Chapter – II

REVIEW OF LITERATURE

Literature related to present study has been discussed under following sections:

2.1 History of Conservation

2.2 The Historical Perspective of Industry in Study Area

2.3 The Present Scenario

2.4 Sustainability Perspective

2.5 Previous Studies

2.6 Biodegradation Processes

2.7 Indian Studies

2.1 HISTORY OF CONSERVATION:

The history of conservation of clothing dates back to World War I, when industrial recession in Europe and USA paved way for repairs, mending and tailoring of old clothing in western society and the concept of reuse of clothing prevailed [Strausser, 2000]. But after the end of Second World War again the scenario was changed, when effluent Western Society adopted the trend of changing their wardrobes more frequently and with the rise of liberalism the tendency gained momentum, thus giving way to solid waste management problem in terms of clothing as well. This is why, in last two decades of the previous century eco-friendly methods for such disposals attracted attention from scholars, industrialists and textile engineers. The Waste Disposal Hierarchy model adopted in western society was, thus – 3R’s

- Reduce
Recently, another R has also been emphasized, i.e.,

- Redesign

However, coming to Indian Society, one finds that here conservation of old clothing is an age-old tradition, where renovation of old clothing, mending and making of other items from old clothing was prevalent due to lower purchasing power and poverty. The situation is undergoing some changes with the rise of Liberalization, Polarization, and Globalization (Popularly known as LPG) since 1990’s. But in spite of changes in economic scenario, social scenario has not changed much in India, as compared to Western Society. Therefore, in India most studies done in this perspective pertain to renovation, mending, repairing, and making out clothing for younger siblings out of clothing of elder siblings, as well as making sacks, bags, quilts and other items from old clothing and so on. But studies done, with the perspective on recycling, are few in number. However, an overview of previous studies is must before proceeding for present study in its eco-friendly and sustainability perspectives, as well as in post-consumer textile management perspective.

2.2 THE HISTORICAL PERSPECTIVE OF INDUSTRY IN STUDY AREA

The textile history of Panipat started after the partition of India and Pakistan, when the weaver's community that was displaced from Hyderabad, a state in Pakistan was facilitated to settle in Panipat by the Government of Punjab, on the directions of Mahatma Gandhi. The following chronology presents the milestones of growth of the textile industry since then:
1947: Initially, these workers used to work with a frame loom of two treadles and manufacture 'Khes' and 'Durries' of coarse hand spun cotton yarn. The main markets for their fabric were in Assam, Bihar and Bengal. Traditionally, before partition of India Muslims used to be considered as more skilled in art of weaving and industry at Hyderabad, Pakistan was considered to be a pioneer industry.

1948: The National Textiles and the General Company of Panipat purchased Jacquard from Joan Harlekar and for the first time introduced it in the Panipat industry.

1960-70: New designs were developed for exports by the master weavers like Mr. Amrit Lal Batra and Mr. D.C. Bhatia. But it was only in 1970 that products entered the export markets through the initiatives of Shri Jaipuriya from Jaipur. During the same period, the hand knotted carpet business was started initially for the domestic market and later for exports. The carpet business was evolved as a result of yarn dyeing of woolens in 1970. Today, the carpet business at Panipat has reached new horizons.

1975-80: Curtains were being made at Panipat by the copying the designs from the Delhi cloth mills. Then table -mats were introduced here in 1980 by Mr. D.C. Bhatia with the inspiration from a Hungarian lady Mrs. B.K Nehru. This lady was an adviser of M/s Central Cottage Industries Corporation of India. After this the curtain industry at Panipat increased manifold and now the city is well known throughout India for the same.
1985-86: The old second hand power looms were introduced by the machine manufacturers of handloom for making bed covers, curtains and other upholstery clothes. In 1985, M/s Mahajan Overseas introduced Chinddi Durries under the guidance of Mr D.C Bhatia.

