

**DIVERSIFIED USE OF COTTON
BLENDED SHODDY YARN**

By

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2013HS9D**

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CERTIFICATE – I

This is to certify that this thesis entitled, '**Diversified use of cotton blended shoddy yarn**', submitted for the degree of **Doctor of Philosophy**, in the subject of **Textiles and Apparel Designing** to the CCS Haryana Agricultural University, is a bonafide research work carried out by **Bharti Sharma**, Adm. No. **2013HS9D**, under my supervision and that no part of this dissertation has been submitted for any other degree.

The assistance and help received during the course of investigation have been fully acknowledged.

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CERTIFICATE – II

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(Bharti Sharma)

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The textile recycling industry is one of the oldest and well established recycling industries in the world and also one of the major industries providing employment and fetching foreign trade for the country. Textile industry is one amongst the most essential consumer goods industries as we all need outfits and other textile products. Average life time of any clothing is considered to be about three years, after which, these are thrown away as old clothes. Sometimes even 'not so worn garments' are also discarded as these become unfashionable or undesirable (**Sakthivel et al., 2012**). Industrialization, up to date lifestyle, problem of over utilization, rapid change in fashion, easy and low-priced availability of textiles, lack of consumer consciousness about environment friendliness, relaxed government policies, lack of classic designs, low popularity of second hand clothing, lack of consumer's textile care knowledge and lack of systematic channel of textile recycling are major causes of textile waste generation (**Wang et al., 2003**).

There are two types of waste or input that can be used for recycled fibres for apparel: post-consumer waste from used and discarded clothing product and post-industrial waste from material collected during the product manufacturing stage. Post industrial waste is also known as pre-consumer waste. Pre-Consumer Textile Waste (PCTW) consists of by-product materials from the textile, fibre and cotton industries (selvage from weaving, fiber waste from spinning, cutting room waste and fabric remnants) that are re-manufactured for the automotive, aeronautic, home building, furniture, mattress, coarse yarn, home furnishings, paper, apparel and other industries. More than 50 percent of post- industrial textile waste is reused or recycled. Post-consumer textile waste can be a household article or a garment that owner does not require any more and decides to discard (<http://www.fibre2fashion.com>). The articles are discarded may be because worn out, damaged, outgrown, or out of fashion. These discarded clothing or textile products such as handbags, home linens or footwear are collected then deconstructed or disassembled and used as raw material for recycled textile fibre or sold to use for other purpose. The textile products are sometimes given to charities and passed on to friends and families (**Hawley, 2008**). But more typically these are disposed into the trash and end up in municipal landfills. Since, most of these are non-biodegradable, hence block out the drainage and waterways. If thrown into incinerators, cause toxic waste and leads to pollution. Textiles make up about three per cent by weight of a household bin. Majority of textile waste originated from household sources and at least 50 percent of the textiles we throw away are recyclable. Waste textiles also arise during yarn and fabric manufacture, garment-making processes and from the retail industry.

One of the biggest problems on earth is management of solid waste. Like other wastes, textile waste disposal through landfill and incineration has been responsible for global warming. To counter the problem of textile waste, industry has taken up many procedures for reducing its negative contribution towards environment. One such measure is textile recycling

of the used clothes and industrial textile waste into a reuse as well as reproduction of fibers. Recycling is a key concept of modern waste management (**Dubey and Jain, 2015**). A large amount of textile waste is disposed of in landfills each year. That not only poses economic and ecological difficulties to the society but also represents a severe waste of resources. Waste management is the notion which helps to save environment, to reduce the cost and other economic benefits to company and people in different way. It is the basic need for any industry and local people to have pollution free environment. It is like two-way benefits of saving resources as well as following government rules and regulation. Waste minimization is instrumental in decreasing pollution load and to some extent production costs. 5 R's of textile waste management (rethink, reduce, reuse, recycle and reintroduce) are very important tools to overcome the problem of textile waste by conserving natural resources, landfill spaces and energy (**Agrawal et al., 2015**).

Recycling of pre-consumed cotton waste and designing was done for construction of value added products from fabric waste. The recycling of textile waste would serve as a means to provide solutions for many economic, environmental and social issues though textile recycling has old history. In recent years it has assumed prime importance due to fast fashion culture in western world which has resulted in over consumption of textiles and corresponding waste generation. Today waste recycling has become a multibillion industry producing innovative high value products. Fibre recycling technologies, usage and range of application of cast-off fibres become a handy tool to add in the waste as value added products. There are three main types of recycling technologies for post-industrial or post-consumer apparel and textiles: mechanical, melt processing and chemical processings. Both natural and synthetic fibers can be recycled mechanically, a process that involves chopping the fibres, blending them with other fiber and re-spun them to form new yarns. Cotton, wool, polyester and nylon fibers are most often mechanically recycled. Mechanically recycled fiber can also reduce impacts associated with dyeing, since the colour from the previous generation of the garment remains in the fibers. Melt processing is that in which fiber can be effectively remelted and remolded to make yarns. Chemical recycling involves breaking the polymer into its molecular parts and reforming the molecules into a yarn of equal strength and quality as original. A vast number of products are made from reprocessed fiber. This fiber is re-spun into new yarns or manufactured into woven, knitted, or non-woven fabrications, shoes insoles, garment linings, household items, furniture upholstery, automobile sound absorption materials, carpeting underlay and soft toys (**Bhatia et al., 2014 and Gullingsrud, 2017**).

Innovations are being made in terms of development of sorting machines, design inputs, innovative high value products to make recycling a profitable proposition. It was found that efforts being made by various agencies and stake holders to achieve the aim of present 15% textile waste diversion rate to 75 percent diversion. The issues due to textile waste production are related to over utilization of textiles in western world. The recreation of old textiles for reuse meets the requirements of clothing for 70 percent of the population in

developing countries. Apart from this, old textiles are Up-cycled into a number of innovative products using traditional Indian embroidery in the craft clusters and household, or passed down to the under privileged in a developing country. As a part of recycling practices, nomadic *Bakkarwal* and *Gujjar* tribes of Jammu and Kashmir and Rajasthan used various recycling based textile craft to preserve the old textiles, their tradition and culture. The nomads convert the old woollen felt blankets into handmade rugs by doing manual needle work embroidery using acrylic yarns. Similarly, tribes that belong to Rajasthan do patch work, embroidery and mirror work to enhance the beauty of their textile products. Lot of accessories like cap, bags, wall hangings, *mojaris* (footwear), cushions, etc. are also created by recycled textiles. *Chindi durries* of Haryana is a very common practice at every next door of rural areas made by using strips of old sarees, shawls, *dupatta* and other garments as raw material for *durrie* weaving. (Bairagi, 2014) Textile recycling also teaches everyone to reuse, reduce and recycle these products instead of throwing them away.

Textiles in India are cast-off both for the household and the worldwide market. The method of reprocessing the used clothing, fibrous material and clothing waste from the manufacturing processes has already been adopted by the shoddy industries. The fibers extracted during recycling of clothing were renewed into recycled yarns and it was used in different textile products and also as fillers. The pre-consumer cotton wastes were a source of raw material for the paper industry. Cast-off silk yarns were renewed to a number of small products and accessories. The recycling of woolen, cotton and acrylic products in Panipat is the biggest textile recycling industrial cluster in India. Sorting and grading of textile wastes for the industrial sector also happens in Kandla Special Economic Zone, Gujarat. Recycled cotton has been re-used in industrial processes for a long time. Old clothing, rags, tailor's clippings of all kinds and waste from cotton manufacturing are all important sources for obtaining fibrous raw materials by these industries, domesticated or remanufactured but is best known in the textile industry as shoddy. Shoddy consists of rags and shreds of stockings, flannels, and other soft worsted fabrics torn and reduced to such garbage of the original fibre. High quality fibres can be produced from discarded fabrics if they include good quality non felted fibres that have not been severely treated. A good quality of reused cotton when woven into a fabric has better resistance to abrasion than poorer quality of cotton fabric. Most reprocessed fibres are produced by the mills themselves, whereas a large proportion of the reused fabrics are bought by shoddy manufacturers who may operate self-regulating enterprise for producing carpets. Shoddy is the name given to an inferior yarn made by shredding scraps of rags into fibres, grinding and mixing them with small amounts of new yarn (<http://www.historyhouse.co.uk/article/html>). Shoddy is a term used for the category of recycling that "opens" textile waste and used clothing and returns them to fibrous form. Uses for shoddy include filling automotive components and carpet underlayment, building materials such as insulation and roofing felt, and low-end blankets (Hawley, 2006).

Very few people are aware about shoddy yarn so there is a need to create awareness among people about good quality of shoddy yarn. However, creating awareness among people about reuse of rags for making usable products will be benefitted for society and shoddy industry, which will be affordable for everyone because of low cost. Many agencies and stake holders are making efforts to contribute towards the aim for saving in resources of raw materials, energy water etc. and reducing the impact on environment for sustainable development. In future, textile recycling industry would be as important as textile manufacturing itself (**Chavan, 2014**).

Textile designing is an art of creating designs for knitted, woven, and non-woven fabrics and also involve surface enrichment and embellishments. Designing textiles is an ancient craft of India, which is one of the most challenging fields as it is having good scope of imagination. Over a period of time, it has become more of an intellectual endeavour to create original designs. CAD is powerful user friendly tool which plays a vital role in facilitating the creation of new designs, improving existing designs and fast production process. With the passage of time, CAD/CAM has reached to zenith in textile designing that besides improving production quality also enable textile designers meet the needs of 21st century consumers.

Over the last ten years, discounting and low retail prices led to increased sales of clothing by 60 percent resulting in a proportional increase in levels of waste. Total solid waste was generated by 217 million people living in urban areas which is expected to increase from 83.8 million tons in 2015 to 221 million tons in 2030. This ignites thinking for waste management. The report by Environmental Resources Management, 2007 advises that consumers be better educated about the environmental impact of discarding unwanted clothes and consigning them to the landfill. Although the environmental awareness of the general public has increased significantly in recent years, still their readiness to actively participate in waste reduction by recycling needs to be enhanced. There is a need to make up our mind to use recycled products to lessen the environmental pollution (**Saravanan, 2011**). Therefore, recycling is becoming more and more relevant in today's society in search for economy and minimal wastage of the resources. The research work is necessary in this field to demonstrate the diversified use of shoddy yarn for the development of textile products to save our planet from pollution. Shoddy yarn can be adopted for developing textile products with new features. Therefore, the present study has been undertaken with view to develop innovative textile products from shoddy yarn with following objectives:

Objectives:

1. To study the existing industry status and usage of cotton blended shoddy yarn
2. To create designs using software for product development and study preferences
3. To study physical parameters of the developed products and their assessment

The literature of the related researches is provide a suitable background for the study undertaken. The review of literature of relevance to the present study is arranged in this chapter under following sub heading:

- 2.1 Existing status of shoddy industry
- 2.2 Textiles waste management
- 2.3 Creation and development of designs using CAD
- 2.4 Product development through shoddy yarn

2.1 Existing status of shoddy industry

Rathi (2017) stated that there were around 600 to 700 shoddy yarn and textile manufacturers in Panipat until 2012 and the number of unit were decreasing yearly. Around 30,000 to 40,000 kg of old clothes come to factory every day. Many organizations like the UN, non-profits agencies, governments, the army, hospitals and even prisons buy shoddy blankets. At the time of the 2001 Bhuj earthquake, around ten lakh blankets were picked up from Panipat. During the Nepal earthquake in 2015 four to five lakh recycled blankets were sold.

Leonas (2017) stated the use of recycled fibers in fashion and home products. The textile, apparel, fashion, and retail industries move to become more sustainable, an area of interest is the use of recycled fiber, yarn, fabric, and product content in the development and production of new products. The decision to use recycled materials in products must occur during design and product development and continue throughout the manufacturing processes. There are several recognized stages in recycling collection, processing, and use in a new product. Recycled materials used in textile and apparel products can be obtained throughout the textile and apparel supply chain and post-consumer collection methods. The use of recycled raw materials aligned with the larger movements of global industries toward a circular economy (vs. linear) and working to achieve a closed-loop production cycle.

Handique (2017) reported that second hand garments from the West have created a thriving business in India, as cheap clothing for millions of the country's poor. The trends lots regularly resurface in urban flea markets such as Sarojini Nagar in New Delhi and Linking Road in Mumbai, where fashionable college goers and their mothers bargains at cheap rates. But now a huge amount of discard from well-heeled consumers in the US, Canada and South Korea are ending up in Panipat, Asia's biggest textile recycling hub, to get a second life. The business of textile waste recycling is less known. Hand-downs that arrive in India are pulped to make everything from low and mid-range doormats and prayers rugs to blanket and bed linen. Leftover garments are cut into square pieces to be sold as industrial wipers for the

paints, chemicals and construction industries, for both local and international buyers in Japan and Australia.

Pant and Nagpal (2016) reported that shoddy a well renowned industry of Panipat mainly focus on recycling of rags through yarn making in which rags were imported from western society and observed that the strength of imported rags was higher as compared to India. A detailed survey report was studied regarding response of public towards shoddy industries at Panipat at three academic standards that were under matriculation, graduates and beyond graduates involving various attributes which were orientation, employability, quality, cost effectiveness, utility, eco-friendly, disposability, receptivity, acceptability and productivity. From these various attributes they concluded that there was no significant difference considering responses between academic standards and industry.

Mariana ICHIM (2016) research was conducted to evaluate the spin ability of blends containing recycled cotton fibres obtained by cutting and shredding of scraps generated from the garment manufacturing. Blends of 20/80, 40/60, 60/40 recycled cotton/virgin cotton fibres and all-cotton virgin fibres were processed into rotor yarns of 37 tex, 29.4 tex and 25 tex linear density. Results indicated that as waste percent increases, yarn tenacity and breaking elongation decrease, while yarn tenacity irregularity and mass irregularity on short terms increase.

Jain and Gupta (2016) stated that the perception of sustainability is at infancy stage although door to door SHC (Second hand clothing) collection by Wagdi communal in exchange of utensils and recycling shoddy industry of Panipat, Haryana. These diverse small and large scale textile recycling based businesses are practiced not for the sake of environmentalism but for the livelihood. In India, along with shoddy various pre and post consumer textile wastes recycling happenings at both industrial and household level are practiced since long. Due to absence of awareness, government support and very low economy in last few decades, these based various organized and unorganized businesses are losing their profit, identity and charm instead of getting promotion and heartened for the sake of environment.

Nagpal (2014) conducted a survey in various shoddy industries of Panipat and found that most of the shoddy industries started production 1989 onwards with investment of Rs. 70 lacs to 80 lacs. Shoddy industries procured rags mainly from U.K. and European countries. Industries produced yarns of 2, 4, 6, 8, 10, 12 and 14 counts. The yarn of 2, 4 and 6 counts was used for blanket manufacturing, while 12 and 14 counts for making shawls. These produced yarns were transported out of Panipat, mainly to Ludhiana and Amritsar. About 63 percent of the industries export their products, while 10 percent consume their own yarn for making products and 27 percent of the industries supply yarn to local units for making products.

Ravasio (2013) reported that shoddy industry of Panipat which is also known as the global textile recycling capital is feasibly one of the most effective, successful and relatively oldest industrial textile recycling practices in India, which recycle approximately 1,44,000 tonnes of second hand clothing discarded by many developed nations each year. Bulk amount of textile wastes especially second hand clothing is used as raw material to generate low quality products like blankets, shawls, carpets etc. Approximately 3 tones of waste fabric produces 1.5 tones of shoddy yarns. After the process of sorting the garments were opened and broken up into fibrous mass on garneting machines. These fibres were then dyed, carbonized and converted into woollen spun yarns from which blankets are made.

Necf *et al.* (2013) conducted a study on recycling the fabric scraps in apparel manufacturing industry with the objective to investigate the usability of recycled garments that were produced from the fabric scraps generated in cutting process of clothing companies. Recycled cotton –polyester (28.50- 50%) yarns were produced from the scraps. The results indicated that there were no distinctive differences between recycled and virgin garments quality. It was concluded that recycled garments produced from the fabric scraps can be used in apparel manufacturing industry.

Anonymous (2013) studied the up-cycling designing techniques and observed that million of tones of textiles are wasted during textiles and garment production, before the clothes reach the consumers. It was estimated that approximately 15% of textiles intended for clothing ends up on the cutting room floor.

Sule *et al.* (2012) studied that at least 3-4% of the weft yarn including catch ends is unavoidable waste in every type of weaving machine. The catch selvedge yarn strip was sold at throw away price. The fibres were separated by the garnetter which used them for stuffing of pillows and quilts. Some used this waste for making fancy composites for floor covering. By using 100% wool yarn as weft or polyester-wool blended yarn, the wool rich catch selvedge can be teased to recover fibres to feed into the woollen cards to produce blankets which have a market in cooler regions. This was a cost-effective solution and provided the wool rich raw materials needed for producing blankets.

Anonymous (2012) reported that approximately 500 million pounds of textiles collected were used by the collecting agency. The balance was sold to textile recyclers, including used clothing dealers and exporters, wiping rag graders, and fiber recyclers. Most textile recycling firms were small, family-owned businesses with less than 500 employees. Majority of the industries employ between 35 to 50 workers, many of whom were semi-skilled or marginally employable workers. In factories, workers separate off worn or stained clothing into many categories. Textiles might end up as wiping or polishing cloths, some cotton waste can be made into rags, buttons and zippers can be reused, after the whole process

only a small portion of 7-5% are leftovers that are non-hazardous natural materials, which can be composted. Hence, textile recycling companies can recycle 93 - 95 % from the waste.

Saravanan (2011) revealed that 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, handbags, shoes, socks, gloves and other products that could be created with these recycled textiles.

Norris (2011) reported that up to 15% of all the worn clothing collected in the UK is sold for fibre recycling. A major portion is sold to recycling factories in India. The town of Panipat, in Haryana, north India, is the centre of the global shoddy industry, which recycles worn clothing by reclaiming their fibres and spinning them into regenerated yarn. Over 300 mills in Panipat import about 100,000 tones of used clothing each year, cast off by consumers from the US, UK, Germany and the Far East. The industries destroy the garments completely, reducing them to a tangled mess of fibres that can be transformed into yarns and woven into fabric.

Laitala and Klepp (2011) suggested that prolonged use of clothing can save environment. They studied the disposal behavior of the respondent and found that many respondents usually use clothing until it is worn out. Most of usable clothing was given to charity organizations or friends or family as selling garments is not very common. Less than ten percent admitted throwing usable clothes in garbage, whereas this was the main disposal method for damaged clothing.

