Importance of Oeko-Tex Standard for Textile Industry

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PREFACE

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Ivona Nemčić

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Abstract

Textile production is extremely complex and involves a multitude of mechanical and physico-chemical processes. It is often very demanding in terms of energy, water and chemicals, in relation both to the environment and the employees in the production processes. Textile product which is produced in eco-friendly manner and processed under eco-friendly limits is called ecotextile. In ecotextile production it is very important to be aware about economic, social and environmentally sustainable product development processes. The producers are the most important factor for environmentally friendly textiles production. For textile consumers the most important interest is the issue of possible influence of hazards from textile products on human health which is called - human ecology. From human-ecological point of view it is clear that the most important tendency is that the product has no harmful effect on health.

Ecolabelling is only one type of environmental labelling that refers specifically to the provision of information to consumers about the relative environmental quality of product materials and substances used in textile industry. Such labelling take the form of Ecolabels awarded by programs operated at national or regional levels. OEKO-TEX® (the International Association for Research and Testing in the field of textile and leather ecology) is the most widespread and best known label for textiles tested for harmful substances on a global level.

OEKO-TEX Standard 100 focused on the development of methods for testing of pH, dangerous substances like heavy metals, toxic dyes, crop protection substances and carcinogenic substances like formaldehyde, phenols or pesticide in testing articles. In addition, test methods must also be in accordance with the requirements of these standards. If all components of a textile comply with the requirements of the Oeko-Tex criteria catalogue without exception, the textile manufacturer receives certification and is entitled to use the Oeko-Tex label to mark the products in the shops.

The Ecolabel and Oeko-Tex Standard recognition and purchases of ecolabelled products is the criteria used as "guidance tools" and key indicator for development and sustainability of the textile industry. Institutes as participants of certification by Oeko-Tex standard are one of the most important factors. Based on their expertise and competence, testing and compliance statement, the customer is able to gain insight into

the quality of the product due to the impact on human health and the conditions of production including the environment.

Key words: Textile, Ecolabelling, Oeko-Tex Standard, certification, STeP

1. INTRODUCTION

The textile industry is the world's oldest branch of consumer goods manufacturing. It is a diverse and heterogeneous sector which covers the entire production chain of transforming natural and chemical fibres (such as cotton, wool, and oil) into end-user goods, including garments, household goods, and industrial textiles [1]. Ecological issues today are present in all the production activities. In recent years, the textile industry addressed much attention to ecology therefore consumer safety and environmental protection have become increasingly factors in the purchase of textiles [1,2].

Textile production is extremely complex and involves a multitude of mechanical, physico-chemical processes. Often is very demanding in terms of energy, water and chemicals, in relation both to the environment and the employees in the production processes (noise, dust, moisture, chemicals and others). Numerous research institutes today are engaged in the application of textile ecology around the world, the result of which are numerous, environmentally suitable solutions in textile production [2,3].

If textile is produced in eco-friendly manner and processed under the eco-friendly limits, it is called Ecotextile. In Ecotextile production it is very important to be aware of economic, social and environmentally sustainable product development processes [4,5].

The producers are the most important factor for environmentally friendlier textiles production through different activities such as:

- Sourcing of suppliers based on their social and environmental performances;
- Substituting of hazardous substances with safer substances;
- Use of best practices in technological innovation which contribute to improvement of the environmental footprint of processes;
- Increase of information exchange with retailers, provide them with information about the latest.
- Innovative solutions to address their sustainability challenges/objectives;
- Development of more environmentally friendlier textiles;

- Promotion of the use of more sustainable fibres like organic cotton, recycled fibres, etc.;
- Engagement in research about new fibres and materials with lower environmental impacts compared to natural fibres;
- Improvement of care labels on products;
- Focus on consumer communication to promote responsible care together with retailers communication to promote responsible care;
- Encouragement of the reuse/recycling of old clothes and textiles to produce new clothes, rather than using raw materials, promote remanufacturing and fashion upgrades;
- Communication with the consumers on the sustainability efforts;
- Demand post on suppliers to implement international social standards [1].

For consumers of textile the most important interest is the issue of possible influence of hazards from textile products on human health so-called human ecology. Use of eco-friendly textile fibres is one of the most important steps in the development of the human ecology. From human-ecological point of view it is clear that the most important tendency is that the product has no harmful effect on health [3].

The importance of aspects according to awareness of consumers in the process of purchasing clothing or textiles today is summarised as follows:

- product quality
- skin-tolerance
- price
- textiles inspected for harmful substances
- social aspects
- high percentage of natural fibres
- environmentally-friendly manufacture
- functional textiles
- country of origin
- current fashion
- brand/manufacturer.

Based on the information given by researches, 89% of surveyed consumers (N=2821) thinks that more products and items should be safe for health and better certified [6-8].
According to the opinion of many consumers, the criteria whose importance will increase in the future are [6]:

- environmentally-friendly manufacturing
- testing for skin-tolerability
- inspection for harmful substances of textiles
- organic cotton/recycled fibres
- product quality
- high percentage of natural fibres
- observance of social standards
- independent testing.

Therefore, the objective of textile industry should be to improve ecology environment and to facilitate the sustainable development and finally to achieve the harmonious development between people and ecology environment [9].

Manufacturers of textile, clothing and other products, especially those who want their products placed on the EU market, are increasingly faced with the demands that guarantee environmental friendliness of its products. In the future such requests will probably be more stringent so in recent times and the level of established the European Union criteria for textile products will be stringent too.
Textile standards provide the specifications and test methods for the mechanical, physical, and chemical properties of textiles, fabrics and cloths, as well as the natural and artificial fibres that constitute them. The textiles covered by these standards are commonly formed by weaving, knitting, or spinning together fibres such as glass fibre strands, wool and other animal fibres, cotton and other plant-derived fibres, sewing threads, yarn and mohair. These textile standards help fabric and cloth designers and manufacturers in testing textiles to ensure acceptable characteristics towards end-use [7,10].
The eco-problems in the textile industry arise during some production processes and they are transferred to the finished product. During bleaching and dyeing, the subsequent fabric makes a toxin that stays in our ecosystem. So, there is need to

produce textiles and apparel which are eco-friendly, and which can be considered *environmentally friendly* for a variety of reasons [11].

2. THEORETICAL PART

2.1. Ecolabelling

Based on the fulfilment of specified requirements according to the standards, textile industry can use the environmental acceptable Eco-labels, defined in 1992, have not been used earlier because the mentioned ecological criteria have not been developed or defined. It is also the main reason of the problem of testing and labelling of human-ecological textiles confidence in some European countries that have solved the problem with the European Union institutes for testing and certification. After the initial multitude of different eco-labels that emerged in the late eighties and early nineties, today the European Union has the leading application system for evaluation of environmental reliability through the Oeko-Tex Association [3,12].

In considering the evolution of ecolabels in textile and apparel industry, there are two important movements focused on different aspects of production, which ultimately gave rise to the ecolabels in the market these days. The first movement is the push for *'environmental safety'* and the second one is the movement for *'improved working conditions and wages*'.

The push for environmental safety in textile production was ingrained primarily in Europe, and then started rapidly when the European Economic Council adopted the Council Regulation No. 880/92 in 1992. Textile was one of the first product groups with Eco-Label mark. The criteria for products with that mark were targeted at concerns for environmental pollution and human health. The criteria established therefore related to toxicological and environmental considerations covering products as textile clothing and accessories, home textiles, yarns, fibres and fabrics.

The movement for improved working conditions and wages became powerful in 1990s. The Campaign for Labour Rights was started in 1993, and the compelling majority of new organizations formed to address labour conditions in textile factories were formed in the mid-1990s [13].

Basically, an ecolabel is a label which overall environmental preference of a product within a product category based on life cycle considerations. Ecolabelling is only one type of environmental labelling that refers specifically to the provision of information to

consumers about the relative environmental quality of a product material and substances used in the textile industry [14]. The ecolabelling can be found in the global concern for environmental protection on the part of businesses and the public. There is a growing trend for the general public to recognise the need for environmental protection. As businesses have come to recognise that environmental concerns may be transformed into a market advantage for certain products. In the textile industry such characteristics take on a special meaning as new technology, new or modified raw materials appear. Information about sustainable materials became a significant factor which allowed environmentally–aware consumers to choose environmentally-friendly textiles. One of the most popular forms of giving information about sustainable textile materials is the use of ecolabelling. In many instances, such labelling take the form of Ecolabels awarded by programs operated at national or regional levels [7,14]. Multiple stakeholder participation in any ecolabelling initiative is important to its overall impact and success (Figure 1).

The importance of Eco-labelling increased in Europe [15] and all over the world [9,16,17]. Within Europe and the world there are many textile Eco-labels, national or private labels. The private labels include: Oeko-tex 100, Oeko-tex 1000, Oeko-tex while the National labels include Nordic Swan, Swedish Nature Conservation Society, Green Mark, Eco-mark and etc. [7,8,16,17].

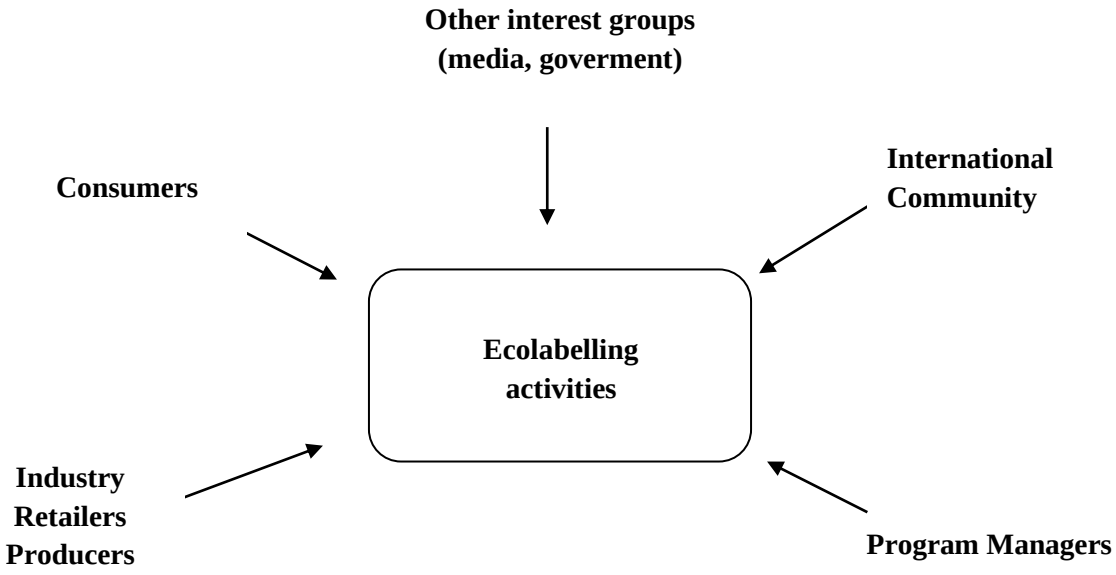

Figure 1 Participants in ecolabelling activities

The Ecolabelling generally contribute to high level of environmental protection and must be subject to greater coordination and on global scale [9]. According to Ecolabel index [18,19] there is currently 465 ecolabels in 199 countries around the world at 25 different industry sectors. Examples of eco-labelled textile products with the name of Eco-label program are presented in Table 1 (in Europe) and in Table 2 (in the world).

