



UNION OF ENGINEERS AND TEXTILE
TECHNICIANS OF SERBIA

VII INTERNATIONAL SCIENTIFIC CONFERENCE
**CONTEMPORARY TRENDS
AND INNOVATIONS IN THE
TEXTILE INDUSTRY**

VII MEĐUNARODNA NAUČNA KONFERENCIJA
**SAVREMENI TRENDovi I
INOVACIJE U TEKSTILNOJ
INDUSTRIJI**

PROCEEDINGS

EDITOR:
Prof. dr SNEŽANA UROŠEVIĆ

Belgrade, 19-20th September, 2024
Union of Engineers and Technicians of Serbia
Dom inženjera „Nikola Tesla“



UNION OF ENGINEERS AND TEXTILE TECHNICIANS OF SERBIA

AND

**UNION OF ENGINEERS AND TECHNICIANS OF SERBIA
FACULTY OF TECHNOLOGY AND METALLURGY IN BELGRADE
FACULTY OF TECHNOLOGY, SHTIP, NORTH OF MACEDONIA
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SOCIETY FOR ROBOTICS OF BOSNIA I HERZEGOVINA
BASTE - BALKAN SOCIETY OF TEXTILE ENGINEERING, GREECE**

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PREFACE

The 7th International conference "Contemporary Trends and Innovations in the Textile Industry" CT&ITI 2024, is co-organized by:

- Union of Engineers and Textile Technicians of Serbia,
- Union of Engineers and Technicians of Serbia,
- Faculty of Technology and Metallurgy in Belgrade, University of Belgrade, Serbia,
- Faculty of Technology, "Goce Delchev" University, Shtip, North Macedonia,
- Faculty of Mechanical Engineering, Polytechnic University of Tirana, Albania,
- Society for Robotics of Bosnia and Herzegovina and
- Balkan Society of Textile Engineering-BASTE of Greece.

The Ministry of Science, Technological Development and Innovation of the Republic of Serbia recognized the importance of this Conference, and thus, supported it.

The aim of this Conference is to consider current technical, technological, economic, ecological, R&D, legal and other issues related to the textile industry, then the application of contemporary achievements and the introduction of technical and technological innovations in the production process of fiber, textile, clothing and technical textile by applying scientific solutions in order to improve the business and increase the competitive advantages of the textile industry on the domestic and global market.

Leading scientists and experts from the Balkans and other countries, working at faculties, textile colleges and institutes, but also individuals who professionally deal with the issues at hand are taking part in this Conference.

The Conference program involves papers dedicated to the scientific and practical aspects of the following topics: Textile and Textile Technology, Textile Design, Management and Marketing in the Textile Industry and Ecology and Sustainable Development in the Textile Industry. The Conference program includes 66 papers, and a total of 158 participants from 17 countries: Albania, Australia, Bosnia and Herzegovina, Bulgaria, Croatia, Germany, Greece, India, North of Macedonia, Montenegro, Portugal, Romania, Serbia, Slovenia, Spain, Turkey and Ukraine.

Therefore, this Conference is an opportunity for establishing scientific, educational and economic cooperation of our country with other countries. Certain number of papers by domestic authors present the project results dealing with fundamental research and technological development, financed by the Ministry of Ministry of Science, Technological Development and Innovation of the Republic of Serbia.

I would like to thank all those who have made it possible to organize the conference Contemporary Trends and Innovations in the Textile Industry and make it a success. First, I would like to thank the Scientific and Organizing Committee for working hard, spending countless hours and finding the best solutions for numerous organizational aspects of our Conference. I also thank all the other institutions that supported the Conference in various ways, because without their support, the Conference could not have been organized. Last but not least, I would like to thank plenary lecturers, all authors and co-authors and guests for their participation in the Conference.

