A Review on Green Approach to Integrate the Textile and Garment Industry for Sustainable Development

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Abstract: In today's world trade scenario increasing competitiveness of the textile and garment industry through reducing the consumption of resource is a vital issue. And, the increased awareness and concern of consumers for the need to protect the environment and following sustainability have adversely affecting the Ethiopian textile and garment industry along the value chain in the export market. With the other scenario the Ethiopia government is giving a high attention to the sector by establishing an industry park in different corner of the country. Therefore to be more competent in the international market a great attention for the green processing of the textile and garment industry will be emerging issues. The study analyze how to make green the textile and garment sector along the value chain from raw material to disposal by collaborating the roles of different stakeholders.

Keywords: Air permeability; stiffness; 100% cotton; cotton/Elastane yarns; knitted fabrics

1. INTRODUCTION

Ethiopia's textile industry is set to gains steady foothold in the international textiles and garment export market. The country now has a unique chance to enable sustainable development and inclusive growth of the sector. The industry aims to export US$ 1 billion worth of garments every year by 2020 and has the potential to create jobs for more than 350,000 people. In the past five to six years, the textiles and apparel industry has growth at an average of 51%. 65 international textile investor projects have registered in the country. Growth is directly linked to the government's industrial development strategy. However, its textiles sector still faces many challenges. Efficiency in factories can often be slow, affecting between 40% and 45% of production volume. Processes need developing and the workforce requires more education. Cycle times can be up to 150 days due to lack of raw materials. Only 40% of the materials needed are available in Ethiopia, 60% are imported. Compared to other countries, manufacturing and production can take 45 to 60 days longer. Challenges also include restriction in technology, specifically in digital processing for transactions. Actors in the sector needed to address these challenges together. International buyers have raised social and environmental standards in past years, due to greater customer demand for fairly produced garments. Growth in the sector and its establishment in Ethiopia need to be sustainable, adhering to international standards and regulations (Ethiopia, 2016-2020).

Consumers, governments and communities alike are concerned with how the manufacturing of consumer products affects

the environment. While retailers and brands work to demonstrate good environmental governance across their supply chains, suppliers are concurrently being asked to continuously improve their environmental performance. A good environmental practices and commitment of different stakeholders along the supply chain will; reducing costs, improving material efficiency, practicing green manufacturing good practice, and, ensuring the organization meets the requirements of tomorrow's employees, communities, investors and customers. This will benefit the business providing greater visibility on environmental commitment and performance by:

- Meeting environmental regulatory requirements
- Reducing both environmental footprint and costs
- Improving material efficiency through better resource management, including recycling, reuse of materials, and waste reduction
- Acquiring sustainable business practices
- Leveraging insights for green production and sustainable purchasing
- Achieving good corporate governance and preferred supplier status
- Demonstrating commitment and robust "Green" credentials to stakeholders (Investors, Employees, Community and Customers) (Intertek Group plc).

Eco friendly clothing is created from resources that are environmentally friendly and sustainable. Consideration is given to the product's total life span as well as its impact on the planet, in other words, the carbon footprint. Eco friendly clothing is created from resources that are environmentally friendly and sustainable, and efficient management of obtaining green clothing requires considering all stages, starting from designing for the environment, obtaining raw materials, producing garments, distributing them to the channels, stores and also considering their reverse logistics and waste. Along the stage of the textile product life-cycle there are many key inputs and key outputs that are very important in the green life-cycle procedure. Green aspects in the textile and clothing industry will be evaluated along the product-life cycle. To win the highly competitive market and restricted laws and regulations the textile and garment industries in Ethiopia have to follow the following green approaches (Senem, 2015).