Table 1 Examples of Eco-labels of textile products in Europe

Eco-label	Eco-label title	Ecolabelled product	Country
	Ekologicky setrny vyrobek (Environmentally Friendly Product)	Textiles	Czech Republic
	EU-Ecolabel	Textiles Shoes Mattresses	European Union (EU)
	National Programme of Environmental Assessment and Ecolabelling in the Slovakia Republic	Textiles	Slovakia
	Oeko-Tex standard 100	Products for children Produst with direct and non-direkt contact with skin Decorations and accessories	European Union (EU)
	Oeko-Tex standard 1000	Textile	European Union (EU)
	European conformity	Toys, Personal protective equipment (PPE) and other products	European Union (EU)

Table 2 Examples of Eco-labels of textile products in the world

Eco-label	Eco-label title	Ecolabelled product	Country
	Global Organic Textile Standard	Organic textile	Australia, Canada, Austria, Denmark, Finland, Germany, Italy, Japan…
	Naturtextil best	Textile Leather	Austria, Belgium, Estonia, Finland, Germany, Netherlands, Switzerland, Turkey
	Green Mark	Textile and other products	Taiwan
	Singapore Green Label Scheme	Textile and other products	Australia, China, Germany, Indonesia, Singapore, Thailand, Vietnam
	Thai Green Label	Textile and other products	Thailand
	Blue Angel	Textile and other products	Australia, United States, EU, United Kingdom, South, Korea, Japan, Finland…

Between the most popular labels in EU are Ecolabel (EU flower) and OEKO-TEX standard 100 [16,20]. The objective of the Ecolabel is to promote products to reduce negative environmental impacts, as compared with other products in the same product group while the OEKO-TEX standard 100 label is focused on health criteria. In the European Ecolabel there are some criteria very close to those of the OEKO-TEX standard 100. But, they are different regarding the limit value and test methods. By comparison Ecolabel and OEKO-TEX standard 100, it is determined that the interest field of Ecolabel is toxicology and environmental parameters while OEKO-TEX standard 100 has interest in toxicological parameters only. Ecolabel has application field in textile clothing and accessories, home textiles, yarns, fibres and fabrics while OEKO-TEX standard 100 has considered human health 4 products classes (babies, direct contact with skin, without direct contact with skin and decoration material) [16].

A review of textile and apparel labels on Ecolabelling.org is presented with only 16 labels of 38 existing. Textiles are often grouped under broad-ranging ecolabels, which cover various products for building, agriculture and consumer goods. Environmental issues addressed across this category include organic production, energy usage, pollution, and biodiversity conservation. Social issues addressed across this category include labour practices, worker health and safety, consumer health and safety, economic development and animal treatment [13].

The examples of some of the major categories are listed below and can be divided to include:

- All consumer goods: Cradle-to-Cradle, BASF Efficiency, Healthy Child Healthy World
- Raw materials only: Soil Association Organic Standard, Organic Farmers and Growers Certification, Global Organic Textile Standard
- Processing only: Oeko-Tex Standard 1000
- Full life cycle, product only: Oeko-Tex Standard 100
- Full life cycle, product + process: Oeko-Tex Standard 100Plus
- Multiple environmental/social attributes: Ecoproof, Zque, Naturtextil
- Environmental attributes only: EcoLogo
- Country-specific multi-product certifications: Environmental Choice New Zealand, Thai Green Label, Ecomark:India

- End product-specific certifications, all of which pertain to carpets/rugs (industrially made or handmade): Rugmark, NSF Sustainable Carpet Assessment Standard, Label STEP.

The textile-only certifications presented on Ecolabelling.org are:

- Ecoproof
- Zque
- AIAB Bio Fibre
- Rugmark
- NSF Sustainable Carpet Assessment Standard
- Naturtextil
- Migros ECO Global Organic Textile Standard
- GUT
- Coop Naturaline: Switzerland
- Label STEP
- OE-100
- Bluesign Standard.

Textile labels with global applicability include: Better Cotton Initiative, Oeko-Tex (100, 100plus, 1000), Organic Exchange 100, NSF-140-2007 Sustainable Carpet Assessment Standard, Bluesign Standard and Global Organic Textile Standard. Country-specific textile-only labels are:

- Switzerland: Coop Naturaline
- Italy: AIAB Bio Fibre
- New Zealand: Zque

More than 50 textile labels currently in existence are differentiated across the following issues: environment, consumer health and safety and other aspects of sustainable development (including labour standards).

The three most important issues that textile and apparel ecolabels cover are environmental pollution (i.e., GOTS), worker's rights (i.e., Fair Trade) and human health and safety (i.e., Oeko-Tex) [13].

Global Organic Textile Standards (GOTS)

The aim of the Global Organic Textile Standard (GOTS) is to define requirements to ensure organic status of textiles, from raw materials, trough environmentally and socially responsible manufacturing up to labelling in order to provide a credible assurance to the end consumer. GOTS is recognized as the world's leading processing standard for textiles made from organic fibres. It defines high-level environmental criteria along the entire organic textiles supply chain [21,22]. The standard was developed by the International Working Group on Global Organic Textile Standards and will be seen on retail shelves beginning in spring 2010.

It is a comprehensive fibre certification where two levels of certification are offered [13]:

1) "organic" or "organic in conversion" for those product containing at least 95% certified organic fibres
2) "made with X% organic materials" for those product containing 70%-95% certified organic fibres

Only textile products that contain a minimum of 70% organic fibres can become GOTS certified. All chemical inputs such as dyestuffs and auxiliaries used must meet certain environmental and toxicological criteria [13,21].

Textile processing, manufacturing and trading entities can apply for certification according to the Global Organic Textile Standard. Entities that wish to become certified are requested to contact an appropriate GOTS approved certification body. The approval for certification is provided for 4 different scopes, which are defined with:

- Certification of mechanical textile processing and manufacturing operations and their products
- Certification of wet processing and finishing operations and their products
- Certification of trading operations and related products
- Release of positive lists of chemical inputs (s.a. dyes and auxiliary agents) to the chemical industry [22]

This label has been adopted so far by H&M, Walmart, Nordstorm, Banana Republic, Levi's and many others.

Fair Trade Certified

The Fair Trade certification model is designed and audited to ensure equitable trade practices at every level of the supply chain. To earn a license from Fair Trade USA to use the Fair Trade Certified™ label on their products, companies must buy from certified farms and organizations, pay Fair Trade prices and premiums and submit to a rigorous supply chain audits. This process entails a high level of transparency and traceability in their global supply chains. Fair Trade Certified™ products were made with respect to people and planet. Our rigorous social, environmental and economic standards work to promote safe, healthy working conditions, protect the environment, enable transparency, and empower communities to build strong, thriving businesses [13,23]. In terms of textiles, the standard offers a guaranteed minimum price to cotton farmers, as well as a fair trade premium to invest in community projects, including health centers, schools and infrastructure. Beyond these financial benefits, requirements in the Fairtrade Standards protect farmers' health and safety, promote efficient water usage, and ban dangerous chemicals and genetically modified cotton seeds. A large percentage of Fairtrade cotton is also organic certified. Fairtrade encourages and empowers cotton farmers to protect the natural environment as an integral part of their farm management [24].

2.2. Oeko-Tex

In 1989, OETI developed a testing and certification system due to the increased public interest in textile ecology and health. This system was labelled with „tested to OTN 100 standard. In 1992, the Oeko-tex standards were stipulated by the German Textile Association (MST) and Austrian (OTN) research Institutes. As the founding member of the OEKO-TEX Association in year 1992, OETI introduced the Standard 100 by OEKO-TEX. [25-27] This standard was developed in order to ensure a comprehensive level of safety for all levels of production – from the manufacture of yarns to the finished product, including accessorise such as buttons and zips. The standard is applicable to textile and leather products. Textile bearing the OEKO-TEX label meet high human ecological requirements [28,29].

Today, OEKO-TEX standards are most frequently standards of which the OEKO-TEX standard 100 is the most used in EU [27].

In 1990, in some countries the environmental policy was characterised by an endeavour towards ecological modernisation and sustainable development. Based on the studies of environmental programs and enterprise responses this article examines how the textile industry has related to this modernisation process, and how the institutional setting and environmental practices of this industry have been transformed. This transformation is understood as a reflexive process where enterprises have responded strategically to programs and institution building based on the national ecological modernisation strategy [30]. The Oeko-Tex is based on the environmental policy and sustainable development.

Oeko-Tex is an acronym for the International Association for Research and Testing in the field of textile and leather ecology. It is a union of 18 independent textile researches and test institutes in Europe and Japan and their worldwide representative offices. The association of these institutes and the draft Eco-tex organization was preceded by increased developments in environmental terms that are 1990 and 1991 present in Europe. The purpose of the merger was to create a unique core of an international organization for the development and integration of environmental reliability textiles and test methods [3,9,12,31].

The member institutes are responsible for the joint development and limit values which form the basis of the product certifications according to STANDARD 100 by OEKO-TEX and MADE IN GREEN by OEKO-TEX as well as the production site certifications according to STeP by OEKO-TEX. They are also entitled to carry out the corresponding laboratory tests and site audits. Additional services of the OEKO-TEX® Association are the MySTeP database for supply chain management and the ECO PASSPORT by OEKO-TEX certification for the verification of chemicals and auxiliaries. On the basis of their wide-ranging activities and core competencies the OEKO-TEX member institutes provide important impulses for innovations within the textile and clothing industry. Through close cooperation with the manufacturers their accredited test system also makes a substantial contribution to the development of high-quality textile [9,12,32].

The main objectives of International Association for Research and Testing by the Oeko-Tex Standard 100 are: getting information about awareness and usage of organic and textile seals and the Oeko-Tex Standard 100 within the group of consumers, gathering relevant aspects influencing the process of purchasing of clothing and textiles, determination of the future relevance of textile-seals from customers view, identification of relevant criteria in the future of textile-seals, identification of growth opportunities and markets for Oeko-Tex [6].

Awareness about Oeko-Tex is raising in different countries all around the world, but the proportion of people (%) in country is different (Table 3) [6].

Table 3 Indication of awarenes (%) about labelled product for consumers

Country	**n**	**%**
Germany	254	70
China	287	63
Austria	255	61
Switzerland	256	53
Denmark	255	49
Turkey	255	49
Poland	256	40
Italy	258	37
Russia	256	36
Portugal	254	31
Spain	255	27
France	253	25
GB	255	10

Especially German, Austrian or Chinese consumers, who bought a labelled product or are aware of a labelled product, are aware of the importance of environmentally-friendly manufacture according to the Oeko-Tex standard.

With over 160,000 issued certificates for millions of labelled textile products, and over 10,000 participating companies along the textile chain, STANDARD 100 by OEKO-

TEX is the most widespread and best known label for textiles tested for harmful substances on a global level (Figure 2).