On behalf of the Organizing Committee

Prof. dr Snežana Urošević, president



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TABLE OF CONTENTS

PLENARY LECTURES	1
Matea Korica, Mirjana Kostić BIOACTIVE TEXTILE MATERIALS BASED ON CELLULOSE AND CHITOSAN	3
Ana Sutlović, Valentina Ferenčak, Jelena Đukanović, Sofija Đukanović REVITALISATION OF NATURAL DYES – RED SHADES OF TEXTILES DYED WITH <i>RUBIA TINCTORUM</i> UNDER DIFFERENT PROCESS PARAMETERS	14
Prodromos Minaoglou, Nikolaos Efkolidis, Athanasios Manavis, Panagiotis Kyratsis CUSTOMIZING THE GARMENT DESIGN USING COMPUTATIONAL DESIGN AND 3D PRINTING TECHNOLOGIES: A CASE STUDY	24
Irem Çelik, Gizem Karakan Günaydın, Hüseyin Gazi Türksoy EVALUATION OF SOME PHYSICAL PROPERTIES OF NEW DEVELOPED “SAXCELL” BLENDED WOVEN FABRICS	32
Ermira Shehi IMPLEMENTATION OF SDGS IN THE TEXTILE SECTOR IN ALBANIA FOR A SUSTAINABLE, GREEN, AND COMPETITIVE SECTOR IN THE REGION	42
Nenad Milijić, Violeta Stefanović ANALYSIS OF SAFETY CLIMATE FACTORS IN TEXTILE INDUSTRY	55
CONFERENCE PAPERS	
SESSION I – TEXTILE AND TEXTILE TECHNOLOGIES	69
İlhan Özen, Oğuz Demiryürek, Kamyar Shirvanimoghaddam, Mino Naebe OPTIMISATION OF PROCESSING CONDITIONS OF PECTIN/RED CLOVER EXTRACT NANOEMULSIONS FOR MEDICAL TEXTILE APPLICATIONS	71
Marija Vukčević, Marina Maletić, Biljana Pejić, Ana Kalijadis, Aleksandra Perić Grujić MODIFIED FIBROUS TEXTILE WASTE AS ADSORBENTS FOR REMOVAL OF PHARMACEUTICALS FROM WATER	79
Emilija Toshikj, Sijche Pechkova OPTIMIZATION OF COP DIAMETER AT BOTTON RING RAIL STAGE IN RING SPINNING PROCESS USING TAGUCHI METHOD	86
Hülya Kesici Güler, Funda Cengiz Çalloğlu A STUDY ABOUT SAFFLOWER OIL LOADED EMULSION ELECTROSPUN NANOFIBERS	93



Mustafa Geysoğlu, Funda Cengiz Çallıoğlu FABRICATION OF PCL/SEPIOLITE COMPOSITE NANOFIBERS	100
Miroslav Kalanj, Tamara Kalanj, Snežana Stanković TOWARDS IMPROVING MEASUREMENT METHOD FOR MECHANICAL PROPERTIES OF TEXTURED FILAMENT/ELASTANE HYBRID YARNS	109
Mustafa Geysoğlu, Funda Cengiz Çallıoğlu EMULSION ELECTROSPINNING OF PVA/ROSEMARY NANOFIBERS	116
Vildan Sölar SOIL DEGRADATION OF DENIM FABRICS PRODUCED BY DIFFERENT FINISHING TREATMENTS	126
Katarina Maričić, Nemanja Kašiković, Teodora Gvoka, Nada Miketić, Gordana Bošnjaković THE INFLUENCE OF AMBIENT TEMPERATURE ON THE RATE OF COLOR CHANGE OF THERMOCHROMIC INKS	131
İlhan Özen, Peng Wu, Kamyar Shirvanimoghaddam, Minoo Naebe PECTIN/CHASTE BERRY OIL NANOEMULSIONS AND NANOFIBERS FOR WOMEN'S HEALTH	139
Muhammed İbrahim Bahtiyari, Ömer Aydinlioğlu, Fazlıhan Yılmaz, Hüseyin Benli, Asım Davulcu A JOURNEY FROM WASTE TO DYEING OF WOOL	147
Hüseyin Benli SUSTAINABLE DYEING OF WOOL FABRICS WITH A BIO-WASTE PISTACHIO TREE (<i>PISTACIA VERA</i> L.) BRANCH	154
Milena Nikodijević, Ivana Petrović, Čedomir Dimić, Nenad Ćirković AIR PERMEABILITY AND PHYSICAL-MECHANICAL PROPERTIES OF FABRICS FOR PRODUCTION OF AIRBAGS IN AUTOMOBILES	161
Emilija Toshikj, Zvezda Bogevska ECO-FRIENDLY NONWOVEN COVERS FOR AGRICULTURAL USE PRODUCED FROM POST-CONSUMER WASTE	171
Ulrike Reinhardt, Lilia Sabantina, Malin Schiller, Soraya Flohr, Anne-Marie Miene, Patrizia Zimmermann COMPARISON OF THE REAL AND VIRTUAL FALLING BEHAVIOUR OF TEXTILE FABRICS	177
Rıza Atav, Eray Akkuş, Deniz İzlen Çifçi, Uğur Ergünay, Yalçın Güneş, Elçin Güneş INVESTIGATION OF COLOR REMOVAL PERFORMANCE IN DYEHOUSE REACTIVE DYEING WASTEWATER USING DENDRIMER TECHNOLOGY	187