Greening the source of raw material

One of the largest polluters industries in the world is the textile industry. Study shows that more than 8,000 chemicals are used to manufacture clothes starting from raw materials. The choice of raw materials for clothing has large impacts on the environment. The most used natural fiber cotton is notorious for its intensive use of water and pesticides. Growing cotton takes a lot of water, land, pesticides, and fertilizers. Studies estimates that 10% of the world's pesticides, 25% of insecticides and as 2.5 percent of all the world's water are consumed by cotton. Most pesticides that were used during the growing of cotton are likely carcinogens. According to the World Health Organization, 20,000 deaths occur annually in developing countries from the

poisons in pesticides that are used in crops. The dyes used for aesthetic value addition on the textile products often also require the use of supplementary chemicals containing toxic metals. Chemicals used in the finishing and dyeing processes impair the quality of soil and groundwater quality. Fiber choice also drives consumer-care requirements, which can indirectly impact the consumption of water, energy and toxic chemicals (Thangavel and Duraisamy, 2014) (Malgorzata, 2018). Synthetic fabrics and dyestuffs processed with heavy chemical agents are facing a sustainability issues because of the harmful effects on our ecology as well as human health. Sustainable agriculture is a renewable resource, with the main idea being that the earth's natural resources are not exhausted. The focus is to have a minimal long-term effect on the environment. Key factors of sustainable clothing are the fibre source and renewability without the use of agro-chemicals, hormones, and pesticides, along the entire manufacturing process from raw fiber to textile (Senem, 2015). As the current scenario Ethiopia are using only cotton as a natural raw materials for the processing of textiles, apart from this research organization, university , governments have to take the initiation to develop fibers from different plant products that are thought at this moment to be considered as a waste.

Greening the Design process

The designing stage has a great impact on the processing and the final output in terms of waste management. The eco design is an approach that seeks improves the ecological quality of a product, by reducing its negative impacts on the environment throughout its life cycle. It is characterized by the taking into account of the environment in the design phase or for a product enhancement. The literature on eco design was focused on two approaches: The respectful of the environment design (environmentally conscious design ECD) and that of the life cycle analysis (LCA). Life cycle assessment (LCA) is used to forecast the impacts of different production alternatives of a product to able to choose the most environmentally friendly one. Today designers in the textile and clothing sector must focus on several different design approaches according to several categories, such as energy use, toxicity, resource depletion, waste management and many others. By comparing different products, designers can make decisions about which environmental hazard to focus on in order to make the product more environmentally friendly. This causes the minimisation of waste and hazardous by-products, air pollution, energy expenditure and other factors. The approach of respectful of the environment design (ECD) is equivalent often to replace a hazardous input or doubtful by another less problematic. While that of the life cycle can be proposed to analyze all the consumptions of the product throughout its life cycle in order to reduce to the maximum (Thangavel and Duraisamy, 2014)

Greening the textile Processing

The processing of textile production involves a number of steps from the fibre stage until the final products. Along this processing stage a number of toxic chemicals are used which are often bonded to the fabric fibres. Many of these chemicals leave residues on the fabric that can never be

easily washed out. Those chemicals are used in several places along the treatment of a single fabric such as sizing, scouring, bleaching, shrink resistance, anti-static and wrinkle reduction, stain and odour resistance, fireproofing and different dyestuffs. Those chemicals are primary responsible for all wastes generated along the processing (Table 1).

Table 1. Wastes generated during textile manufacturing

Process	Waste generated
Fiber preparation	Fibre waste and packaging waste
spinning	Packaging wastes; fibre waste; and processing waste
sizing	BOD; COD; metals, Fibre lint; yarn waste; packaging waste; size unused
Weaving	Packaging waste; yarn and fabric scraps; used oil.
Knitting	Packaging waste yarn and fabric scraps
De-sizing	BOD, lubricants; ,anti-static compounds Packaging waste; fibre lint; yarn waste
Scouring	Disinfectants, insecticide residues; NaOH, detergents
Bleaching	H2O2, stabilizers; high pH
Mercerizing	High pH; NaOH
Dyeing	Metals; salt; surfactants; BOD; COD; sulfide; acidity/alkalinity;
Printing	Suspended solids; urea; solvents; colour; metals; heat; BOD; foam
Finishing	contaminants in purchased chemicals; formaldehyde vapours; COD; suspended solids; toxic materials; Fabric scraps and trimmings; packaging waste

Moreover more than 150 litres of water per kilogram of fabric was used in all over step of the textile process, which are full of chemicals, which in turn pollutes the environment via the effluent's, because it is saturated with dyes, chemicals, auxiliaries and many other chemicals used during the process. Those chemicals have a great impact on the ecosystem and marine life with have also a long term impact on human health's as shown in Table 2 (Thangavel and Duraisamy, 2014).