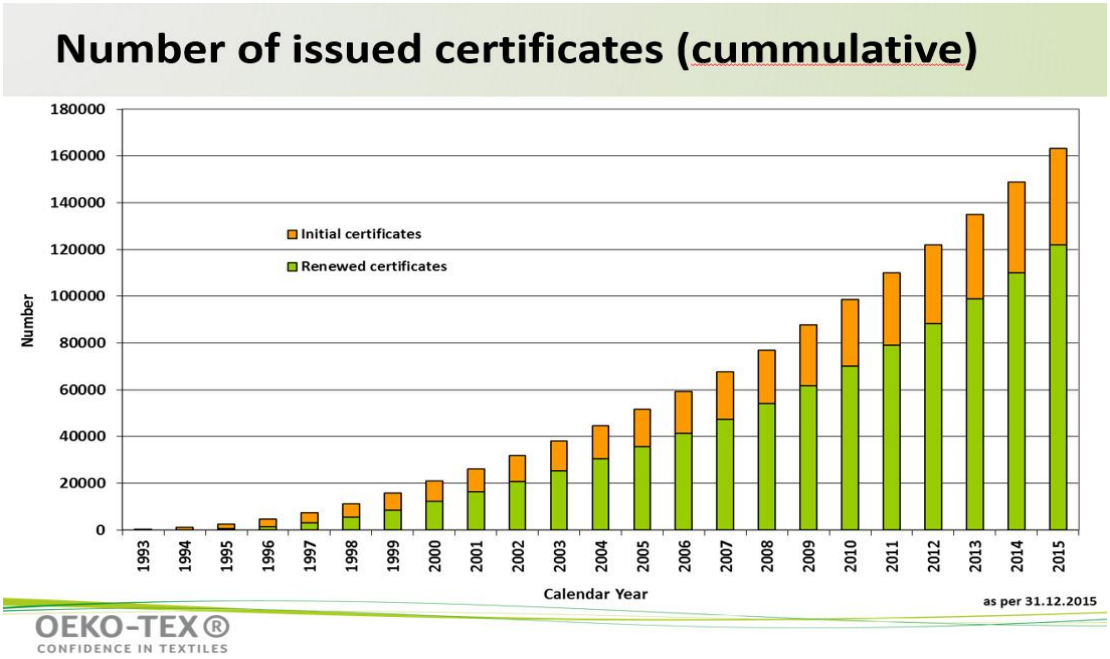

Figure 2 STANDARD 100 by OEKO-TEX - certificates issued worldwide

On the presented figure dating from December 2015, the number of issued certificates has increased significantly since 1993 onwards. With 25 years of experience, OEKO-TEX leads the world in empowering and enabling consumers and companies to protect our planet by making responsible decisions. OEKO-TEX provides standardised solutions which optimise customers' manufacturing processes and help deliver high quality and more sustainable products. All of the products within the OEKO-TEX portfolio are used to strengthen the customers' systems, processes or products and, ultimately, they help to create more sustainable companies. Up to date, 10,000 manufacturers, brands, and retailers in almost 100 countries are working with OEKO-TEX to ensure that their products are tested for potentially harmful substances and millions of consumers around the world look for OEKO-TEX labels before making their buying decisions [32].

Sustainable Textile Production (STeP) is the novel Oeko-Tex certification system for brands, retail companies and manufacturers from the textile chain. Certification is possible for production facilities of all processing stages. From July 2013 on, STeP

replaced the previous certification of production sites according to Oeko-Tex Standard 1000 [33]. By means of a holistic assessment of all operational areas (chemicals management, environmental performance, environmental management, social responsibility, quality management, occupational health & safety) the STeP by OEKO-TEX offers brands, retailers and manufacturers the possibility to analyse, and to continuously improve their performance with respect to sustainable aspects such as the use of environmentally friendly technologies and fair working conditions [32].

STeP by OEKO-TEX includes the requirements that apply to: waste water criteria, ethically correct behaviour, social responsibility, banned chemicals and processes, production waste, chemicals management and exclusionary criteria [33,34].

Implementation of all aspects defined in STeP by OEKO-TEX is certified (Figure 3) and offers guarantees sustainable textile production [33].

Figure 3 Sustainable textile production label

The Global Ecolabelling Network (GEN) was established in 1994. It is a non-profit interest group composed of 27 members, environmental performance labelling organisations throughout the world. Moreover, their members attained the status "Type 1" specified in the ISO 14024 standard and that means:

- their ecolabelling programmes are voluntary
- their standards address multiple environmental criteria over the life cycle of a product or service
- standards are published and clear
- ecolabels are awarded using independent third-party confirmation.

The aim of GEN is to further exchange information between national eco-label activities in order to improve, develop and promote the Ecollabelling of products and services [35].

2.2.1. Hohenstein

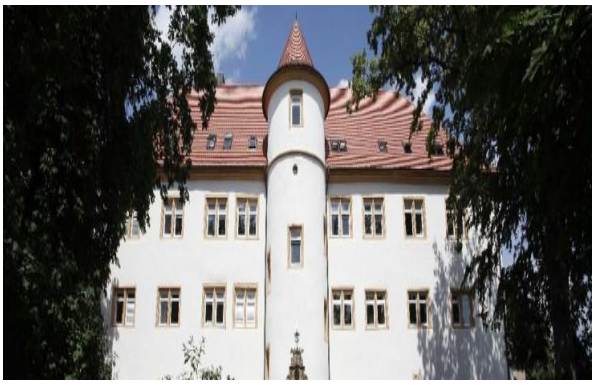

Figure 4 Hohenstein Institute – Bönnigheim (Germany)

Hohenstein Institute was founded in 1946 by Prof. Dr.-Ing. Otto Mecheels for whom the link between research and practical applications was of prime importance. His son Prof. Dr. Jürgen Mecheels continued to lead the Hohenstein Institute along the same lines and developed it into an inter-disciplinary research and service company. Since 1995, a representative of the third generation has taken over in charge of the family company, Stefan Mecheels [36].

The Hohenstein Institute (Figure 4) is a test laboratory and research institute. Its work first and foremost involves the testing and certification of textiles. Besides these services, the institute offers research and development in the field of textile products and applications of all kinds relating to its core competencies. The laboratory conducts chemical and technological textile tests, toy testing, survey of workmanship and fit, checking of the finished measurement charts, testing protective clothing, work wear, industrial clothing, and related preliminary products etc.

The laboratory tests and investigations offer extend from classical material testing through quality assessment of a wide range of product characteristics to the evaluation of product performance for many different applications. Comparative testing of goods provides for targeted product development with an eye to possible competitors.

Additionally, Hohenstein Institute offers numerous education courses and programmes aimed for example at industry, dealing with all issues throughout the textiles production chain. They allow creation of master and doctoral work as well as internship semester.

Hohenstein Institute offers Certification and Services by OEKO-TEX:.

- ECO PASSPORT by OEKO-TEX® is testing and verification of textile chemicals, colourants and auxiliaries for their human-ecologically safety.
- Textile testing for human ecological harmlessness and quality according to OEKO-TEX Standard 100.
- Auditing and certification of sustainable textile production facilities according to STeP by OEKO-TEX
- Product labelling Made in Green by OEKO-TEX® Label for textiles tested for harmful substances and sustainably produced textiles-comprehensible and transparent for consumers
- Customer support for using the database MySTeP by OEKO-TEX® independently of an existing OEKO-TEX® certification, companies can manage their supply chains regarding aspects of sustainability.

Figure 5 Locations of Hohenstein Institute

The Hohenstein Institute unites four independent organisations working on behalf of customers:

- **The Hohenstein Textile Testing Institute GmbH & Co**. KG offers certifications to OEKO-TEX Standard 100, Sustainable Textile Production (STeP) by OEKO-TEX and Made in Green by OEKO-TEXas well as numerous material and quality tests and inspections for all types of textiles.
- **The Hohenstein Laboratories GmbH & Co**. KG offers a wide range of tests and certifications which industry, trade and retail rely on as a proven basis for decision making in the development and marketing of products.
- **The Hohenstein Institut for Textilinnovation GmbH** uses its application-oriented research and development of innovative products and methods to open up new market segments for the entire textile industry and its target markets.
- **The Hohenstein Academy e.V.** offers basic and advanced training, workshops and conferences for the entire textile and clothing industry as well as for the related sectors of the economy [36].

Hohenstein laboratory is accredited for compliance with Norms **ISO 17025.** Testing include the physical and chemical testing of textile raw materials, yarns, fabrics and wearing apparel, semi-finished and finished products, accessories, floor coverings et. and certification of harmful substances occurring in textile products. They are recognized as a European notified test centre for personal protective equipment and are a member of the most important international and national associations.

2.2.2. OETI

Figure 6 OETI Institute – Wien (Austria)

In 1967, Oeti established an accredited testing laboratory and certification body within the Institute (Figure 6) for both manufacturers and traders of textile and similar products. Since then, Oeti continuously develops and improves their services and increases the quality of their services. Their milestones are shown in Table 4.

As one of the founding members of the "International OEKO-TEX" Association, a union of 16 renowned institutes for ecological textile research and testing, OETI certify products to the „STANDARD 100 by OEKO-TEX" as well as textile manufacturers and retail companies to the "STeP by OEKO-TEX" certification system.

Table 4 Milestones of Oeti

Year	Oeti activities
1967	establishment of OETI under directing of Wilhelm Herzog
1978	the Austrian Carpet Research Institute merges with the Austrian Fibre Research Institute to form the Austrian Textile Research Institute
1992	as founding member established an International OEKO-TEX Association
1994	accredited their quality management system according to the new standard EN 45001
2007	established its office in Egypt
2010	set up offices in Czech Republic and Ukraine
2013	became part of the TESTEX family
2014	set up its office in Turkey
2015	established its office in Republic of Moldova
2016	established offices in Italy and Iran

The mission of institute is the following:

- independence, professionalism and customer orientation
- high quality testing, certification and consulting services with team of specialists
- responsibility towards employees and customers

- responsibility towards environment
- comprehensive services in the field textiles, flooring technology and interior materials
- increasing competitiveness of customer.

As services providers OETI tests and certify textiles and offer a wide range of tests along the production chain from fibres, textile material components to finished products and clothing. Through their activities they offer and testing and evaluating of resilient and laminate flooring. They determine specific charasteristics for floor covering such as castor chair suitability, suitability for use on stairs or underfloor heating. In addition they test safety-related properties like fire behaviour or anti-slip properties.
They are competent for the certification of personal protective equipment (PPE) (Figure 7) [37] according to CE marking requirements and ensure PPE products meet the specific requirements. PPE are products like bulletproof vests, protective clothing for welders or foundry workers, chemical-protection suits, safety vests or garden gloves etc. PPE clothing protects people against risk to health or life and must carry CE mark.

Figure 7 Personal protective equipment (PPE)

Additionally OETI is doing tests for interior design materials, determination and certification of UV protection capability of textile products so as testing and certification of the indoor air quality of new or converted rooms for the Clean Air Forum.

They also develop and promote their own new services according to their own standards and brands like „IS-OTI TESTED", "IS-OETI INSPECTED" and "Checking and Evaluation of indoor air quality" and mark high quality products with their standards. In addition, OETI mark materials tested both for harmful substances and come from a sustainable production with the “MADE IN GREEN by OEKO-TEX“ label. OETI tests and certify products used in the textile industry including colourants, auxiliaries and chemicals according to "ECO PASSPORT by OEKO-TEX". OETI offers intellectual services and training. They offer their customers seminar programmes and different kinds of training. Seminar topics available include textile and safety knowledge.