Hakan Sayimlı, Hülya Kesici Güler, Funda Cengiz Çalhoğlu WASTE POTASSIUM BASED RECYCLE AGENT PREPARATION AND NANOFIBER PRODUCTION	197
Tijana Adžić, Snežana Stanković THEORETICAL ANALYSIS OF COMPRESSION OF RIB KNITTED FABRIC	206
Sibel Kaplan, Havva Tokgöz BED MICROCLIMATE MANAGEMENT PERFORMANCES OF MATTRESS TICKING FABRICS ACCORDING TO THEIR TRANSFER CHARACTERISTICS	214
Subrata Das, Sharmila Soundararajan IMPACT PROTECTION IN BODY ARMOUR USING SHEAR THICKENING FABRIC	221
Nazife Korkmaz Memiş, Sibel Kaplan PVDF FILMS WITH OPTIMIZED POROUS STRUCTURE USING NON-SOLVENT INDUCED PHASE SEPARATION FOR PASSIVE RADIATIVE COOLING	235
Dušan Nešić CLASSIC COMMON FASTENERS FOR TEXTILES AS CONNECTIONS IN ELECTRONICS ON TEXTILES	242
Dragana Grujić, Aleksandar Savić, Ljiljana Topalić-Trivunović, Blanka Škipina, Branka Ružičić, Boštjan Novak ANTIMICROBIAL PROPERTIES OF INSOLES PRINTED WITH MODIFIED BENTONITE AND EXTRACT OF <i>PICEA OMORICA</i>	250
Sara Lakić, Tatjana Botić, Aleksandra Borković, Boštjan Novak, Svjetlana Janjić COMPARISON OF PHYSICAL AND MECHANICAL PROPERTIES OF CHROME AND VEGETABLE TANNED LEATHER	264
Njegoš Dragović, Snežana Urošević, Milovan Vuković INNOVATION OF USING 3D PRINTING FOR TEXTILE FIBERS	274
CONFERENCE PAPERS SESSION II - TEXTILE AND FASHION DESIGN	285
Maja Jankoska, Ruzica Stevkovska-Stojanovska CONNECTION OF WOMEN'S FASHION DESIGNS AND ARCHITECTURAL CONSTRUCTIONS	287
Banu Hatice Gurcum, Özge Öztürk COLOURS AND MOTIFS OF THE TRADITIONAL HAND-KNITTED SOCKS OF AĞRI PROVINCE OF TURKEY	296



Tatjana Spahiu, Liliia Chertenko, Henrique Almeida, Ermira Shehi, Panagiotis Kyratsis DIGITAL TOOLS FOR DESIGN AND MANUFACTURING OF FOOTWEAR PARTS AS HEELS	309
Panagiota Ligka, Nikolaos Efkolidis, Athanasios Manavis, Panagiotis Kyratsis COMBINING COMPUTATIONAL DESIGN AND BIOMIMETICS: A CASE STUDY	320
Sanja Risteski, Silvana Zhezhova, Saska Golomeova Longurova, Sonja Jordeva, Vangja Dimitrijeva-Kuzmanoska THE COSTUME IN EGYPT AS INSPIRATION FOR THE REDESIGN OF MEN'S CONTEMPORARY CLOTHES	326
Mariya Koleva FASHION FROM DIFFERENT ERAS IN A MODERN VIEWING	334
Kertakova Marija SUSTAINABLE DESIGN AND ITS IMPORTANCE IN CONTEMPORARY FASHION – AN ANALYSIS OF THE WORK OF FASHION DESIGNER STELLA MCCARTNEY	341
Julietta Ilieva, Liliana Indrie, Zlatin Zlatev, Amalia Sturza INTEGRATING TEXT-TO-IMAGE IN FASHION ACCESSORIES DESIGN	354
Banu Hatice Gurcum THE ETHNOGRAPHIC RESEARCH FOR CULTURAL SUSTAINABLE DESIGN	359
Nikola Maksimović, Gordana Čolović, Danijela Paunović DESIGNING EFFICIENCY: ANALYZING THE IMPACT OF PRODUCT DESIGN ON GARMENT MANUFACTURING COSTS	369
Maja Jankoska, Ruzica Stevkovska-Stojanovska, Angela Donevska 3D VIRTUAL SIMULATION OF CLOTHES FITTING AND FABRIC DRAPING	375
Gözde Yetmen, Banu Hatice Gürcüm DIGITAL FASHION CONCEPT: DIGITAL FASHION HOUSES	385
Damjana Celcar, Veronika Gruden Bole THE IMPORTANCE OF CONSUMER PERCEPTIONS IN SLEEPWEAR DESIGN	396
Mirjana Devetaković, Petar Vujošević, Đorđe Đorđević A GEOMETRIC TRANSPOSITION OF TRADITIONAL WEAVED MOTIFS INTO NATURAL STONE MOSAICS	406