The green processing of textile means the integration of the environment as a major component of the management of the firm. Today's consumers want a high-quality textile that are harmless to their health and made in facilities which are environmentally friendly and social responsible. To make the textile and garment manufacturing process greener the companies along the value chain have to be more committed to improve their environment in a clear and transparent way by implementing different sustainable and social standards in which international retailers and brands are looking for greening the operations and following a circular production

The main application of green operations is improving an existing product or process. These operations include manufacturing and remanufacturing, circular production, network design and waste management. The main goal of green manufacturing is to reduce the environmental impacts of a product by using proper material. Green manufacturing includes activities such as reducing and recycling; while remanufacturing includes reusing and product/material recovery. Also green manufacturing and remanufacturing requires inventory management, production planning and scheduling besides the usual planning

due to varying and unknown amounts of products returned for recycling.

Reducing is a technique in which the consumption rate of scarce materials and/or energy is minimised. Recycling refers to activities performed to recover material from products. Reusing is the concept of using intact parts of used products for manufacturing activities. Product/material recovery refers to activities performed to regain the product value at the end of its lifecycle. These activities include repair and dis assembly. Waste management is the management of waste generation and its impacts through activities such as source reduction, pollution prevention and disposal. Waste minimisation is defined as reducing hazardous waste generated during production and operations, and afterwards treating, storing or disposing wastes. Source reduction and pollution prevention strategies try to hinder pollution at the generation source, while disposal is intended to dispose waste after its generation.

Table 2 Environmental and social impact of textile manufacturing processes

Textile processing	Ecological impact	Social impact
Fibre production	Intensive use of pesticides, synthetic fertilisers Soil exhaustion and destruction of self-regeneration capacity Disturbance of soils' water balance. drying-out and contamination of sources,	High impacts on human health Financial dependence on pesticide, synthetic fertilisers and chemical companies
Spinning and fabric production	Energy intensity	
Dyeing and Finishing	Toxicity of chemicals (dyestuff and Chemicals) Pollution of waste - water and insufficient degradability Use formaldehyde, use of banned amines and heavy metals, high water and energy consumption	High impacts on human health
Clothing production	Low impacts	Labour conditions ,Minimum wages, Child labour

Textile waste can be classified as either pre-consumer or post-consumer. Pre-consumer textile waste consists of by-product materials from the fibre, textile and garment industries. This waste is recycled into new raw materials for the automotive, furniture, mattress, coarse yarn, home furnishings, paper and other industries. Post-consumer textile waste consists of any type of garments or household articles discarded either because they are worn out, damaged, outgrown, or have gone out of fashion. They are sometimes given to charities but more typically are disposed of in the trash and end up in municipal landfills. Textile scrap categories can be classified as cotton, wool, jute, nylon, synthetic textile scrap, carpet scrap, used and recycled bags, used clothing, used footwear, leather scrap and other textile scrap. The average lifetime of any clothing is deemed to be for about 3 years, after which they are thrown away as old clothes.