1984-90: The Shoddy Industry introduced blankets manufacturing in Panipat. From the period of 1984-1990, when terrorist activities were at their peak in Punjab, many of the manufacturers in Panipat started manufacturing blankets. The business of blankets expanded very fast and in due course Panipat became famous for blanket market. A good quantity of blanket was even exported to Japan but later the market of Japan was closed due to a devastating earthquake in 1997. During this period shoddy industry also paved its way in Panipat which was earlier confined to Ludhiana and Amritsar in Punjab.

1990-91: The throws of different designs were manufactured in power-loom. And the hand tufted carpets and handloom carpets were introduced. The shuttle-less looms were introduced by Paliwal export then Mr Kaluram of Liberty Velvets and Mr. Om Bhatia of Loom Drape used them for manufacturing upholstery clothes.

1998: Paper printing began at Panipat and now there are around 20 units in this sector.

1999: New kinds of Made ups i.e. with embroidery and embellishments were introduced. This has led to evolution of new products, which is going strong even today.

[Report of The Textiles Committee: Ministry of Textiles, Government of India]
2.3 THE PRESENT SCENARIO

Panipat is today world-famous for its beautiful and jubilant handloom made-ups, blankets and other upholstery. This new fame seems to have superceded the nostalgia of the three historical battles of Panipat. Some important features of the textile industry of Panipat are:

- There is hardly any city of this small size in India that has such a big textile manufacturing base.
- Panipat Industry comprises of seven segments i.e. handloom, woollen carpets, shoddy yarn spinning, open end cotton yarn spinning, power-loom industry, wet processing and hosiery woollen yarn industry. All of these together makes a business of around Rs 4000 crores and provide employment to 2 lacs people.
- Panipat contributes 50% of the total exports of the Handloom products from the country.
- Panipat town has got a global distinction of having the maximum number of shoddy spinning units at one particular place.
- Panipat has been awarded Gold Trophy by the Export Promotion Council for the highest quantity of exports in woolen hand tufted carpets,
- The industry of Panipat is meeting out 75% demand of Barrack Blankets for the Indian Military.

In a nutshell, Panipat is an industry where one can witness a wide range of handloom textiles, whether for a five star hotel or for a poor man's cottage. However, Panipat is not an exception case during these days of overall industry recession. The industries of Panipat are seriously suffering from low capacity utilization, shrinking margins, overseas competition and changing preferences of consumers, which is resulting in close down of factories. In view of above there is an urgent need for a need based, flexible, focused and action oriented programme targeted at sustained development of the industry.
2.4 SUSTAINABILITY PERSPECTIVE

The concept of Sustainability has its roots in Greek literature, where Goddess of Earth is known as “Gaia” [Hughes, 1983]. The Gaian philosophy is centred around the theme – ‘survival of human depends upon the survival of earth’. The scientific innovation and technical advancements have led to overexploitation of resources, while sustainable development advocates judicious exploitation of resources in a way that coming generations may not feel dearth of resources. Thus, the essence of sustainability is in – renewability, reusability, substitution, maximization of efficient use of economic resources [Sinha, 2003: pp – 124-125]. Although, sustainable growth was conceptualized by Burtland Commission (1987) during Cocoyok summit, yet the views on environmental conservation started in 1970’s. In India Prime Minister Smt. Indira Gandhi expressed concern in 1972 at the first U.N. Conference on the Environment, where she declared that ‘Poverty is the greatest danger to the environment.’ [Quoted in Sinha, 2003; p-125]

In 1978, ‘Policy of Integrated Textile Development’ was presented in Parliament on August 7, 1978, with a view to “streamlined development of the various sectors of the industry to the ultimate benefit of the ordinary consumers of textiles” (pp – 53-59); objectives of which have been given in Chapter I, Introduction. In this policy framework “shoddy” industry found an oblique reference for attention as yarn supply to industries was to be ensured in general and woollen yarn in particular for poor people, so that they may have an access to cheap blankets of shoddy industry.