Kristina Savić, Olga Stojanović, Marija Savić Pojužina TECHNICAL DESIGN CONCEPT FOR A PROTECTIV SUIT INSPIRED BY BIOMIMETICS	416
CONFERENCE PAPERS SESSION III - MANAGEMENT AND MARKETING IN THE TEXTILE INDUSTRY	423
Gordana Kokeza, Sonja Josipović, Snežana Urošević INNOVATIVE ENTREPRENEURSHIP AS A KEY FACTOR IN CREATING A SUSTAINABLE TEXTILE AND FASHION INDUSTRY	425
Gordana Čolović, Nikola Maksimović, Danijela Paunović ANALYSIS OF NORMS METHODS IN THE GARMENT INDUSTRY	438
Bruno Završnik CONSUMER BEHAVIOR FOR BUYING CLOTHES	444
Bruno Završnik THE EFFECT OF PRICE DISCOUNTS ON SHOPPING BEHAVIOR IN A CLOTHING STORE	452
Dragan Dimitrijević, Natalija Dimitrijević, Jasmina Gligorijević, Snežana Urošević, Živoslav Adamović, Filip Cvetković SUPPLY CHAINS AND LOGISTICS OF TRANSPORT IN SME TEXTILE AND CLOTHING INDUSTRY	460
Olga Stojanović, Kristina Savić, Mina Mazić, Marija Savić Pojužina E-BUSINESS IN THE GARMENT INDUSTRY	474
Mina Mazić, Nikola Maksimović, Olga Stojanović, Danica Stojanović PROCESS MANAGEMENT IN THE CLOTHING INDUSTRY	482
Sonja Jordeva, Silvana Zhezhova, Saska Golomeova Longurova, Sanja Risteski, Vangja Dimitrijeva-Kuzmanoska FINAL QUALITY CONTROL OF SHIRTS	487
CONFERENCE PAPERS SESSION IV- ECOLOGY AND SUSTAINABLE DEVELOPMENT IN THE TEXTILE INDUSTRY	495
Ineta Nemeša, Marija Pešić, Nadiia Bukhonka, Valentina Bozoki, Jovana Šušćević TRANSFORMABLE CLOTHING TO REDUCE PRE AND POST CONSUMER TEXTILE WASTE	497
Igor Sutlović IMPACT OF CO₂ EMISSIONS REGULATIVE ON TEXTILE INDUSTRY	505



Milica Vlahović, Darja Žarković, Nataša Đorđević, Slavica Mihajlović, Miljan Vlahović, Nenad Vušović AN OVERVIEW ON THE VIABLE METHODS FOR TEXTILE WASTEWATER TREATMENT	510
Adela Medović Baralić, Biljana Popović, Ljiljana Sretković STANDARDS OF SUSTAINABILITY IN THE FASHION INDUSTRY	522
Milena Savić, Dragana Erfulanović GREENWASHING AS A MARKETING STRATEGY IN THE FASHION INDUSTRY	530
Darja Žarković, Marija Vučićević, Milica Vlahović ENVIRONMENTAL ISSUE OF SUSTAINABLE TEXTILE INDUSTRY – EXAMPLES OF GOOD MANUFACTURING PRACTICES	541
Vasilije Petrović, Dragan Đorđić, Danka Đurđić, Anita Milosavljević, Milada Novaković, Marija Petrović LIFE CYCLE AND RECYCLING OF CLOTHING	550
Marina Jovanović, Snežana Urošević IMPACT OF THE TEXTILE INDUSTRY ON THE ENVIRONMENT	559
Asude Hanedar, Mehmet Şaş, Elçin Güneş, Gül Kaykioğlu, Yalçın Güneş DETERMINATION OF ATMOSPHERIC MICROPLASTIC LEVELS IN A TEXTILE INDUSTRY INTENSIVE REGION	568
Gül Kaykioğlu, Şeyda Görgülü, Asude Hanedar ADSORPTION OF METHYLENE BLUE FROM TEXTILE WASTEWATER WITH PYROLYZED WALNUT SHELL	577
Albana Leti, Ermira Shehi, Silva Spahija ALBANIAN GARMENT AND LEATHER FOOTWEAR INDUSTRY; CHALLENGES FOR SUSTAINABILITY AND GREEN DEVELOPMENT	586
Violeta Stefanović, Snežana Urošević, Ivana Mladenović-Ranisavljević, Ljiljana Takić LIMIT VALUES OF WASTEWATER EMISSIONS OF THE TEXTILE INDUSTRY AND THEIR INFLUENCE ON THE SUSTAINABLE MANAGEMENT OF WATER RESOURCES	595
Author index	604