As testing and certification body, they prove their quality and professionalism by an accreditation according to EN ISO/IEC 17025 and EN ISO/IEC 17065 standards and on EU level by a Notified Body (NB 0534). (Figure 8)

Figure 8 Accreditation of OETI according to EU Norms and standards

2.2.3. TESTEX

Figure 9 TESTEX Institute – Zurich (Switzerland)

TESTEX is a self-contained Swiss testing and certification organisation (Figure 9) operating worldwide with the focus on textile sector. TESTEX has been testing, analysing and certifying since 1846.

Laboratory of TESTEX institute conduct textile-related physical and chemical tests on fibres, yarns, woven and knitted fabrics, non-wovens and finished products. Their services include tests related to clothing physiology on fabrics and ready-made textile products. They conduct tests based on the requirements for personal protective equipment (PPE). Their laboratory conducts measurement of colour, whiteness and UV transmission (according to UV standard 801) and they test toy safety (mechanical, chemical and physical tests).

Very important services are testing indoor air quality for living areas and workplaces. They include: ambient air measurements, measurements of harmful substances for verifying the occupational exposure limit (OEL values) in commercial and industrial workplaces, climate measurements, fine-particle measurements, evaluation of biological parameters, hygienic evaluations of heating, ventilating and air-conditioning systems and noise and light measurements.

General requirements for proficiency testing are becoming increasingly important. TESTEX conducts proficiency testing with international participation (in the fields of yarn, colour fastness, fabric properties and function) and confirm quality of other laboratories and help them to the necessary corrective actions.

Except office in Zurich, the TESTEX Group has 20 branches worldwide and employs more than 190 staff members. One of the major branches is in North America, Europe and especially in the Asia/Pacific region (Figure 10).

Figure 10 Locations of Institutes - OETI and TESTEX group

Testex has become highly appreciated, in Europe and also worldwide, for its high-quality services, its independence and its innovative energy. They conduct tests in agreement with national, continental and international standards and regulations. They confirmed their quality by accreditations according to EU Norms. TESTEX is accredited for compliance with Norms **ISO 17025** since 2001 (general requirements for the competence of testing and calibration laboratories) and **ISO 17043** since 2011 (conformity assessment – general requirements for proficiency testing). Since 2006, TESTEX is recognised as a certification body for personal protective equipment (PPE) and textile products and accredited according to **ISO 17065** (Figure 11)**.**

Figure 11 Accreditation of Testex according to EU Norms and standards

3. EXPERIMENTAL PART

The OEKO-TEX Standard 100 is a worldwide consistent and independent testing and certification system that defines general and specific conditions which must be complied with textile or leather products to be awarded the standard. Award of the Oeko-Tex Confidence in Textiles label certifies that the article has been examined for the absence of dangerous substances, like heavy metals, toxic dyes, crop protection substances, and carcinogenic substances like formaldehyde etc. Dangerous substances within the context of this standard refer to substances which may be present in a textile product and exceed the maximum amount which may have an influence on human health. The Confidence in Textiles mark guarantees the consumer that a textile, leather or alike articles do not contain banned or restricted substances in excess of binding maximum thresholds, known to be non-hazardous to human health and certifies that examination/testing has been performed by an authorised laboratory [2,12,38]. These products are under supervision of an institute belonging to International Association for Research and Testing in the field of textile ecology [12,35].

The main objective of OEKO-TEX Standard 100 is to produce of all types of products as raw, semi-finished and finished textile products at different processing levels as well accessory materials used in the process which are safe from a human-ecological point of view and to accelerate delivery relationships for manufacturers and retailers wishing to offer their customers product safety. OEKO-TEX Standard 100 can ensure and reliable product labelling for consumers who place great emphasis on textiles that are safe and harmless to health [12,20,38,39].

Certification according to STANDARD 100 by OEKO-TEX offers a number of benefits to companies in the textile, leather and garment industry that wish to supply their customers with products that are safe for health. The certification by OEKO-TEX standard ensures that textile products at all processing stages can be inspected and certified. The responsibility for the human-ecological quality of products rests with the level that changes the quality or chemical composition of the product during processing. This also allows manufacturers, which are the last link in the production chain, to certify their collections at a reasonable expense.

The catalogue of OEKO-TEX criteria (published in January 2014) offers a standardised requirements profile for purchase and delivery conditions, which simplifies the flow of information. The catalogue divides articles, including their components (fibres, yarn, fabrics) into four classes, depended on their intended use. The product classes differ generally in the requirements that the products have to fulfil and by the test methods applied [2,34,38].

3.1. Product classes

OEKO-TEX Standard 100 has limits for over 100 harmful chemicals, substances and emissions in textiles and accessories.

OEKO-TEX Standard 100 test certifies that a fabric passes the following performance criteria standards [20]:

- article does not contain allergenic dye stuffs and dye stuffs that form carcinogenic arylamines of the MAK-groups III A1 and III A2.
- article that not carry pesticides and chlorinated phenols
- article free from formaldehyde or containing trace amounts lower than the limits
- article with a skin friendly pH
- article that have been tested for the release of heavy metals
- articles free from chloro-organic carriers.

Based on human-ecological requirements that need to be complied with ECO STANDARD 100, groups of different articles are categorised according to their utilisation in four product classes [2,38].

Product class I (products for babies):

This class contains all products for babies, which means all articles, materials and accessories provided for the production of articles for babies and children up to the age of 36 months with the exception of leather clothing.

Product class II (products with direct contact to skin):

These products are those which are worn or used with a large part of their surface in direct contact with the skin. For example: blouses, shirts, underwear, mattresses…

Product class III (products without direct contact to skin):

Articles without direct contact to skin are those, which are worn with only a little part of their surface in direct contact to skin (for example stuffings).

Product class IV (decoration material):

Decoration materials in the context of this standard are all articles which are used for decoration, including initial products and accessories. They are materials such as table cloths, wall coverings, furnishing fabrics and curtains, upholstery fabrics, and floor coverings.

3.2. Criteria

The test criteria and limit values on which OEKO-TEX testing for harmful substances is based are globally binding and are modified and expanded each year.
Testing includes [40]:

- substances banned by law
- substances regulated by law
- substances known to be harmful to health which have not yet been explicitly regulated by law
- parameters for secure health.

In the context of this standard, active chemical and biological products are all preparations incorporated into the fibre material or those applied in a later step of processing or that have intention to destroy. Harmful substances are flame retardant products (active chemical products that are used to reduce combustibility or flammability). Because of possible influence chemicals on human health, OEKO-TEX Standard determined limiting values for testing parameters (Table 5) [12].

Table 5 Oeko-tex standard 100 limits

Parameter (mg/kg)	Product class			
	I	II	III	IV
pH	4-7.5	4-7.5	4-9	4-9
Formaldehyde	20	75	300	300
Antimony	30,0	30,0		
Arsenic	0.2	1.0		
Lead	0.2	1.0		
Cadmium	0.1	0.1		
Chromium	1.0	2.0		
Chromium (VI)	Under detection limit			
Cobalt	1.0	4.0		
Copper	25.0	50.0		
Nickel	1.0	4.0		
Mercury	0.02	0.02		
Pesticides	0.5	1.0		
PCT/TeCP	0.05	0.5		
Banned dyes	Not used			
Chlorinated organic carriers	1.0			
Biocidic and flame-retardant finishes	none			
Colour fastness				
Water		3		
Acidic perspiration		3-4		
Alkaline perspiration		3-4		
Rubbing, dry	4	4	4	4
Rubbing, wet	2-3	2-3	2-3	2-3
Emission of volatiles				
Aromatic hydrocarbons	0.3		0.3	

Organic volatiles	0.5	0.5
Odour	No abnormal odour	

3.3. Testing methods and procedures

Since 1992, OEKO-TEX Standard 100 focused on the development of methods for testing of pH, dangerous substances like heavy metals, toxic dyes, crop protection substances and carcinogenic substances like formaldehyde, phenols or pesticide in testing articles. In addition, used test methods must also be in accordance with the requirements of these standards [2,20,26,39].

The following is a description of the testing methods according to OEKO-TEX standard 100.

3.3.1. pH value

The pH value is important information if textiles coming into direct contact with skin. The required pH range corresponds to the natural pH value of human skin approximately 5,5. This avoids skin irritation due to the release of acidic or alkaline substances from textile or other articles. The pH maximum limit value for safe material is 4,0-7,5 [41]. This acceptable value was presented by researches that evaluate pH values of selected branded T-shirt products made by industry from Bangladesh [41]. For goods which have to undergo a subsequent wet processing step a pH value can be between 4,0-10,5. But in some cases for example in foams pH value might lie between 4,0 and 9,0. The pH value for coat or laminated leather products (product class IV) can range between 3,5 and 9,0 [2].

The pH value of an aqueous extract of the article is determined usually by ISO 3071 method [2,41,42].

3.3.2. Formaldehyde

Formaldehyde has sensitizing and allergenic effects, even at low concentrations and has an irritant effect on the respiratory tract and mucous membranes in concentrations above 0,5 mg/m^3 air. Hence, there are many studies which explore whether clothing

today contains formaldehyde levels likely to cause contact allergy in formaldehyde-allergic patients [43-47].

The exact incidence of textile dermatitis is unknown because of the lack of controlled epidemiological studies. But some researches have been demonstrated and assess the frequency and relevance of sensation to textile dyes and resins in patients. According to their results, 12,9 % patients had an allergenic reactions to a dye and resin allergen of them 33,7 % had positive patch tests to the formaldehyde [43]. Positive results were shown by other researches [44]. Eleven out of the 20 textiles have shown positive for formaldehyde. After the first and second washes the majority did not show a reduction in the formaldehyde content [44]. But in some cases washing the new garments before wearing generally reduced the amount of the formaldehyde released from the fabric [47].

Formaldehyde emissions into the air from textile floor coverings, mattresses, foams and large coated articles are also limited because breathing formaldehyde vapour can result in irritation of nervous systems,, a sore throat, teary eyes, blocked sinuses, runny nose sneezing or itching sensations [2,47].

There are several methods to test formaldehyde content. Nowadays, the most popular is the ISO method [46,48,49].

There are two main steps of testing for formaldehyde [48]:

- Qualitative testing for the presence of formaldehyde – qualitative tests have to be done first to show whether subsequent quantitative tests will be necessary.
- Quantitative determination of the content of free and releasable formaldehyde – according to this method, formaldehyde is integrally determined aquatic extract using the acetyl-acetone method on spectrophotometer

Formaldehyde was at first analytically determined using LAW 112, the internationally accepted acetylacetone method according to Japanese [2,46]. This method determines free formaldehyde as well as some cleavable formaldehyde. According to International organization for standardization ISO 14184-1:2011 (earlier ISO 14184-1:1999) specifies a method for determination the amount of free formaldehyde and formaldehyde extracted partly through hydrolysis by means of water extraction method. This method can be applied to the testing of textile samples in all forms [50,51].

Based on examinations results of a patient suspected of having contact dermatitis, proportion of contact allergy to the tested substances was 0,5-1%. European Environmental Contact Dermatitis Research group (EECDRG) recommended guideline with baseline patch test series to diagnose allergic contact dermatitis. Formaldehyde is one of the components of the mix for allergenic tests. The present guideline summarizes all aspects of patch testing for the diagnosis of contact allergy in patients suspected of suffering, or having been suffering, from allergic contact dermatitis or other delayed-type hypersensivity skin and mucosal conditions [52].