2.5 PREVIOUS STUDIES

An important milestone of “Recycling In Textiles” was achieved in 2006 with the publication by Wood head publishing , Cambridge (England) with the same title in which Wang (editor) has
compiled 14 studies including expertise from Textile and Fiber Engineering, Textile and Fiber management, sustainability, as well as, chemical and Bio-molecular engineering, pertaining to recycling in textiles. In introductory remarks Wang rightly points out –

“There are many compelling reasons for the recycling of waste from textile products and processes. They include conservation of resources, reduction of the need for landfills and paying the associated tipping fees and provision of low-cost raw materials for products. Yet, in reality the rate of recycling in textiles is not very high... Recycling, a seemingly obvious choice, is more complicated than it appears” [Wang, 2006; p-1].

Wang further opines “recovery from the waste stream includes re-use of a product in its original form, a common practice for clothes (primary approach), and recycling to convert the waste into a product (secondary, tertiary and quaternary approaches)” [Wang, 2006; p-2]. Wang is of the view that above mentioned four approaches exists for fiber recycling. Further, feasibility of a recycling process may be tested by answering the following two basic questions:

1. Do the energy savings and pollution from the recycling process outweigh the alternatives such as, virgin materials, other recycling approaches, waste-to-energy?
2. Do the products have viable markets and are they cost-competitive?

Divita (1996) rightly calls it as a “hidden industry” and argues that textile industry is one of the oldest and most established recycling industries in the world; yet few people understand the industry, its myriad players, or reclaimed textile products in general. Throughout the world, used textile and apparel products are salvaged as reclaimed textiles and put to new uses. The textile recycling industry is able to process 93% of the waste without the production of any new hazardous waste or harmful by-products. Council for Textile Recycling in United States of America indicated virtually all after-
use textile products can be reclaimed for a variety of markets that are already established. Even-so, the textile recycling industry continues to search for new viable value-added products made from used-textile fiber [www.textilerecycle.org].

Elliot (1995) pointed out, in order to make progress in the textile recycling process, “all parties must be on common ground of understanding about how to reach an attainable goal” [Elliot, 1995; p-222]. Similarly, Hamilton (1997) asserted, “if most research is grounded in paradigms that focus on one or a few levels of analysis, then the resulting body of knowledge is incomplete to that extent and integration among levels is virtually impossible” [Hamilton, 1997; pp – 164-171].

All the above mentioned studies underline the need for recycling but the elaborate model was developed by Hawley, 2000 for the same –

“The juxtaposition of a throw-away society with the realization that natural resources are threatened is a vivid illustration of the perplexing problem of contemporary lifestyle. As we consider the case of textile and apparel recycling it becomes apparent that the process impacts many entities and contributes significantly, in a broader sense, to the social responsibility of contemporary culture. By recycling, companies can realize larger profits because they avoid charges associated with dumping in landfills, while at the same time contributing to goodwill associated with environmentalism, employment for marginally employable laborers, donations to charities and disaster relief, and the movement of used clothing to areas of the world where clothing is needed.” [Hawley, 2000; p-7]

Hawley (2000) also applied System Theory on textile recycling and advocates for adoption of this technology. Textile recycling material can be classified as either pre-consumer or postconsumer waste; textile recycling removes this waste from the waste stream and recycles it back into the market
(both industrial and end-consumer). Pre-consumer waste consists of by-product materials from the textile, fiber, and cotton industries that are re-manufactured for the automotive, aeronautic, home building, furniture, mattress, coarse yarn, home furnishings, paper, apparel and other industries. Postconsumer waste is defined as any type of garment or household article made from manufactured textiles that the owner no longer needs and decides to discard. These articles are discarded either because they are worn out, damaged, outgrown, or have gone out of fashion. They are sometimes given to charities or passed on to friends and family, but additionally they are deposited into the trash and end up in the municipal landfills. Hawley opines – “because textiles are nearly 100% recyclable, nothing in the textile and apparel industry should be wasted”. Hawley further elaborates – “the textiles and apparel recycling effort is concerned with recycling, recyclability, and source reduction of both pre-consumer and post-consumer waste” [Hawley, 2000]. Hawley further expanded the ‘micro-macro interface’ by Hamilton and studied textile recycling in System Approach perspective. He opines that textiles are nearly 100% recyclable and hence nothing in the textile and apparel industry should be wasted. Hawley’s work was a pioneer work in the field of recycling of textiles as it was based on 5-year qualitative data collected on primarily, apparel and other fashion products consumed throughout the USA and the World. Moreover, micro-macro model using social system theory provided a useful tool for projection of future trends for textile and apparel recycling process.