Prince (2010) stated that India consume about 33 million kg of wool in worsted fabric, knitwear and shawl industries. The rising power of Indian consumers and their growing aspiration of good quality clothing would lead to double the consumption of wool containing materials. However due to changing trend in fashion, compromising quality in raw material and finishing and lack in technical knowledge witnessed a negative growth in woollen sector.

Aniet (2009) conducted a research on recycling of textile waste through textile collage, with the objective of contributing to the development of new eco-friendly technologies, with reduction in manufacturing waste and introducing innovation through new visuals as differentiation factors in products of fashion design. The research defined the right way for the development of sustainable products with high value addition and applying the process of creating and developing products / fashion accessories and serving the artisans, belonging to the most diverse types of communities in their income generation and improving their livelihoods. Research concluded that clean wastes from textile companies can be recovered to create new textile substrates to sustain the fashion industry both in relation to clothing and accessories, and in the area of decoration.

Kaplan (2008) investigated that manufacturing of shoddy yarn was one of the recycling processes. Being the manufacturing of shoddy yarn, wool, discarded woollen garments, new pieces of woollen fabrics, and rags were used which included old scraps of cloth like men's and women's worn out garments, suiting, coats, sweaters, stockings, etc. The primary raw materials were imported from Australia, Belgium, New Zealand, Argentina and United Kingdom. Locally available wool was used for manufacturing of blankets, lining of flasks, etc. to some extent. Woollen shoddy was normally used for making readymade garments, whereas, synthetic shoddy was mainly suited for blankets.

Hawley (2008) conducted a study on recycling of worn-out clothing and found that ninety-nine percent of used clothing was recyclable. The textile recyclers sell about half of the clothing overseas in developing countries and in Asia. Unusable garments, particularly cotton t-shirts, were turned into wiping and polished clothes that were used by a variety of industries as well as sold to consumer. Raw material created from recycled content generally cost less, making their use attractive to manufacturers.

2.2 Textiles waste management/ diversified uses of textiles

Devi (2015) developed trimmings using underutilized textile materials. Ten designs of laces, borders and twenty designs for tassels were created using CAD software. Four top preferred designs of laces and borders and eight top preferred designs of tassels were used for developing the trimmings using different designing and surface embellishment techniques. It was inferred that the borders, laces and tassels developed using underutilized textile materials were appreciated by majority of the consumers in terms of design, suitability of material, designing techniques and innovative creativity with WMS ranging between 2.34 -3.00.

Bhatia et al. (2014) described the fibre recycling technologies; usage and range of application of recycled fibres. Recycled fibre becomes a handy tool to incorporate the waste as value added product. A vast number of products were made from reprocessed fiber. This fiber was re-spun into new yarns or manufactured into woven, knitted, or non-woven fabrications, shoes insoles, garment linings, household items, furniture upholstery, automobile sound absorption materials, carpeting underlay and soft toys.

Fatma and Goel (2014) emphasized that increase in solid and hazardous waste is rapidly becoming increasing problem for environment. It is necessary to ensure efficient and sustainable management of waste. Reuse of waste textile and clothing products is a way which avoids throwing the items away and redistributing the items in the form of SHC. Reusing fabrics also introduced as eco-fashion like jeans can be reused and converted to make various other items like purse, coaster, baby romper, sleeper, bags and also household articles i.e. pot holders, napkins and rugs. Reusing the textiles at household level is very simple and more effective pollution prevention method. It is a way to sustain safe and quality of life along with supportive product economy.

Crang et al. (2013) stated that textile recyclers promote themselves as green businesses, reducing waste, supporting government targets and supplying export markets with affordable clothing. Their costs include the infrastructure of collecting and sorting, but they obtain their stock at a cheap rate or free of cost. The globally second hand clothing economy is a profitable and rapidly expanding secondary market controlled largely by recyclers and brokers with international networks of buyers and efficient sorting systems.

Priyetta (2011) conducted a study to develop footwear tops using underutilized textile resources. Twenty-five designs were developed with Corel Draw-12. These designs along with samples of textile materials were shown to specialists. Velvet, brocade, sateen, denim, cotton, silk, knitted macramé, shimmers and jute fabrics were top ten textile materials. Sandals and baileys were the two most preferred categories of footwear for casual as well as formal wear. Beads, button, buckles and embroidery were the most liked ornamental materials used on footwear tops. Designs with low heel and elastic at ankle level for baileys and low heel and beads at ankle level for sandals were most preferred designs. The opinion ‘developed designs produced using underutilized textile resources and accessories are innovative’ was strongly favored by the respondents.

Seema (2011) conducted a study on creative use of discarded textiles. Five designs of each preferred ten articles were designed using Corel Draw12. The top ranked design of each article that is children almirah, table mat, laundry bag, runner, multipurpose kit, apron, wall pocket, sports bag, hand towel, bed sheet and baby sleeping bag were prepared using different designing techniques. Embellishment was also done conferring to need of design. Seven days training was gave to twenty rural women. There was significant gain in the knowledge concerning construction of creative products, various types of designing techniques and embellishment materials used to decorate the creative articles. In terms of total appearance apron was the most preferred followed by laundry bag and multipurpose kit.

Yeboah (2011) produced handmade paper by combining waste fabric with paper mulberry bark. The study engrossed mainly on identifying waste fabrics that might produce useful sheets of papers when combined with paper mulberry bark. The waste fabrics comprised pieces of linen, cotton, acetate, nylon, polyester and wool fabrics from cutting floors of garment manufacturers and old cloths that are no more of use to their owners. The waste fabrics were combined with paper mulberry inner back in the ratio of 30% paper mulberry and 70% waste fabrics to produce handmade papers. Coloured pencils, pastel, water colour, poster colour, oil and acrylic paints were tried on the papers produced from the identified fabrics.

Priyanka (2011) conducted a study on creative use of discarded garments. Discarded garments were reused for making ten top ranked products that is bed cover, jewellery box, partition curtain, *saree* storage kit, reversible jacket, laptop bag, wall pocket, gift packing

(*potli*), skirt and decorative hanging. These articles were embellished with lace, *sitara* and sequins work, coloured thread. The prepared articles were found useful and attractive by the consumers.

Anonymous (2010) made bags and home ware items, such as cushion covers from waste plastic bags. The project was introduced by ART D'ECO, an enterprise that provides product and design development support to artisan groups in India. The project employs local rag pickers to collect plastic bags from the nearby town of Bhuj and these were sorted by colour, washed, and cut into strips. The weaver used these strips as a warp and weft pattern on a loom, to make yardage. They also made bathroom mats with plastic bags, which were cut and stitched narrowly, on a cement bag, with an inner tube from a car, on the inside, to give grip to the mat, so that it does not slip away. They used new materials, with traditional skills, recycling discarded cement bags, which, were embroidered with brightly coloured wool, with typical Kutch designs.

Aiswariya et al. (2010) found that willow waste can be treated to become compost that can enable organic cotton to a viable enterprise. Their work was intended at bio managing cotton waste by means of a three-tier system of enzyme, earthworm- microbe interaction. An attempt was also made for translation of hospital textile waste, domestic and post-industrial wastes, diapers, effluent waste, sanitary pads and other nonwoven (disposals) into compost. They assessed the properties of the compost made from various textile wastes. The study is targeted on the success of growing cotton using the prepared compost as support and new innovation in the cultivation of organic cotton.

Farrant et al. (2010) worked on environment benefits of reusing clothes through a survey done in Sweden, Africa and Estonia. It was concluded that the purchase of 100 SHC would save 60 and 85 new garments depending on the place of reuse. Out of 100 collected items 60 would be reused, 30 recycled in other ways and 10 go to final disposal. The recycling of SHC has insignificant impact on the environment in comparison to the saving that are achieved by replacing virgin clothing. The results of the study highlighted that reuse of textile waste can significantly contribute to reduce the environment burden. The recycling of 100 garments results in 14 percent decrease of global warming and 45 percent reduction of human toxicity.

Sharma (2010) conducted a study on diversified use of empty fertilizer bags. Empty fertilizer bags were reused for making various diversified products that is shopping bag, wall pocket, mobile cover, hand fan, foot mat. The empty fertilizer bags were reused as a top surface and as an interlining material of the products. The surface of the products was enriched with canvas embroidery and appliqué work. The prepared articles were cost effective as very less cost was involved and were found very useful.

2.3 Creation and development of designs using CAD

Rani (2017) collected traditional motifs of cutwork to develop designs and applied these designs on border using digital embroidery embellishment technique. A total sixty designs were developed in corelDRAW-12 software using selected thirty motifs and got evaluated by thirty experts for selection of five top ranked designs for placements on borders. Out of three prepared colour ways, most preferred colour ways was selected for development of border through digital embroidery technique. All the borders were found very appealing and accepted by the consumers.

Oates (2016) remarked that CAD has become indispensable for textile designers leading to endless possibilities. The entire process of designing is revolutionized where previously designers used to labour over graph paper and stencils, now they simply have to play with a mouse or stylus pen to come out with original designs. The results not only enhance speed but greater accuracy than the manual process. It is no doubt that even small-scale textile designer and manufacturing companies are using CAD systems.

Kavita (2016) conducted a study on adaptation of traditional canvas embroidery motifs for fabric painting. Forty five designs were developed using nine selected motifs and three placements of selected four designs were prepared. The top ranked placements of selected four designs were worked in canvas embroidery and replicated in fabric painting for making *kurti*. Consumers had high opinion about all the designs of developed embroidered and painted *kurti*. Fabric painting was found easy in implementation and has successfully replicated the effect of canvas embroidery to maintain its beauty. Thus, transformation of innovative designs of canvas embroidery into fabric painting has enhanced the range of designing and productivity.

Rani (2016) collected henna motifs to develop designs and apply them on sari using fabric painting technique. A total of fifty designs were developed in CorelDRAW X5 software using selected twenty motifs and got evaluated by a panel of thirty experts for selection of five top preferred designs for placement on saris. Three colour ways for each selected five design placements were prepared and most preferred colour way was selected for development of saris through fabric painting using nozzle technique. All the fabric painted saris were found very appealing and accepted by consumers on all the parameters of assessment. Traditional henna motifs adapted for development of designs for saris were found to supply the demands of high-end consumers through diversity of designs and unique technique of fabric painting.

Chouhan (2016) collected Madhubani motifs and selected fifteen motifs to develop designs for shawls. Selected motifs were used to develop ten shawl placements and best five placements were selected for development of Madhubani painted shawls. The developed products were highly appreciated by all the respondents. Thus, it can be concluded that

developed shawls, being inspired from traditional folk art of Madhubani painting were found totally fresh and unique by the respondents and consumers.

Sharma (2016) revived traditional craft of appliqué of India through stencil and digital printing embellished with hand, machine and digital embroidery. Total one thousand motifs were collected from primary and secondary sources and 110 motifs were found suitable for appliqué work on saris. Twenty motifs were selected as per preferences of experts for simulation of designs with the help of CAD software. The five top preferred designs were used to develop design placement. The most preferred colour way of each selected five design placements were selected as per expert's preferences. Forty five saris i.e. nine saris of each selected design were developed of organdie fabric in light yellow colour through appliqué, stencil and digital printing and embellished with hand, machine and digital embroidery as per preferred placements and colour ways of selected five designs to produce the effect of appliqué work. It was found that stencil and digital printed saris embellished with digital embroidery gave illusion of appliqué work. Thus traditional motifs of appliqué work can be revived at low cost through digital embroidery.

Sunita (2016) developed digital embroidered products using designs produced from traditional motifs of Haryana. The identified motifs were categorized into five categories viz. geometrical, floral and foliage, animal and bird, human and religious motifs. A total of sixty designs, twenty for each category of products i.e. apparel, home textiles and utility articles were developed. The design placements and colour ways of selected designs were simulated with the help of CAD software. Twelve products two of each were developed through digital embroidery technique using most preferred placement and colour way of selected twelve designs. The developed products were assessed on different parameters. The cost of the digital embroidered products was appropriate by half (50%) of the consumers. All the developed products were found highly appreciated and well accepted by consumers for digital embroidery technique on apparels, home textiles and utility articles. Thus, traditional motifs of Haryana adapted to develop designs for various products and applied using digital technology has broadened the design base for apparels and textile products.

Sharma and Paul (2015) developed fusion designs from Madhubani and *Warli* painting using CAD and applied on various apparels i.e. saris, dress material and *kurti* using digital printing. The adaptation of the prepared designs on the apparels using digital technique facilitated the production with high accuracy within less time span. It was further stated that with technological advancement, designs can be produced and applied on textiles through digital technology which results in faster product development, so commercialization and economic gain is better.

Poelo (2015) reported that computerized embroidery became popular because it lessens the amount of labour placed into the work and cost incurred in embroidery digitizing.

The computer and the digitizing software do most of the work like perfecting the design and embroidery. With this embroidery technique, less time and efforts are required.

Banu et al. (2015) designed and created sari borders inspired from Roman ornamental motifs. A total of twenty motifs were selected for the development of border designs according to their suitability to screen printing. Ten border designs were developed using selected motifs with the help of CorelDRAW software and five top preferred designs were used for preparation of borders. The printed saree borders were embellished with stones, sequins, glitters and *zardozi* work and subjected to visual evaluation by a panel of thirty judges on five point rating scale. The results of the study showed that borders prepared with combination of screen printing and embroidery technique were unique in terms of aesthetic appeal and would add variety to existing designs of borders. Moreover the adapted border designs would act as a source for designing apparel and other household items.

Sapra (2015) collected traditional motifs from Kutch region of Gujarat using secondary sources to develop designs and applied them on bed covers through digital embroidery technique. A total of thirty three designs were developed in CorelDRAW software using selected sixteen motifs and got evaluated by a panel of thirty experts for selection of top preferred five designs for placement on bed covers. Twenty five developed design placements were again shown to the experts and one best design placement of each design was selected for development of colour ways and most preferred colour way was used for development of bed covers through digital embroidery. All the five developed bed covers were found very appealing and accepted by consumers for suitability of digital embroidery technique in design development. Thus, traditional Gujarat motifs adapted for designing the bed covers using digital embroidery has broaden the design base for textile products.

Sharma and Paul (2015) reported that CAD technology opens the avenues for the designers to fulfill the ever changing demands of consumers especially for those who hunt for the ethnic motifs in designs in their attire and other textile products and to preserve these designs by developing a repository, which could be accessed as and when needed.

Vaishnav (2015) emphasized that emerging CAD technology is capable of facilitating the preservation, dissemination and generation of new designs based on traditional forms, and also offers enhanced capabilities in terms of colour variety and colour differentiation. It provides at a glance the customers an idea about the application of motifs in different colour ways, placements and usage on different textile products. It can also facilitate outsourcing business in the form of the design ideas and product development.

Vedika et al. (2014) screened suitable *Warli* motifs and adapted for development of thirty designs, ten for each apparels including *kurti*, suits and saris with the help of CAD software. The two most preferred designs for each apparels were applied using prepared blocks of selected designs. All the prepared products were highly appreciated and well accepted with regards to

colour combination, suitability of designs for the end products, surface enrichment technique used, overall appearance and cost effectiveness. It was concluded that *Warli* motifs were successfully adapted for designing the apparels using block printing and has paved the way for the plethora of product diversification that could lead to a flourishing market.

Dwivedi and Dwivedi (2013) reported the role of CAD/CAM in design and manufacturing for mechanical and textile industries. CAD plays an important role in textile designing as well as fabric simulation. Fastest and accurate data manipulating system is designed to automatically accept and store input data. These processes give customer satisfaction, on time delivery, variety in designs and colour and rapid transmission of designs to consumers. CAD/CAM involves all the processes of conceptualizing, designing, analyzing, prototyping and actual manufacturing with assistance of computers.

Rani et al. (2013) developed screen printing designs for sari using Chinese motifs. Thirty one Chinese motifs were identified for application on saris comprising of eleven geometrical, twelve floral and eight animal motifs. The selected motifs were created on computer using CorelDRAW software to get the required intricacy and fineness. Collected motifs were got evaluated from thirty experts and five top ranked motifs were selected from each category. Selected motifs were used for development of twenty two designs suitable for application through screen printing. Out of twenty two designs, six designs were finally selected for application on sari with all possible design arrangements. Placement of designs on border with scattered motifs was most preferred followed by overall placement and border placement.

Pant and Gahlot (2013) developed ready to use borders using screen printing. The selected fifteen *Aipan* motifs were used to develop designs for designer borders and a total of eight combinations each of two motifs were made. For each combination of motifs, five border arrangements were made. In this way forty designs were prepared for borders. The five best designs were selected on the basis of their weighted mean score for preparation of borders. The borders were printed in red- violet and yellow-green colour combination using screen printing. Surface enrichment of borders was done with embroidery, beads, stones and laces. The consumer acceptability of prepared borders was assessed on three design parameters i.e. embroidery, embellishment and overall appearance. The results of the study showed that all the prepared borders were liked by the consumers on all the design parameters and most of the respondents stated that they would definitely purchase these borders if available in the market.

Kashyap and Ojha (2012) emphasized that introduction of computer for creating designs provides immediate visualization of the results of any design on the computer monitor and any detailed alteration can be done in minutes. This whole process does not require tedious labour. The conventional method of drawing the design can be swapped by

computerized designing. There is great accuracy in designing and repetition and placement of the motif or designs can be done quickly which reduces the time period.

Weng *et al.* (2012) discussed that in recent years, the computer aided design (CAD) technology is being utilized in the textile and clothing industry, thus simplifying the overall process and shortening the cycle from design to manufacturing. This greatly improved the manufacturing efficiency and also the product quality. Theme of 3D garment CAD technology facilitates the intelligent apparels CAD systems, including parametric design, combination of artificial intelligent and CAD and the close relationship between CAD and the internet.

Sethi and Sharma (2011) highlighted that computer in the hands of a designer can prove to be a tool of unlimited creativity with the system working as simple as an artist sketch book. Modifying sketches or images of design concept is simplified with changes in silhouette, style line and colour all with the pressing of keynotes or at the click of mouse. In fraction of a minute, more than a million ideas can be visualized on the monitor screen. The demonstrated benefits of CAD include increased productivity, reduced product development time, increased creativity to improve conceptual design, high product design capacity, reduced cost of sample and prototype.