Reusing; - There are important benefits of recovering and recycling textiles, chemicals both environmental and economic. The first

advantage is reducing the need for landfill space. Certain synthetic fibre products do not decompose. The second advantage is reducing pressure on virgin resources. This includes materials traditionally used in textiles, such as cotton or wool, as well a soil and other chemicals employed to produce synthetic fibres. Reducing pollution as well as water and energy consumption and reducing the demand for dyes and fixing agents are other advantages. More than a million tons of textiles are thrown away each year, most of which by households rather than industry. Today especially in developed countries there are many recycling centres, charities and collection projects accept textile goods, as that in developing countries like Ethiopia this trends have to come in to practices. Integrating the garment factories with those textile recycling factory are very important to use effectively the scraps, currently dumped to the land which have a long term impact on the environment.

Recycling; - The recycling process starts with sorting collected textiles according to their condition and the types of fibres used. Only 20% of clothing waste is collected globally for reuse or recycling. The remaining 80% is landfilled or incinerated, which results in a great loss energy and raw materials (Lewis, 2015). Un-wearable textiles are sold to the 'flocking' industry for shredding and re-spinning. The colour sorting means no re-dyeing is needed to save energy and avoids pollutants. Then textile materials are shredded or pulled into fibres and depending on the end use of the yarn, other fibres maybe incorporated. The blended mixture is carded to clean and mix the fibres. The yarn is re-spun ready for later weaving or knitting. In the case of polyester-based materials, recycling starts by cutting the garments into small pieces. The shredded fabric is then granulated and turned into polyester chips, which are melted and spun into new filament fibres used to make new polyester fabrics. Knitted or woven woollen and similar materials are reused by the textile industry in applications such as car insulation, roofing felt, loudspeaker cones, panel linings and furniture padding. Cotton is used to manufacture paper and to wipe and polish cloths for a range of industries from the automotive to the mining sector. Other types of textiles can be reprocessed into fibres for upholstery, insulation, and even building materials.

Green logistics; - For industries with lower margins, such as the clothing industry, green supply chain management can lead to lower supply chain related costs. These cost reductions can be translated into significant competitive advantages and profit. Other benefits of green supply chain management include reducing risk, improving productivity, increasing property value, improving public image and creating healthier environments.

Green supply chain management concepts manage environmental impacts where they occur, ideally before they occur. It tries to minimise the undesirable environmental impacts of supply chain processes within the participating organisations and the whole supply chain as well. It defined as "integrating environmental thinking into supply-chain management, including product design, material sourcing and

selection, manufacturing processes, delivery of the final product to the final consumer as well as send-of-life management of the product after its useful life".

Reverse logistics (RL) is also a very important concept, and it was defined as "the process of planning, implementing and controlling the efficient, cost effective flow of raw materials, in-process inventory, finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal." Reverse logistics activities vary form product to product and industry to industry, but common activities are collection, transportation, inspection/sorting, storage, reprocessing (including recycling, reusing, repairing) and/or disposal. The eco-logistics and reverse logistics it is two different terms which belong to the great family of the logistics. The eco logistics refers to all actions that help reduce the impact of logistics on the environment. It concerns mainly the transport and CO_2 emissions which it is at the origin.

Recycling is a very important function in the context of the reverse logistics because it intervenes in the phase of recovery of the raw material used so that it can be reused in the production process.

Green procurement is another subject important in the green supply chain. It was defined as the process of "Deciding what, when and how much to purchase; the act of purchasing it; and the process of ensuring that what is required is received on time, and in the quantity and quality specified". Procurement activities include inventory management, identifying requirements, determining requirement specifications, finding appropriate suppliers, contract negotiation and management (price, amount, quality, delivery schedules etc.), receiving, quality inspection, storage and inbound distribution.

Green procurement tries to minimise the environmental impacts of selected products and services. The eco sourcing it encompasses the whole of supply made from suppliers, subcontractors, providers integrating environmental criteria. These criteria can be applied to all phases of the procurement process, but it is essentially in the requirements definition that these criteria are applied. Upstream of the procurement process, it is part of the definition of needs in materials/products and the identification of suppliers.