General System Theory (GST) was initially propounded by Bertalanffy in 1950’s to provide a super-structure which can be applied in various scientific fields. But in later years this theory was successfully applied to various human phenomenons, as well as, in economics, biology, organizations and engineering. Systems Theory provides a useful theoretical framework for comprehending the textile recycling process, as a ‘holistic view’ [Olsen et.al, 2002], systematic thinking helps to explain
the connectedness, interdependencies, feedback processes and integration of the textile recycling system. Social systems theory offers a unified framework for the analysis of social reality at a higher level. The theory allows for the understanding of individual behavior in the context of the environment and situational factors. For example, rather than simply acknowledging the importance of environmental factors, social systems theory makes it clear that many things, such as economics, legal/political constraints, technological advancement, cultural perspectives, competitive environment, and infrastructure, must be considered. In the case of individual behavior of textile recycling, environmental factors such as local solid waste policies, convenience of local charity shops and local attitudes toward recycling can all effect individual recycling behavior. The textile recycling social systems model developed by Hawley after extending Hamilton’s (1997) micro-macro heuristic tool, incorporates various data as evident from figure 2.1.

![Figure 2.1 The Textile Recycling Social Systems Model (After Hawley)](image-url)
As evident from above diagram textile recycling industry occurs along a pipeline with various activities and numerous constituents that function within a socio-cultural system which, in turn, affects attitudes and behaviors of the people. In the absence of inter-relatedness of the constituents, the system fails to operate to full potential. The model also provides an understanding regarding the disposal of textile products. The continuum signifies three positions ranging from the micro (the consumer) to the macro (cultural system), situational factors, such as, economic, legislative, political, technological, cultural, infrastructural and competition play a vital role in developing attitudes, behaviors, social organizations and beliefs, etc. In nutshell, one may say that the model incorporates all the constituents of textile recycling and their inter-relationships in a comprehensive manner.

*Peoples (2002)* opines that “most definitions stress that sustainability requires making decisions that recognize connections between actions and effects in the environment, economy and society. Sustainability is very much about what kind of legacy we want to leave for our children and grandchildren.” He developed a spider diagram to reveal the reduction of HAP water wastage, energy usage, CO₂ emissions and so on.

![Figure 2.2 ‘Spider’ Diagram (After R. Peoples)](image-url)
The ‘Spider’ diagram reveals the major strides in the reduction of its environmental footprint. On a per square metre basis carpet industry has seen major reduction in five of six HAPS (Hazardous Air Pollutants), water usage, energy usage, carbon dioxide emissions, manufacturing waste generation and landfill of post-consumer carpet. These have been summarized graphically in ‘Spider’ diagram given above, by taking 1990 as base year and analyzed up to figures of 2002. R. Peoples rightly suggests that “this is the best way to ensure progress in sustainability – coupling environmental benefits with sound economic returns”.

Gulich (2003) advocated for recycling of textiles in Germany and rightly opined – “textile recycling remains a current necessity. The ways of recycling textile materials must develop, along with the technical progress in the textile industry and the continuously rising call for textile products in all fields of application”.

Gulich also entrusts the responsibility on producers, and says they should –

- develop, make and sell textile products which, at the end of life, can be recycled or disposed of in an eco-friendly way,
- have integrated product policies,
- attempt to use reclaimed textile waste or secondary raw materials as much as possible to make new textiles or textile-based products,
- at the end of product life, take back their products.

He also developed a model on option for material life cycle.
Further Gulich asserts – “Products consisting of only one material in a single system (non-composite) are easy and pure to re-use. With them, it is not generally necessary to separate the product structure prior to processing. This is why single-material systems are preferable when it comes to the design of products easy to recycle. Such systems, however, might meet their limits in cases where

- high quantities of special materials are used,
- the material used is expensive,
- product functionality requires the use of several layers of material (single material composites).
Combinations of different kinds of textile made from the same polymer (e.g. PP fibre material and PP film or coating) are single-material composite systems, which are also easy to recycle.