Kaur (2011) developed the motifs into designs by using CAD software. Motifs were divided into nine categories viz. fruits, vegetables, animal, birds/insects, indoor games, outdoor games, cartoons, transport and floral motifs for design development. Fifty-four designs were sketched for nine lines of draperies and bed linen for children. The line with an apple motif which got the highest rank was considered for developing designs consisting of bed sheet, pillow covers, cushion covers, duvet, duvet cover and a curtain. Pillow covers were most preferred as a utility article by majority of the respondents; followed by duvet and cushion covers. Majority of the respondents regarded prepared bed sheet, duvet cover, curtain, pillow cover, cushion covers as very good and duvet scored as good according to its commercial feasibility. The results showed that most of the respondents found design line of draperies to be very good. The quoted prices of the articles were found to be adequate by the sixty-three per cent of the respondents and profit margin ranged from 26.87 to 27.83 per cent.

Naik and Byadgi (2010) stated that in the present scenario of fast life style, designs with assistance of CAD have not only expanded horizon of designing but also created library for further designing. CAD systems are more advantageous with respect to the speed, pattern creation, editing, repeating, flexibility, variety, colour ways and cost effective.

2.4 Product development through shoddy yarn

Saini *et al.* (2018) studied the status and usage practices of shoddy woollen industries. Twenty units were selected randomly with the help of District Industries Centre, Panipat, comprising 10 units engaged in yarn manufacturing units and 10 units in products

manufacturing units. Technical information was gathered from owners/ representatives of the shoddy units. The results revealed that most of the owners were graduates in both types of shoddy units. Wool, polyester and acrylic were used by all units as raw material followed by cotton in less. Polyester, acrylic and cotton was highly used by units as blending fibres with wool for manufacturing of shoddy blankets, rugs with good strength. No single units were using any type of dyes for manufacturing the yarns/ fibre and fabric. Thus, the recycling process is eco- friendly and safe for environment also.

Saini et al. (2018) studied the fabric designing for product development by combination of weaves through CAD. Different weave patterns as well as combination of two or more weaves in development of products were created by Corel DRAW. Total eleven different weaves were created. Out of eleven top ranked, three weaves were selected for creation of weave combination designs. Total thirty weave combination designs were created. Out of thirty designs, top ranked six designs were selected on the basis of experts' preferences. These six designs were selected for preparation of fabrics with different weave combination designs and color combination suitable for the development of the products. Thus, the prepared fabrics used for the development of apparels. It was concluded that the geometrical designs of weave combination can be created by successfully adapted by CAD for preparation of different textured fabrics. The prepared fabric with different weave patterns can be use for development of apparel, household articles and also for utility articles.

Rani and Jamal (2018) stated that textile industries are accused of being one of the polluting industries, not only at production but at consumption also. Textile recycling is advantageous for environmental and economic conditions, reducing demand for textile chemicals used in processing, reduction of landfill space, consumption of less energy and reducing of water wastage. They said that to boost consumer awareness and to encourage manufacturers to increase the use of recycled textile waste into new products efforts need to directed towards market research. They also observed that awareness can be increased through educating public about recycling. Ninety-five percent of consumers' textiles can be recycled to be re-worn or reused. Wearable items are either sold or circulated by charities. Un-wearable items are cut into wipes and rags or into fiber to manufacture stuffing, insulation and carpet underlayment. Household textiles like curtains, drapes, sheets, pillow cases, linens, tablecloths and towels are all recyclable.

Gupta (2016) studied that development of value added products from shoddy yarn. She collected the yarn from Ludihana and Amritsar for preparing the fabric. Two count of shoddy yarn i.e. 10Nm and 12Nm were selected for the product development. Twenty four prototype samples were designed, from which six most preferred design were obtained for development of value added products. Consumer acceptability were assessed and found that majority of the respondents preferred the developed products.

Gupta and Saggi (2015) surveyed the six shoddy units, three each in Ludhiana and Amritsar districts of Punjab to elicit the information regarding socio-personal traits, employment pattern, sources of raw materials used in shoddy units. The results revealed that in Ludhiana, owners were of different age group and were having proprietorship. In Amritsar, most of the owners were of 65 years of age and their units were private ltd. All the owners were graduates in both districts. Maximum numbers of workers were unskilled males in shoddy units in both districts. In Ludhiana, majority of units purchased raw materials from local market as well as domestic and international market. Nearly eighty three percent units purchased raw material from international market in Amritsar. Polyester yarn was mostly used as raw material followed by wool and acrylic for weaving blankets in Ludhiana. Wool was mostly consumed followed by polyester and acrylic for blanket weaving in Amritsar.

Gupta and Saggi (2015) elicit the general information regarding shoddy units of Ludhiana and Amritsar districts of Punjab, which included year of establishment, finance taking from bank and investment and also documented the factors considered while procurement for raw materials, preparation of different products, method of construction, factor considered for calculating the cost of products in shoddy units. The results revealed that the shoddy units were established during the year 1981-1990 with an initial capital investment limit 5-10 crore (67%) followed by 10-15 crore (33%) in Ludhiana and Amritsar districts of Punjab. In Ludhiana, maximum units (67%) took finance from banks and rest of them were self financed; where as in Amritsar all the units were financed through banks. The result also revealed that colour was highly preferred for procuring the raw materials and quality of spinning while making the textile products from shoddy yarn in Ludhiana. In Amritsar preference regarding the procurement the raw materials were same as in Ludhiana but grade of wool were highly preferred for making the textile products from shoddy yarn. All units were manufacturing blankets in the both the districts by weaving technique. Similarly all the units were using polythene bags and bales for wrapping and packaging the blankets in Ludhiana and Amritsar. Suitability to utility was the most preferred factor for calculating the cost of production in Ludhiana and Amritsar districts.

Sanches *et al.* (2015) conducted the research study to compare the properties characteristics of knitted fabrics made from recycled fibres. They employing the Chauvenet Criterion, Factorial Design and Statistical Analysis that fabrics used for clothing manufacture should offer comfort, protection, ease of maintenance, strength and aesthetics. In this study fabric made from two type of yarns 80% polyester-20% recycled polyester and 50% recycled polyester -50% cotton and tests for different parameters like weigh, pilling, burst pressure, elasticity and elongation, moisture, absorption and dimensional change. It was found that the 80% polyester-20% recycled polyester yarns was best for producing knitted fabrics. Because of more resistant, have less dimensional change and absorb moisture better than 50% recycled polyester- 50% cotton fabrics.

Bairagi (2014) observed the practices of nomadic *Bakkarwal* and *Gujjar* tribes of Jammu and Kashmir and Rajasthan, they used various recycling based textile craft. This is a part of their tradition, culture and help to preserve the old textiles. Tribes of Jammu and Kashmir converts the old woollen felt blankets into handmade rugs by doing handmade needle work embroidery using acrylic yarns. Similarly, tribe that belong to Rajasthan do patch work, embroidery and mirror work to enhance the beauty of their textile products. Lot of accessories like cap, bags, wall hangings, footwear (*mojaris*), cushions, etc. are also created by recycled textiles. *Chindi durries* of Haryana, was very common practice at every next door of rural areas made by using strips of old *sarees*, shawls, *dupatta* and other garments as raw material for *durrie* weaving.

Brock (2012) stated that pretty flowers can be prepared from variety of textile scrape such as left over cutting fabrics and discarded garments. These can be used for making hair accessories like clips, headbands, brooches and trimmings for apparel.

Sakthivel et al. (2012) investigated that the UK-based Recycling Association estimated that up to 95 per cent of the textiles that are land filled each year could be recycled of the textile waste recovered by the charities. Sixty per cent clothings were those that could be reworn or reused and 15 per cent could be torn into industrial wiper cloths. Disturbingly, 25 per cent was out of order and sent to landfill. There were more than 2,664 products or listing of textile waste included such as hosiery cuttings, clips, polyester tow, cotton shoddy, used clothing wiping rags, denim/ jean clippings and 100 per cent cotton yarn waste, silk fibre waste etc. Collection was mostly second hand clothing by means of society donations deposited into charity bins.

Komal (2012) directed study on the development of designs for home textiles from hosiery waste fabrics. The results revealed that the floral and foliage motifs were most preferred for bedlinen and curtains while geometrical motifs were preferred for bolsters and animal motifs for cushion covers. Patch work was preferred for developing products from 24 hosiery waste fabrics. Thirty designs were developed through CAD (Corel Draw X4) and total 120 colour schemes created for preferred products were finally used for preparing products by using hosiery waste fabrics having various defects. The quoted prices were considered adequate with a profit margin ranging from 27.47 to 57.07 per cent. Bolsters and cushion covers had significantly high commercial viability. The designed products were highly appreciated.

Gohad (2012) definite that wall hangings are simply the stunning art works that are carried out on cloths and are specially used to design and decorate walls. They provide people setting, style and atmosphere with a sense of fashion and personality. Furthermore, they can also be used as an ideal gift for house warming parties and many such occasions. People are bound to come across a variety of wall hangings, featuring multicoloured patchwork, interesting mirror work, hand painted tapestry, wooden or handmade paper. These are made in different types of materials, including - jute, coir and cloth with thread work, appliqué work,

patch work, embroidery, etc. in wood, metal, glass and many other things. The choice of themes and designs vary from state to state. From geometric and floral designs to images of gods and goddesses, a variety of options are available. Besides a symbol of welcome and hospitality, wall hangings add a touch of grace and elegance to the aesthetics.

Sharma and Gupta (2012) conducted a study on best out of waste and developed home furnishing articles like bed spread, furnishing fabrics, curtains, durries, placements, table covers and many more articles by using old discarded saris. A market survey was conducted for checking the accessibility level as well as techniques used in manufacturing of these articles such as quilting. Constructed articles evaluated by target group for checking the acceptability of these articles. Results revealed that people were highly interested in articles made by utilizing the waste textile material.

Saxena (2012) that designing had been subjected to various modes of expressions like buildings, canvas, walls, floors etc. One of such field was fabric surface enrichment, which always attracted the attention of the viewers. Surface enrichment refers to the structural or applied designing for textile materials may be achieved by dyeing, printing, finishing, embroidery and weaving. The art of home furnishing and decorating abode was really quiet a big undertaking. The furnishings were related pleasantly by proper placing both for convenience and visual effect. The furnishing revealed the taste and interests of the family.

Wood (2011) conducted a study on sustaining crafts and livelihoods: handmade in India. The study revealed that many Indian craft enterprises are adapting traditional skills to create eco products, by reclaiming waste, recycling it and extending the life of a material, and, or by 'up-cycling', discarded material to create new products. Often, recycled crafts, have emerged as a result of the creative use of waste in urban areas, and provide work to craft innovators.

Handique (2010) explained that recycling of textiles was a domestic craft in India but currently there are textile clusters and small scale industries who work on second hand imported clothing and create a range of products like recycled yarns, doormats, prayer rugs, blankets and bed linen. The leftover garments are cut into square pieces to be sold as industrial wipers for the paints, chemicals and construction industries, for both local and international buyers of Japan and Australia. Waste is used to stuff pillows and mattresses. Bathroom mats that use recycled cotton yarn, is an INR 2,000 crore industry.

Thiry (2009) said that reused and recycled into brand new products, recycling incomes old things and makes new again. Today's textile industry has joined the hunt for buried treasure. Consumer's growing demand for "green" products has driven brands and retailers to offer these items in their product lines. One way to go "green" and still offer the performance properties of synthetic fibres non-woven fabric is recyclable and reusable to fabricate functional product with high additional value. Two ends of non woven fabric almost is used for filling toys.

Methodology is the scientific way of conducting a research in order that the study is reliable and conducted with accuracy. It describes the procedures which have been adopted for the work. The present study entitled ‘Diversified use of cotton blended shoddy yarn’ was carried out as per the planned objectives of research. The methods, techniques, tools and procedures adopted for conducting investigation are described under the following sub-heads:

- 3.1 Existing status of shoddy industries
- 3.2 Usage pattern of shoddy industries
- 3.3 Selection of yarn for product development
- 3.4 Physical testing of the selected yarn
- 3.5 Selection of products and preparation of fabric
- 3.6 Physical testing of prepared fabric
- 3.7 Creation and selection of constructional designs for selected products
- 3.8 Selection of surface enrichment technique
- 3.9 Creation and selection of designs and design placements for surface enrichment
- 3.10 Development of products and their cost estimation
- 3.11 Assessment of developed products
- 3.12 Analysis of data and application of statistical tools
- 3.13 Preparation of design catalogue

Locale of the study: The present study was conducted in Panipat city of Haryana state to collect information regarding existing status of industries making cotton blended shoddy yarn. As a number of shoddy industries are located in Panipat city of Haryana state, hence ten industries making cotton blended shoddy yarn were selected purposively with the help of District Industries Centre, Panipat. Product development, testing and assessment of the developed products was done in Department of Textile and Apparel Designing, I.C. College of Home Sciences, CCS Haryana Agricultural University, Hisar.

Selection of respondents (experts and consumers): Thirty experts comprising of faculty members and PG students from I.C. college of Home Sciences, CCS, Haryana Agricultural University, Hisar were selected purposively on the basis of their knowledge and availability for taking preferences for selection of yarn, blend proportion, ply of yarn, yarn count, products, product designs, enrichment techniques, design and design placements and embellishment materials. Thirty consumers were selected randomly from CCS, Haryana Agricultural University campus for assessment of prepared products.

3.1 Existing Status of Shoddy Industries:

The information was collected using a self structured interview schedule and supplemented by observations. Existing status of selected ten shoddy industries was studied with respect to personal profile of the owners/ representative, place of the unit, establishment year of unit, nature of unit, size of the unit, ownership pattern, factory premises, work experience, employee profile, capital investment, annual turnover, manpower, facilities provided to employees in the selected industries. The data regarding different problems faced by the owners/ representative i.e. managers, supervisors, skilled, semiskilled, unskilled workers of selected ten industries during the collection of data (Annexure-Ia).

3.2 Usage pattern of Shoddy Industries:

Information on existing usage pattern from selected ten shoddy industries was collected using self structured interview schedule with respect to sources of procurement of raw material, forms of raw material procured, storage facility, techniques and production processes used for making shoddy yarns and fabrics, factors considered for purchasing raw materials, type of rags, blend proportion of cotton blended shoddy yarn, yarn count, ply of yarn, type of weaves used for fabric preparation, tests performed, accessories used for product development, method of labeling of prepared product, distribution channels and marketing of products (Annexure-Ib).

3.3 Selection of Yarn for Product Development:

3.3.1 Procurement of yarns and fabrics: Samples of cotton blended shoddy yarns of different ply, yarn count and blend proportions and their fabric samples available at the time of research study in available colours were procured from the selected shoddy industries.

3.3.2 Selection of yarn: The collected five samples of yarns and their fabric samples of respective yarns were shown to the experts to seek their preferences. The selection was done by the panel of thirty experts on the basis of yarn count, ply, blend proportion, texture and visual appearance of yarn and their fabric samples on three point rating scale as highly preferred, preferred and somewhat preferred which were given scores 3, 2, and 1, respectively. The yarn which was most preferred by the experts was selected for fabric construction and further product development (Annexure-II).

3.4 Physical Testing of the Selected Yarn:

The selected one yarn was tested for various parameters i.e. yarn strength (CN/Tex), yarn twist (TPI) and count strength product (CSP) using standard test methods:

A) Yarn strength (CN/Tex): The yarn strength of selected yarn was determined using tensile strength tester as per BS1932 test methods. Sample of single yarn was hanged between two jaws of the tester. The instrument was started by moving the upper jaw upwards till the sample broke. The breaking load was noted from the point on the dial meter and measured in Centi newton/Tex (CN/Tex). An average of five readings was calculated

B) Yarn twist (TPI): The yarn twist is defined as the spiral arrangement of the fibres around the axis of the yarn. It is the measure of the turns /inch of yarn. Twist is given in order to hold the constituent fibres or threads together. The amount of twist inserted in a yarn defines the appearance and strength of the yarn. The selected yarn was tested to determine the twist per inch with the help of twist tester based on the mechanism of un-twisting and retwisting a specific length of yarn with a proper tension applied to the yarn. Revolution counter indicated the total turns of twist. Five readings for each yarn were taken and twist per inch was calculated using following formula:

$$\text{Turns per unit (TPI)} = \frac{\text{Total no. of turns}/2}{\text{Length of the test specimen}}$$

C) Count Strength Product (CSP): CSP is the count strength product for calculating count strength of lea. Total 5 leas were made on a wrap reel and the lea was loaded in a fixed & movable jaw to determine lea strength (L1). For Count Strength Product the following formula was applied:

$$\text{Strength Product} = L1 \times Ne$$

Where, L1 = average breaking load of the lea in pounds.

Ne (English cotton counts i.e. No of 840 yds / pound of yarn).

3.5 Selection of Products and Preparation of Fabrics:

3.5.1 Selection of products: An exhaustive list of different products which can be prepared using selected cotton blended shoddy yarn was prepared after discussion with the advisors. For the selection of products, selected yarn sample and available fabric samples were shown to the experts and their preferences were sought using self structured preferential choice index as highly suitable, suitable and somewhat suitable which were assigned score as 3, 2 and 1, respectively. On the basis of mean scores, ranks were assigned and most preferred five top ranked products were selected for further work. (Annexure-II)

3.5.2 Selection of colour of the yarn: Ten colour swatches of yarn samples in different colours available in the shoddy industries during the course of procurement and research study were collected for selection of colour for preparation of fabrics for product development. The collected colour samples were shown to the experts for their colour preferences for the selected products. On the basis of mean scores, ranks were assigned and most preferred colour were selected individually for selected products. The experts' preferences were sought through self developed preferential choice index as highly preferred, preferred and least preferred which were given score as 3, 2 and 1, respectively (Annexure-III).

3.5.3. Preparation of fabric: The fabrics were got woven from one of the selected shoddy industry at Panipat as per the selected yarn specifications and colours for preparation of products.

3.6 Physical Testing of Prepared Fabric:

The woven fabric was tested for fabric count, fabric weight, thickness, tensile strength, elongation and bending length using standard test methods:

A) Fabric count: Fabric count refers to the total number of warps i.e. end/inch (EPI) and wefts i.e. picks/ inch (PPI) of a woven fabric. Pick glass was used to determine the fabric density of prepared fabrics using ASTM D3775 standard test method. It was done by counting number of ends (warp) threads per inch & No. of weft (picks) / inch from different places of the fabric. An average of five readings was calculated.

B) Fabric weight: The weight of fabric is defined as weight of a known area of the material and then computing the weight per unit area. Samples were cut from different places of the fabric with the help of round cutter for GSM. The samples were weighted separately on GSM Quadrant balance using ASTM D3776: 1990 test method. An average of five readings was calculated and weight per unit area in grams per square meter was calculated.

