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TECHNOLOGICAL EVOLUTION OF TEXTILE INDUSTRY IN INDIA

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Abstract: India's textiles sector is one of the oldest industries in Indian economy dating back several centuries. Even today, textiles sector is one of the largest contributors to India's exports with approximately 13 per cent of total exports. The textiles industry is also labour intensive and is one of the largest employers. The textile industry has two broad segments. First, the unorganised sector consists of handloom, handicrafts and sericulture, which are operated on a small scale and through traditional tools and methods. The second is the organised sector consisting of spinning, apparel and garments segment which apply modern machinery and techniques such as economies of scale. The Indian textile industry has the capacity to produce a wide variety of products suitable to different market segments, both within India and across the world.

Textile industry today is shattering decades old stereotypes of a labor-intensive, factory-based industry in which men and women toiled over looms and spinning jacks. The clang of the early production machinery has been replaced by a computer-driven enterprise that is making significant contributions to fields ranging from athletic performance equipment to human health and rehabilitation.

Among other innovations, textile engineers are developing high-tech fibers that are used as substrates in biomedical applications, as well as materials that aid in energy conservation and pollution control.

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Index Terms - Textile, Technological, Evolution, Textile sector

1. INTRODUCTION

The Textile Sector in India ranks next to Agriculture. Textile is one of India's oldest industries and has a formidable presence in the national economy in as much as it contributes to about 14 per cent of manufacturing value-addition, accounts for around one third of our gross export earnings and provides gainful employment to millions of people. The textile industry occupies a unique place in our country. One of the earliest to come into existence in India, it accounts for 14% of the total Industrial production, contributes to nearly 30% of the total exports and is the second largest employment generator after agriculture.

Textile Industry is providing one of the most basic needs of people, maintaining sustained growth for improving quality of life. It has a unique position as a self-reliant industry, from the production of raw materials to the delivery of finished products, with substantial value-addition at each stage of processing; it is a major contribution to the country's economy.

Several countries, including India, have introduced strict ecological standards for textile industries. With more stringent controls expected in the future, it is essential that control measures be implemented to minimize effluent problems. Industrial textile processing comprises pretreatment, dyeing, printing, and finishing operations. These production processes not only consume large amounts of energy and water, but they also produce substantial waste products. This manuscript combines a discussion of waste production from textile processes, such as designing, mercerizing, bleaching, dyeing, finishing, and printing, with a discussion of advanced methods of effluent treatment, such as electro-oxidation, biotreatment, photochemical, and membrane processes.

1.1 Contribution of Textile Industry in growth of GDP of India

India's textiles sector is one of the oldest industries in Indian economy dating back several centuries. Even today, textiles sector is one of the largest contributors to India's exports with approximately 11 per cent of total exports. The textiles industry is also labour intensive and is one of the largest employers. The textile industry has two broad segments. First, the unorganised sector consists of handloom, handicrafts and sericulture, which are operated on a small scale and through traditional tools and methods. The second is the organised sector consisting of spinning, apparel and garments segment which apply modern machinery and techniques such as economies of scale. The textile industry employs about 40 million workers and 60 million indirectly.

The Indian textiles industry is extremely varied, with the hand-spun and hand woven textiles sectors at one end of the spectrum, while the capital intensive sophisticated mills sector at the other end of the spectrum. The decentralised power looms/ hosiery and knitting sector form the largest component of the textiles sector. The close linkage of the textile industry to agriculture (for raw materials such as cotton) and the ancient culture and traditions of the country in terms of textiles make the Indian textiles sector unique in comparison to the industries of other countries. The Indian textile industry has the capacity to produce a wide variety of products suitable to different market segments, both within India and across the world.