Green Packaging is very important, and the materials of which used for packaging must be environmentally friendly. This can be achieved through the reuse of shipping products, the elimination of unnecessary paper and packaging products, the efficient use of materials and space, the use of recycled or recyclable materials and also the use of packaging from the green sources. The end-of-life of a product is very important because some products emit dangerous chemicals into the air, ground and water after they are disposed of in a landfill.

All these negative environmental impacts could be significantly mitigated if the textile and clothing sector chose to replace the take-make-disposal model with a circular one. Effective recycling of the textile waste and reusing it as raw materials could largely

reduce the demand for the end products and fibres (Malgorzata, 2018).

CONCLUSIONS

Problems such as global warming, caused by increasing atmospheric carbon dioxide levels from the burning of fossil fuels, natural resource depletion, toxic waste disposal, and increasing air, water, and soil pollution from both agriculture and industry are becoming issues of global importance, requiring concerted international action to solve them. In such a scenario, it becomes every individual's responsibility to contribute proactively and participate in the solving of these problems. Every industrial sector and the leading companies in each sector are also now being held to account for their impact on human health and the environment (Allwood et al., 2006). The aim of this review article was to analyse the current situation of textile and clothing industry to increase the awareness for making it greener and to be competitive in the international market. The competitive environment forces industries to redesign their existing structures, and today it is an obligation to be environmentally responsible in the textile and clothing industry. Starting from the product design stage, raw material selection, to the processing and production decisions, transportation, retailing and waste management, it is possible to make textile and clothing production more environmentally friendly by taking precautions and can be more competent in the international market (Table 3). Therefore different stakeholders that are involving in the value chain of the textile processing have to act in a proper manner to make the textile and garment industries greener for long term sustainable development.

Table 3: Summary of green supply chain management practices

Process	Good practices
Eco-design	• Use of ecologic raw materials and recycling product at end of life. • Life cycle analysis of product • Environmental product Conception • Partners collaboration • Reduction of energy expenditure by good planning
Eco-Sourcing	• Selection of suppliers with ecological manufacturing process • Application of environmental criteria in choosing suppliers • Choice of suppliers that have environmental management systems • Ensure supplier compliance with the ISO 14001 standard, other sustainable standards • Establish an environmental partnership with suppliers • Use of e-procurement • Inspection Hazardous Materials daily storage areas for hazardous waste • Energy Efficiency in Warehouses • Donation of surplus stocks or obsolete to local communities
Eco-Manufacturing	• Equipping an environmental management system • Use of production techniques respectful of the environment • Choice of plan the picks of production at the time or the energy demand is low • Minimization of packaging materials • Use of recyclable packaging
Eco-logistic	• Limitation of the -distances travelled by the raw materials and products • Use of alternatives of transport which Optimization of the route of vehicles (reduction in fuel consumption) • Selection of carriers based on environmental criteria • Reuse of packaging materials • Consume less fuel
Reverse logistic	Product recovery for recycling

REFERENCES

Allwood JM, Laurse SE, de Rodrígue CM, Bocke NMP (2006) Well dressed? The present and future sustainability of clothing and textiles in the United Kingdom. University of Cambridge, Institute for Manufacturing

Ethiopia, T. M. (2016-2020). 71852.html. Retrieved from www.giz.de/en/worldwide : https://www.giz.de/en/worldwide/71852.html

plc, I. G. (2020). *sustainability*. Retrieved from www.intertek.com: https://www.intertek.com/sustainability/

Karthik Thangavel, Gopalakrishnan Duraisamy Environmental Analysis of Textile Value Chain: An Overview

Lewis, T. Apparel disposal and reuse. In sustainable apparel production, processing and recycling, Blackbum,R, Ed. Elsevier.2015

Malgorzata Koszewska, circular economy-challenges for the textile and clothing industry, 2018

Selin Hanife Eryuruk Department of Textile Engineering,Textile Technologies and Design Faculty, Istanbul Technical University, Istanbul, Turkey

Senem, K. B. (2015). Use of Artificial Neural Networks for. FIBRES & TEXTILES in Eastern Europe , 90-99.