C) Fabric thickness (mm): Fabric thickness is defined as the distance between two parallel surfaces while exerting a specified pressure on the material. The thickness tester was used to determine thickness of constructed fabric samples using ASTM D1777-96 test method. A sample of standard size was placed on the flat surface below the pressure foot of instrument, without any folds and wrinkles. The pressure foot was lowered slowly upon the sample until the pointer of the dial meter stopped moving further and reading was recorded in mm. An average of five readings was calculated for the fabric thickness of each fabric separately.

D) Tensile strength (kg): Tensile strength is the ability of fabric to withstand the load of force usually expressed as kilograms. The tensile strength of the fabric was determined on tensile strength tester using ASTM-D1682-64 test method. The samples of size 12x2.5 inches were cut from warp and weft directions of the fabric. The yarns were unraveled from both sides to obtain sample of same width i.e. 2 inches. The samples were mounted between the jaw at a distance of 10 inches. The instrument was started and moving the lower jaw downwards till the sample broke. The breaking load was noted from the pointer of dial meter. An average of five readings of the specimens from both sides (warp and weft) were taken and calculated.

E) Elongation (%): Elongation of the fabric is the original length of the samples at breaking point. The elongation of the fabric was determined on tensile strength tester using ASTM-D1682-64 test method. For findings the elongation at break, the distance between grips at the instant of failure of the test specimens was measured on the scale against the

pointer fixed on the grips. The percent elongation at breaking point was calculated using the following formula:

$$\text{Elongation at break (\%)} = \frac{L_f - L_i}{L_i} \times 100$$

Where,

L_f = Final reading

L_i = Initial reading

F) Bending length (cm): Bending length is the length of the fabric that will bend under its own weight to a definite extent and it determines the drapability of the fabric. The bending length of the samples was determined on the stiffness tester using BS 3356: 1961 test method. Samples of 25/ 200 mm i.e. template size were cut from warp and weft directions with the help of template. Both template and sample were transferred to the platform with the fabric underneath, coinciding the zero mark of the scale and zero line engraved on the side of the platform. The template moves slowly till the top specimen viewed in the mirror cut in between the index line. The bending length was read from the scale and noted in cm. An average of five readings was calculated.

3.7 Creation and selection of constructional designs for selected products:

3.7.1 Creation of constructional designs for selected products: A scaled outline of each selected product was drawn and created using corelDRAW-12 software incorporating designing and constructional features varied as per the selected product. Total fifty constructional designs i.e. ten for each selected product were created (Annexure-III, Design Catalogue pages 2-16).

3.7.2 Selection of product designs: Created constructional designs were shown to the experts for seeking their preferences for selection of designs for each product and the preferences of experts were sought on three point rating scale as highly preferred, preferred and least preferred scoring 3, 2 and 1, respectively. On the basis of experts' preferences top preferred three constructional designs were selected for each product, hence total fifteen designs were selected.

3.8 Selection of Surface Enrichment Technique:

A list of surface enrichment techniques that included patch work, appliqué work, screen printing, stencil printing, block printing, fabric printing, spray printing and embroidery was prepared after discussion with the advisors on the basis of their suitability to the selected products and created constructional designs. Experts' preference for surface enrichment techniques were obtained on a preferential choice index as highly suitable, suitable and least suitable which were given scores 3, 2 and 1, respectively. Top two surface enrichment techniques found highly suitable were selected. Top preferred surface enrichment technique was used for product development and the second preferred technique was used to enhance the beauty of the surface enrichment designs (Annexure-IV, Design Catalogue pages 17-21).

3.9 Creation and Selection of Designs and Design Placements for Surface Enrichment Technique:

3.9.1 Creation and selection of designs: Fifty designs for two top preferred selected surface enrichment technique were created with help of CorelDRAW software. Experts' preferences were sought for the selection of design for each product using preferential choice index. Experts' preferences were sought for surface embellishment materials for each product. On the basis of weighted mean scores, ranks were assigned and top ranked one design for each product was selected. Hence, out of the created fifty designs, five designs were selected for application on the selected products (Annexure-V).

3.9.2 Creation of design placements: Three design placements of each selected design for each constructional design of the selected product were created as per the suitability of design and shape of the product. Hence, total 45 design placements were created i.e. five products with three shapes with three design placements (Design Catalogue pages 22-26).

3.9.3 Selection of design placements: The printouts of prepared design placements were taken and were evaluated by thirty experts and preferences were sought using developed preferential choice index (Annexure-VI). Out of the three design placements of each shape of the product, one design placement was selected for one shape of the product. Hence, total fifteen design placements were selected for product development.

3.9.4 Selection of colour for surface enrichment designs & embroidery thread: The colour for surface enrichment designs for each product was selected on the basis of the base colour of the fabric. Embroidery thread and their colour for outlining of surface enrichment designs according to the fabric colour and screen printed design for each product.

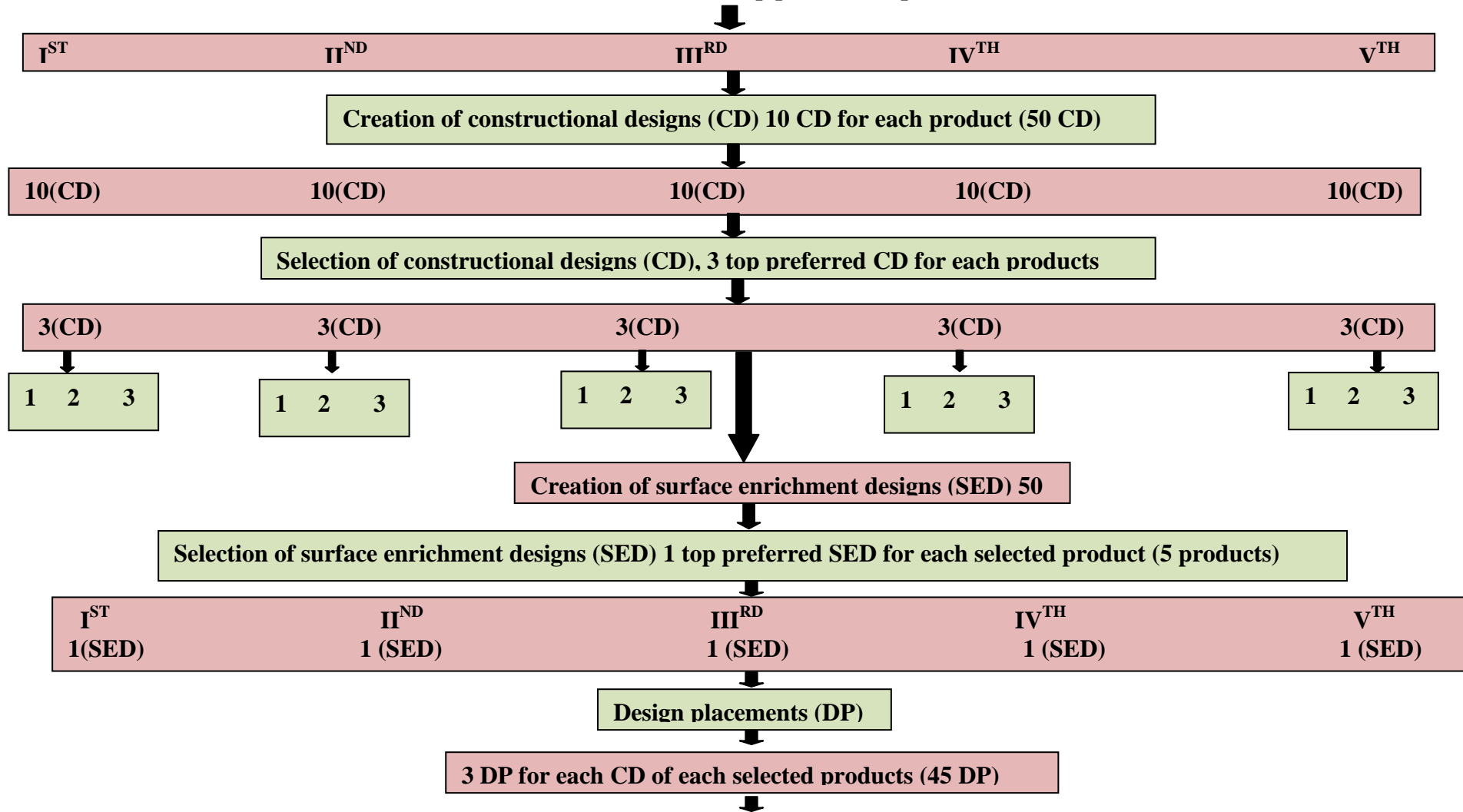
3.9.5 Selection of embellishment materials: A list of embellishment materials was prepared on the basis of suitability of design and product. Experts' preferences were sought for surface embellishment materials for each product on the basis of weighted mean scores, ranks were assigned (Annexure-V).

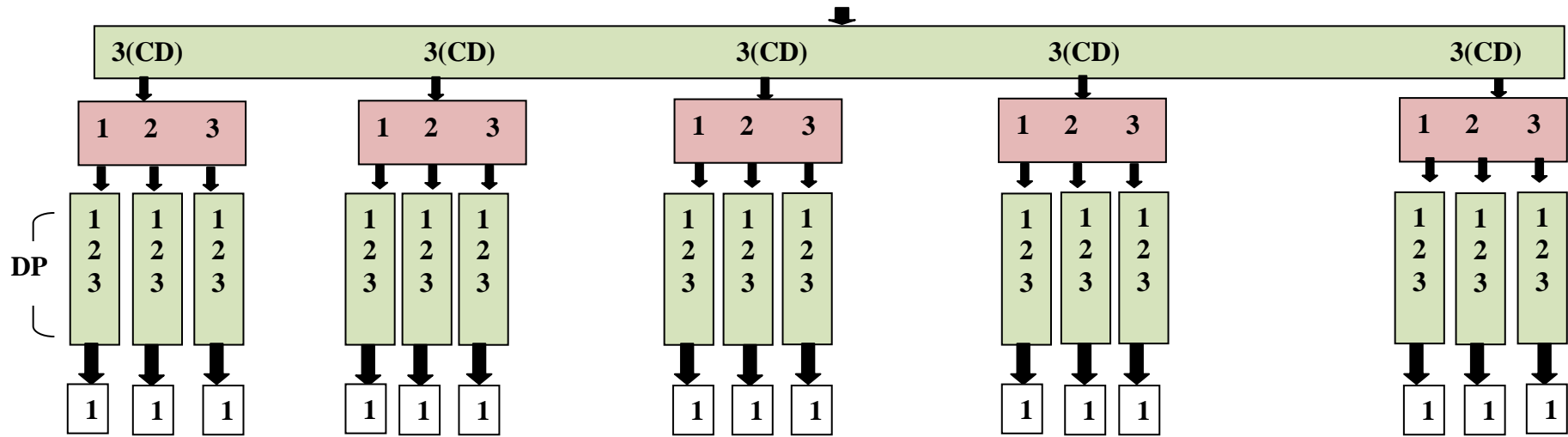
3.10 Development of Products and Their Cost Estimation:

3.10.1 Development of products: Selected top ranked five products were developed with top ranked three constructional designs of each product. The developed products were enriched with surface enrichment technique in selected design and design placements. The surface designing was enhanced using running stitches with embroidery thread of contrast colour. Total fifteen products were developed.

3.10.2 Cost estimation: Cost is one of the important features of any developed product. The actual cost of developed products was worked out separately, including the cost of fabric, embellishment materials, screen printing charges and stitching charges. The cost of screen was excluded in the actual cost because it was one time investment (Annexure-VII).

Product Development
Selection of Products (Top preferred 5 products)





1 DP selected for each CD of each selected products. Hence, (15) products were developed (3 for each selected product)

3.11 Assessment of Developed Product on Different Parameters

3.11.1 Consumers' opinion regarding developed products: An exhibition was put up in the department of Textile and Apparel Designing, I.C. College of Home Sciences CCS HAU, Hisar. The developed products were evaluated on various parameters such as texture, design, utility and appearance. Thirty consumers who visited the exhibition were selected randomly. All the attributes were assessed using three-point rating scale as most appealing, appealing and least appealing scoring as 3, 2 and 1, respectively (Annexure-VII).

3.11.2 Acceptability of cost of developed products: The opinion of the consumers regarding the cost of the developed products was taken using self developed assessment index (Annexure-VII). The consumers' opinion was obtained about their acceptability for cost of developed products in terms of high, appropriate and low and analyzed using percentages.

3.12 Analysis of Data and Application of Statistical Tools:

The collected data were coded, tabulated and analyzed using suitable statistical tools to draw the meaningful inferences.

Frequency: Frequencies were calculated and used to analyze the existing status of shoddy industry, usage pattern of shoddy industry, cost acceptability.

Percentage: Percentage was calculated for analysis of data regarding the existing status of shoddy industry, usage pattern of shoddy industry, and acceptability of cost of developed products.

Weighted mean score: To quantify the data regarding the preferential choice of experts for selection of yarn and products, constructional designs of products, enrichment techniques, design and design placements, embellishment materials and acceptability of developed products. WMS were calculated.

$$\text{Weighted mean score} = \frac{\text{Total weighted score}}{\text{No. of respondents}}$$

3.13 Preparation of Design Catalogue:

A design catalogue comprising of created constructional designs of selected products, screen printing designs, design placements, developed products was prepared using suitable textile designing software for documentation.

The results of the present study derived through the use of prescribed methodology and standard tools mentioned in methodology have been compiled and presented in this chapter. These are described under different sub-heads as mentioned below:

- 4.1 Existing status of shoddy industries
- 4.2 Usage pattern of shoddy industries
- 4.3 Selection of yarn for product development
- 4.4 Physical testing of shoddy yarn
- 4.5 Selection of products, preparation of fabric and physical testing of shoddy fabric
- 4.6 Creation of constructional designs for selected products
- 4.7 Selection of surface enrichment techniques
- 4.8 Creation and selection of designs and design placements
- 4.9 Development of products and their cost estimation
- 4.10 Assessment of developed products
- 4.11 Preparation of design catalogue

4.1 Existing status of Shoddy Industries:

There are a number of shoddy industries located in Panipat city of Haryana state. As per the research plan ten shoddy industries making cotton blended shoddy yarn & products were selected purposively with the help of District Industries Centre, Panipat. To study the existing status of shoddy industries, the information was collected using a self structured interview schedule and supplemented the results with observations. Existing status of ten shoddy industries was studied with respect to personal profile of the owners, place of the unit, establishment year of unit, nature of unit, size of the unit, ownership pattern, factory premises, work experience, employee profile, facilities provided to the employees and health problems faced by owners/ representative and the employees in the industries. The information regarding existing status of shoddy industries has been presented in this section (Table 1 to 7 and fig.1 and fig.2).

4.1.1 Personal profile of the owners of shoddy industries: It includes the personal profile of the owners of ten selected shoddy industries regarding age, education, marital status, family type, family size and work experience.

The information regarding different variables namely age, education, marital status, family type, family size and work experience of the owners of the selected shoddy industries is presented in table 1.

Table: 1 Personal profile of the owners of shoddy industries**n=10**

Sr. No.	Variables	Categories	Frequency (f)	Percentage (%)
1	Age (Years)	Below 25	-	-
		25- 50	3	30.00
		Above 50	7	70.00
2	Education	Graduate	7	70.00
		Post graduate	3	30.00
3	Marital status	Married	8	80.00
		Unmarried	2	20.00
4	Family type	Joint	4	40.00
		Nuclear	6	60.00
5	Family size	Small (Below 5)	6	60.00
		Medium (5 to 10)	2	20.00
		Large (Above 10)	2	20.00
6	Work experience (years)	10-30	2	20.00
		Above 30	8	80.00

Age: The age wise distribution of the respondents indicated that majority of the owners (70.00%) were in age group of above 50 years followed by age group of 25 to 50 years (30.00%).

Education: The data regarding education of the owners resulted that majority of the owners (70.00%) were graduate and 30.00 percent were post graduate.

Marital status: The data revealed that majority of the owners (80.00%) were married and 20.00 percent were unmarried.

Family type: Sixty percent owners had nuclear family type whereas 40.00 percent had joint family type.

Family size: Sixty percent owners had small family size that is below five members in the family and twenty percent each had medium family size having 5 to 10 members and large family size having above 10 members in the family.

Work experience: Majority of the owners (80.00%) had above 30 years work experience and twenty percent of the owners had 10-30 years work experience.

Therefore, it was found that maximum number of the owners was in the age group of above 50 years, graduate, married, had nuclear family type having below five family members and had above 30 years of work experience.

4.1.2 Status of shoddy industries: The section includes place, establishment year, nature, size, ownership pattern, factory premises, capital investment, annual turnover, manpower,

facilities provided to employees and problems faced by the employees and owners of the selected industries.

Table: 2 Status of shoddy industries

n=10

Sr. No.	Variables	Categories	Frequency (f)	Percentage (%)
1	Place of industry	Panipat	10	100.00
2	Establishment year of industry	1970-80	2	20.00
		1981 -85	4	40.00
		1986-90	4	40.00
3	Nature of the industry	Registered	10	100.00
4	Size of industry (on the basis of no. of employees)	Small (below 150)	5	50.00
		Medium (151-250)	3	30.00
		Large (above 250)	2	20.00
5	Ownership Pattern	Single proprietors	5	50.00
		Partnership	5	50.00
6	Factory premises	Own	5	50.00
		Rented	5	50.00

It is apparent from table 2 that out of the selected cotton blended shoddy industries in Panipat were established from 1970 onwards. Twenty percent industries were established during the years 1970-80 and forty percent each established during the years 1981-85 and between 1986-90. All the industries were registered. According to number of employees working in the industries, 50.00 percent industries were of small size having below 150 workers, 30 percent industries were of medium size having 151 to 250 workers and 20.00 percent were of large size having above 250 workers in the industry.

All the industries were being run privately, out of that half of industries were being run on single proprietors and rest half of the industries were running in partnership. Half of the industries (50.00%) were located in rented building and other 50.00 percent in own factory premises.

4.1.3 Capital investment and annual turnover of the industries: Capital investment is denoted as the initial investment of industry. Capital investment refers to funds invested in a firm or enterprise for the purpose of furthering its business objectives. Annual turnover is an accounting term that calculates how quickly a business collects cash from accounts receivable or how fast the company sells its inventory. In the industry, turnover is defined as the percentage of a portfolio that is sold in a particular month or year (Fig 1 and 2).

