

**POLYTECHNIC UNIVERSITY OF TIRANA
FACULTY OF MECHANICAL ENGINEERING
TEXTILE AND FASHION DEPARTMENT**

BOOK OF PROCEEDINGS

6th INTERNATIONAL TEXTILE CONFERENCE

**Tirana, ALBANIA
November 20th, 2014**



6th International Textile Conference

November 20th, 2014, Tirana, ALBANIA

BOOK OF PROCEEDINGS

Organized by
Polytechnic University of Tirana
Faculty of Mechanical Engineering
Department of Textile and Fashion

Department of Textile and Fashion

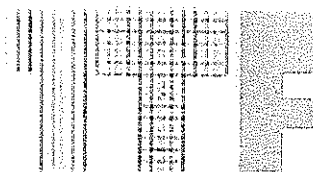
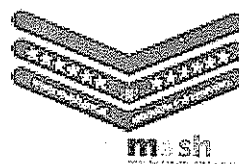
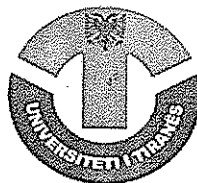
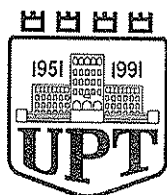
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ANADOLU ÜNİVERSİTESİ

PREFACE

The Textile and Fashion Department at the Mechanical Engineering Faculty, Polytechnic University of Tirana (PUT) since 2004 every two years organizes the textile conference with the participation of the professors/lectors of the Department of Textile and Fashion, other departments at PUT, University of Tirana and foreign universities with similar research areas in textile technology and textile materials.

The Department of Textile and Fashion in PUT is full member of AUTEX since 2008.

The mission of AUTEX (Association of Universities for Textiles) is to facilitate cooperation among members in research and teaching in textile field at the top level. Full members and associates members are consolidated reputable universities in higher education and research in the field of textile. AUTEX was established in 1994. Currently there are 34 members from 28 countries. PUT, Department of Textile and Fashion is accepted as full member in June 2008. The current president is Prof. C. Dominique Adolphe, Université de Haute Alsace, France.

The First Conference of Textile Tirana was organized in July 2004. At the first conference that coinciding with the 20th anniversary of the Textile Department at the Faculty of Mechanical Engineering there were presented 12 papers. (Proceedings book, Scientific Library FIM)

The Second Textile Conference in Tirana was organized in July 2006. At this conference there were presented 12 papers. (Proceedings book, Scientific Library FIM).

The Third International Conference of Textile in Tirana was organized on November 20, 2008 in the framework of FP6 "RETEXRESALB", in which the Department of Textile and Fashion was the coordinator. The primary objective of conference was technology transfer. There were presented 14 papers. (Proceedings Book ISBN 978-99956-16-27-4).

The Fourth International Conference of Textile in Tirana was organized on November 19, 2010. At this conference there were presented 26 papers. (Proceedings book, Scientific Library FIM).

The Fifth International Conference of Textile in Tirana was organized on December 7, 2012 at this conference there were presented 20 papers. (Proceedings book, Scientific Library FIM).

In the Sixth International Conference of Textile in Tirana, November 20, 2014 organized by the Department of Textile and Fashion in PUT, the participants will be from:

ALBANIA

Polytechnic University of Tirana

Faculty of Mechanical Engineering,

Department of Textile and Fashion

Department of Production and Management

Faculty of Mathematical Engineering and Physical Engineering

Department of Mathematical Engineering

Faculty of electric Engineering

Department of Electrotechnics

Department of Automation Industry

University of Tirana

Faculty of Natural Sciences

Department of Industrial Chemistry

Faculty of Economy

Ministry of Education and Sports, National Agency for Examinations,

Department of admissions and matriculation

Department of database and systems

Albanian Institute for the Research and Education in Information Technology (ISSETI)

CROATIA

University of Zagreb, Zagreb

Faculty of textile technology, Department of Clothing technology

ENGLAND

London College of Fashion, University of the Arts London

FRANCE

University of Haute Alsace

Laboratory of Mechanical and Physical Textiles

MACEDONIA

University of Saint Cyril and Methodius

Faculty of Technology and Metallurgy

University Goce Delčev

Faculty of Technology, Štip

TURKEY

Anadolu University, Faculty of Architecture and Design

Department of Fashion Design Eskisehir

Ege University

Textile Engineering Department, Izmir

TOPICS OF THE CONFERENCE

Garment Manufacturing
Textile Testing and quality control
Textile Processing
Biopolymers and Biotechnology
Comfort and Wellbeing
Developments in Textile Machinery
E-activities and E-commerce
Ecology and Environment in Textile Production
Fibre Physics and Textile Mechanics
Finishing, Dyeing and Treatment
Medical Textiles
Modelling and Simulation
Nanotextiles
Smart and Interactive Textiles
Supply Chain Management and Logistics
Technical and Protective Textiles
Textile Design and Fashion
Textile Education