1.2 Indian Government's Initiatives

The Indian government has come up with a number of export promotion policies for the textiles sector. It has also allowed 100 per cent FDI in the Indian textiles sector under the automatic route. Some of initiatives taken by the government to further promote the industry are as under:

- India's first integrated textiles city, which will largely cater to the export market and build a brand for Indian textiles abroad, is likely to be set up in the state of Andhra Pradesh.
- The Clothing Manufacturers' Association of India (CMAI) has signed a memorandum of understanding (MOU) with China Chamber of Commerce for Import and Export of Textiles (CCCT) to explore potential areas of mutual co-operation for increasing apparel exports from India.
- The Department of Handlooms and Textiles, Government of India, has tied up with nine e-commerce players and 70 retailers to increase the reach of handlooms products in the Indian market, which will generate better prices and continuous business, besides facilitating direct access to markets and consumers for weavers.
- The Union Ministry of Textiles, which has set a target of doubling textile exports in 10 years, plans to enter into bilateral agreements with Africa and Australia along with working on a new textile policy to promote value addition, apart from finalising guidelines for the revised Textile Upgradation Fund Scheme (TUFS).
- The Government of India has started promotion of its 'India Handloom' initiative on social media like Facebook, Twitter and Instagram with a view to connect with customers, especially youth, in order to promote high quality handloom products.
- Subsidies on machinery and infrastructure.
- The Revised Restructured Technology Up gradation Fund Scheme (RRTUFS) covers manufacturing of major machinery for technical textiles for 5 per cent interest reimbursement and 10 per cent capital subsidy in addition to 5 per cent interest reimbursement also provided to the specified technical textile machinery under RRTUFS.
- Under the Scheme for Integrated Textile Parks (SITP), the Government of India provides assistance for creation of infrastructure in the parks to the extent of 40 per cent with a limit up to Rs 40 crore (US$ 6 million). Under this scheme the technical textile units can also avail its benefits.
- The major machinery for production of technical textiles receives a concessional customs duty list of 5 per cent.

Specified technical textile products are covered under Focus Product Scheme. Under this scheme, exports of these products are entitled for duty credit scrip equivalent to 2 per cent of freight on board (FOB) value of exports

- The Government of India has implemented several export promotion measures such as Focus Market Scheme, Focus Product Scheme and Market Linked Focus Product Scheme for increasing share of India's textile exports.
- Under the Market Access Initiative (MAI) Scheme, financial assistance is provided for export promotion activities on focus countries and focus product countries.
- Under the Market Development Assistance (MDA) Scheme, financial assistance is provided for a range of export promotion activities implemented by Textiles Export Promotion Councils.
- The government has also proposed to extend 24/7 customs clearance facility at 13 airports and 14 sea ports resulting in faster clearance of import and export cargo.

1.3 Sector wise Division of Textile Industry

India is the second largest producer of fibre in the world and the major fibre produced is cotton. Other fibres produced in India include silk, jute, wool, and man-made fibers. 60% of the Indian textile Industry is cotton based. The strong domestic demand and the revival of the Economic markets by 2009 has led to huge growth of the Indian textile industry. In December 2010, the domestic cotton price was up by 50% as compared to the December 2009 prices. The causes behind high cotton price are due to the floods in Pakistan and China. India projected a high production of textile (325 Lakhs bales for 2010 -11). There has been increase in India's share of global textile trading to seven percent in five years. The rising prices are the major concern of the domestic producers of the country.

- The Cotton Sector: It is the second most developed sector in the Indian Textile industries. It provides employment to huge amount of people but its productions and employment is seasonal depending upon the seasonal nature of the production.
- The Handloom Sector: It is well developed and is mainly dependent on the SHGs for their funds. Its market share is 13%. of the total cloth produced in India.
- The Woolen Sector: India is the 7th largest producer. of the wool in the world. India also produces 1.8% of the world's total wool.
- The Jute Sector: The jute or the golden fiber in India is mainly produced in the Eastern states of India like Assam and West Bengal. India is the largest producer of jute in the world.

The Sericulture and Silk Sector: India is the 2nd largest producer of silk in the world. India produces 18% of the world's total silk. Mulberry, Eri, Tasar, and Muga are the main types of silk produced in the country. It is a labor-intensive sector.