IMPACT OF THE TEXTILE INDUSTRY ON THE ENVIRONMENT

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ABSTRACT: The topicality of the topic of this research work lies in the growing interest in environmental protection in the context of the textile industry. The textile industry has become one of the key actors in the discussions on environmental protection, given its complexity and significant impact on the ecological balance. This paper investigates the specific challenges and problems that the textile industry presents to the environment, analyzes various aspects of its impact, and presents possible strategies and solutions to reduce negative effects. Through a detailed analysis of current events, trends, and needs in society, the research focuses on identifying key points for intervention and improving the sustainability of the textile industry. This paper aims to contribute to the understanding of the complex problems arising from the impact of the textile industry on the environment, as well as to offer practical guidelines for addressing these challenges at the current time. The results of this research can serve as a basis for further discussions and decision-making to preserve the environment and promote the sustainability of the textile industry.

Keywords: textile industry, environment, sustainability, environmental impact, environmental awareness, challenges, strategies.

UTICAJ TEKSTILNE INDUSTRIJE NA ŽIVOTNU SREDINU

APSTRAKT: Aktuelnost teme ovog istraživačkog rada leži u sve većem interesu za očuvanje životne sredine u kontekstu tekstilne industrije. Tekstilna industrija je postala jedan od ključnih aktera u raspravama o zaštiti životne sredine, s obzirom na njenu kompleksnost i značajan uticaj na ekološki bilans. Ovaj rad istražuje konkretne izazove i probleme koje tekstilna industrija predstavlja za životnu sredinu, analizira različite aspekte njenog uticaja i predstavlja moguće strategije i rešenja za smanjenje negativnih efekata. Kroz detaljnu analizu aktuelnih događaja, trendova i potreba u društvu, istraživanje se fokusira na identifikaciju ključnih tačaka za intervenisanje i unapređenje održivosti tekstilne industrije. Cilj ovog rada je da pruži doprinos razumevanju složenih



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problema koji proističu iz delovanja tekstilne industrije na životnu sredinu, kao i da ponudi praktične smernice za adresiranje tih izazova u trenutnom vremenskom periodu. Rezultati ovog istraživanja mogu poslužiti kao osnova za dalje diskusije i donošenje odluka u cilju očuvanja životne sredine i promocije održivosti tekstilne industrije.

Ključne reči: *tekstilna industrija, životna sredina, održivost, ekološki uticaj, ekološka svest, izazovi, strategije.*

1. INTRODUCTION

The textile industry ranks among the activities that have an extremely large negative impact on the environment. The products of the textile industry are among the products that make significant negative contributions to the environment at all stages of their life cycle. The factors that most influence the unsustainability of textiles and clothing include the use of chemicals that harm the environment during the production of these products, high consumption of water and energy, long transport distances, the generation of large amounts of solid waste and the use of non-biodegradable packaging.

The specificity of the textile industry and the products that are created in it is reflected in the existence of significant sources of negative impact on the environment in all stages of their production and use, starting from the production of raw materials, until the end of the use of these products. It is this specificity that imposes the need to use an approach based on the evaluation of the entire life cycle when assessing the impact of the textile industry on the environment. The Life cycle assessment is a scientifically based and systematic approach that analyzes the environmental impacts that occur during the entire life cycle of textile products.