![Figure 2.4 Principles of Material Systems: Recycling friendly construction and functionality. (After Gulich)](image)

If the required characteristics of a product are not achievable using but one material, multi-material composite systems are necessary. Systems containing separable composites need to be disassembled prior to recycling, which can be done manually or by machine. This is what happens, for example, to non-textile functional elements used within garments, and to technical textiles.

Processes such as gluing, laminating or stitching, result in composites which cannot be separated. With regard to complete re-use, the materials chosen should go well together so they can be
processed together. Currently, processing makes sense as long as the secondary raw material produced can be well marketed.”

Western society, particularly in Europe and U.S.A, stood up for the cause of sustainability and recycling in textiles during last decade of the twentieth century, while in India this tendency is yet to develop. It may be so, as the developed economies experienced the perils of waste management and the developing economies are not foreseeing the problems. Peoples (2002) reviewed the scenario since 1990’s and rightly observed –

In scientific terms, the human ecosystem, inclusive of the communities we build, is a subset of the larger ecosystem we call Earth. The carpet industry works from the definition of sustainability that sees human activities as part of and dependent upon the natural world. Most definitions stress that sustainability requires making decisions that recognize the connections between actions and effects in the environment, economy, and society. Sustainability is very much about what kind of legacy we want to leave for our children and grandchildren.

“Nature practices the process of evolution as a way to eliminate the bad and incorporate the good. Our ultimate destination is sustainability and we have only just begun the journey. We as a society are evolving”.

Further, he underlines, three elements of sustainability in terms of recycling in textiles –

- Design of systems for future recyclability
- Infrastructure for collection and handling of Post Consumer Materials
- New innovative outlets for the recovered material.
Coming to the European scenario, one finds that the increase in environmental awareness led to recycling perceptions and even governments also encouraged recycling of rags for sustainability perspective on one hand and to manage minimization of landfill due to lack of landfill areas [Miraftab et al; p-3]. Such studies were undertaken in United Kingdom as well as in Europe. On 15th July 1994 German Government came up with a legalisation effectively banning dyes (John R Easton) [Easton, 2008]. In “Sustaining the Rag Trade, IIED identified the key elements of the sustainability of the clothing supply chain, which are –

- Eliminating Environmental Hazards
- Improving energy and water efficiency
- Cutting pollution and waste
- Establishing social justice

Easton also identified key sustainability issues in dyeing and finishing, which are as under-

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<tr>
<th>Environmental Hazards</th>
<th>Carcinogenic, Toxic and Allergenic Dyes</th>
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<td>Use of PCP and formaldehyde in finishing</td>
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<td>Materials Efficiency</td>
<td>High Water Consumption for Dyeing</td>
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<td>High Energy Use for Dyeing and Finishing</td>
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<td>Pollution and Waste</td>
<td>Biodegradation of Surfactants</td>
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<td>Emissions from Chlorine Bleaching</td>
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<td>Effluent from unfixed dyes</td>
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<td>Social Justice and Equity</td>
<td>Child Labour, Job Security, Equal Opportunity,</td>
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<td>Wages, Working Hours, Freedom of Association,</td>
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<td>Collective Bargaining</td>
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All these studies were centered on developing eco-designs and technological developments for sustainability aspects. But, the study by *Yukie Nakano [2008]* was based upon field survey in which people reaction towards recycled clothes were taken into consideration. However, the survey was confined to people perceptions towards recycled clothing and potential markets, as well as, quality comparisons of the products. The findings of these surveys may be applicable in Western society, but in Indian society perceptions are altogether different in terms of recycling. Similarly Easton has found legalization, eco-labels, green consumers and Environmental Management System (EMS) as key drivers in textile industry.

However, application of Eco-design Approach in Clothing and Textile Industry by *Bhamra [2008]* and integration of environmental considerations into design process across the product life cycle was superb as evident from the model.