PRE-CONSUMER APPAREL WASTE MANAGEMENT IN MACEDONIA

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Keywords: textile waste, apparel cutting waste, textile waste management

Abstract

By its origin textile waste can be divided in two broad categories: post-consumer waste derived from households, and pre-consumer waste generated during the manufacturing process. The division of the clothing supply chain between developed consumer markets and developing countries where apparel production capacities are outsourced implies that post-consumer waste is present in the former countries, whereas the later generate more pre-consumer waste. To effectively utilize the textile waste an accurate prediction of the quality of generated waste is required. Due to the structure of the industry textile waste in Macedonia mainly consists of apparel cuttings. The purpose of this exploratory study was to investigate the current state of apparel waste management practices in Macedonia, characterize the apparel cuttings waste and determine the attitudes of Macedonian top management towards managing the apparel cuttings. Data was obtained via a structured questionnaire distributed to top managers in apparel manufacturing. The results indicated that almost all apparel manufacturers use landfills to dispose of their waste. The analysis showed that the waste stream consisted principally of woven fabrics, predominately cotton and cotton blends, with presence of lycra. Bearing in mind the waste composition the most appropriate end use for the produced pre-consumer waste is insulation materials. Considering that the industry consists of small and medium companies with limited resources there is low likelihood of individual investments in recycling equipment. The survey results also show that the top management of Macedonian apparel companies has strong negative attitudes towards sorting and preparing cutting waste for further processing. Availability of workforce, sorting according to color and fiber content, and introduction of baling during the packing process are identified as key impediments to introducing sorting in the companies. Low awareness of waste management practices and technologies, as well as of existing markets for recycled products contribute to the negative attitudes to waste management.

Introduction

According to the 2011 FAO/ICAC survey issued by the United Nations [1], the world fiber consumption, and therefore the consumption of final product made of fibers, e.g. clothing, home textiles or industrial textiles, has grown nearly 30 times since the 1950s. The growing consumption of textile products is an indicator of the growing amount of textile waste generated in the world today. Waste is considered to be a problem for many reasons, of which the harm to the environment and human health, limited space for land fields, and increasing costs to use existing and replace landfills are dominant. As textiles present a nonhazardous solid waste, their recycling is often sidelined. Even though all contemporary waste management systems consider land fields disposal as the worst option, they remain the preferred manner of textile waste removal [2].

By its origin textile waste can be divided in two broad categories. On one hand, there is the post-consumer or household waste, while on the other the so called post-industrial waste generated during the manufacturing process. The division of the clothing supply chain between developed consumer markets and developing countries where apparel production capacities are outsourced, implies that household waste is present in the former countries, whereas the later generate more post-industrial waste. In the developed world increasing environmental awareness, as well as social responsibility, reinforced by strict legislations, has led to recycling postconsumer textile waste in innovative products. For instance, postconsumer textile waste is recycled into insulation materials in the EU, by companies such as the French Matériaux Naturels and the British Bonded logic. However, on the producer side of the supply chain, particularly amongst apparel producers, recycling post-industrial waste is not common [3, 4]. This fact gains importance as the apparel industry can produce up to 20% of waste in the form of apparel cuttings, depending on marker efficiency. Macedonia presents a typical example of an apparel producing country with high post-industrial apparel waste generation. About 1.400.000 pieces of clothing are exported per month, which leaves behind a large amount of apparel cutting waste, compared to the country size and per capita. A preliminary analysis has shown that annually 1.7 kg/per capita of new and clean textile waste, with preserved physical and mechanical properties, were left behind. The majority of apparel manufacturers dispose the apparel cutting waste together with community waste on land fields [5]. The generation of apparel waste infers not only a loss of valuable resources and energy, but also causes ecological problems and creates expenses for collecting, transporting and managing the waste. Hence, it is necessary to raise the awareness of all stakeholders, in particular apparel manufacturers, of the economic and ecological benefits from collecting, sorting and reusing apparel waste [5].