3.3.3. Pesticides

A large number of pesticides are used in sheep rearing and cotton growing. Provided they are used correctly, hardly and trace residues of modern pesticides can be found in raw cotton or wool. Traces of pesticides are usually chemically destroyed or washed out during the various pre-treatment phases (scouring, bleaching or desizing). According to Oeko-Tex standard 100, the pesticides of native fibres are stringent limited. The list of pesticides which might be used for natural fibres and are critical because of their persistence is defined [42]. Forty-five pesticides out of fifty-four are regulated in this standard that explains the technical specification for ecological textiles, which pose no risk whatsoever to health. The nine compounds that were removed are: six phenoxy acid herbicides, Dinoseb, Captafol and Toxaphene. To increase the applicability of this method, 23 other highly toxic pesticides are strictly limited by most countries [53].

Pesticides include all classes of chemicals used to kill or repel insects, fungi, vegetation, and rodents. It is well accepted that acute poisonings cause health effects, such as seizures, rashes, and gastrointestinal illness. Chronic effects, such as cancer and adverse reproductive outcomes, have also been studied extensively, and the results have been interpreted in various ways as evidence that pesticides are safe or cause for concern because they can be detrimental to human health [54].

Strong evidence of association with pesticide exposure was found for all neurologic outcomes, genotoxicity, and 4 of 6 reproductive effects: birth defects, fetal death, altered growth, and other outcomes.

Exposure to pesticides generally doubled the level of genetic damage as measured by chromosome aberrations in lymphocytes. Only a few high-quality studies focused on the dermatologic effects of pesticides. In some of these studies, rates of dermatitis were higher among those who had high exposure to pesticides on the job.
Evidence from research on humans consistently points to positive associations between pesticide exposure and 3 of the 4 non-cancer health outcomes studied [54]. The results of health effect of pesticides are shown on Table 6.

Table 6 Health effect of pesticides

HEALTH EFFECT	NO. OF STUDIES FOUND	NO. OF STUDIES INCLUDED*	RESULTS
Dermatologic effects	11	10	7/10 studies positive for dermatitis with pesticide exposure
Neurotoxicity	60	41	39/41 studies positive for increase in 1 or more neurologic abnormalities with pesticide exposure
Reproductive outcomes	64	59	birth defects: 14/15 studies positive; time to pregnancy: 5/8 studies positive; fertility: 7/14 studies positive; altered growth: 7/10 studies positive; fatal death: 9/11 studies positive; other outcomes: 6/6 studies positive
Genotoxicity	15	14	11/14 studies positive for increased chromosome aberrations with pesticide

	exposure[†]

Most studies on non-Hodgkin lymphoma and leukaemia showed positive associations with pesticide exposure. Some showed dose-response relationships, and a few were able to identify specific pesticides. Children's and pregnant women's exposure to pesticides was positively associated with the cancers studied in some studies, as was parents' exposure to pesticides at work. Many studies showed positive associations between pesticide exposure and solid tumours. The most consistent associations were found for brain and prostate cancer. An association was also found between kidney cancer in children and their parents' exposure to pesticides at work. These associations were most consistent for high and prolonged exposures. Specific weaknesses and inherent limitations in epidemiologic studies were noted, particularly around ascertaining whether and how much exposure had taken place [55].

Because of harmful influence of pesticides on human health it is very important to determine the content of pesticides in articles before use. The most used method for determination of organophosphorus pesticides (OPP) in textile is solid-phase microextraction and gas chromatography with mass spectrometry, SPME-GC/MS [56]. For determining of organochlorine pesticides (OCP) in ecological textile very often used method is hollow-fibre-liquid phase microextraction (HF-LPME) coupled chromatograph/mass spectrometry (GC/MS) [57].

3.3.4. Heavy metals

Because of positive and negative effects and the toxicity of trace heavy metals on human health and the environment, many researchers have studied the analysis of the trace metal contents of the environmental and industrial samples including textile products. Textile products contain some organic and inorganic substance including trace metal ions. Especially, reactive and pigment dyes contain trace heavy metals at high level. Trace metals may be health risks for human even at low concentrations in textile products. Traces of heavy metals are often present in different textile process such as metal complex dyes, dye stripping agents, oxidizing compounds, antifungal, odor-preventive agents and mordant reactive. Toxic and allergic metals include

cadmium, copper, nickel and zinc etc. [58,59]. Prolonged exposure to heavy metals may cause health problems such as allergies, and even cancer, because the concentration of metals is determined in various textile fibres (cotton, acrylic, polyester, nylon, viscose and polypropylene) of different colours. Pollution problem of toxic metals in the products of shoe leather especially in children s leather shoes must be avoided. By the use of the environmental new chemical raw materials and the development of green processing technology, the pollution problem of metals in shoe leather should reduce the health risk [60,61]. According to some researches [59] the examined textiles vary very significantly from a type to another or from one colour to another. The concentrations of lead were above limits of OEKO-TEX standards in some products. Therefore, people are exposed to heavy metals from textile materials due to contact with textile (clothes) and health risk and textile or leather should be analysed regularly [58,59].

For this reason, the determination of the metal content of textile materials is very important in textile productions not only for the safety of consumers but also for the textile industry.

In recent years, microwave digestion procedures in closed vessels have been developed as a rapid and reproducible sample preparation method for a great variety of complex matrices [1,34,39,59].

Instrumental techniques like inductively coupled plasma-optical emission spectrometry (ICP-OES) and inductively coupled plasma-mass spectrometry (ICP-MS) are used for the determination of metal ions in real samples at traces levels [58-60,62].

At OEKO-TEX standard 100 requirements relating to cadmium (Cd), nickel (Ni), mercury (Hg), copper (Cu), cobalt (Co), chromium (Cr) and (Cr) (VI) ion, lead (Pb), arsenic (As) and antimony (Sb) [26]. The methods of quantitative determination for heavy metals including [48,63]:

- Extraction with artificial acid sweat solution – accessorize made from painted, unpainted metal and galvanized plastics must be enclosed in fewest layers of inert, undyed textile to avoid mechanical properties.
- Digestion of the samples – the samples are digested by acids to get a clear solution.
- Testing for chromium (VI) ion – the test is performed by using artificial acid sweat solution.

- The precondition for the certification of leather materials is in accordance with LEATHER STANDARD by OEKO-TEX.

3.3.5. Dyes

Dyestuff industries manufacture about 4000 different commercial dyestuffs in various countries in Europe and the world. Dyestuffs include azo, anthraquinone, oxazine, azine etc. Most of these dyestuffs are azo dyes. According to some researches the high acute toxicity was found among the basic dyes and disazo direct dyes [61]. About 31 dyes mainly disperse with anthraquinone or azo structures are found to cause allergic contact dermatitis. Contact dermatitis was determined in many researches [64-68]. The incident dermatitis varied between 1% and 16% depending on the country, patient sample and number of dyes in the patch test series. For the example, one research [65] determined positive Basic red 46 past test reaction (on testing acrylic blend socks) in 555 suspected patients from a patch test clinic population (about 1.2 %). Therefore they suggest that patients with foot dermatitis should be tested for textile dyes [65]. It was determined that D Orange can course contact allergy too and frequency of allergy was about 1.5 % of patients. Textile dye mix (TDM) positive patients more often had dermatitis on arms, face, neck or hand [66]. Certain dangerous substances as azo colourants in textile products have taken the worldwide lead in restricting some dyes as results of carcinogenic influence [67]. Among the textile dyes, disperse dyes are common sensitizers and researches [68] examined whether patch testing with a textile dye mix consisting of eight dispersing dyes would be equivalent to testing with separate ingredients of the mix at the concentrations used in the mix. 2% of patients (N=1780) reacted to the mix and 34 were allergic to ingredient tested. Performed research emphasized the importance of ingredient concentration of the textile dye which can increase the sensitivity of the mix [68].

A dyestuff, mainly with benzene ring by the reduction process with the skin can produce the carcinogens compounds [67,69]. In 2004, the mutagenic effect of textile dyes on Salmonella typhimurium (positive results in 28 % of samples) or on mouse (about 28% samples) has been shown. Based on the data, 14 dye products of 281 have shown mutagenic effect [70].

Possible genotoxic or mutagenic effect of textile dyes or allergenic effect are most often discussed with respect to selected azo dyes therefore use of these dyes has been drastically reduced in Europe due to national regulations (German, Netherlands, Turkey, France etc.) or textile quality labels (for example Oeko-Tex standard 100).

Azo dyestuffs and pigments

There are lists which contain banned azo dyes whose application is forbidden at EC area. According to Oeko-Tex Standard requirements and documents, the use of azo dyes is prohibited because they can be cleaved to aryl amines, MAK groups III A1 (Table 7) and III A2 (Table 8). Therefore, 24 listed arylamines following reductive azo cleavage cannot be used in the production of textiles according to OEKO-TEX standard 100 [2,42,61,69].

MAK-group III, A1 – substances which are known to be able to cause cancer in human beings.

Table 7 MAK-group III, A1-substances to be able to cause cancer

Dyes (substances)
4-Chlor-o-toluidine (4-Chlor-2-methylaniline)
2-Naphtylamine
4-Aminobiphenyl (Biphenyl-4-ylamine)
Benzidine

MAK-group III, A2 – substances which are definitely carcinogenic to animals, when these animals are exposed to such conditions.

Table 8 MAK-group III, A2- substances which are carcinogenic to animals

Dyes (substances)
o-Tolidine
o-Dianisidine
3,3-diclorobenzidine
4-chloroaniline

o-Toluidine
o-aminoazotoluene
2-amino-4-nitrotoluene
2,4-diaminotoluene
2,4-diaminoanisole
4,4-diaminobiphenylmethane
4,4-diamino-3-3-dimethylbiphenylmethane
4,4-diamio-3,3-diclorobiphenylmethane
4,4-diaminobiphenylether
4,4-diaminobiphenylsulfide
2,4,5,-trimethyleniline
p-cresidine
o-anisidine
2,4-xylidine

The OEKO-TEX standard permits the use of azo pigments which contain an azo bonded MAK amine as a structural element. This amine cannot be split under test conditions of methods. This standard permits the use only non-cleaveable azo pigments.

The official test method for a different amin detection is EN14362-3 (Gas chromatography with Mass Spectrometer-GC-MS). However, some pigments can cause false positive detection of banned amine. Caused by interfering substances [61] or by thermal cleavage of amide bonds in the pigment in the heater block of the gas chromatography which is used as method for the amine detection and quantification. If any of these amine is present its qualification must be done by HPLC (High performance liquid chromatography with DAD (Diode array detector) method [2,61].

Allergenic Dyestuff

Some of disperse dyestuffs can cause dermatitis in sensitive individuals. The reactions depend on the amount of allergenic dyestuff that migrates from the dyed textile to skin.

There is a list of dyestuffs known as allergenic substances as Disperse blue 1, 3, 7, 26 etc; Disperse orange 1, 3, 37 etc; Disperse red 1, 11, 17; Disperse yellow 1, 3, 9 etc.