![Figure 2.5 Product Life Cycle System (After Keoleian and Menerey, quoted in Tracy Bhamra)](image)
As evident from ‘Product Life Cycle System’ diagram, this approach aims to reduce and balance the adverse impact of a manufactured product on the environment by considering this cycle. Tracy Bhamra rightly defines Eco-design which is understood as systematic integration of environmental considerations into the design process across the product life cycle, from cradle to grave, that is, from acquisition of raw materials, through manufacturing, distribution and use to final recycling and disposal. Tracy Bhamra finds these eco-designs as – cost saving, competitive, innovative, motivating and communicative. This is why legislative regulations are being framed for the same.

Bhamra reviewed eco-design studies and rightly opined that these were – cost saving, competitive, innovative and motivating. He also reviewed the situation as per Brezet’s Model [Brezet, 1997; quoted in Bhamra, 2008] which is as under:

![Figure 2.6 Four-stage Model of Eco-Design Innovation (After Brezet, 1997)](image-url)
The four steps in above diagram have been described as –

- **Product Improvement**
  The improvement of existing products with regards to pollution prevention and environmental care. Products are made compliant.

- **Product Redesign**
  The product concept stays the same, but parts of the product are developed further or replaced by others. Typical aims are increased reuse of spare parts and raw materials, or minimizing the energy use at several stages in the product life cycle.

- **Function Innovation**
  Involves changing the way the function is fulfilled. Examples include a move from paper-based information exchange to e-mail, or private cars to ‘call a car’ systems.

- **System Innovation**
  New products and services arise requiring changes in the related infrastructure and organizations. For Example, a changeover in agriculture to industry-based food production, or changes in organization, transportation and labour based on information technology are typical.

*Macaulay (2008, p-3)* after reviewing studies pertaining to recycling of rags in European scenario, rightly concludes-“A world leader in this area is a German company who sort all their clothes via a tiered selective system:

- Special clothing to theatrical hire companies for costumes;
- ’Hip` clothing to boutique-type second- hand shops;
- Normal second-hand clothing for charity shops and Third World areas;
- The residue is pulled back into fibre-often after sorting into fibre type\colour.”
2.6 BIODEGRADATION PROCESSES:

Eco-friendly perspective in textile industry also attracted the studies of processes for reducing pollution in the process. In aiming to reduce pollution Kint and Munoz-Guerra (1999) reviewed biodegradation processes for Polyester (Synthetic Yarn) in which they found that the main focus was on hydrolysis at high temperatures. Adanur et.al (1998) discuss the recovery and re-use of PVC (Polyvinyl Chloride), coated polyester in which three necessary stages were identified – that is, Swelling, Separation by the use of solvent and removal of glue. An anonymous author (1999) was able to recycle thermoplastic fibres without the need for a spin finish by the use of high vacuum.

It is preferable though to ensure that drying and melting are carried out without oxidation to minimize discoloration and the use of vacuum during the drying reduces the risk of viscosity loss. The recovery of recycled components from carpets is currently one of the more interesting developments in effort to make textile production less ecologically harmful. Sellers (1998) while reporting the development of a new initiative in recycling carpets, cites as an example the conversion of polypropylene carpet backing materials to geo-textiles. The range of steps needed is documented and includes collection, identification, sorting and recovery of chemical materials or polymers, Griffith et.al (1997) carry out separation and recovery of nylon from carpet waste by supercritical fluid extraction, where solvent and anti-solvent can be recycled.

All these studies mentioned above reveal a concern for eco-friendly techniques and recycling, as well as, in perspective of biodegradation processes.
2.7 **INDIAN STUDIES:**

In India such studies have not been common so far except some scattered field surveys in dissertations and monograph (unpublished) confined to libraries in bookshelves. This is so because of the following reasons:

1. Environmental Awareness has not received much attention in India so far due to lack of general concern. In spite of legalisation provisions people attitude towards environmental concerns is casual. Even textile industries are not caring for eco-provisions of the legalisation which is a cause of concern.

2. In Indian society the clothing are used to its full strength and renovation and mending is common practice in Indian women. Moreover, use of clothing in wiping, polishing, dusting and so on leads to mutilated end of clothing where its strength is completely exhausted. Therefore, recycling has never been cared for in the past, though at present some eco-friendly technologies have been developed in textile industry.