- Man Made Fibres: This includes manufacturing of clothes using fibre or filament synthetic yarns. It is produced in the large power loom factories. They account for the largest sector of the textile production in India. This sector has a share of 62% of the India's total production and provides employment to about 4.8 million people

1.4 Technological development of Textile Industry

Before the 1760s, textile production was a cottage industry using mainly flax and wool. A typical weaving family would own one hand loom, which would be operated by the man with help of a boy; the wife, girls and other women could make sufficient yarn for that loom. The knowledge of textile production had existed for centuries, and the manual methods had adequately provided enough cloth for the needs of that society. Cotton started to be imported and the balance of demand and supply was disturbed. Two systems had developed for spinning: the simple wheel, which used an intermittent process and the more refined, Saxony wheel which drove a differential spindle and flyer with a heck that guided the thread onto the bobbin, as a continuous process. But neither of these wheels could produce enough thread for the looms after the invention by John Kay in 1734 of the flying shuttle. This made the loom twice as productive. Cloth production moved away from the cottage into manufactories. The first moves towards manufactories called mills were made in the spinning sector. The move in the weaving sector was later. By the 1820s, all

cotton, wool and worsted was spun in mills; but this yarn went to outworking weavers who continued to work in their own homes. A mill that specialized in weaving fabric was called a weaving shed.

2. OBJECTIVES OF THE STUDY

Historical development of Textile Industry since time immemorial.

- Technological development of Textile Industry with reference to methodology adopted by the artisans at difference period of time.

Skill set development process adopted by the entrepreneurs and Indian government to keep artisans abreast with technological development.

- Indian government's policy and plan towards promotion of Textile industry

Role and integration of Information, Communication and Technology promotion of Textile product Marketing.

Role of social media in promotion of marketing of Textile goods.

3. LITERATURE REVIEW

The archaeological surveys and studies have found that the people of Harrapan civilization knew weaving and the spinning of cotton four thousand years ago. Reference to weaving and spinning materials is found in the Vedic Literature. There was textile trade in India during the early centuries. A block printed and resist-dyed fabrics, whose origin is from Gujarat is found in tombs of Fostat, Egypt. This proves that Indian export of cotton textiles to the Egypt or the Nile Civilization in medieval times were to a large extent. Large quantity of North Indian silk were traded through the silk route in China to the Western countries. The Indian silk was often exchanged with the Western countries for their spices in the barter system. During the late 17th and 18th century there were large export of the Indian cotton to the western countries to meet the need of the European industries during industrial revolution. Consequently, there was development of nationalist movement like the famous Swadeshi movement which was headed by the Aurobindo Ghosh.

The Indus Valley Civilisation (IVC) was a Bronze Age civilisation (3300–1300 BCE; mature period 2600–1900 BCE) mainly in the northwestern regions of South Asia, extending from what today is northeast Afghanistan to Pakistan and northwest India. Along with ancient Egypt and Mesopotamia it was one of three early civilisations of the Old World, and of the three, the most widespread. It flourished in the basins of the Indus River, which flows through the length of Pakistan, and along a system of perennial, mostly monsoon-fed, rivers that once coursed in the vicinity of the seasonal Ghaggar-Hakra river in northwest India and eastern Pakistan. Aridification of this region during the 3rd millennium BCE may have been the initial spur for the urbanisation associated with the civilisation, but eventually also reduced the water supply enough to cause the civilisation's demise, and to scatter its population eastward.

At its peak, the Indus Civilisation may have had a population of over five million people. Inhabitants of the ancient Indus river valley developed new techniques in handicraft (carnelian products, seal carving) and metallurgy (copper, bronze, lead, and tin). The Indus cities are noted for their urban planning, baked brick houses, elaborate drainage systems, water supply systems, and clusters of large non-residential buildings.