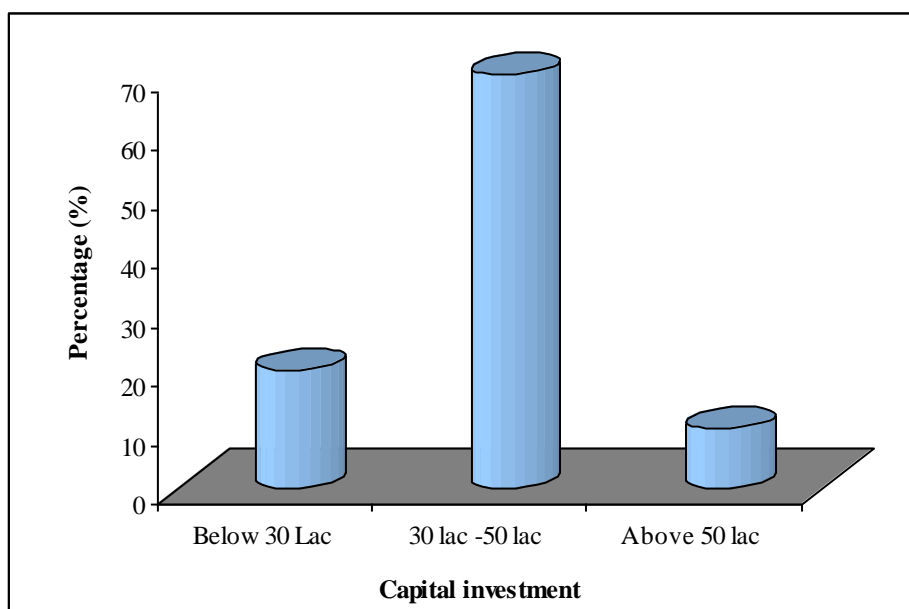


Fig 1: Capital investment of cotton blended shoddy industries

It is indicated from the fig. 1 that 70.00 percent industries were started with Rs. 30 to 50 lac as capital investment followed by 20.00 percent industries with less than Rs. 30 lac and 10.00 percent industries with capital investment of above Rs. 50 lac.

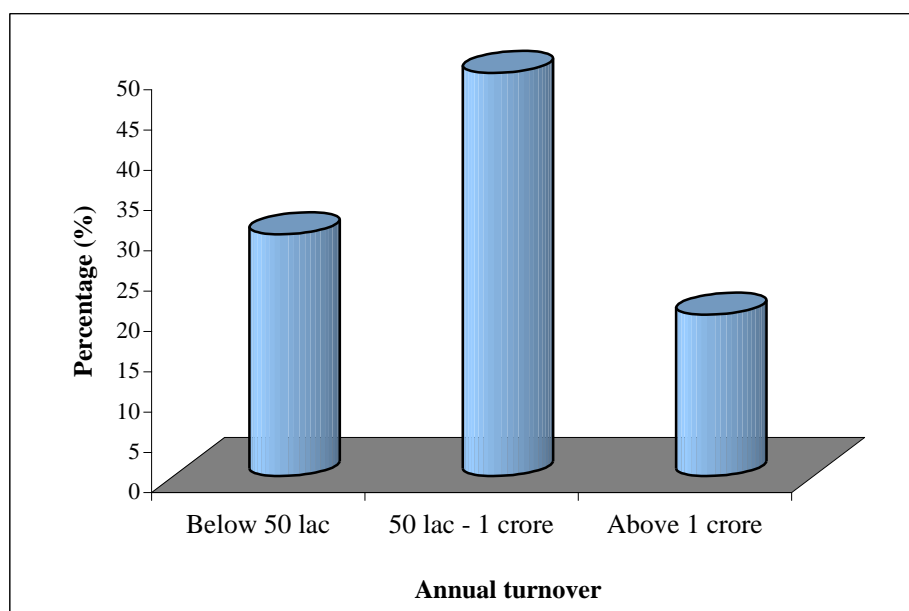


Fig 2: Annual turnover of cotton blended shoddy industries

It is apparent from the fig. 2 that the 50.00 percent industries had an annual turnover of Rs. 50 lac to 1 crore, followed by Rs.50 lac (30.00%) and 20.00 percent shoddy industries with more than Rs.1 crore.

4.1.4 Manpower employed in the cotton blended shoddy industries: It included number of employees working in the industries during collection of data. There were 2040 total

employees (including managers, supervisors and other skilled, semi-skilled and unskilled workers) in the selected ten industries.

Table 3: Manpower employed in the cotton blended shoddy industries n=10

Manpower employed	Male (Frequency)	Female (Frequency)
Managerial post		
Manager	15	-
Supervisor	35	-
Worker		
Skilled	410	115
Semi skilled	215	200
Unskilled	460	600

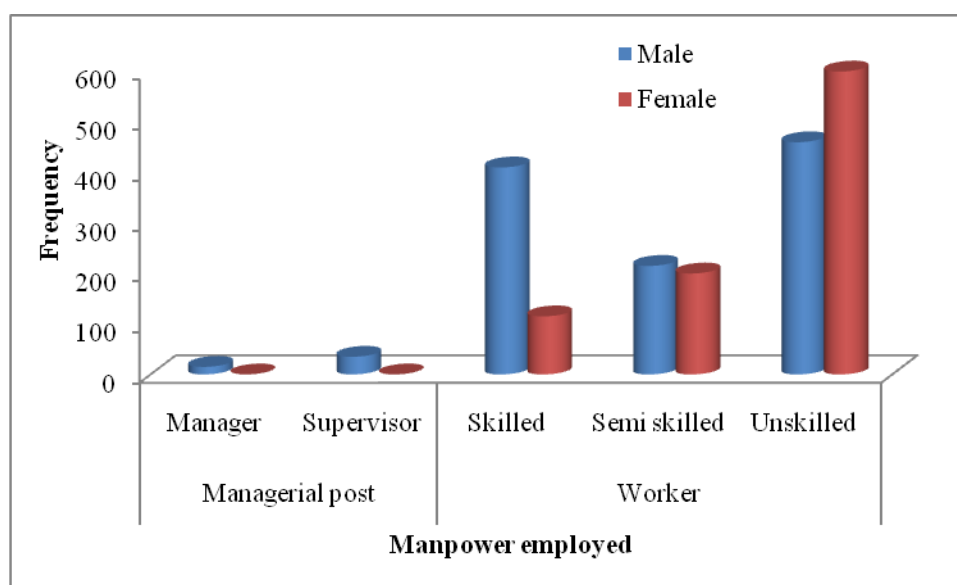


Fig. 3: Manpower employed in the cotton blended shoddy industries

The data presented in table 3 and fig. 3 depicted the manpower employed in selected cotton blended shoddy industries during collection of data. Numbers of persons working on managerial post were: 15 as manager and 35 persons as supervisors in all the selected industries. All the persons employed on managerial post were male. No female was employed on managerial post. The workers were categorized as skilled, did the work of testing of yarn and fabric, blending and preparing products; semiskilled, did the work of garneting, packaging, finishing; whereas the unskilled were engaged in sorting, removal of button, zips etc. It was found that there were more skilled male workers (410) as compared to female workers (115). There was approximately equal number of male (215) & female (200) working as semi skilled workers. Majority of the female workers were under the categories of unskilled workers (600) as compared to male (460). No child labour worker was found in any of the unit.

4.1.5 Facilities provided to employees in industries

Table 4: Facilities provided to employees in industries

n=10

Facilities	Frequency (f)	Percentage (%)
Bonus on festivals	8	80.00
Medical facilities (First aid)	10	100.00
Parking	5	50.00
Sanitary facility	10	100.00
Changing room	10	100.00
Drinking water	7	70.00
Canteen	10	100.00

Multiple responses

The data present in the table 4 gives the observations with respect to the facilities i.e. bonus on festivals, medical facilities, parking, sanitary facility, changing room, safe drinking water and canteen provided to the employees in the industries. It was found that medical facilities, sanitary facility, changing room and canteen facilities were provided by all the industries (100% each). Majority of industries (80%) gave bonus on festivals in form of gifts, sweets and clothes etc.; followed by safe drinking water facilities (70%). Half of the industries (50%) provided parking facilities to their employees.

4.1.6 Problems faced by the owners/ representatives and employees in industry: Data

regarding the problems faced by the owners and employees working in the industries are presented in table 5 and 6 respectively.

Table 5: Problems faced by the owners/ representatives in industry

n=10

Problems		Frequency (%)	
		Yes	No
Managerial problems	Price inflation of raw material	10(100.00)	-
	Lack of quality raw material	9(90.00)	1(100.00)
	Lack of govt. support	10(100.00)	-
Technical problems	Electricity	10(100.00)	-
	Skilled labour	5(50.00)	5(50.00)
	Lack of employees with technical experience	6(60.00)	4(40.00)
Health problems	Allergy	1(10.00)	9(90.00)
	Breathing problems	2(20.00)	8(80.00)
	Skin Problems	1(10.00)	9(90.00)
General problems	Toilet facility	-	10(100.00)
	Medical facility	-	10(100.00)
	Safety for women	2(20.00)	8(80.00)
	Uncomfortable environment	-	10(100.00)
	Safe drinking water	-	10(100.00)

It is clear from the data that all of the owners/ representatives (100.00%) faced the managerial problems like price inflation of raw materials, lack of govt. support and technical problem like electricity. Majority of the owners/ representatives faced the managerial problem like lack of quality raw material (90.00%), technical problems like lack of employees with technical experience (60.00%). Fifty percent faced non-availability of skilled labour, twenty percent owners faced health problems like breathing problem, allergy and skin problems (10.00% each). None of the owners/ representatives complained (100.00%) like toilet facility, medical facility, uncomfortable environment and safe drinking water except twenty percent owners/ representatives faced problem related to safety of women.

Table 6: Problems faced by the employees in cotton blended shoddy industries n=190

Problems	Employees				
	Managers (n=10) F(%)	Supervisors (n=30) F(%)	Unskilled (n=50) F(%)	Semi-skilled (n=50) F(%)	Skilled (n=50) F(%)
Physical					
Allergy	-	10(33.00)	50(100.00)		
Breathing problem	-	30(100.00)	50(100.00)	50(100.00)	
Skin problem	-	-	35(70.00)	32(64.00)	20(40.00)
Uncomfortable environment	-	-	25(50.00)	25(50.00)	-
Administrative					
Parking	-	-	-	30(60.00)	40(80.00)
Electricity	10(100.00)	15(50.00)	-	-	-
Lack of employees with technical experiences	10(100.00)	15(50.00)	-	-	-

Problem faced by the employees was studied on randomly selected 190 respondents i.e manager (10), supervisor (30), unskilled (50), semiskilled (50) and skilled (50) representing all the selected industries. It was studied that physical problem allergy reported by unskilled workers (100.00%) and supervisors (33.00). Breathing problems reported by unskilled and semi-skilled workers and supervisors (100.00% each). Skin problem reported by unskilled (70.00%), semiskilled (64.00%) and skilled workers (40.00%). Uncomfortable environment reported by unskilled and semi-skilled workers (50.00% each). Administrative problem like parking reported by skilled (80.00%) and semi-skilled workers (60.00%). Electricity and lack of employees with technical experience were the problems reported by managers of the selected industries (100.00%).

4.2 Usage Pattern of Shoddy Industries:

Information on existing usages pattern of cotton blended shoddy industries with respect to source of procurement of raw material, form of raw material procured, storage

facility, techniques and production processes for making yarns and fabrics, purchasing factors considered for raw materials, type of rags, blend proportions of cotton blended shoddy yarn, yarn count, ply of yarn, type of weaves used for fabric preparation, selection of colour of rags and products, test performed, accessories used for product development, method of labeling on product, distribution channels and marketing of products in the shoddy industries was studied.

4.2.1 Sources of procurement of raw materials: This section comprises of the sources of procurement of raw materials in the industries.

Table 7: Sources of procurement of raw materials

n=10

Source		Frequency (f)	Percentage (%)
Local market	Vendors	2	20.00
	Industries (handloom & mills)	5	50.00
	Scrap shops	4	40.00
Other places	State	7	70.00
	National	2	20.00
	International	5	50.00

Multiple responses

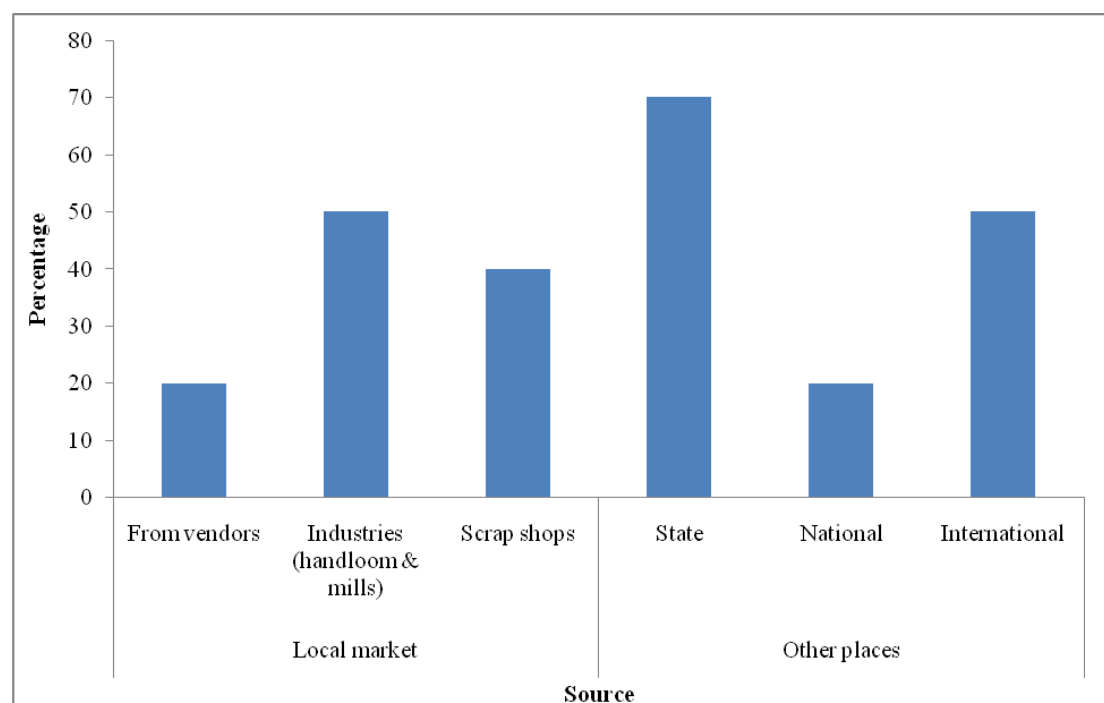


Fig. 4: Sources of procurement of raw materials

The data related to source of procurement of raw material is presented in table 7 and fig. 4. The raw material was procured from the local market i.e. from the Panipat local area and from the other places like state that is from other places of Haryana state; national, i.e. from other places of India and International i.e. from European Countries, U. K, U.S.A.,

Australia and other countries. This is so due to the fact that in western society normally people change their wardrobes more frequently and these rags were preferred because of their greater strength. Another source was procured from the consignments.

Fifty percent raw material was purchased from the local industries as number of handloom & mills are located in Panipat city followed by 40.00 percent from the scrap shops that collect the discarded & unused rags from different sources and 20.00 percent from the vendors who collect rags from houses. As well the raw material was purchased from other places of Haryana state through marketing channel (70.00%), from other countries (50.00%) and from the other places of India (20.00%).

4.2.2 Forms of raw material procured in industry: The data given in table 8 and fig. 5 revealed that raw material procured in the industries in the form of rags and handloom & cloth mills (100.00%) each followed by cuttings (90.00%) and tailoring waste (20.00%).

Table 8: Forms of raw material procured in industry **n=10**

Form of raw material	Frequency (f)	Percentage (%)
Rags	10	100.00
Tailoring waste	2	20.00
Industry waste (handloom and cloth mills)	10	100.00
Cuttings	9	90.00

Multiple responses

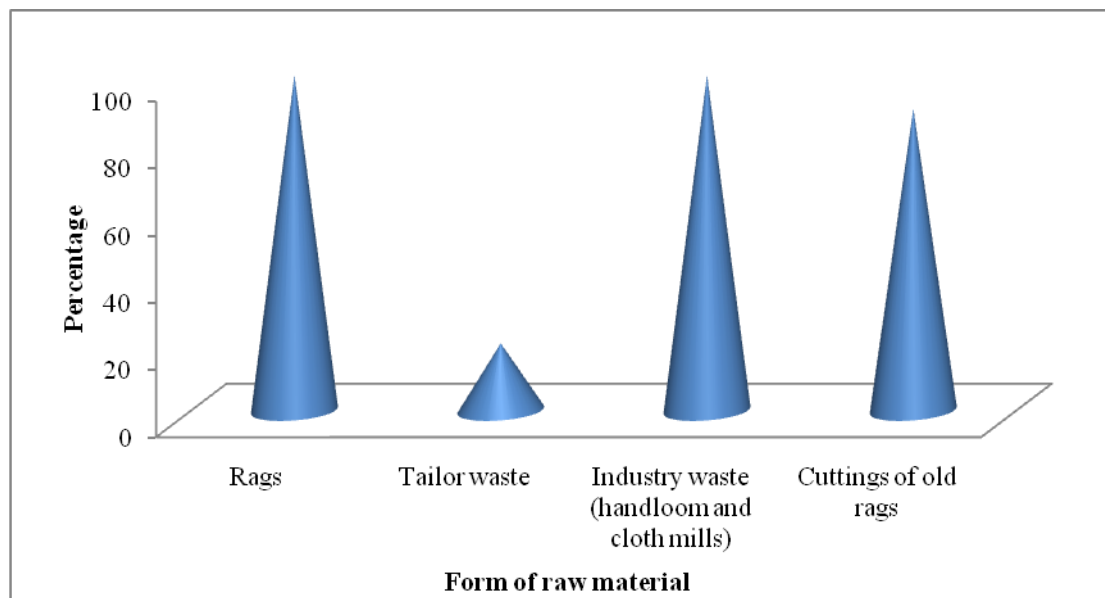


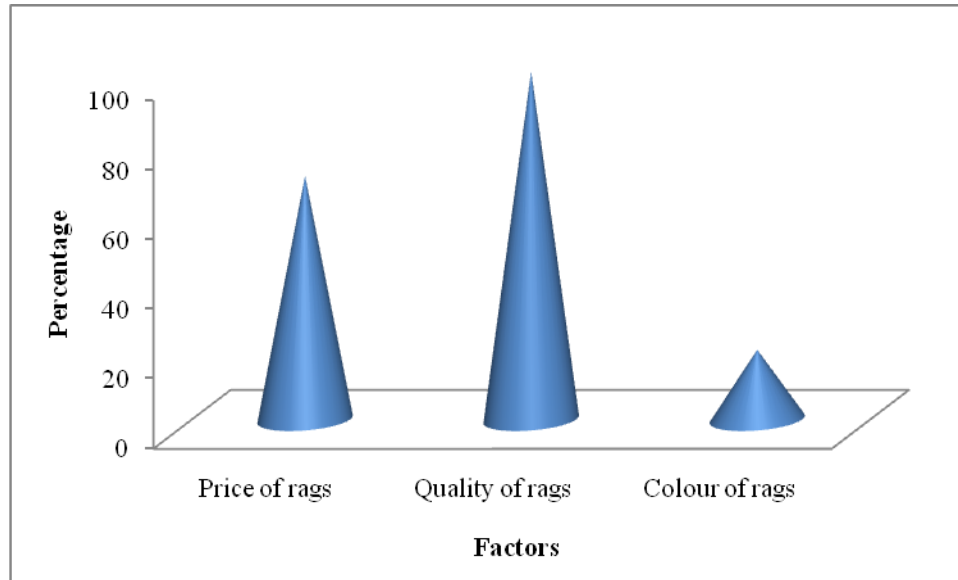
Fig. 5: Forms of raw material procured in industry

4.2.3 Factors considered while purchasing raw material: The data related to the factors that influenced the purchase of raw material in the industry is given in table 9 and fig. 6.