3. Consumer perception in Indian society is more oriented towards pricing and availability in terms of end-product. Lower middle class and poor population is more interested in cost factor rather than quality. Therefore, ‘shoddy’ industry provides cheap products to population with lower purchasing power. On the other hand, researchers are attracted towards such products which are popular, saleable and quality products. In this way recycle based textiles have not received much attention for studies. This is why, such studies are not common in India.
4. Lack of new technological innovations in Indian Textile Industry has also led to neglect of these types of studies. Moreover, in developing economy like India, budget for Research and Development is much lower as compared to developed economies.

However, in spite of the above factors some studies have also been undertaken in India pertaining to recycling of textiles, its potentials, prospects and application aspects. Although, these studies are quite few in number, yet these are significant from academic, as well as, pragmatic point-of-view.

*Dixit (2001, pp – 187-190)* stated that in India, as well post-consumer textile waste created due to change in fashion, taste of consumer and old clothing after serving the wardrobes for a pretty long time need a proper disposal. He opined that textiles are now added to the municipal recycling programs, but as per industry estimates-“only 15 percent of textile materials were being diverted from the waste stream for recycling today.” He also estimated that textiles comprised only a small segment of the textile waste, to be more specific about four to six percent of the residential waste stream. This is mainly due to the fact that unlike western society, Indian middle class utilizes the clothing up to a longer period and up to here 70-80% of the strength of the garment is diminished, which cannot be utilized in formation of yarn. This is why, such garments are used for alternate uses, such as, wiping, cleaning, polishing and so on.

*Ansari and Thakur (2002)* in their study concluded that textile waste is originated from two sectors, that is, domestic and industrial sector. But the share of textile waste in total waste output is merely 2% out of which major part goes to landfill and only 8.2% of the total textile was recycled. Parfitt (2002) also estimated that only 3% of the textile waste is recycled.
Iyer(2006) in her study of the same area, that is, Panipat –“Nothing Shoddy about it” rightly points out:

“Many people would dismiss shoddy yarn as being second hand and dirty. But when I look at shoddy, I see the near-magical transformation of torn rags into something of commercial value. Which is why I say, though its name suggests otherwise, there’s indeed nothing shoddy at all about shoddy yarn”. (www.business-standard.com/india/news/geetanjali-krishna-nothing-shoddy-about-it/254399)

Saravanan (2011) has rightly emphasized the practical aspects of textile recycling and its benefits from Indian point-of-view. He opines –

Recovery and recycling provide both environmental and economic benefits. Textile recovery:

- Reduces the need for landfill space. Textiles present particular problems in landfill as synthetic (man-made fibres) products will not decompose, while woolen garment do decompose and produce methane, which contributes to global warming.
- Reduces pressure on virgin resources.
- Aids the balance of payments as fewer materials are imported for our needs.
- Results in less pollution and energy savings, as fibres do not have to be transported from abroad.

Reclaiming fibre avoids many of the polluting and energy intensive processes needed to make textiles from virgin materials, including:

- Savings on energy consumption when processing, as items do not need to be re-dyed or scoured.
• Less effluent, as unlike raw wool, it does not have to be thoroughly washed using large volumes of water.

• Reduction of demand for dyes and fixing agents and the problems caused by their use and manufacture.

Textile recycling also results in better economics since it provides job opportunities for people. More people get into curtain making, making rags, blankets, accessory making like belts, ribbons, laces and others. This also creates jobs for people to make socks, handbags, shoes, gloves, hats and other products that could be created with these recycled textiles.

Textile recycling also teaches everyone to reuse, reduce and recycle these products instead of throwing them away. Since most of these are non-biodegradable, they clog out drainage and waterways. If thrown into incinerators, they cause pollution and more damage to the air around us. So, it is the time to think and make up our mind to use recycled products to reduce the environmental pollution.

“Recycling in Textiles” by Roznev et.al covers recycling of textiles and the procedures of recycling in various countries ranging from USA to Russia through India, Nigeria, Australia and United Kingdom. After reviewing various studies the authors have rightly opined that environmental benefits of recycling in the world are multifarious.