The Indus Valley Civilisation is also known as the Harappan Civilisation, after Harappa, the first of its sites to be excavated in the 1920s, in what was then the Punjab province of British India, and now is Pakistan. The discovery of Harappa, and soon afterwards, Mohenjo-Daro, was the culmination of work beginning in 1861 with the founding of the Archaeological Survey of India in the British Raj. Excavation of Harappan sites has been ongoing since 1920, with important breakthroughs occurring as recently as 1999. There were earlier and later cultures, often called Early Harappan and Late Harappan, in the same area of the Harappan Civilisation. The Harappan civilisation is sometimes called the Mature Harappan culture to distinguish it from these cultures. As of 1999, over 1,056 cities and settlements had been found, of which 96 have been excavated, mainly in the general region of the Indus and Ghaggar-Hakra Rivers and their tributaries. Among the settlements were the major urban centres of Harappa, Mohenjo-daro (UNESCO World Heritage Site), Ganeriwala in modern-day Pakistan; and Dholavira, and Rakhigarhi in presentday India.

The Harappan language is not directly attested and its affiliation is uncertain since the Indus script is still non decipherable. A relationship with the Dravidian or ElamoDravidian language family is favoured by a section of scholars.

3.1 Technological Development in Textile Industry

From the discovery of many spindles and spindle whorls in the houses of Indus valley, it is evident that spinning of cotton and wool was very common. That both the rich and poor practiced spinning is indicated by the whorls being made of the expensive faience as also of the cheap pottery and shell no textiles of any description have been preserved in the Indus valley owing to the nature of the soil.

A close and exhaustive examination in the textile laboratory of the pieces of cotton, which were found attached to a silver vase, shows the specimen to be a variety of the coarser Indian cotton, cultivated in upper India today, and not of the wild species. Some more specimens of woven materials adhering to various copper objects have also been found to be mostly cotton, but some were best fibres.

There is no indication from the ruins as to the existence of flax, which is largely grown in India at present and was known in ancient Elam and Egypt. The purple dye on a piece of cotton has been taken to have been produced from the madder plant. Dyers' vats found on the site indicate that dyeing was practiced.

3.2 Start of revolution

In 1734 in Bury, Lancashire, John Kay invented the flying shuttle one of the first of a series of inventions associated with the cotton industry. The flying shuttle increased the width of cotton cloth and speed of production of a single weaver at a loom. Resistance by workers to the perceived threat to jobs delayed the widespread introduction of this technology, even though the higher rate of production generated an increased demand for spun cotton.

In 1738, Lewis Paul (one of the community of Huguenot weavers that had been driven out of France in a wave of religious persecution) settled in Birmingham and with John Wyatt, of that town, they patented the Roller Spinning machine and the flyer and bobbin system, for drawing wool to a more even thickness. Using two sets of rollers that travelled at different speeds yarn

