduzeća*, In: Ekonomija teorija i praksa, 2021, 14, 3, 64–82, https://doi.org/10.5937/etp2103064M

[17] Popović, M., Jevtić, B., Kvrgić, G., *Information Technologies, Education and Skills for IT Jobs Challenges*, In: Limes plus, 2020, 3, 39–63, https://doi.org/10.5281/zenodo.4627026.9

[18] UNCTAD, *Technology and innovation report 2021*, Available at: https://unctad.org/system/files/official-document/tir2020_en.pdf [Accessed on May 15, 2022]

[19] *State of Fashion 2022: Am uneven recovery and new frontiers*, State of Fashion, McKinsey, 2022

[20] Ellen MacArthur Foundation, *A New Textiles Economy: Redesigning fashion's future*, Available at: https://www.ellenmacarthurfoundation.org/publications/a-new-textiles-economy-redesigning-fashions-future [Accessed on May 15, 2022]

[21] EEA briefing, Textiles in Europe's circular economy, Available at: https://www.eea.europa.eu/themes/waste/resourceefficiency/textiles-in-europe-s-circulareconomy [Accessed on May 15, 2022]

[22] Fair and Sustainable Textiles, *European civil society strategy for sustainable textiles, garments, leather, and footwear*, Available at: https://fairtrade-advocacy.org/wp-content/uploads/2020/04/Civil-Society-European-Strategy-for-Sustainable-Textiles.pdf [Accessed on May 15, 2022]

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