Although numerous researchers have written on the subject of textile waste, academic research on the specific problem of apparel waste management is sparse. Most researchers have begun by categorizing the type of waste generated by a local industry and reviewing the current recycling practices [3, 4, 6]. Further on, some have researched the challenges posed to the introduction of

recycling by apparel manufacturers [6, 7, 8]. For instance, the level of support for recycling textile waste by Missouri sewn products manufacturers by analyzing four independent variables: material utilization, community size, land fields fee increase, and economic feasibility to recycle were investigated. Results indicated that support was greater for plants in urban rather than rural areas, large companies with greater economic feasibility, those that have greater concern for efficient materials usage, and those in regions of the country that have experienced the greatest increases recently in landfill fees [8]. Furthermore, a study in South Africa has investigated market and technology barriers for recycling within apparel companies [6].

The purpose of this exploratory study was to (a) give a characterization of the apparel cuttings waste, (b) define the current state of apparel cuttings waste management and (c) determine the attitudes of Macedonian top management towards managing the apparel cuttings.

Methodology

The research was conducted through a questionnaire distributed to the top management of Macedonian apparel manufacturers. The questionnaire was designed to analyse: the waste types generated (type of fabric, fibre content, lycra content), waste packing practices, the waste disposal behaviours of manufacturers, waste disposal cost, and the attitude towards recycling apparel cuttings. Structured, multiple-choice questions, with a minimum of 5 and a maximum of 7 alternative answers were used. A pilot test was conducted to ensure the clarity of the questionnaire. The questionnaire was distributed to top managers in 120 apparel manufacturers in Macedonia, during September 2012. The sample included all companies belonging to the largest trade association of apparel manufacturers in the country – the Textile Trade Association. Together these companies contribute to about 70% of the employment and 90% of the GDP generated by this industry. All respondents were notified of the end use of obtained data. In 66% of cases a personal interviewing method was used, while 34% of questionnaires were distributed via e-mail. From the distributed questionnaires, 86 questionnaires completed by the companies' top management were used in the analysis. In the Stip region, as the largest apparel production centre, 54 (62.8%) of the companies were located, whereas the remainder were from other regions in the country. The processing of the obtained data has been conducted by applying standard statistical analysis.

Results and discussion

The sample profile included companies of various size. According to EU classification [12] the companies were typically medium sized with 50 to 250 employees (48.8%), followed by small companies with under 50 employees (26.7%), and large companies with over 250 employees (17.4%). In 6 cases data for the number of employees was missing.

The results of the research confirmed that apparel cuttings are the main textile waste generated, since 97.67% of companies reported apparel cuttings as their dominant waste, while only 2.32%

had other textiles (nonwovens, fibres, yarns). This reflects the structure of the Macedonian textile industry, mainly composed of apparel manufacturers. The absence of vertically integrated companies implies no possibilities for in situ regeneration of textile waste in the overall production process.

The employed materials were further analysed according to the type of fabric, fibre content and presence of lycra. In general, the analysis showed that the waste stream consisted principally of woven fabrics, predominately cotton and cotton blends, with presence of lycra. Fabric type, fibre content and presence of lycra determine the procedures for further treatment of the textile waste, which can be mechanical, chemical or thermic. At present, mechanical rather than chemical recycling methods are preferred due to their cost-efficiency.

As seen from Figure 1, the majority of companies, 45.35%, used both woven and knitted fabrics. Only woven fabrics were used by 41.86% of the companies, whereas considerably less companies, 10.47% used only knitted fabrics. Nonwoven fabrics were reported by 2.33% of the companies. Standard mechanical recycling of fabrics requires cutting and opening. The opening process of fabrics necessitates loose structure; therefore woven fabrics, excluding wool, are harder to process. In order to create demand for woven fabric waste, products using woven fabric cuttings need to be developed.

The type of material used according to fibre content is shown in Figure 2. Pure cotton and cotton blends were most common as raw materials, cumulatively contributing to 50%, while 8.14% worked only with synthetic materials. A substantial number of companies, 41.86%, used materials with different fibre content, including cotton, cotton blends, synthetics, wool, flax, etc. Presence of animal fibres, such as wool or wool blends, which are frequently regenerated, was negligible (1.16%). The analysis showed that the biggest amount of waste consists of mixed fibre waste. Utilization of textile waste from blends and synthetic fibres appears to be a great problem, as these fibres are not biodegradable, hence the task of recycling such fibres should be given priority. In perspective this type of waste can be used in the construction industry as soundproof blocks, insulation, roofing felt, bank stabilization, pollution control filters, etc. Although cotton fibres are completely degradable, they can theoretically be fully recycled, partly in the spinning process or for quality paper production.