could be twisted and spun quickly and efficiently. This was later used in the first cotton spinning mill during the Industrial Revolution.
1742: Paul and Wyatt opened a mill in Birmingham which used their new rolling machine powered by donkey; this was not profitable and was soon closed.
1743: A factory opened in Northampton, fifty spindles turned on five of Paul and Wyatt's machines proving more successful than their first mill. This operated until 1764.
1748: Lewis Paul invented the hand driven carding machine. A coat of wire slips were placed around a card which was then wrapped around a cylinder. Lewis's invention was later developed and improved by Richard Arkwright and Samuel Crompton, although this came about under great suspicion after a fire at Daniel Bourn's factory in Leominster which specifically used Paul and Wyatt's spindles. Bourn produced a similar patent in the same year.
1758: Paul and Wyatt based in Birmingham improved their roller spinning machine and took out a second patent. Richard Arkwright later used this as the model for his water frame.
The Duke of Bridgewater's canal connected Manchester to the coal fields of Worsley. It was opened in July 1761. Matthew Boulton opened the Soho Foundry engineering works in Handsworth, Birmingham in 1762. These were both events that enabled cotton mill construction and the move away from home-based production. In 1764, Thorp Mill, the first water-powered cotton mill in the world was constructed at Royton, Lancashire, England. It was used for carding cotton.
The multiple spindle spinning jenny was invented in 1764. James Hargreaves is credited as the inventor. This machine increased the thread production capacity of a single worker initially eightfold and subsequently much further. Others credit the original invention to Thomas Highs. Industrial unrest forced Hargreaves to leave Blackburn, but more importantly for him, his unpatented idea was exploited by others. He finally patented it in 1770. As a result, there were over 20,000 spinning jennies in use (mainly unlicensed) by the time of his death.
Richard Arkwright first spinning mill, Cromford Mill, Derbyshire, was built in 1771. It contained his invention the water frame. The water frame was developed from the spinning frame that Arkwright had developed with (a different) John Kay, from Warrington. The original design was again claimed by Thomas Highs: which he purposed he had patented in 1769. Arkwright used waterwheels to power the textile machinery. His initial attempts at driving the frame had used horse power, but a mill needed far more power. Using a waterwheel demanded a location with a ready supply of water, hence the mill at Cromford. This mill is preserved as part of the Derwent Valley Mills Arkwright generated jobs and constructed accommodation for his workers which he moved into the area. This led to a sizeable industrial community. Arkwright protected his investment from industrial rivals and potentially disruptive workers. This model worked and he expanded his operations to other parts of the country.
Matthew Boulton partnership with Scottish engineer James Watt resulted, in 1775, in the commercial production of the more efficient Watt steam engine which used a separate condensor.
Samuel Crompton of Bolton combined elements of the spinning jenny and water frame in 1779, creating the spinning mule. This mule produced a stronger thread than the water frame could. Thus in 1780, there were two viable hand operated spinning system that could be easily adapted to run by power of water. As early mules were suitable for producing yarn for use in the manufacture of muslin, and which were known as the muslin wheel or the Hall i' th' Wood (pronounced Hall-ith-wood) wheel. As with Kay and Hargreaves, Crompton was not able to exploit his invention for his own profit, and died a pauper.
In 1783 a mill was built in Manchester at Shudehill, at the highest point in the city away from the river. Shudehill Mill was powered by a 30 ft diameter waterwheel. Two storage ponds were built, and the water from one passed from one to the other turning the wheel. A steam driven pump returned the water to the higher reservoir. The steam engine was of the atmospheric type. An improvement devised by Joshua Wrigley, trialled in Chorlton-uponMedlock used two Savery engines to supplement the river in driving on overshot waterwheel.
In 1784, Edmund Cartwright invented the power loom, and produced a prototype in the following year. His initial venture to exploit this technology failed, although his advances were recognised by others in the industry. Others such as Robert Grimshaw (whose factory was destroyed in 1790 as part of the growing reaction against the mechanization of the industry) and Austin developed the ideas further.
In the 1790s industrialists, such as John Marshall at Marshall's Mill in Leeds, started to work on ways to apply some of the techniques which had proved so successful in cotton to other materials, such as flax. In 1803, William Radcliffe invented the dressing frame which was patented under the name of Thomas Johnson which enabled power looms to operate continuously.

3.3 Lateral part of revolution

With the Cartwright Loom, the Spinning Mule and the Boulton & Watt steam engine, the pieces were in place to build a mechanised textile industry. From this point there were no new inventions, but a continuous improvement in technology as the mill-owner strove to reduce cost and improve quality. Developments in the transport infrastructure the canals and, after 1831, the railways facilitated the import of raw materials and export of finished cloth.
The use of water power to drive mills was supplemented by steam driven water pumps, and then superseded completely by the steam engines. For example, Samuel Greg joined his uncle's firm of textile merchants, and, on taking over the company in 1782, he sought out a site to establish a mill. Quarry Bank Mill was built on the River Bollin at Styal in Cheshire. It was initially powered by a water wheel, but installed steam engines in 1810. In 1830, the average power of a mill engine was 48 hp, but Quarry Bank mill installed an new 100 hp water wheel. This was to change in 1836, when Horrocks & Nuttall, Preston took delivery of 160 hp double engine. William Fairbairn addressed the problem of line-shafting and was responsible for improving the efficiency of the mill. In 1815 he replaced the wooden turning shafts that drove the machines at 50rpm, to wrought iron shafting working at 250 rpm, these were a third of the weight of the previous ones and absorbed less power. The mill operated until 1959.
In 1830, using an 1822 patent, Richard Roberts manufactured the first loom with acastiron frame, the Roberts Loom. In 1842 James Bullough and William Kenworthy, made the Lancashire Loom. It is a semiautomatic power loom. Although it is self-acting, it has to be stopped to recharge empty shuttles. It was the mainstay of the Lancashire cotton industry for a century, when the Northrop Loom invented in 1894 with an automatic weft replenishment function gained ascendancy.