2. NEGATIVE EFFECTS OF FAST FASHION ON THE ENVIRONMENT

The negative impacts of the textile industry on the environment have, during the past two decades, increased to an extremely large extent due to the development of fast fashion.[1] Fast fashion is based on the constant creation of new styles and clothing based on them, which is sold at very low prices. It is based on cheap products, usually of low quality, which are intended for use during one or at most two seasons, after which they are thrown away. Fast fashion products are based on trends, which is why their use usually stops after they stop being trendy, not because of their damage or loss of functionality. The development of fast fashion has led to an enormous increase in the amount of clothing being thrown away, even though it is still completely usable.[2] In this way, large amounts of waste are created, which, in most cases, are difficult to recycle, which is why they are disposed of in landfills.

Fast fashion is a consequence of the desire of companies that produce clothes, shoes, and accessories to maximize the market on which they can sell their products. It is one of the most drastic examples of ignoring care for the environment and socially responsible business for the sake of making a profit. Numerous researches that have had the impact of the textile industry on the environment as a subject point to the conclusion that fast fashion



and the concept on which it is based are the generators of most of the damage that the textile industry causes to the environment.[3] Awareness of the negative effects of fast fashion on the environment has resulted in increasingly intensive activities aimed at extending the life of clothes and shoes, to reduce the amount of textile waste generated and the negative effects on the environment that occur during the first few washes.

3. OVERUSE OF NATURAL RESOURCES

The textile industry is based on the use of extremely large amounts of resources that are required to produce products. The largest number of textile products still contain significant proportions of cotton, the use of which in the production of fashion products is associated with extremely high use of various resources, many of which are non-renewable. The production of textile products requires large amounts of water and land to grow cotton or produce other fibers from which they are made. As much as 2,700 liters of fresh water are needed to produce one short-sleeved cotton T-shirt.[4] This amount of water is sufficient to meet the drinking water needs of an average person for a period of 2.5 years.

During 2020, the textile sector was the third largest source of land use and water degradation. In 2020, an average of 9,000 liters of water, 400 square meters of land, and 391 kilograms of raw materials were used to produce clothes and shoes for every citizen of the European Union.[4] The production of the amount of clothing and footwear that the average citizen of the European Union needs annually leads to the creation of about 270 kilograms of carbon dioxide, which is equivalent to the emissions that passenger cars with Euro 6 emission standards generate when traveling 2,500 kilometers.

The textile industry is one of the segments of modern society whose impact on the use of resources is often ignored or poorly understood. A factor that additionally affects the negative effects that arise as a result of the production of textile products is reflected in the fact that this industry is characterized by a high level of use of non-renewable resources. Excessive use of resources is largely a consequence of insufficient attention to business sustainability in the textile industry.[1] This industry is characterized by emphasizing the lowest possible production costs and motivating consumers to constantly buy new clothes, which are in line with current trends that last very short. The characteristics of the textile industry and the sources of competition in the textile products market greatly influence companies to ignore the efficiency of using natural resources and the negative effects on the environment that arise as a consequence of their operations.

4. THE MOST SIGNIFICANT NEGATIVE IMPACTS OF THE TEXTILE INDUSTRY ON THE ENVIRONMENT

The textile industry creates a large number of different negative impacts on the environment. Some of these impacts are very large and can significantly affect the occurrence of pollution and irreparable damage to the environment. The most significant negative impacts on the environment, that arise as a result of the activities carried out in the textile industry, can be singled out:



-
- water pollution,
 - air pollution and gas emissions that lead to the creation of the greenhouse effect,
 - soil pollution and occupation of arable land, and
 - generation of large amounts of waste.

4.1. Water pollution

The production of textiles is classified among the activities that have an extremely large negative impact on the environment through water pollution that occurs in the various stages of the production of textile and fashion products. It is estimated that textile production is responsible for about 20% of the total global clean water pollution.[4] These pollutions mostly occur as a result of the processing, and dyeing of textile materials and the use of textile products. During one wash of textile products made of polyester fibers in a washing machine, around 700,000 microplastic fibers are produced. Most of these fibers end up in water, with a significant part of these harmful materials also reaching various segments of the food production process.

It is estimated that in 2017, the textile industry generated about 20.6 million tons of various types of hazardous waste that were released into the water.[5] Most of this pollution occurs during the release of dyes during the dyeing and final processing of clothing. An additional negative impact of the production of textile products on water is reflected in the consumption of large amounts of water, which is used during the removal of excess pigments and chemicals so that only the amount that was fixed on the products remains on them. The dyeing of fibers, materials, and products is one of the most important elements that influence the occurrence of pollution and negative environmental impacts [6].