The content of lycra in fabrics was analysed separately, because it has significant influence on the recycling process. Only 14.12% of companies used materials with no lycra. The majority of companies – 60.0% used up to 30% of materials containing lycra in their production, whereas 25.88% used over 30% of materials containing lycra. The presence of lycra in fabrics would make the process of classical mechanical recycling even more difficult.

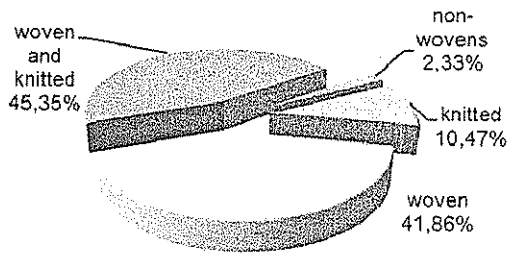


Fig. 1 Materials according to fabric type

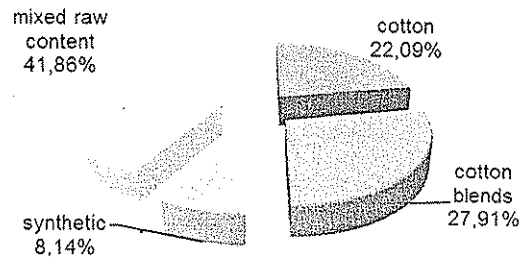


Fig. 2 Materials according to fibre content

Furthermore, the methods of apparel waste management within the companies were analysed, including methods of packing the waste, presence of impurities, waste disposal practices and costs. (Figure 3). Packing in plastic bags was the most frequent way of collecting apparel cuttings, as 55.81% of companies used it, followed by packing in cardboard boxes – 17.44%, throwing cuttings straight in containers – 16.28%, baling – 4.65 %, or other methods (e.g. packing in cotton bags) – 5.81%. In other words, the commonly used packing methods do not add any value to the produced waste, as Grasso suggested that baling was the preferred option [9]. The generate textile waste was mainly clean, since 58.14% of companies reported that the bags, boxes or bales did not contain any other objects (Figure 4). Dominant non-textile impurities were cardboard and paper – 16.28%, as well as buttons and reels, 16.28%. With 9.3% of companies mixed impurities - cardboards, metal parts, buttons, and reels were present in the waste.

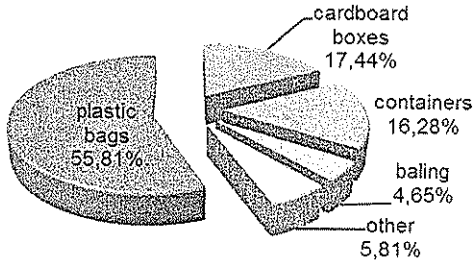


Fig. 3 Waste packing practices

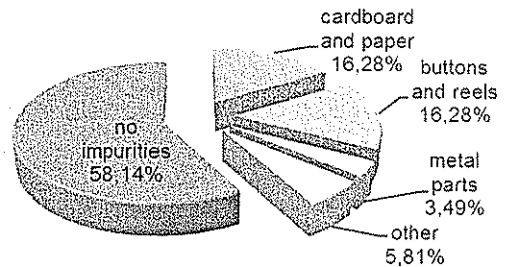


Fig. 4 Presence of impurities in the textile waste

Recycling practices were virtually non-existent, as only one company recycled the cutting waste. In the majority of companies, 94.19%, apparel waste was collected together with municipal solid waste by governmental waste service companies, and subsequently disposed of in landfills, where it was combusted. Less frequent waste collection methods were by licensed companies, 3.49%, or individuals, 1.16%. Waste management had a small cost compared to the total company budget. For 44.3% of companies waste disposal costs were less than 1% of the budget, and for 34.18% they were between 1-2% of the budget. Merely 5.06% had disposal cost of above 5%. Relatively low disposal costs indicate that this factor is not a very important motivator for recycling.

General attitudes among top managers regarding the recycling of textiles were negative. The majority of top managers, 59.3% stated that they would not be willing to sort produced waste, compared to 40.7% who would be willing to do so. The main obstacle to sorting is the introduction of sorting process in companies, as 66.3% considered it difficult, and only 32.6% thought it would be easy. On the contrary, positive attitudes regarding the perceived usefulness of sorting prevailed: 84.9% thought sorting may be useful and 14.1% not useful.