“The environmental benefits gained from using recycled raw materials rather than virgin materials to make these products include conservation of natural resources as well as reduced energy
consumption, carbon dioxide (CO₂) and other emissions, and waste going to landfills”, according to TextileWorld.com.

"There's been a fundamental change in our culture when it comes to recycling and sustainability," remarked Jasper, president and CEO of Greensboro, "The younger generation thinks about it differently than the older generation. It's really much more important now, and it's going to continue to be. People are starting to recognize there is only so much landfill space and only so much oil."  

*Jasper (quoted in Roznev et.al)*

The study of *Tirupur in Southern India (2006-07)* has taken a different perspective of sustainability and environmental concern which is evident from the following paragraphs –

- The current practice of water usage, effluent treatment and discharge and sludge storage and disposal were not sustainable and would cause irreparable damage to the ecosystem while threatening the livelihoods of the farmers in the vicinity of the textile units. There was need for intervention.
- Reverse Osmosis, was the technology option recommended by the TNPCB for zero effluent discharge and recycling of water. The financial issues involved in its adoption needed to be further understood.

*Norris (2012)* has done a remarkable survey of the linkage between “Recycling Imported Textiles in shoddy mills at Panipat” (the area under present study) and the implications in UK Trade. The observations made by Norris highlight some noteworthy aspects of shoddy industry at Panipat. As per his observations –
“Panipat, in north India, is the world’s largest textile recycling hub, producing reclaimed “shoddy” wool yarns and blankets out of used clothing. The industry sources its materials from the international worn clothing market, including the UK. (Much smaller recycling industries producing blankets and felt products are also located in North, South and East Africa).

Commercial recyclers in the UK export to these factories directly, with some larger firms buying up recycling grades from other UK textile recyclers. For example, Wilcox has estimated that up to 20% by volume of its turnover is exported to India for recycling. The trade is not illegal, and providing the clothing is mutilated before it crosses the Indian border, provides a source of raw materials for the Indian wool industry.

However, it is an unregulated industry employing at least 70,000 people who work in poor social and environmental conditions that would not satisfy minimum ethical standards applied to the manufacture of consumer goods by responsible companies.”

Further Norris has also put forward some estimates, such as –

“Up to 50% of worn clothing collected is recycled rather than reused, i.e. they are destroyed in order to re-use the fabric or the fibres. There is little innovation in developing industrial products from recycled textiles; only 3 flocking companies remain in the UK, although there are more in Europe, and the European shoddy spinning industry virtually collapsed in the 1980s. Panipat in north India is now the world’s largest textile recycling hub, with over 300 mills producing shoddy (“regenerated”) yarn from recycled fibres.

This recycled yarn is woven into poor quality cloth and blankets for the domestic market (85%) and for export (15%). Panipat supplies over 90% of the shoddy-wool relief blankets bought by international aid agencies for use in global disasters.
The Indian Ministry of Textiles’ last published figures show that the total import of mutilated rags from the global market, both woollen and synthetic, for the shoddy industry in 2007-08 was 92.47 million kg (92,470 tonnes), down from a reported peak of 110.26 million kg the previous year. There is no firm data concerning the overall tonnage, or %, or value of UK used clothing that goes to India for recycling, and this needs to be identified as a pathway in policy initiatives and quantified. In the 2009 Morley report, this pathway remains black-boxed as ‘recycled abroad’; some positive examples of sustainable recycling are covered, but there is no research into problematic areas such as this industry”.

Thus, an overview of the studies done in U.S.A., U.K., Europe, India and other parts of the world reveal a growing concern for sustainability aspect and environment concern. Moreover, with increasing awareness regarding environmental conservation and growing concern for green technology such studies have attracted attention from textile engineers and industrialists, as well as, from academicians. In present study eco-friendly, sustainability and cost-effective aspects have been incorporated for the study. These objectives have been attained through an exhaustive survey from the industry persons and general population. These aspects have been dealt with in detail in Chapter III, Methodology.