The textile industry uses a large number of processes that involve the dyeing of fibers, materials, or products. In addition, treatments that require large amounts of water and whose aim is to improve the quality, appearance, or functionality of the product are often used. Dyes used in the textile industry are mostly made of synthetic materials.[7] The wide application of synthetic dyes is due to their ability to stay on clothes much longer than dyes made from natural materials. After the processing process, the textile materials must be rinsed and washed, in order to remove the unused dye that is excess. During this process, large amounts of water are used, which after its completion contain significant amounts of paint residues. A factor that has an additional negative impact on the environment is the fact that the dyes used in the textile industry are made of chemical components that can be very harmful to people and the environment. Another factor that negatively affects the environment is the fact that the dissolution period of the materials from which the paints are made is very long [6].

The development of fast fashion has greatly increased the negative effects on water that arise as a result of the use of fashion products. Most of the harmful microparticles are released from textile products after the first few washes. The short lifespan of fast fashion products results in frequent purchases of new fashion products and their first washes. The concept on which fast fashion is based promotes a large number of first washes and consumer behaviors that are very harmful to the environment. The washing of synthetic products results in the collection of more than half a million tons of microplastics on the ocean floor each year.

Microfibers that arise as a result of the use of synthetic materials during the production of clothing lead to water pollution, which is not given enough attention.[8] The results of numerous researches point to the conclusion that the synthetic microfibers used in the production of textiles are too small to be filtered, which is why they create pollution that ends up in water and has significant negative impacts on animals and the environment.[9] Water pollution that occurs as a result of the work of the textile industry is an ecological problem that is not given enough attention. This pollution is particularly dangerous in the vicinity of factories where various activities related to the production of textile products are carried out.

4.2. Air pollution and gas emissions that lead to the creation of the greenhouse effect

Air pollution resulting from activities carried out in the textile industry can manifest itself in several different ways. The textile industry has a significant share in the total global air pollution, which is largely a consequence of the processes that take place during the production of fibers, materials, and finished products. Most often, air pollution in the textile industry is generated in the form of emissions of carbon dioxide, carbon monoxide, sulfur dioxide, and nitrogen gases [10].

The textile industry is among the industries that have a significant participation in the generation of carbon dioxide and other gases that lead to the creation of the greenhouse effect. The negative impact of the textile industry on the creation of the greenhouse effect is best illustrated by the fact that in 2020 it contributed 10% to the total global carbon dioxide emissions. Aviation and maritime transport together contribute less to global carbon dioxide emissions than the textile industry [4]. Textile products consumed in the European Union resulted in the emission of gases that led to the creation of the greenhouse effect in the amount of 121 million tons, which is only one-third less than the total amount of these gases emitted by passenger cars in the European Union.

The largest part of emissions of harmful gases in the textile industry occurs during the production process of fashion products. Numerous stages in the production of textile products require high temperatures, which results in the consumption of large amounts of energy and the emissions of harmful gases associated with it.[11]. The negative impacts of the textile industry in the form of air pollution and emissions of harmful gases that lead to the creation of the greenhouse effect are additionally increased due to the characteristics of the production processes that take place in it. These processes most often lead to the creation of a combination of several harmful gases, the negative effect of which is greater than the sum of the individual negative effects of each of these gases.

The textile industry is classified as one of the activities in which human labor has a large share in the total costs. Fast fashion and the emphasis on low production costs have placed the imperative of minimizing all segments of production costs before companies engage in the production of fashion products [3]. Most fast fashion products are produced in countries with low labor costs (most often in Southeast Asia), which are located a long distance from the largest markets. The large distances over which raw materials and fashion products are transported due to savings in human labor costs increase the negative impact of the textile



industry on the environment, primarily through the emission of carbon dioxide that occurs during transportation.

4.3. Soil pollution and occupation of arable land

Every year, textile factories globally generate about 280,000 tons of industrial wastewater, which has significant negative effects on the soil [12]. There are a large number of factors associated with the textile industry that lead to soil pollution, the most significant of which are the synthetic dyes used, heavy metals, and organic compounds. The greatest negative effects of the textile industry through soil pollution are realized due to the use of synthetic dyes, the release of which after the production process results in the contamination of the soil near the factories and along the waterways through which these dyes pass [13]. Some of these dyes can be carcinogenic if they are not treated appropriately after the end of the textile production process [13]. A frequent source of soil pollution is the biotransformation of bacteria used in paints.