Lack of workforce was one of the key impediments seen by top managers when introducing sorting, as 79.1% of them disagreed that workforce for sorting was available. When looking into the processes of sorting, packing and transportation of the cuttings most difficulty was seen with the in situ sorting of apparel cuttings. Sorting by color, fiber content or type of material was considered difficult by 80.2%, 86.1% and 58.1% of top managers, accordingly. In addition, the majority of respondents considered sorting costly. Packing cuttings in bales, which requires obtaining new machinery, was considered a barrier, as 75.6% of the respondents considered the process to be difficult and 81.4% to be costly. Conversely, packing in boxes and plastic bags was considered an easy method by nearly three quarters of respondents. Opinions relating to the cost of both methods were evenly divided. Overall, packing in plastic bags was considered to be the easiest and least expensive method of collecting the cuttings within the factory. Positive attitudes were associated with the organization of transport as 67.5% of respondents considered it easy, although the process itself was deemed to be costly by 68.6% of them. Location of the production capacities was considered as a barrier by only 19.8% of respondents. Profitability is a vital aspect when introducing new operations. Even though 68.6% of respondents believed sorting can perceptively be profitable, lack of market, i.e. customers interested in apparel cuttings, was recognized as a problem by 66.2% of them. Almost all respondents (96.5%) identified preserving the environment as an important aspect of their operations.

Conclusion

The analysis showed that the waste stream mainly consists of woven fabrics, predominately cotton and cotton blends, with presence of lycra. According to its composition the waste has low value for textile application, excluding non-woven production. Therefore alternative usage should be explored. Recycling the apparel cuttings for insulation products in the construction industry would be the most appropriate end use for the produced pre-consumer waste. Priority should be given to non-biodegradable waste, using cutting rather than opening as a recycling method.

Disposal on landfills is the dominant waste management practice. The waste is typically clean of any impurities and collected in plastic bags. Almost all waste is collected by governmental-waste service companies. One factor that may play a role in inhibiting recycling practices is the insignificant waste disposal costs reported by most manufacturers.

The results of this exploratory study indicate that The top management of Macedonian apparel companies shows strong negative attitudes towards sorting and preparing cutting waste for

further processing. Key difficulties are perceived regarding the availability of workforce, sorting according to color and fiber content, and introduction of baling technology for packing. Low awareness of waste management practices and technologies, as well as existing markets for recycled products contribute to the negative attitudes to waste management.

References

- [1] Food and Agriculture Organization of the United Nations and the International Cotton Advisory Committee (2011) A summary of the world apparel fiber consumption survey 2005-2008. Retrived June 1, 2013, from www.fao.org/fileadmin/templates/est/COMM_MARKETS_MONITORING/Cotton/Documents/World_Apparel_Fiber_Consumption_Survey_2011_-_Summary_English.pdf
- [2] Sakthivel, S., Ramachandran, T., Gowthami, R., Chandhanu R., Padmapriya J., Vadivel P.& Gokulraj S. (2012) Source & effective utilisation of textile waste in Tirupur, Indian Textile Journal, 122 (4), 22-26.
- [3] Kazakevičiūtė, G., Ramanauskien, R., Abraitienė, A. (2008) A survey of Textile Waste Generated in Lithuanian Textile, Apparel and Soft Furniture industry, Environmental Research, Engineering and Management, 2 (44), 41-48.
- [4] Tomovska, E. & Zafirova, K. (2010) Investigation on waste produced by apparel manufacturers, XXI Congress of Chemists and Technologists of Macedonia, Book of Abstracts, 169.
- [5] Altun, Ş. (2012) Prediction of Textile Waste Profile and Recycling Opportunities in Turkey, FIBRES & TEXTILES in Eastern Europe, 20 (5-94), 16-20.
- [6] Larney, M.& Aardt, A. (2010) Case study: Apparel industry waste management: a focus on recycling in South Africa, Waste Management&Research, 28 (1), 36-43.
- [7] Grasso, M. (1996) Recycling Fabric Waste-The Challenge Industry, Journal of the Textile Institute, 87 (1), 21-30
- [8] Divita, L. & Dillard, B. (1999) Recycling Textile Waste, An Issue of Interest to Sewn Products Manufacturers, Journal of the Textile Institute, 90 (1), 14-26.