Table 9: Factors considered while purchasing raw material**n=10**

Factors	Frequency (f)	Percentage (%)
Price of rags	7	70.00
Quality of rags	10	100.00
Colour of rags	2	20.00

Multiple responses

**Fig. 6: Factors considered while purchasing raw material**

It is observed from the data that all the cotton blended shoddy industries give prime importance to quality of rags (100.00%) followed by the price of rags (70.00%) whereas 20.00 percent industries considered the colour of rags while purchasing raw material as per the requirement of product preparation.

4.2.4 Storage of raw material in industry: The data in regards to storage of raw material are presented in table 10. Sixty percent industries used the covered space for storage of raw material and 50.00 percent of the industries used the open space for storage of raw material.

Table 10: Storage of raw material in industry**n=10**

Storage Facility	Frequency (f)	Percentage (%)
Open space	5	50.00
Covered space	6	60.00

Multiple responses

4.2.5 Technical process: The collected rags are subjected to number of technical processes to make shoddy yarn to shoddy fabric. The technical processes included collection of rags, sorting of rags, mixing of rags, garneting of rags, carding, spinning, weaving and finishings (Plate-1-11).

Collection of rags: Collection of rags from local market, other places of India & from other countries in the form of rags, cuttings of old rags, tailor waste, industry waste was collected

through marketing channels. The collected rags were stored in open & covered area of industry premises (Plate 1).

Sorting of rags: Sorting was done according to the colour, quality of available rags. The coloured pieces were sorted and used as such hence no dyeing was required. This is also beneficial for the environment and helpful for saving the energy and reducing the pollution. (Plate 2)



Plate 1: Collection of rags:



Plate 2: Sorting of rags

Mixing of rags: Mixing was generally done to meet the cost and improve the quality of fabric. The collected material was shredded into fibres depending on the end use of yarn and products. Two or more than two different yarns were mixed in the desired blending proportion. These were sucked into a large mixing box which had air blown around to mix the different fibres. Blending was done at different points along the entire process of making yarns from rags (Plate-3)



Plate 3: Mixing of rags

Garneting of Rags: Garneting is a process of recovering the fibres from twisted yarns, rags and waste and garnet machine was used for this process. It was also known as waste opening machine and shredding machine. Each machine had one or more drums with sharp edges. Each of these drums rotated the rags and shredded in pieces and then defibered by drums. The materials were shredded into pieces again and again until a complete and perfect fibre removal was obtained. Sometimes additional blending was done at this stage to improve the quality and strength of the product.

Sliver formation of yarn was done to separate, align and deliver fibres in a sliver form, which was described as a continuous and thick as man's thumb (Plate-4, 5)



Plate 4: Garneting of Rags



Plate 5: Sliver formation

Carding: is the process to further remove the impurities still present in the material. The carding equipment consisted of cylinders with teeth and crush rolls to break down remaining impurities. Further the fibres were brought into parallel alignment for spinning (plate 6).



Plate 6: Carding

Spinning: In the spinning process the yarn were given more twist to increase the strength. After that, yarn was wound through the numbers of spool pins fixed on the machine (Plate 7).



Plate 7: Spinning

Weaving: Weaving is a method of textile production in which two sets of yarns are interlaced at right angles to form a fabric. Weaving process consisted of basic operations like shedding, picking, beating up, let off and take up. Power looms were used for weaving of fabric in shoddy industries. Yarns were prepared in different yarn counts that is 2.5s, 4s, 6s, 8s, 10s (Plate 8).



Plate 8: Weaving

Finishing: Finishing was done to improve the appearance and quality of manufactured fabric. Fabric was passed through the steel rollers and the short fibres were removed. After that pressing was done (Plate-9).



Plate 9: Finishing

4.2.6 Type of rag used as raw material in industries: It is evident from the data that all the selected industries (100.00%) used different types of rags as raw material to make cotton blended shoddy yarn. In addition to cotton/ cotton blends the industries also used wool/ wool blends (100.00%), acrylic/acrylic blends (80.00%), polyester/ polyester blends (70.00%) and nylon/ nylon blends (40.00%) rags as raw material (Table 11).

Table 11: Types of rag used as raw material in industries **n=10**

Types of rags used	Frequency (f)	Percentage (%)
Cotton / Cotton blend	10	100.00
Acrylic / Acrylic blend	8	80.00
Polyester/ Polyester blend	7	70.00
Nylon / Nylon blend	4	40.00
Wool / Wool blend	10	100.00

Multiple responses

4.2.7 Cotton blended shoddy yarn: The data in regards to the proportion percentage of blended yarn with cotton in various yarn counts prepared in the industries is presented in table 12.

Table 12: Proportion percentage of blended yarn with cotton in different yarn counts prepared in the industries **n=10**

Cotton blended shoddy yarn	Blend %	Yarn count (s)				
		2.5	4	6	8	10
		F(%)	F(%)	F(%)	F(%)	F(%)
Cotton + Acrylic	Below 20%	6(60.00)	10(100.00)	6(60.00)	6(60.00)	7(70.00)
	Above 20-40%	10(100.00)	10(100.00)	10(100.00)	10(100.00)	10(100.00)
Cotton + Polyester	Below 20%	10(100.00)	10(100.00)	10(100.00)	10(100.00)	10(100.00)
	Above 20-40%	10(100.00)	5(50.00)	2(20.00)	1(10.00)	2(20.00)
Cotton + Nylon	Below 20%	10(100.00)	10(100.00)	7(70.00)	7(70.00)	7(70.00)
	Above 20-40%	6(60.00)	5(50.00)	5(50.00)	5(50.00)	
Cotton + Other fibre	Below 20%	7(70.00)	5(50.00)	5(50.00)	4(40.00)	4(40.00)

Multiple responses

It was studied that the selected industries manufacture the cotton blended shoddy yarn in different blends proportions percentage in 2.5s, 4s, 6s, 8s and 10s. All the selected industries (100.00%) manufacture shoddy yarn of cotton with acrylic blend (above 20-40%), cotton with polyester blend (below 20 %) in 2.5s, 4s, 6s, 8s & 10s and cotton with acrylic blend (below 20%) in 4s, cotton with polyester blend (above 20-40%) in 2.5s, cotton with nylon blend (below 20 %) in 2.5s and 4s. Seventy to sixty percent industries manufacture shoddy yarn of cotton with acrylic blend (below 20%) in 10s, cotton with nylon blend (below 20%) in 6s, 8s & 10s, cotton with other fibre blend (below 20%) in 2.5s (70.00% industries). Cotton with acrylic blend (below 20%) in 2.5s, 6s, 8s, cotton with nylon blend (above 20-40%) in 2.5s manufactured by (60.00% industries). Fifty percent industries manufactured cotton with polyester blend (above 20-40%) in 4s, cotton with nylon blend (above 20-40%) in 4s, 6s & 8s, cotton with other fiber (below 20%) in 4s & 6s. Cotton with other fibre blend (below 20%) in 8s & 10s was manufactured by 40.00 percent industries. Twenty and ten percent industries manufactured shoddy yarn of cotton with polyester blend (above 20-40%) in 6s & 10s (20.00%) and in 8s (10.00 %).

4.2.8 Type of cotton blended shoddy yarns manufactured in the industries: This section includes the different type of cotton blended shoddy yarns manufactured in the industries.

Table 13: Type of cotton blended shoddy yarns manufactured in the industries

n=10

Type of yarn	Frequency (f)	Percentage (%)
2ply	10	100.00
4ply	2	20.00

Multiple responses

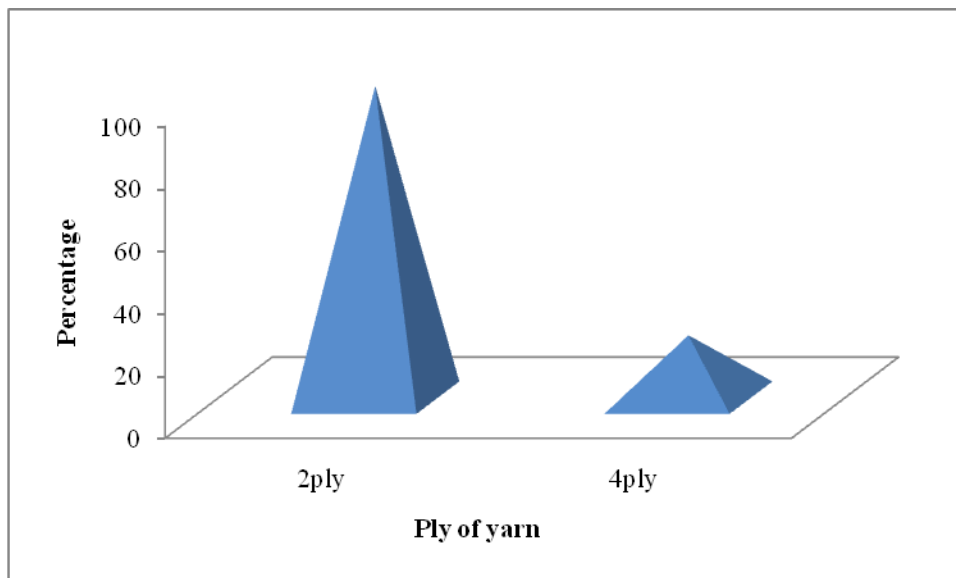


Fig. 7: Type of cotton blended shoddy yarns manufactured in the industries

The data presented in the table 13 and fig. 7 revealed that all the industries (100.00%) manufactured the 2 ply cotton blended shoddy yarn. Twenty percent industries also manufactured 4 ply cotton blended shoddy yarn as per the requirement of the product to be prepared.

4.2.9 Tests parameters performed for shoddy yarn in industries: This part is related to various tests performed for shoddy yarn in the industries.

Table 14: Tests parameters performed for shoddy yarn in industries n=10

Type of tests	Frequency (f)	Percentage (%)
Yarn count	10	100.00
Blend analysis	10	100.00
Twist per inch (TPI)	10	100.00
Yarn strength & elongation	10	100.00

Multiple responses

The parameters performed to test of the prepared cotton blended shoddy yarn in the industries are given in table 14. It was found from the data that all industries (100.00%) tested the yarn count, blend analysis, twist per inch (TPI) and yarn strength & elongation of prepared cotton blended shoddy yarn.

4.2.10 Test parameters performed for shoddy fabric in industries: Various tests including fabric count, fabric weight, thickness, bending length and tensile strength were performed to test the prepared cotton blended shoddy fabric in the industries.

Table 15: Test parameters performed for shoddy fabric in industries n=10

Test parameters	Frequency (f)	Percentage (%)
Fabric count	10	100.00
Fabric weight	10	100.00
Thickness	7	70.00
Bending length	5	50.00
Tensile strength	10	100.00

Multiple responses

All the industries (100.00%) tested the fabric count, fabric weight and tensile strength of the shoddy fabric. Majority of the industries (70.00%) also tested the fabric thickness and 50.00 percent industries also tested bending length.

4.2.11 Colour criteria for the shoddy fabric in industries: The data with regards to colour criteria for shoddy fabric in the industries are presented in table 16 and fig. 8, which revealed that as rags were sorted according to the colour and shoddy fabric was prepared as per the availability of colour of rags in all industries (100.00%). It was found that prepared fabric was of dark colour in (50.00%) and of light colour in (40.00%) as per the available rags at the

period of research. It was also found that shoddy fabric prepared according to buyers' order as per their colour preferences available in the industry (60.00%).

Table 16: Colour criteria for the shoddy fabric in industries **n=10**

Colour	Frequency (f)	Percentage (%)
Dark colour	5	50.00
Light colour	4	40.00
According to availability of rags	10	100.00
According to buyers order	6	60.00

Multiple responses

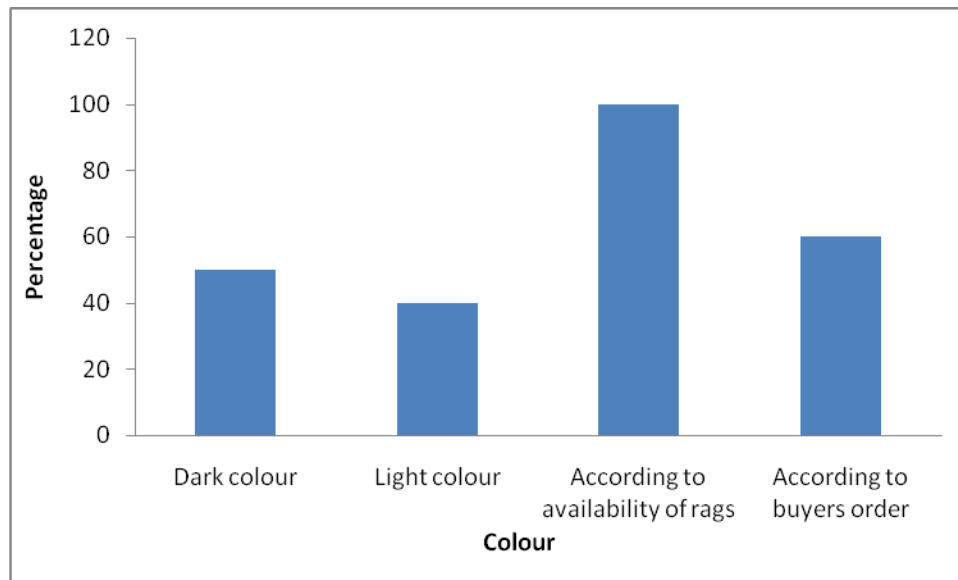


Fig. 8: Colour criteria for the shoddy fabric in industries

4.2.12 Type of weaves used for making of cotton blended shoddy fabrics in the industries: The data presented in the table 17 revealed that all the industries (100.00%) manufactured shoddy fabrics with plain weave and twill weave followed by rib weave and dobby weave (30.00%) each. Twenty percent industries also manufactured jacquard fabric to produce different products from cotton blended shoddy fabrics.

Table 17: Type of weaves used for making of cotton blended shoddy fabrics in the industries **n=10**

Weaves	Frequency (f)	Percentage (%)
Plain weave	10	100.00
Twill weave	10	100.00
Rib weave	3	30.00
Dobby weave	3	30.00
Jacquard weave	2	20.00

Multiple responses

4.2.13 Defects in fabrics manufactured in the shoddy industries: Defects in manufactured shoddy fabrics in the industries was studied and reported in table 18.

Table 18: Defects in fabrics manufactured in the shoddy industries**n=10**

Defects	Frequency (f)	Percentage (%)
Uneven yarn thickness	8	80.00
Slippage of yarn	10	100.00
Use of uneven yarn	7	70.00
Mismatch of colour	5	50.00

Multiple responses

Results indicated that a numbers of defects were reported that is uneven yarn thickness, slippage of yarn, use of uneven yarn and mismatch of colour in shoddy industries. Slippage of yarn was the main defect reported in all the industries (100.00%) followed by uneven yarn thickness (80.00%), use of uneven yarn (70.00%) and mismatch of colour (50.00 %).

4.2.14 Products prepared using cotton blended shoddy fabrics in the industries: The data related to various products prepared in different counts from cotton blended shoddy fabrics in the industries are presented in table 19.

Table 19: Products prepared using cotton blended shoddy fabrics in the industries**n=10**

Products prepared	Counts				
	2.5	4	6	8	10
	F(%)	F(%)	F(%)	F(%)	F(%)
Rugs	10(100.00)	10(100.00)	-	-	-
Contour (Toilet rug for seat cover)	2(20.00)	2(20.00)	-	-	-
Foot mat	10(100.00)	10(100.00)	9(90.00)		
<i>Khes</i>	10(100.00)	9(90.00)	10(100.00)	6(60.00)	7(70.00)
Stool mat	10(100.00)	10(100.00)	10(100.00)	-	-
<i>Durries</i>	-	7(70.00)	6(60.00)	5(50.00)	5(50.00)
Prayer mat	4(40.00)	4(40.00)	-	-	-
Beach towel	-	-	-	5(50.00)	6(60.00)

Multiple responses

Shoddy fabrics with 2.5s was used to make rugs, foot mat, *khes*, stool mat (100.00%) followed by beach towel (40.00%) and contour (20.00%). Shoddy fabric with 4s was used to make rugs, foot mat, stool mat (100.00%) followed by *khes* (90.00%), *durries* (70.00%), beach towel (40.00%) and contour (20.00%). Shoddy fabrics with 6s was used to make *khes*, stool mat (100.00%) followed by foot mat (90.00%) and *durries* (60.00%). Shoddy fabrics with 8s was used to make *khes* (60.00%) followed by *durries* and beach towel (50.00%) each. Shoddy fabrics with 10s was used to make *khes* (70.00%) followed by beach towel (60.00%) and *durries* (50.00%).

4.2.15 Accessories used on developed products: Type of accessories used on the developed products was studied through observations that were prepared during research study period and ready stock with them.

Table 20: Accessories used on developed products **n=10**

Accessories used	Frequency (f)	Percentage (%)
Frills/ fringes	10	100.00
Gote / band	10	100.00
Piping / taping	3	30.00

Multiple responses

The data presented in table 18 depicted the different types of accessories used for the development of products. All the industries (100.00%) used frills, *gote*/band followed by piping/ taping (30.00%) for development of the products.