Large amounts of soil pollution generated by the textile industry also occur as a consequence of its contamination, which is a consequence of the use of heavy metals. Production processes in the textile industry require the use of large amounts of heavy metals, which, in addition to negative effects on water and air quality, can also lead to soil contamination [14]. The high concentration of organic compounds produced during the production of textile products harms the health of the soil, thereby endangering the lives of plants, animals, and people.[14] The results of numerous studies point to the conclusion that organic compounds from the textile industry can contribute to the emergence of a large number of soil problems, which are especially pronounced in urban areas [15].

The cultivation of cotton and other natural materials used in the textile industry requires large amounts of arable land, on which raw materials from which fibers and materials are obtained are produced. Despite the development of a large number of modern, synthetic materials, cotton still plays a large role as a raw material from which fashion products are produced, even in the fast fashion industry [12]. The production of cotton requires large areas of arable land, which is in short supply in most of the countries where it is grown, which is why it is often cited as one of the factors influencing the increase in hunger.

4.4. Generation of large amounts of waste

The generation of large amounts of waste is a factor that significantly increases the negative impact of the textile industry on the environment. An additional problem with this type of negative impact is the constant increase in the amount of clothing that is thrown away, which is largely a consequence of the development of fast fashion, in which the emphasis is placed on shortening the lifespan of products and replacing them with new ones as often as possible. In addition to the extremely large amounts of clothes that end up being used, the generation of large amounts of textile waste is also influenced by changes in the way consumers relate to the clothes they no longer want to wear. Instead of donating old clothes, which were popular in the past, consumers increasingly decide to throw them away, considering that they no longer have a functional value.

In European Union countries, less than half of end-of-life clothing is collected for reuse and recycling, with only 1% of used clothing being converted into new clothing [4]. The



low percentage of recycling is largely due to the fact that the technologies that enable the recycling of clothing into fibers that can be used to make new ones are still in the early stages of development. As one of the solutions to the problem of generating large amounts of textile waste, donating clothes to less developed countries and exporting them in the form of used products is increasingly being used. In this way, short-term solutions are created, which reduce the amount of textile waste in developed countries and increase this problem in less rich countries, which take upon themselves the storage of clothing after its use has ceased [3].

The negative impact of fast fashion on the environment and the increase in the amount of waste it leads to, represent an increasing threat to the environment and modern society. Large amounts of waste generated in the textile industry threaten the environment and require large areas of land where textile products that are no longer used can be disposed of. The European Union and a large number of other countries place increasing emphasis on extending the life of clothing, through the introduction of rules and various measures aimed at disincentivizing the discontinuance of clothing that is still functional and has useful value.

The extent of the negative impact of textile waste on the environment can best be seen based on the data that the citizens of the European Union use about 26 kilograms of clothing on average per year and that they throw away about 11 kilograms every year.[4] Used clothing, due to the impossibility of its recycling, can be exported to countries outside the European Union, where about 87% of discarded textile products are burned or disposed of in landfills.[4] Reducing the amount of fully functional textile products that are discarded is one of the basic and most important tasks that must be accomplished to reduce the negative impacts of the textile industry on the environment.

5. CONCLUSION

The textile industry has extremely large negative impacts on the environment, which are accompanied by very low levels of business sustainability. The negative impacts of the textile industry on the environment and sustainability are largely the result of the development of the concept of fast fashion, in which the emphasis is placed on maximizing sales and profits, while much less attention is paid to environmental protection and business sustainability. The development of fast fashion had a key impact on the increase in the consumption of clothing and footwear, which also had numerous negative effects on the environment. The development of fast fashion was largely influenced by social media and the fashion industry, which used them to present fashion trends to a larger number of customers, with the dynamics of changing these trends significantly faster than in the past. Activities that should ensure the reduction of negative impacts of the textile industry on the environment must be directed towards reducing the consumption of textile products and finding efficient ways for recycling. Significant savings could also be achieved by bringing the places of production of textile products closer to the places of their consumption, which would significantly reduce emissions of harmful gases that occur during transport. Reducing the negative impacts of the textile industry on the environment



can be achieved by creating new strategies, such as the development of a business model for renting clothes, designing products in a way that allows for a greater number of their use, and simpler recycling (circular fashion), persuading customers to buy clothes of better quality that will last longer instead of fast fashion products (slow fashion) and direct customers to direct their behaviors towards ensuring sustainable consumption of textile products.

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