The list of dyestuffs will be changed with those which are known in medicine [42,68]. OEKO-TEX standards forbid a total 21 generic disperse dyes as potentially allergenic.

The identification and quantification of these dyes is based on chromatographic methods [2,42,61]. Used testing method for these dyestuffs is extracting a textile sample followed by LC/DAD/MS analysis. In Germany, a standard method used for detecting allergenic dispersing dyes is DIN 54231:2005.

Carcinogenic dyestuffs

Dyestuffs classified as carcinogenic can cause cancer, therefore, according to Directive (2002/61/EC) [67] dangerous substances (azo colourants) in textile production are banned. Oeko-Tex compliant textile may not use Dyestuffs classified as carcinogenic: acid red 26, basic red 9, basic violet 14, direct black 38, direct blue 6, direct red 28, disperse blue 1, disperse orange 11 and disperse yellow 3 [2].

Other banned dyestuffs

This group of colourants is banned due to other human and ecological properties and can be found under the corresponding category in OEKO-TEX Standard 100 [48]. This group includes Disperse orange 149 and Disperse yellow 23.

The identification and quantification of other banned dyestuffs is made by chromatographic methods too [2,42].

Colour fastness

Colour fastness is not a hazard for human health, but as part of criteria set for products with eco-label, the high quality implementation and maintenance must be ensured. [69,71] Colour fastness refers to the resistance of colour to fade or bleed of a dyed or printed textile materials to various types of influences as light, water and washing, perspiration. These influences are normally exposed in textile daily use and in the manufacturing [71]. Factor affecting the colour fastness properties: type and quality of the substrate (chemical nature of the fibre), the molecular structure of a dye molecule, type of pretreatment, dyeing or printing method used, the amount of dye, the presence of other chemicals in the material and conditions prevailing during the exposure [2,71].

Apart from the dyestuff itself, colour fastness method has several parameters [53]:

- determination of colour fastness to water

- determination of colour fastness to acidic and alkaline perspiration
- determination of colour fastness to rubbing dry
- determination of colour fastness to saliva and perspiration
- fast to saliva and perspiration
- not fast to saliva and perspiration.

Basic methods for the evaluating of colour fastness are:
ISO 105-A01 and ISO 105-A03-methods for the evaluating the test
ISO 105-E01-determination of colour fastness to water
ISO 105-E04- determination of colour fastness to acidic and alkaline
As is required in Oeko-Tex standard 100 dyestuff must comply to the colour fastness specification and limits [12].

3.3.6. Phenols

Phenols are components used as ingredients of dyes, polymers or other organic substances. They are harmful exotoxins and are hematotoxic, hepatotoxic and has mutagenic and cancerogenic influence toward humans. Phenols are toxic through two main processes: unspecified toxicity related to hydrophobicity of some compounds and through formation of free radicals. They damage DNA and enzymes and concern histopathological changes. Therefore, phenols are very toxic towards living organisms in environment and humans [72].

In the textile industry, phenols are used for raw material conservation or for treatment of the finished product. They can be in textile floor cover consisting of wool or wool blends [42]. Some of them are still used to prevent rot and mould in raw fibres and textile during prolonged transport or storage. Sometimes they are used to stabilize printing pastes. Phenols can occur as impurities from raw materials and by-products in chemical synthesis [2]. They can be determined in products of the leather industry [73,74].

Because the phenols are very toxic for human health they are determined in different kinds of materials. All the isomers as the pentachlorophenol (PCP), isomers of

tetrachlorophenol (TeCP) and Trichlorophenol (TrCP) are determined for samples where PCP, TeCP and TrCP are used in a raw material conservation or for the treatment of the finished products [2,74].

For analysis of phenols gas chromatography can be used with GC with mass spectrometric (MSD) or electron capture detection (ECD). Phenols can be determined also by high performance liquid chromatography-mass spectrometry (HPLC-MS) method [73,74].

3.3.7. Emissions

Floor and wall coverings, mattresses as well as large coated articles that are not used for clothing, might cause an unpleasant odour in the room because of the vaporization of formaldehyde or easily volatile organic compounds [2,26,42]. There are different researches relating to emissions of volatile organic compounds [75-78] in indoor environments.

About 90% of time people spend indoors where they are exposed to chemical and biological contaminants and possibly to carcinogens. These agents may influence on respiratory system or the neurologic symptoms and cause different diseases as allergies, asthma and lung cancer [78].

It was shown that exposure is much higher from wet paint and new carpets compared with dry paint and old carpets. It is known that the type and quantity of volatile organic compounds in the material, the surface area of the material and the depth of the volatile organic compounds within the material are also important factors that effect exposure. In contrast, ventilation and air conditioning tend to reduce indoor volatile organic compounds. In general, indoor concentrations are higher than outdoor concentrations, and concentrations in winter are greater than in summer. Homeowners can improve the air quality in their homes, usually with relatively simple measures, which should provide health benefits [78]. It was found that respiratory symptoms were related to residential formaldehyde and volatile organic concentrations [77,79].

Therefore, materials and products for indoor use should be evaluated for emissions that might effect indoor air quality [76,77].

The emission tests for articles that might emit in the air of interiors is carried out at elevated temperatures, under realistic conditions relating to climatic parameters and substrate [76,77].
There are two main kinds of parameters that are determined: formaldehyde emitting in the air and the volatile and odorous compounds [79].

Quantitative determination of formaldehyde emitting into the air – the test is performed in a chamber of defined size, using samples of defined area. The sample is brought to equilibrium with air free of formaldehyde at defined air exchange rate. Under continuing ventilation a defined amount of air is sampled and the contained formaldehyde is quantitatively absorbed in a test solution.

Determination of the emission of volatile and odours compounds by gas chromatography:
a) individual components: Toluene, Styrene, Vinylcyclohexene, 4-Phenylcyclohexene, Butadiene, Vinyl chloride
b) sum parameters: Aromatic hydrocarbons, Volatile organic compounds

3.3.8. Sensory Odour testing

Sensory Odour testing may be a valuable complement to instrumental methods.
The odour test is performed with reference to SNV 195 651 [48]. The test determines the development of odour in a closed system, counting time, temperature and humidity both in as-delivered state and after storage. Six trained people will judge the odour and the intensity is registered by grade scale as follows.
Grade scale: 1 = odourless
2 = weak odour
3 = medium odour
4 = strong odour
5 = very strong odour
Odour test on other articles – this test must be performed before the start of other tests and immediately after delivery of the sample.

Odour can be from [48]:

a) mould

b) high boiling fraction of petrol (colour printing)

c) fish (permanent finish)

d) aromatic hydrocarbons (carrier…)

4. RESULTS & DISCUSSION

For the purpose of quality assurance of textile products the testing institutes and certification body gives a guarantee that the tested and certified products do not contain any harmful substance that is a danger to human health. More than 4200 companies that are active in textile production are involved in Oeko-Tex certification network [80].

The label (Figure 12) **"Confidence in Textiles – Tested for harmful substances according to Oeko-tex Standard 100"** is used to mark textile products that have demonstrated to pose no threat to health in comprehensive laboratory tests carried out by independent institutes. The quality mark is only issued to products of which all components are found to be free of harmful substances [20,38,80]. Marked product fulfils the conditions specified in standard and is under supervision of an institute belonging to the OEKO-TEX.

Figure 12 The label "Confidence in Textiles"

According to criteria of OEKO-TEX standard, certification system include 3 means levels:

- Verification of provided documents
- Laboratory tests on provided sample materials
- Compliance Statement (declaration of conformity)

This standard is applicable for different kinds of products as:
textile and leather, non-textile accessories, mattresses, feathers, foams, upholstery and similar products. The procedure itself has several steps of certification.

4.1. Communication and request for certification

Prior to submitting of the application form, it is necessary to do an interview with the applicant to obtain information about content of requirements. The group of products is a combination of several products that can be united under the same certificate. And these are, for example:

- textiles which differ only in the physical properties, and are made from well defined basic materials
- certified products according to OEKO-TEX Standard 100 but subjected to process of mechanical processing
- and textiles from the same fibre

The application for a certificate and the use of the mark shall be made on the appropriate form, together with the samples and directed to one of the 13 institutes or associate member of the International Association for Research and Testing in the field of textile ecology. In the request the name of the product and specification with data whether the applicant seeking certification for the manufacturer or retailer must be provided. Manufacturer of textile products and accessories for the textile product is a company that produces or company that has orders for production. The request should state the name of the product that will later define the product group, and will be named in the certificate. Manufacturers that use more material as the finished product must accurately define and describe each material separately in detail.
If the product, partially or completely is made of materials that are already certified according to Oeko-Tex Standard 100, the copy of the certificate with data as the form of products, certificate number, name of the supplier, and the deadline by the certificate can be used, should be enclosed.

The application for certification must contain the following informations:

- type and composition of the used yarns
- pretreatment material
- dyeing processes
- applicable dyes
- plant breeding in order to achieve specific properties

For the complete information it is necessary to specify description in detail and attach a description of the origin and manufacturers of the means, and eventual certificate.
The applicant must send a declaration of secrecy which contains:

- guarantee of data that are in demand
- commitment to the certification institute that issued the authorization to use the mark, notify any change regarding raw materials, production processes and recipes,
- the obligation that after the deadline will stop use the organic label

The company applicant assumes the full responsibility for the declaration and puts labels on the product.

4.2. Sample preparation

The applicant shall provide a sufficient number of representative samples whose weight must be at least 100 grams.
The samples must be individually packaged in polyethylene bags of high strength to avoid contamination during transport. The bags must be double wrapped with foil and taped with duct tape.
By agreement of the group of products to be certified, enterprise approaches into production, preparing samples of raw yarn to the finished product. It is important to know that when preparing, samples should be included in all processing to be implemented in the daily production of products for which wants to acquire certification. Components of the end product are packed separately in bags that are numbered as well as garments. Since the required tests depend on the composition, the structure and the materials used for production, it is necessary precisely to edit the documentation for obtaining the certificate [3].

The most used method for sample preparation is ISO 5089:1977 (last version in 2013). This method describes methods of obtaining laboratory test samples of textile materials from laboratory bulk samples taken from a bulk source, and gives general instructions for the preparation of test specimens of convenient size for chemical tests. Definitions in relating to bulk source, laboratory bulk sample, laboratory test sample and test specimen are described in this method [81]. For sample preparation other method, such as DIN EN ISO 5089:1977(last version 2015) is used [82].

4.3. Testing samples and documentation

The Institute considers a submitted request for certification by the applicant, material samples and all the received documentation. The institute must be authorized for the type and scope of tests, depending on type of product and information provided by the applicant.
Samples that have inadequate odour shall be exempt from testing. Verification of all documents and received samples is followed by testing.

OEKO-TEX tests include more than 100 different parameters known as harmful substances and go far beyond legal requirements. Limits of parameters are the most stringent for babies. Example of testing parameters for baby products:
formaldehyde, heavy metals, allergenic dispersion dyes, carcinogenic dyes, pesticides, pH, softeners, colourfastness [80].
Costs depend on effort and investing and information that come with the product for certification. The more attached information means also more economical costs.