4.2.16 Method of labelling on products: The labels were tucked on products using various methods in all the industries. The information regarding the method of labeling on the prepared products as presented in table 21.

Table 21: Method of labelling on products **n=10**

Methods of Label	Frequency (f)	Percentage (%)
Stitched	2	20.00
Disposable	1	10.00
Removable/Detachable	7	70.00

It was found that seventy percent industries used the removable labels followed by stitched labels and disposable labels by 20.00 % and 10.00% on the prepared products respectively.

4.2.17 Factors considered for calculating the cost of products: As cost of the product is the main criterion for sale & demand in the market, the various factors considered by the industries for calculating the cost are manufacturing cost (100.00%), utility of the product (100.00%), overall appearance (80.00%) and texture (50.00%) (table 22).

Table 22: Factors considered for calculating the cost of products **n=10**

Parameters	Frequency (f)	Percentage (%)
Utility	10	100.00
Texture	5	50.00
Overall appearance	8	80.00
Manufacturing cost	10	100.00

Multiple responses

4.2.18 Distribution channels adopted by the industries: This section presents the distribution channels used for marketing of products by the industries.

Table 23: Distribution channels adopted by the industries**n=10**

Channels	Frequency (f)	Percentage (%)
Personal contacts	7	70.00
Agents	10	100.00
Wholesalers	10	100.00
Retailors	1	10.00

Multiple responses

**Fig. 9: Distribution channels adopted by the industries**

Industries used various distribution channels for marketing the products. The data presented in table 23 and fig. 9 shows that marketing of the products has been done through agents and wholesalers (100.00% each), followed by personal contacts (70.00%) and retailer (10.00%) also.

4.2.19 Marketing of products by the industries: The information regarding marketing of the products is reported in table 24.

Table 24: Marketing of products by the industries**n=10**

Marketing of product	Frequency (f)	Percentage (%)
Local market	10	100.00
Domestic market	8	80.00
International market	4	40.00

Multiple responses

All the industries (100.00%) marketed the products in the local market. Majority of the industries (80.00%) also marketed the products domestic market (all over India) and 40.00 percent industries did export the products through different channels.

4.3 Selection of Yarn for Product Development:

Selection of cotton blended shoddy yarn was done by procuring samples of cotton blended shoddy yarns of different yarn count, ply, blend proportions and respective fabric samples available during study in the selected industries (Plate-10 & 11).

4.3.1 Procurement of yarns and fabrics: In the present study for the selection of yarn, five samples of cotton blended shoddy yarn and fabric samples of different ply i.e. 2ply & 4ply, count i.e. 2.5, 4, 6, 8, 10 and blends proportions i.e. cotton+ acrylic, cotton + polyester, cotton + nylon and cotton + other fibre (other leftover fibres) that were procured from the selected shoddy industries.

4.3.2 Selection of yarns: The collected five samples of yarns and fabric samples were shown to the experts to get their preferences for product development. Selection of yarn was made on the basis of experts' preferences considering yarn count, ply and blend proportions and respective fabric samples through physical observations. The most preferred yarn was selected (table 25, 26 & 27).

Table 25: Selection of cotton blended shoddy yarns **n=30**

Sr. No.	Blend proportion (%)	WMS	Ranks
1	Cotton + Acrylic (60+40)	2.13	II
2	Cotton + Polyester (70+30)	2.16	I
3	Cotton + Nylon (60+40)	2.10	III
4	Cotton + other fibre (60+40)	1.73	IV

Table 26: Selection of yarn count **n=30**

Sr. No.	Diameter (s)	WMS	Ranks
1	2.5	1.90	IV
2	4	2.03	III
3	6	2.03	III
4	8	2.13	II
5	10	2.25	I

Table 27: Selection of yarn type **n=30**

Yarn ply	WMS	Ranks
2ply	2.24	I
4ply	1.90	II

Data pertaining to preferences for cotton blended shoddy yarn revealed that cotton blended with polyester (70+30%) ranked Ist (WMS 2.16) followed by cotton blended with acrylic (60+40%) ranked IInd (WMS 2.13), cotton blended with nylon (60+40%) ranked IIIrd (WMS 2.10) and cotton blended with other fibre (60+40%) ranked IVth (WMS 1.73).

Data pertaining to preferences for yarn count revealed that 10s yarn got ranked Ist (WMS 2.25) followed by 8s ranked IInd (WMS 2.13), 6s ranked IIIrd (WMS 2.03), 4s ranked IVth (WMS 2.03) and 2.5s got Vth ranked (WMS 1.90). Data pertaining to preferences for yarn ply revealed that 2 ply was ranked Ist (WMS 2.2.4) followed by 4 ply ranked IInd (WMS 1.90).

4.4 Physical Testing of Selected Shoddy Yarn:

This part deals with physical testing of selected blended yarn that is cotton with polyester blended (70+30%) in 10s and 2 ply yarn for yarn strength, yarn twist (TPI) and count strength product. CSP is a yarn parameter which contributes mainly the spinning performance of any yarn.

4.4.1 Fibre composition of selected yarn: Fibre composition of yarn was 10s with cotton/polyester blend proportion (70/30%) was selected.

Table 28: Physical tests of selected yarn

Selected yarn with blend ratio (10s and 2ply)	Test parameters		
	Yarn strength (CN/Tex)	TPI	CSP
Cotton + Polyester (70+30%)	18.0±	13-15	2250±

It is clear from the data presented in table 29 that the mean twist value of 10s cotton blended shoddy yarn was 13-15 with fibre composition as cotton 70 percent, polyester 30 percent, yarn strength was 18.0+ CN/TEX and CSP value of 10s cotton blended shoddy yarn was 2250±.

4.5 Selection of products, preparation of fabrics and physical testing of fabrics:

This section comprises the selection of products for product development, selection of the colour of fabric, preparation of fabrics for product development and physical testing of woven fabrics.

4.5.1 Selection of products: An exhaustive list of products was prepared, consent with advisors keeping in mind the experts' preferences for selected cotton with polyester (70+30%) blended shoddy yarn in 10s and 2 ply yarn considering opinion on collected fabric samples through observations. Experts' preferences were considered for selection of the products (table 29).

Table 29: Preferences of experts' for the products made from cotton blended shoddy yarn n=30

Sr. No.	Products	WMS	Ranks
1	Foot mat	2.06	XX
2	Stool mat	1.76	XXXVIII
3	Prayer mat	1.90	XXXIV
4	Curtain	2.56	I
5	Table mat	2.46	II
6	Cushion cover	2.43	III
7	Skirts	2.03	XXII
8	<i>Mudha</i> cover	2.42	IV
9	Sofa cover	2.00	XXIII
10	Wall hanging	2.35	VII
11	Settee cover	2.10	XVII
12	Diwan cover	2.26	XI
13	Bed runner	1.83	XXXV
14	Shopping bag	1.83	XXXV
15	Ladies shirt	2.40	V
16	Jacket	2.10	XVII
17	Hand bag	1.36	XLII
18	Mobile Phone cover	2.33	VIII
19	Saree cover	2.13	XVI
20	Wall pocket	1.96	XXVII
21	Wall key holder	1.96	XXVII
22	Computer cover	1.93	XXXIII
23	A.C. cover	1.80	XXXVII
24	Washing machine cover	1.60	XL
25	Stitching machine cover	2.20	XIV
26	Hand Fan	1.96	XXVII
27	Magazine holder	1.96	XXVII
28	Table Cover	2.26	XI
29	File cover	2.16	XV
30	Cover for water bottle/thermos	1.96	XXVII
31	Cotton picking bag	2.06	XX
32	Purse	2.00	XXIII
33	Laundry bag	1.96	XXVII
34	Jewellery kit	1.43	XLI
35	Pen/ Pencil holder	1.76	XXXVIII
36	<i>Chakla</i>	2.30	IX
37	Bangle box	2.26	XI
38	Shoe wrapper	2.00	XXIII
39	Bolsters	2.30	IX
40	School bag	2.10	XVII
41	Coasters	2.36	VI
42	<i>Bander wall</i>	2.00	XXIII

The data depicted that curtain was the most preferred product with ranked Ist (WMS 2.56) followed by table mat (2.46, II), cushion cover (2.43,III), *mudha* cover (2.42, IV), ladies shirt (2.40, V). The other products obtained the declining order as coasters (2.36, VI), wall hanging (2.35,VII), mobile phone cover (2.33,VIII), *chakla*, bolsters (2.30 IX), diwan set, table cover, bangle box (2.26, XI), stitching machine cover (2.20, XIV), file cover (2.16,XV), saree cover (2.13,XVI), settee cover, jacket, school bag (2.10,XVII), foot mat (2.06, XX), skirt (2.03,XXII), sofa cover, shoe wrapper, *banderwall* (2.00,XXIII), wall pocket, wall key holder, hand fan, magazine holder, cover for water bottle/ thermos and laundry bag (1.96,XXVII), computer cover (1.93, XXXIII), prayer mat (1.90, XXXIV), bed runner, shopping bag (1.83, XXXV), A.C cover (1.80, XXXVII), stool mat, pen/pencil holder (1.76, XXXVIII), washing machine cover (1.60, XL), jewellery kit (1.43, XLI). Handbag was the least preferred product by experts and was ranked XLII (WMS 1.36).

The data envisaged that the top ranked five products were curtain, table mat, cushion cover, *mudha* cover and ladies shirt (Plate-12).

Plate 12: Selected products for product development

Product No.	Product	WMS	Rank
4	Curtain	2.56	I
5	Table mat	2.46	II
6	Cushion cover	2.43	III
8	<i>Mudha</i> cover	2.42	IV
15	Ladies shirt	2.40	V

4.5.2 Colour of the fabrics: A sample of yarns (swatches) in various colours available during study in the shoddy industries was shown to experts for their colour preferences for the selected products (Plate- 13).

The data pertaining to the preferences of experts for suitable colour for preferred products that is curtain, table mat, cushion cover, *mudha* cover and ladies shirt given in Table 31. It is clear from the data that colour listed at serial no.6 was ranked Ist (2.70) for the curtain and other colour were in declining order as serial no. 2 (2.50, II), 8 (2.33, III), 4 (2.13, IV), 10 (2.03,V), 5 (1.96,VI), 7 (1.83,VIII), 9 (1.76,IX). Color listed at serial no. 3 was least preferred with WMS 1.33 and ranked Xth.

Data revealed that for table mat colour listed at serial no.3 ranked Ist (WMS 2.36). The others were in declined order as serial no. 2 (2.33, II), 8 (2.26, III), 6 (2.06, IV) serial no. 10 and 1 (2.00, V) each, serial no. 4 (1.96, VII) serial no.5 and 7(1.93,VIII each), colour listed at serial no. 9 with WMS 1.83 and ranked Xth.

Table 30: Preference for suitable colour for preferred products**n=30**

Colour swatches of samples	Products									
	Curtain		Table mat		Cushion cover		<i>Mudha</i> cover		Ladies shirt	
	WMS	Rank	WMS	Rank	WMS	Rank	WMS	Rank	WMS	Rank
1	1.90	VII	2.00	V	2.46	II	2.20	II	1.90	VIII
2	2.50	II	2.33	II	2.30	IV	1.96	V	2.58	II
3	1.33	X	2.36	I	2.56	I	1.33	X	1.76	X
4	2.13	IV	1.96	VII	1.96	VII	2.00	IV	2.46	III
5	1.96	VI	1.93	VIII	2.20	V	1.82	VI	2.78	I
6	2.70	I	2.06	IV	1.43	X	1.76	VIII	2.00	VI
7	1.83	VIII	1.93	VIII	2.00	VI	1.80	VII	2.00	VI
8	2.33	III	2.26	III	2.36	III	2.33	I	2.26	V
9	1.76	IX	1.83	X	1.83	VIII	2.06	III	2.36	IV
10	2.03	V	2.00	V	1.76	IX	1.76	VIII	1.90	VIII

Data revealed that for cushion cover colour listed at serial no. 3 ranked Ist with (WMS 2.56) and other were in declined order as serial no. 1 (2.46,II), 8 (2.30,III), 2 (2.30,IV), 5 (2.20V), 7 (2.00,VI), 4 (1.96,VII), 9 (1.83,VIII), 10 (1.76,IX) and colour listed at serial no.6 was least preferred with WMS 1.43 and ranked Xth.

Data revealed that for *mudha* cover colour listed at serial no. 8 got Ist ranked (WMS 2.33). The other were in declined order as serial no. 1 (2.20,II), 9 (2.06,III), 4 (2.00,IV), 2 (1.96,V), 5 (1.82,VI), 7 (1.80,VII) serial no.6 and 10 (1.76,VIII each). Colour listed at serial no. 3 was least preferred by the experts with WMS 1.33 and ranked Xth.

Data revealed that preferred colour for ladies shirt was listed at serial no.5 got Ist ranked (WMS 2.78) and other colour were in declined order as serial no. 2 (2.58,II), 4 (2.46, III), 9 (2.36,IV), 8 (2.26,V) serial no. 6 and 7 (2.00,VI) each, serial no. 1 and 10 (1.90,VIII) each. The least preferred colour for ladies shirt was serial no. 3 with 1.76 WMS and ranked Xth.

Thus, it was concluded that the selected swatches of colour listed at serial no.6 for curtain, 3 for table mat and cushion cover, 8 for *mudha* cover and 5 for ladies shirt (Plate-17).

4.5.3 Preparation of fabrics: The fabrics were got prepared from Panipat in one of the selected shoddy industry as per selected specifications i.e. cotton with polyester 70:30 blend proportion, 2ply and 10s in selected colour for selected products.

4.5.4 Physical testing of fabric: The selected woven fabric was tested for fabric count, fabric weight, thickness, tensile strength & elongation and bending length using standard test methods.

Table 31: Physical tests of fabric prepared for product development

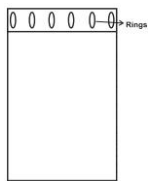
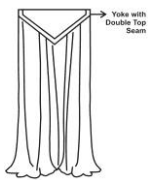
Prepared fabric(10s and 2 ply)	Warp	Weft
Fabric count(s)	10	9.9
Tensile strength (CN/TEX))	24.30	22.45
Elongation %	3.90	4.50
Bending length (cm)	1.7	1.9
Fabric wt.(GSM)	164	
Fabric thickness(mm)	0.47	

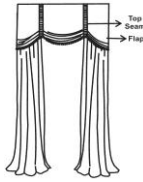
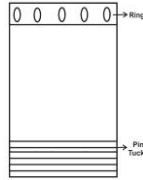
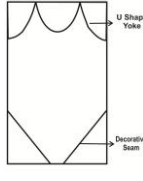
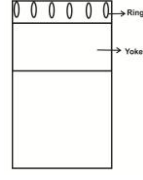
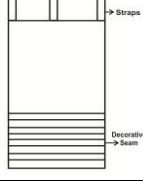
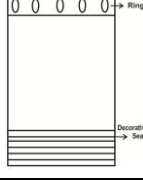
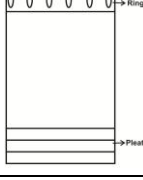
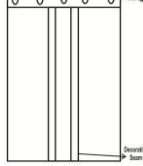
Data in table 31 shows the mean value of physical test i.e. fabric count, fabric weight, fabric thickness, tensile strength, elongation and bending length of prepared fabric for product development. The mean value of the fabric count was 10 x 9.9 for warp and weft. The mean value of fabric wt. in GSM (gram per square) was 16.4 and fabric thickness was 0.47 mm of 10 count fabric. The mean value of tensile strength was 24.30 and 22.45kg for warp and weft respectively. Warp elongation was 3.9% and weft elongation was 4.5%. The bending length was 1.7 cm and 1.9 cm for warp and weft respectively.

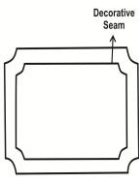
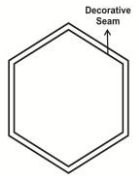
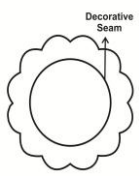
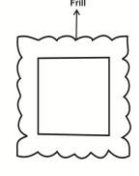
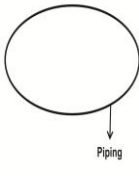
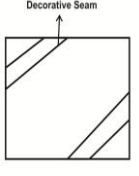
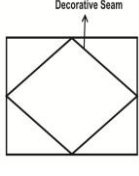
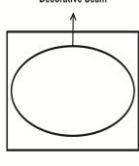
4.6 Creation of Constructional Designs for Selected Products

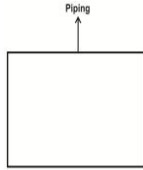
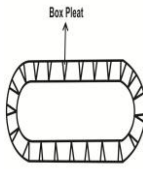
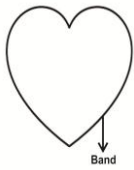
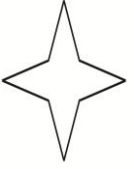
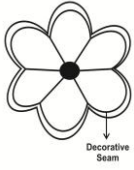
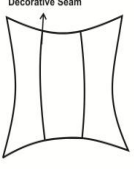

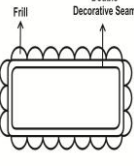
4.6.1 Creation & Selection of constructional design for products: Experts' preferences were sought for selection of constructional designs for each product using preferential choice index. Ten constructional designs for each product were created and out of that three preferred constructional designs for each product were selected. Hence, fifteen preferred constructional designs were selected.