3.4 Current Technology in use

Textile engineering today is shattering decades old stereotypes of a labor-intensive, factorybased industry in which men and women toiled over looms and spinning jacks. The clang of the early production machinery has been replaced by a computer-

driven enterprise that is making significant contributions to fields ranging from athletic performance equipment to human health and rehabilitation.
Among other innovations, textile engineers are developing high-tech fibers that are used as substrates in biomedical applications, as well as materials that aid in energy conservation and pollution control.
"When compared to what was once commonplace in the United States, the golden age of textile manufacturing has ended," says David Brookstein, the executive dean for university research at Philadelphia University and a fellow of ASME. "At the same time, there has been spectacular development of innovative textile materials for a wide range of high-value items."
While the textile industry in some parts of the world is labor-intensive, new technology has advanced manufacturing processes in many markets. "Industrial looms today incorporate air jets to weave at speeds of 2,000 picks per minute," says Jonathan A. Stevens, the president and chief executive officer of the American Textile History Museum in Lowell, MA, and foremost authority on the industry. "In 1980, 200 picks per minute was considered fast."
Computer-aided design and computer-aided manufacturing have also impacted textile production, as companies seek efficiency gains to remain profitable and competitive. Machine designs have become increasingly sophisticated and precise, enabling innovations in specialty fabrics used in the biomedical field. In addition to substrates that are used to rehabilitate damage to the human heart and vascular system, other textile innovations include Dupont's Lycra, a specialty material used in compression pants worn by competitive bicyclists.
"Textiles are also showing up in road construction and environmental applications," says Stevens. "There is much activity today that extends far beyond clothing and home furnishings.
" Brookstein believes that nanotechnology has the potential to make major contributions to material innovations going forward. "A breakthrough technology would be the cost-effective development of nano fibers," says Brookstein.
Stevens concurs. "Nanotechnology will drive innovations in the field," he says. "Nanoscience will bring advances in lightweight materials and durable materials and will provide keys to understanding methods by which less energy can be used in textile design, fabrication, and manufacturing. The fabrics of the future will be nanotechnology-based."

4. CONCLUSION

India's textiles sector is one of the oldest industries in Indian economy dating back several centuries. Even today, textiles sector is one of the largest contributors to India's exports with approximately 13 per cent of total exports. The textiles industry is also labour intensive and is one of the largest employers. The textile industry has two broad segments. First, the unorganised sector consists of handloom, handicrafts and sericulture, which are operated on a small scale and through traditional tools and methods. The second is the organised sector consisting of spinning, apparel and garments segment which apply modern machinery and techniques such as economies of scale.
The Indian textiles industry is extremely varied, with the hand-spun and hand-woven textiles sectors at one end of the spectrum, while the capital-intensive sophisticated mills sector at the other end of the spectrum. The decentralized power looms/ hosiery and knitting sector form the largest component of the textiles sector. The close linkage of the textile industry to agriculture (for raw materials such as cotton) and the ancient culture and traditions of the country in terms of textiles make the Indian textiles sector unique in comparison to the industries of other countries. The Indian textile industry has the capacity to produce a wide variety of products suitable to different market segments, both within India and across the world.
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Among other innovations, textile engineers are developing high-tech fibers that are used as substrates in biomedical applications, as well as materials that aid in energy conservation and pollution control.
India is poised for growth in technical textile consumption along with overall growth of the economy and modernization of the country. India's manufacturing competitiveness is also improving and the technical textile manufacturing industry needs to further gear up for tapping the huge domestic and global opportunities. With the appropriate measures, the industry has potential to emerge as a global hub for technical textile manufacturing in the coming years.

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