4.4. Compliance Statement

Before getting the certificate, the applicant shall sign a declaration of conformity of the product. The statement shall be submitted on the official form to the OEKO-TEX institute based on a positive assessment of the test. The applicant of certificate must confirm that the whole production include products that are in accordance with the analyzed samples. The recognition of the credibility of the quality assurance in the company of the applicant is also an important factor for obtaining this certificate.
The company undertakes to provide, on their own expense, the control of products based on the request of institute. The information must include all registered products as described below:

- the name and address of the applicant
- permission to institute after notice has access to production facilities
- product identification
- note on the testing carried with the number of tests and the date of the test report
- date of issue statement

- signature of authorized person
- note that the statement is issued by the applicant with full responsibility

If all components of a textile comply with the requirements of the OEKO-TEX criteria catalogue without exception, the textile manufacturer receives certification and is entitled to use the OEKO-TEX label to mark the products in the shops. The OEKO-TEX certificate (Figure 13) is issued for a period of one year and can be extended subject to further successful testing. In order to ensure ongoing compliance with the test criteria, the authorised OEKO-TEX Institutes carry out control tests every year on a minimum of 15% of all certificates issued on OEKO-TEX products available in the shops [83].

Figure 13 The Oeko-Tex Certificate examples

4.5. After certification

After signing the Declaration of Conformity, a company gets a certificate that allows them to sell their products that may refer to the OEKO-TEX label. The duration of the certificate is one year.

During this time, the criteria that have been established during the authorization are applied. If it is found that if the implementation of production is not the same as agreed during the certification process, the institute for certification take away the right to use eco-labels (withdraw mark). Authorisation can be withdrawn when the mark does not comply with the conditions of this standard. Withdrawn certificate can be re-instated if the corrected measures are documented to the certifying institute. The measures implementation is verified by separate audit followed by certification separately.

After the expiration of a period allowing the use of the certificate, the applicant can ask for an extension for next year. In extending the right to use the mark, the institute for certification determines a reduced testing program based on its sole discretion [38].

4.6. Sustainable Textile Production

In considering the evolution of the textile and apparel industry it is important to recognize two different movements that are focused on main aspects in the textile industry which gave rise to eco-standards in the market today.

The first is environmental safety in textile industry which was rooted primarily in Europe and began in 1992 when the Community eco-label award scheme was established. Criteria were mainly focused at concerns regarding environmental pollution and human health and safety (organic production, energy usage, pollution, biodiversity conservation). The second movement are social issues addressed to secure good working conditions and wages (worker and consumer health and safety, economic development and animal treatment [84].

Some researches assess the relationship between green supply chain initiatives and performances outcomes. They showed that green supply chain initiatives have significant positive effect on the four types of outcomes [85]:

- environmental,
- economic,
- intangible outcomes and
- cost reductions.

They have shown that designing environmentally friendly products and taking back products and packaging can generate benefits to the environment through reused waste and better resource utilization and to the cost reductions.

Consumers demand the quality levels for textile products but also safety and ecology. Therefore, the fashion supply chain places more and more importance on sustainability, forcing textile producers relating to high environmental and social standards in the entire textile-clothing chain, from raw materials to retail. Consumer and postconsumer (reuse, recycle, disposal) phases are also very important for eco-friendly consumers. To answer the needs of consumers, several eco-labelling systems which include requirements for “organic” textile, have been developed. The major ecolabels that are used in the European Union including OEKO-TEX standard 100 and the new certification scheme Sustainable Textile production (STeP) [86].

Sustainable Textile Production (STeP) by OEKO-TEX is a certification system for manufacturers, retail companies and different brands from the textile chain who want to communicate their achievements regarding sustainable manufacturing processes to the public in a transparent, credible and clear manner. Certification is possible for production facilities of all processing stages from fibre production, spinning mills, weaving mills, knitting mills to finishing facilities and manufacturers of ready-made textile items. Through modular analysis of all relevant company areas such as management of chemicals, environmental performance, environmental management, occupational health and safety, social responsibility and quality management, the STeP certification allows a comprehensive and reliable analysis of the extent of sustainable management provided by a production facility [29]. (Figure 14)

Modular and independent certification (STeP) provides targeted support for brands, manufacturers and retailers on their way to more sustainability - and creates even for consumers a high degree of transparency and reliability.

Figure 14 STeP – Model of sustainable management

4.6.1. STeP certification criteria

Industries currently face pressure on environmental initiatives from both global competition or government regulations and from consumer pressure. Hence, industries are forced to implement sustainable practises to improve their environmental, social and economic performance. The sustainable system is a concept which ensures environmentally practices in traditional supply chains. This is essential for textile industries around the world. The safety perspective of industries is an implementation of sustainability in practice including adoption of safety standards and green practise, health and safety issues, employment stability and community economic welfare. Hence, sustainability system provides the motives of enablers and they should establish and maintain their sustainability program through three steps: engage their people, use proven frameworks and implement best practices [87].

The implementation of sustainability program in accordance with STeP by OEKO-TEX must comply with the requirements for the certification of environmentally friendly and socially responsible facilities. In some countries sustainability criteria were evaluated in textile supply chains consisting from multinational garment retailers (customers), suppliers to manufacturers and garment manufactures. Studies consider workforce, society and environmental issues as sustainability criteria. The researchers' results indicate that the criterion of long working hours is critical for both categories of

suppliers while pollution and unfair competition were the most important criteria in the case of garment manufactures. It was determined that employing child labour was a critical criterion in the case of ancillary suppliers [88]. Despite the widespread use of OEKO-TEX standards in the world, sustainable development is not implemented by many manufacturers in the world.

4.6.2. Environmental performance

Environmental performance refers to compliance with the stipulated limit values, use of best available production technologies, optimisation of production processes, efficient use of resources, reduction of the CO2 footprint and responsible handling of waste, waste water, emissions etc.

Waste water criteria

Production locations must comply with new criteria relating to their waste water. The following values are applicable:

Parameter	**Limit Value**
FOA	µg/l 50
PFOS	µg/l 10
Nonylphenol (AP)	µg/l 0.1
Octylphenol (AP)	µg/l 0.3
Nonylphenolethoxylate (APEO)	µg/l 1
Octylphenolethoxylate (APEO)	µg/l 1

Production waste

The guidelines for production waste prescribe appropriate storage areas that must provide and ensure, wherever possible, that pollution of the immediate environment and groundwater is excluded. The guidelines also specify that the storage of production waste must be protected from external weather conditions and from fire. The objective for production companies is to ensure that the storage of production waste has no effect wherever on the environment [28,29].

4.6.3. Banned chemicals and processes

Banned processes that have a very negative influence on the environment and occupational health and safety are listed in Appendix D4 of the STeP standard – *Banned Chemicals and Processes*. Two additional processes have also been included in the list of excluded processes. These are [28,29]:

- Sandblasting for the treatment of jeans and other articles. Excluded from the ban are closed systems, provided that the dust emissions at the workplace do not exceed the limit value specified in Appendix G07 of the STeP standard.
- The use of thickening agents based on aromatic hydrocarbons for textile printing.

4.6.4. Chemicals management

The prerequisite for STeP certification is the compliance with the guidelines of a restricted substances list (RSL) and introduction of a suitable harmful substances management. Compliance with the principles of 'green chemicals' is also very important for certification. STeP certification requires periodical training and further education regarding the handling of the used chemicals and requires the monitoring of chemicals. The guidelines recommended an obligation for appropriate communication regarding the chemicals used and their risks [28,29].

4.6.5. Ethically correct behaviour

With immediate effect, STeP standard requires all employees to comply with ethically correct behaviour. Therefore, companies must provide their employees with a written Code of Conduct, which defines the ethical principles of the company and lists corresponding specific directives. OEKO-TEX will also establish a neutral point of contact for employee complaints from STeP certified production sites. With regard to the purchase of feathers and down used in bedding or clothing manufacturing, STeP certified companies are required to obtain their raw materials from suppliers who can prove they do not adopt practices, such as live plucking and/or forced feeding [28,29].

4.6.6. Social responsibility

To exclude the worst forms of child labour, STeP certified companies must, in the future, also be able to provide evidence of compliance with International Labour Organization (ILO) standard C182 [28,29]. ILO standards are aimed at promoting opportunities for workers to obtain decent and productive work, in conditions of freedom, equality and safeness [89].

Figure 15 Employees - Social responsibility

If the employees (Figure 15) of STeP certified companies receive additional donations from their employers, it must be clearly documented. Medical investigations required by law, for example, HIV tests, are not categorised by the STeP standard as discriminatory, but must be documented and monitored. In addition, workers and salaried employees may drink water, and take a break or use the toilets, at any time within the extent prescribed by law without fearing any disciplinary action.

4.6.7. Health and safety

STeP certified companies must ensure suitable measures required for health and proof measures to ensure the required health and safety in the workplace (e.g. filter systems, ear protection etc.) STeP standard requires and guaranteed safety of buildings and production plants (e.g. through constructive measures, escape plans, separation of

production areas etc.) and risk prevention. Implementation of existing safety standards (e.g. OHSAS 18001) is very important [28,29].

4.6.8. Exclusionary criteria

The list of exclusionary criteria includes other aspects. For example, the specifications that each employee must receive a written employment contract, that the company ensures specific workplace conditions for young employees and that the payment of deposits for the recruitment of new employees is not permitted.

4.6.9. STeP certified companies

The number of STeP certifications issued has risen substantially over the last years. Importantly, the overall number of inquiries has dramatically increased which illustrates the desire companies in the textile supply chain have for improving their sustainable practices specifically focused on the environmental, chemical and social fronts. To date, over 30 production facilities around the world have successfully received STeP certification and companies from a total of 22 countries from around the world have received STeP certification, e.g. Germany, Switzerland, Italy, China, India, Bangladesh, Indonesia, Brazil etc. In addition, production sites at all production levels along the value-creation chain, from fibre manufacturing to textile logistics centres, have successfully received certification. In spite of the differences in the individual companies, STeP is flexible enough and has been adapted to the textile industry in such a way that can provide equal support to all customers. In contrast to other certifications and management systems, which often only concentrate on narrowly defined areas such as social responsibility or occupational health and safety, STeP analyses all relevant parts of the company to gain as meaningful an assessment as possible with regard to the achieved level of sustainability and improves a corporation’s image. This is a tool with which companies can analyse and manage their whole supply chain from a sustainable point of view, and not just the individual production facilities [90].

This ability is particularly important for larger companies such as brands or retailers but can also be helpful for smaller or medium-sized manufacturers if they have not yet established their own analysis systems. Examples of STeP certified companies are listed below.

5. “Galeb” – AN EXAMPLE OF CROATIAN HIGH QUALITY

“Galeb” started its production as rope and net factory in 1928. The knitwear “Galeb” was formed 1951. In this section it started knits production (spinning and colouring) and implemented further modernization of the technological process. After that, “Galeb” became one of the most significant producers of underwear in this part of Europe. In this time, “Galeb” has been operating successfully and exported almost 85% of its production.

Figure 16 The high-quality Croatian brand in the production of underwear

For the past ten years, “Galeb” (Figure 16) has been working intensively and now offers new models by development of their collections both on the existing product range and on the expansion of the clothes and swimwear. Over the years, based on the experience and on the commitment to meet the needs of customers in all age groups, “Galeb” was, within product program itself, created a new brand of products that are now recognized as quality products, safe for human health and the environment. As a confirmation of the high environmental standards, both for raw materials used in the production process and for the twists and finished products, “Galeb” has been certified according to OECO-TEX since 1997. Their quality has been confirmed by the institute for certification of International Association for Research and Testing to which they send samples for analysis annually in order to prolong the validity of the certificate.

In the selection of the raw materials, “Galeb” cooperates only with reputable suppliers of European origin which results in a product that meets the highest quality and environmental standards. Their products have been labelled as “Croatian quality” by the Croatian Chamber of Economy since February 2007.

In 2010, “Galeb” won the prestigious “Best Buy Award” in the men's underwear category. It means that “Galeb” is one of the best in ratio between price and quality in the category for which company was awarded. “Galeb” is the first manufacturer that has marked products by this brand (Best Buy) in this part of Europe.

Today, customers more and more look for price-quality ratio and based on this ratio bring the final decision about buying the product. The ratio between the goods’ prices and the highest possible quality (Best Buy) increasingly favors high-quality products. The “Best Buy Award” testing and certification offer to the consumers in the market the best price and at the same time - top quality.

The quality system and policy management in “Galeb”

A team of experts for visual realization of the design, technological adaptation and realization of production and marketing expert contribute to quality improvement of their products. It is visible through the quality of working, customer satisfaction and constant concern about the impact on the environment.

The mission of the “Galeb” is the production of clothes in accordance with the nature and time for consumers who choose high quality products. Their vision is to expand production and sell quality products on the market of the European Union countries.

Good policy of production and sustainable development of “Galeb” is realized through:

- Expertise
- Creativity
- Tolerance
- Openness
- Social responsibility
- Loyalty
- Partnership
- Quality
- Flexibility
- Teamwork
- Social sensitivity.

According to their policy management, the most important factors that guarantee satisfaction of customer and sustainability of production in the market are:

- The continuity of quality based on integrity of the production process and control of quality
- The flexibility of production of a specific product that contributes to a short time from the request to its manufacture
- Regular research of market needs and respect of feedback from end customers
- Regular use of databases that provides annual information on trends in the global market by department for new product development
- The introduction and implementation of Norms and ECO-TEX standard.

Based on the decisions about the implementation of the requirements of ISO 9001: 2008, ISO 14001: 2004, OHSAS 18001:2007 and ISO 50001:2011 in the existing management system, management of "Galeb" has defined the management policy for the area of knitwear:

1. To coordinate internal processes in a way that employees can express their expertise and loyalty. To ensure advancement of skills and ability of employees in all fields of work through trainings and educations.

2. All activities should perform according to highly professional rules and each employee is responsible for his work. In case of inability of proper operation, each worker must be stopped in his actions until the cause of non-compliance is removed.

3. The relationship with the suppliers is based on professional and partner relationships and considering quality, cost, delivery and influence on the environment. After analyzing procurement of equipment and services, energy-efficient options should be preferred.

4. In their activities and processes of analyzing all aspects of the environment, security and use of energy and their impact and importance of the organization, it is important to compose adequate goals, plans and programs for the most important aspects and to monitor legislation and other regulations in order to agree with them.

5. In all the work processes and in the all operations of the company it is important to implement the requirements of the ECO-TEX standard and other standards and to continuously improve the quality system, environment, security, system performance and energy consumption. Also, undertaking appropriate preventive actions in order to prevent non-conforming work, environmental pollution, unsafety for employees or inadequate relation towards energy is also required.

6. Promotion of all segments of management at all levels of society and in that sense, become an example of implementing good practice through relationship of production and service organization.

The development of the "Galeb"

Based on high quality products and the implementation of sustainable development, "Galeb" develops a new type of special products designed for smaller segments of consumers.
A new kind of production refers to:

• Anti-allergy program designed for people with skin allergies and with dysfunction of the individual limbs

• Functional underwear, intended for people who work in particularly difficult conditions such as fire department, military, police, as well as all those who are in the workplace exposed to low temperatures or large variations in temperature. In this segment, "Galeb" has developed three different programs in underwear for women and men, "without moisture" underwear, and "thermoregulation" underwear and less fuel and non-flammable underwear.

• Sports underwear made of polypropylene, intended for families with children and those who are due to efforts increased sweating. This underwear enables the transfer of sweat from the skin to the outside and keeps the skin dry.

Also, by collection development "Galeb" plans to maintain the continuity in production of underwear as well as heightened development of the assortment of outdoor clothing. "Galeb" has always referred attention to the quality and comfort of its products. Underwear and clothing made by "Galeb" has the certificate of "OEKO-TEX" standard,

which indicates that the used raw materials and technological processes meet the strict environmental criteria.

“Galeb” is a positive example of good management, the implementation of sustainable development and high quality products in accordance with the regulations of the EKO-TEX standard and EU Norms (Figure 18) which ensures the expansion and strengthening of market and customer satisfaction in Europe. The Croatian customers and many international partners have been ensured in the quality of their products because “Galeb” exports about 50% of its products, mostly to the countries of West Europe [97].

Figure 18 Implementation of EU Norms and EKO-TEX standard

6. CONCLUSIONS

Textile labels are in general of high importance for consumer worldwide. Almost every second consumer worldwide states that seals are of high relevance when buying clothes and textiles. Worldwide product quality and health safety are considered the most important factors when purchasing textiles and clothes. The discussion on the environmental indicators in textile production should continue within EU and globally in order to decrease the environmental and health effects of textile products. It will provide a more effective means of promoting the sales of cleaner products. Hence it is very important to develop good management and monitoring of environmental and health effects.

An ecolabelling program is a voluntary policy instrument which uses marketplace rather than regulation to achieve their objectives. An increase in certified products indicates the advantage in displaying the ecolabel. The popularisation of eco-labels and eco-textile allows distinguishing one eco-textile from another on the open market. It is necessary to increase the level of awareness of sustainable materials and textile products application.

OEKO-TEX is the best worldwide known textile seal. A textile that has successfully passed the test may be marked with the OEKO-TEX label. The motto *"Confidence in Textiles"* has become a synonym worldwide for environmentally-friendly manufacture as well as for responsible textile production. OEKO-TEX standards provide safety and transparency in textile production. Certification procedures are connecting best practice, actual practice and requirements of standards. The certification including very important decisions considering reducing risk, differentiating products from competitors, finding new cost saving, ensuring long-term supply, reputational gains and realizing a price premium for the product.

In order to continue the use of advantages of eco-certification according to the OEKO-standard like SteP, it is important to get information about awareness and usage of organic and textile seals and the OEKO-TEX Standard within the group of consumers, gathering relevant aspects influencing the process of purchasing of clothing and textiles, determination of the future relevance of textile-seals from customers view,

identification of relevant criteria in the future of textile-seals, identification of growth opportunities and markets for OEKO-TEX Standards.

Advantages of Oeko-Tex standard for consumers

The advantages of certification in accordance with STANDARD 100 by OEKO-TEX are very important for marketing in the textile industry. OEKO-TEX and OEKO-STANDARD 100 are helpful marketing tools enabling companies to transparently document their responsibility with respect to the product safety of their articles in terms of human ecology and for their consumers along the textile. Consumers demand quality levels of products but also safety for health and producing in environmental acceptable requirement. OEKO-TEX standards developed systems which provide to customer safety eco-friendly products.

Ecolabels in certified products indicate safety for consumers. More and more consumer surveys testify to a consistent preference for products that are perceived as environmentally positive. While consumers focus on criterion production (for example elimination of toxic substance, packing) a large proportion of consumers choose “green” products and pay a high price for them.

Consumer recognition and demand is critical to the success of an ecolabelling program. Without evidence that the program promotes its activities and licensees, and consumer recognition and trust in the ecolabel, it is difficult to maintain industry confidence. A key task is to ensure that information about the ecolabel and the certified products effectively reaches the consumers. Therefore tracking consumer recognition has been an important feature of many programs. Based on the recognition of trust of ecolabelling program, consumers will be motivated to make purchasing decisions if they believe that the product chosen will cause less environmental damage than its alternatives.

Very important factors which have contributed to increasing the level of consumer awareness of environmentally preferable products are environmental non-government organisations and the media. In countries where consumer awareness of environmental issues is low, it may be difficult to convince textile companies that there is any

advantage to be gained from an ecolabel by OEKO-TEX standard. This suggests that some initial education work may be necessary prior to, or in conjunction with, the introduction of ecolabelling.
Even in countries with a high degree of environmental awareness, initial promotion and education about the benefits of ecolabel products is always necessary.

The ecolabel and OEKO-TEX standard recognition and purchases of ecolabelled products is the criteria used as "guidance tools" and key indicator for development and sustainability of the textile industry. Institutes as participants of certification by OEKO-TEX standard are one of the most important factors. Based on their expertise and competence, testing and compliance statement, the customer is able to gain insight into the quality of the product due to the impact on human health and the conditions of production including the environment. The most frequently used labels are the OEKO-TEX standard of which the OEKO-TEX 100 is one of the most often used in EU countries. The OEKO-TEX standard 100 was developed in co-operation between German and Austrian textile research institutes. The development of the Association for Research and Testing which includes institutes in Europe and world, contribute superior quality of products in the textile industry and the advantages for the consumer with regard to textile products.
In laboratories of the institutes, testing products on harmful substances and the elimination of unsatisfactory samples resulted with the smaller impact of textile products on human health (allergies, carcinogenic and mutagenic effects, etc.), which ultimately reduces the global health problems so as the high cost of medical treatment. The benefit of such testing is multi-disciplinary with regard to health, environmental and economic outcomes to both sides – users and producers.

Significance of sustainability for companies

Certified products are easier distributed in the EU so as in Russia, Ukraine, US, Canada, Japan and other countries around the world. OEKO-TEX was precursor of STeP. Its modular and independent certification provides targeted support for brands, manufacturers and retailers on their way to more sustainability and creates even a high degree of transparency and reliability for consumers.

Certification by STep includes management of chemicals, environmental management and performance, occupational health and safety, social responsibility and quality management. STeP certification allows a reliable analysis of the sustainable management provided by a production. Companies that operate on sustainable principles must develop modes of product-related environmental communication which can be utilised in global market with a high profit. Eco-design certified by STeP has significant positive effect on the four types of outcomes: environmental outcomes, economic outcomes, cost reduction and intangible outcomes. Hence, manufacturers are increasingly giving importance to sustainable development through environmental and social standards that comply with the requirements of a certification scheme of sustainable textile production (STeP).

With the globalization of markets increasing and the requirements for OEKO-TEX and STeP programs and certification, with objective to expand their effort for market and beyond domestic borders, is increasing. Companies which want to participate in a certification by OEKO-TEX or STeP program submit their products to independent institutes on testing or verification and must comply with other requirements of this standard. By offering products that reduce stress on the environment and take into account the social aspects, the companies can establish a better market and positive corporate image.

In developed countries where there is a high level of consumer awareness, certification by STeP provides information on the environmental impacts of products in the marketplace and it can promote the selection of certified products. In countries where consumers are at low level awareness and are not motivated by environmental concerns, certification can be used to promote environmentally beneficial actions. By the joint efforts of manufacturers and institutions that promote, support and implement eco-certifications sustainable development of the textile industry will be provided.

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