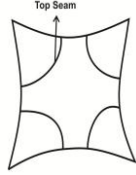
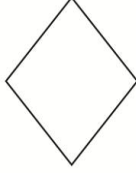
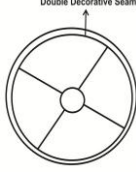
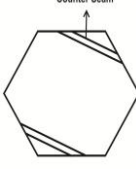
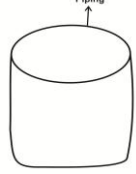

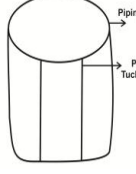
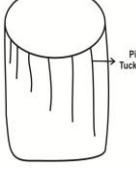
Table 32: Preferences for constructional designs of preferred products n=30

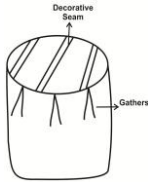
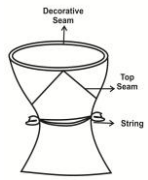
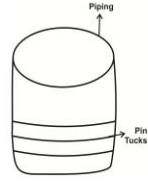
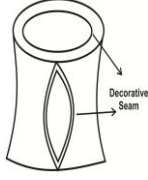
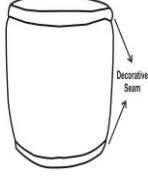
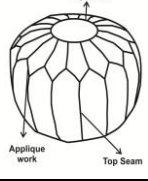


Product No.	Products	Design no. and shape with construction features	Constructional designing features	WMS	Rank	
4 ranked I ST	Curtain	1		Rings on the top portion for hanging	2.76	I
		2		V shaped yoke with double top seam	1.90	IX



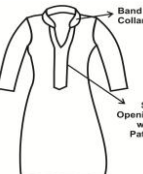

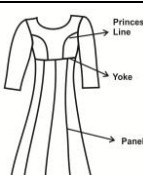

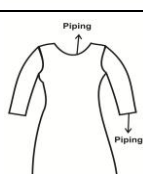
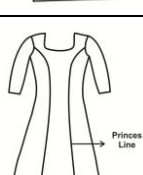
Product No.	Products	Design no. and shape with construction features	Constructional designing features	WMS	Rank	
		3		Curved shaped flap with top seam	2.06	VII
		4		Horizontal pin tucks in the bottom and rings for hanging	2.60	II
		5		U shaped yoke on top portion and diagonal decorative seam in the bottom	2.43	IV
		6		Rectangle shaped yoke on top portion with rings for hanging	2.26	VI
		7		Horizontal decorative seams lines in the bottom half portion and straps for hanging	2.03	VIII
		8		Horizontal decorative seam lines in the 1/3 bottom portion with rings for hanging	2.43	IV
		9		Horizontal pleats in the bottom portion and ring on the top portion for hanging	2.46	III
		10		Vertical decorative seam lines in the centre and ring on the top portion	1.30	X

Product No.	Products	Design no. and shape with construction features	Constructional designing features	WMS	Rank	
5 ranked II nd	Table mat	1		Rectangular shape with shaped corners and decorative seam	2.03	VI
		2		Hexagon shape with decorative seam	1.36	IX
		3		Outer scalped shape and inner round shape with decorative seam	1.16	X
		4		Square shape with frill	2.16	V
		5		Oval shape finished with piping	2.00	VII
		6		Rectangle shape with diagonal decorative seam on corners	2.36	III
		7		Outer rectangle shape with inner diamond shape with decorative seam	2.40	II
		8		Outer rectangle shape and inner oval shape with decorative seam	1.76	VIII

Product No.	Products	Design no. and shape with construction features	Constructional designing features	WMS	Rank	
		9		Rectangle shape with piping	2.43	I
		10		Box pleat strip on outer edge	2.26	IV
6 ranked III rd	Cushion cover	1		Heart shape with band	1.90	IX
		2		Star shape with decorative seam	2.26	IV
		3		Flower shape with decorative seam	1.90	IX
		4		Semi rectangular shape with decorative stitch in centre	2.60	I
		5		Triangle shape with decorative seam and piping	2.03	VI
		6		Rectangular shape with fringe and double decorative seam	2.03	VI

Product No.	Products	Design no. and shape with construction features	Constructional designing features	WMS	Rank	
		7		Semi rectangular shape with curved decorative stitch finished with piping on the corners	2.46	II
		8		Diamond shape with piping	2.43	III
		9		Circular shaped with double decorative seam on outer edges	2.26	IV
		10		Hexagon shape with counter seams	1.93	VIII
8 ranked IV th	Mudha cover	1		Top finished with piping	2.60	I
		2		Top is designed with frill and decorative seam and top seam on bottom line	2.00	VI
		3		Vertical pin tucks all around and top finished with piping	2.43	III
		4		Vertical pin tucks in ascending order all around	1.83	X

Product No.	Products	Design no. and shape with construction features	Constructional designing features	WMS	Rank			
		5		Gathers on body and diagonal decorative seams on the top portion	2.13	IV		
		6		Decorative seam on the top edge. Inverted 'v' shape with top seam on upper portion, centrally tied with string	2.10	V		
		7		Horizontal pin tucks in the lower half portion and upper portion is finished with piping	2.46	II		
		8		Decorative seam on the top portion and oval shape curve with decorative seam all around	1.96	VIII		
		9		Decorative seam on the top and on bottom line	2.00	VI		
		10		Top and body designed with v- shaped applique work with top seam	1.96	VIII		
		15 ranked V th	Ladies shirts	1		Designed with yoke with vertical false centre opening from bust level to bottom with button, 3/4 sleeve length	1.93	IX
		2			Designed with yoke with slit opening and band collar. Flared silhouette and half sleeve	2.36	IV	

Product No.	Products	Design no. and shape with construction features	Constructional designing features	WMS	Rank
		3 	Designed with band color with shoulder opening, straight silhouette with centre slit opening, $\frac{3}{4}$ sleeve length	1.33	X
		4 	Straight waist level yoke with piping, straight silhouette, $\frac{3}{4}$ sleeve length	2.63	I
		5 	Band color neckline, slit opening with shaped patch work till waist level, straight silhouette, $\frac{3}{4}$ sleeve length	1.96	VIII
		6 	Designed with semi curved shaped yoke with piping, straight silhouette, $\frac{3}{4}$ sleeve length	2.50	II
		7 	Yoke designed with princess line, panelled shirt, $\frac{3}{4}$ sleeve length	2.10	VI
		8 	Designed with false centre front opening with decorative buttons, straight silhouette, $\frac{3}{4}$ sleeve length	2.36	IV
		9 	Simple shirt finished with piping on the neck and sleeve with straight silhouette, $\frac{3}{4}$ sleeve length	2.40	III
		10 	Designed with princess line, A-line silhouette, $\frac{3}{4}$ sleeve length	2.00	VII

The data in table 32 illustrated the developed ten constructional designs of each product i.e. curtain, table mat, cushion cover, *mudha* cover, ladies shirt. It is clear from the data that for curtain design No. 1 was ranked Ist with 2.76 weighted mean score followed by design no. 4 (2.60) and design no. 9 (2.46) ranked IInd and IIrd respectively. The other designs obtained the descending rank order of preferences as design no.5 and 8 (2.43,IV), 6 (2.26, VI), 3 (2.06,VII), 7 (2.03,VIII), 2 (1.90, IX). The least preferred design was design No.10 with 1.30 WMS and ranked Xth.

The most preferred constructional design for table mat was design no. 9 ranked Ist with 2.43 weighted mean score followed by design no. 7 (2.40) and design no. 6 (2.36) ranked IInd and IIrd respectively. The other designs obtained the descending rank order of preferences as design no. 10 (2.26,IV), 4 (2.16,V), 1(2.03,VI), 5 (2.00,VII) ,8 (1.76,VIII), 2 (1.36,XI). The least preferred design for table mat was design no. 3 with 1.16 weighted mean score and ranked Xth.

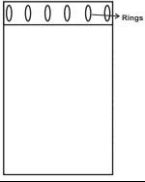
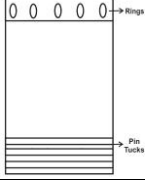
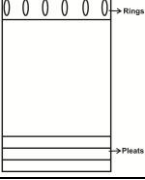
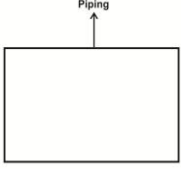
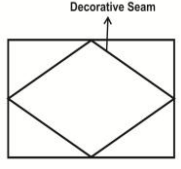
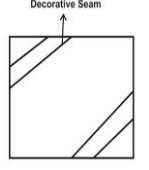
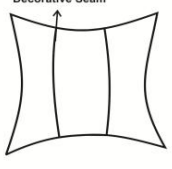
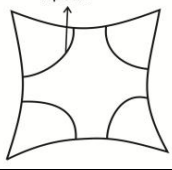
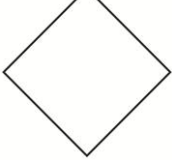
The most preferred constructional design for the cushion cover was design no.4 ranked Ist with weighted mean score 2.60 followed by design no. 7 (2.46) and design no. 8 (2.43) ranked IInd and IIrd respectively. The other designs obtained the descending rank order of preferences as design no. 2 and 9 (2.26, IV), 5 and 6 (2.03VI), 10 (1.93VIII). The least preferred design for cushion cover was design no 1 and 2 with weighted mean score 1.90 and ranked IXth.

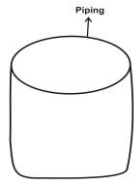
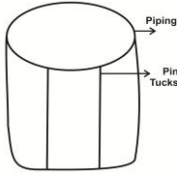
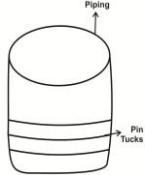


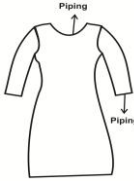
The most preferred constructional design for *mudha* cover was design no. 1 ranked Ist with weighted mean score 2.60 followed by design no. 7 (2.46) and design no. 3 (2.43) ranked IInd and IIrd respectively. The other designs obtained the descending rank order of preferences as design no. 5 (2.13, IV), 6 (2.10, V), design no. 2 and 9 (2.00 VI), 8 and 10 (1.96, VIII). The least preferred design for *mudha* cover was design no. 4 with 1.83 weighted mean score and ranked Xth.

Design no.4 was ranked Ist with 2.63 weighted mean score for ladies shirt followed by design no. 6 (2.50) and design no. 9 (2.40) ranked IInd and IIrd respectively. The other designs obtained the descending rank order of preferences as design no. 2 and 8 (2.36, IV), 7 (2.10,VI), 10 (2.00,VII), 5 (1.96,VIII), 1 (1.93, IX). The least preferred design was no. 3 with 1.33 weighted mean score and ranked Xth.

Thus it is concluded that top three preferred constructional designs for each product were design no.1, 4, 9 for curtain, design no. 9,7,6 for table mat, design no. 4,7,8 for cushion cover, design no. 1,3,7 for *mudha cover* and design no. 4,6,9 for ladies shirt (Plate-14).

Plate 14: Selected designs for selected products

Product (no.)	Design no.	Constructional design	WMS	Rank
Curtain (4)	1		2.76	I
	4		2.60	II
	9		2.46	III
Table mat(5)	9		2.43	I
	7		2.40	II
	6		2.36	III
Cushion cover(6)	4		2.60	I
	7		2.46	II
	8		2.43	III

Product (no.)	Design no.	Constructional design	WMS	Rank
Mudha cover (8)	1		2.60	I
	3		2.43	III
	7		2.46	II
Ladies shirt (15)	4		2.63	I
	6		2.50	II
	9		2.40	III

4.7 Selection of Surface Enrichment Techniques:

To find out the preferred surface enrichment technique, a list that included patchwork, appliqué work, screen printing, stencil printing, block printing, fabric painting, spray painting and embroidery was prepared. Experts' preferences were sought through preferential choice index.

Data presented in table 33 revealed that screen printing was ranked Ist with, 2.60, 2.76, 2.56, 2.46, 2.50 weighted mean score followed by hand embroidery ranked IInd with weighted mean score 2.56, 2.50, 2.40, 2.35, 2.33 for curtain, table mat cushion cover, *mudha* cover, ladies shirt respectively.

Table 33: Experts' preference for surface enrichment technique for preferred products
n=30

Techniques	Products									
	Curtain		Table mat		Cushion cover		Mudha cover		Ladies shirt	
	WMS	Rank	WMS	Rank	WMS	Rank	WMS	Rank	WMS	Rank
Patchwork	2.03	V	1.86	VIII	1.70	VIII	2.00	V	1.82	VIII
Appliqué work	1.86	VII	2.33	IV	2.20	V	1.92	VII	2.00	V
Screen printing	2.60	I	2.76	I	2.56	I	2.46	I	2.50	I
Stencil printing	1.80	VIII	2.35	III	1.96	VII	2.00	V	2.13	III
Block printing	2.33	III	2.03	V	2.36	III	2.33	III	2.03	IV
Fabric painting	2.06	IV	2.00	VI	2.30	IV	1.86	VIII	2.00	V
Spray painting	1.96	VI	1.90	VII	2.00	VI	2.03	IV	1.92	VII
Hand embroidery	2.56	II	2.50	II	2.40	II	2.35	II	2.33	II

Block printing was ranked III for curtain with weighted mean score 2.33, cushion cover (2.36), *mudha* cover (2.33). Stencil printing ranked III for table mat (2.35), ladies shirt (2.13).

The other ranked orders were as: for curtain, fabric painting (2.06, IV) patchwork (2.03, V), spray painting (1.96, VI) appliqué work (1.86, VII) and stencil printing (1.80, VIII). For table mat, appliqué work (2.33, IV) fabric painting (2.00, VI), spray painting (1.90, VII), patchwork (1.86, VIII). For cushion cover, fabric painting (2.30, IV) appliqué work (2.20, V), spray painting (2.00, VI), stencil printing (1.96, VII) and patchwork (1.70, VIII). For *mudha* cover, spray painting (2.03, IV), stencil and patchwork (2.00, V) appliqué work (1.92, VII), fabric painting (1.86, VII). For ladies shirt, block printing (2.03, IV), fabric painting, appliqué work (2.00, V), spray painting (1.92, VII) and patchwork with 1.82 weighted mean score ranked VIII.

Thus it was concluded that screen printing was selected as top ranked surface enrichment technique for all the products and second ranked hand embroidery using running stitches was used for outline the screen printed designs to enhance the beauty of the products.



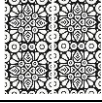




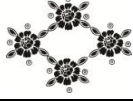
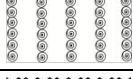

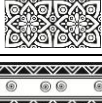



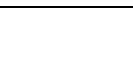
4.8 Creation and Selection of Designs and Design Placement for Surface Enrichment:









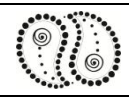

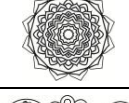










The section comprises the creation and selection of designs and design placement for surface enrichment technique for product development.





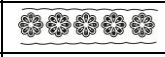









4.8.1 Creation & selection of designs: Screen printing designs were created with the help of CorelDRAW-12 software. Experts' preferences for top ranked designs for screen printing of each product were studied.

Table 34: Experts' preferences for screen printing designs for preferred products

n=30

Design No.	Designs	Products									
		Curtain		Table mat		Cushion cover		Mudha cover		Ladies shirt	
		WMS	Rank	WMS	Rank	WMS	Rank	WMS	Rank	WMS	Rank
1		2.20	XXVIII	2.76	III	2.00	XXV	2.33	XX	2.90	I
2		2.40	XXII	1.96	XXXIX	1.90	XXXVIII	2.70	VI	2.00	XXXV
3		2.40	XXII	2.60	VIII	1.60	XLIX	2.75	IV	2.33	XXVI
4		2.16	XXXII	1.90	XLII	2.10	XX	2.00	XXIX	2.78	IV
5		2.72	IX	2.00	XXVIII	2.75	IV	2.01	XXV	2.75	V
6		1.90	XLIV	1.98	XXXVII	2.60	VIII	2.50	XII	2.01	XXIX
7		2.60	XIV	2.01	XXIII	1.90	XXXVIII	2.86	I	2.88	II
8		2.50	XVII	2.60	VIII	1.75	XLV	2.00	XXIX	2.81	III
9		2.00	XXXVII	2.80	II	2.01	XXI	2.40	XVI	2.75	V
10		2.88	II	1.75	XLIX	2.50	XII	2.33	XX	1.96	XLI
11		2.20	XXVIII	2.50	XIII	2.60	VIII	2.70	VI	1.90	XLVII
12		2.16	XXXII	2.00	XXVIII	2.00	XXV	2.80	II	2.70	XI
13		2.66	XII	1.96	XXXIX	1.96	XXXV	2.45	XV	2.45	XXI
14		2.50	XVII	2.01	XXIII	2.00	XXV	2.01	XXV	2.01	XXIX
15		2.40	XXII	2.72	VI	1.90	XXXVIII	2.75	IV	2.70	XI

Design No.	Designs	Products									
		Curtain		Table mat		Cushion cover		Mudha cover		Ladies shirt	
		WMS	Rank	WMS	Rank	WMS	Rank	WMS	Rank	WMS	Rank
16		1.90	XLIV	2.56	XI	1.50	L	1.75	XLVI	2.70	XI
17		2.90	I	2.00	XXVIII	2.33	XVII	2.00	XXIX	2.01	XXIX
18		2.73	VIII	2.50	XIII	1.96	XXXV	1.75	XLVI	2.33	XXVI
19		2.33	XXV	2.33	XIX	2.40	XIV	2.76	III	2.00	XXXV
20		2.33	XXV	2.40	XVI	2.01	XXI	2.00	XXIX	1.96	XLI
21		2.72	IX	2.83	I	2.76	II	1.90	XLII	2.50	XVIII
22		2.50	XVII	2.33	XIX	2.00	XXV	2.20	XXII	2.00	XXXV
23		2.33	XXV	2.01	XXIII	1.75	XLV	2.50	XII	2.40	XXII
24		2.86	III	2.40	XVI	2.80	I	1.75	XLVI	2.33	XXVI
25		1.96	XXXIX	2.33	XIX	2.20	XIX	2.03	XXIV	2.50	XVIII
26		1.96	XXXIX	2.01	XXIII	2.00	XXV	1.70	L	2.40	XXII
27		2.46	XX	1.90	XLII	1.75	XLV	1.90	XLII	1.96	XLI
28		2.20	XXVIII	2.00	XXVIII	1.90	XXXVIII	1.98	XXXIX	2.00	XXXV
29		2.16	XXXII	1.90	XLII	1.98	XXXIV	2.10	XXIII	2.01	XXIX
30		2.60	XIV	2.01	XXIII	2.00	XXV	1.95	XLI	1.95	XLVI
31		2.13	XXXV	1.98	XXXVII	1.95	XXXVII	2.00	XXIX	2.00	XXXV
32		2.10	XXXVI	1.96	XXXIX	2.76	II	2.70	VI	1.96	XLI
33		2.00	XXXVII	2.00	XXVIII	2.01	XXI	2.40	XVI	1.75	L
34		2.76	VI	2.50	XIII	2.40	XIV	2.10	XXIII	2.40	XXII
35		1.90	XLIV	2.00	XXVIII	1.80	XLIV	2.00	XXIX	2.01	XXIX
36		2.80	V	2.40	XVI	2.70	V	1.90	XLII	2.60	XV

Design No.	Designs	Products									
		Curtain		Table mat		Cushion cover		<i>Mudha</i> cover		Ladies shirt	
		WMS	Rank	WMS	Rank	WMS	Rank	WMS	Rank	WMS	Rank
37		1.90	XLIV	2.00	XXVIII	2.00	XXV	2.01	XXV	2.75	V
38		2.66	XII	1.75	XLIX	2.60	VIII	2.70	VI	2.75	V
39		1.76	XLIX	1.80	XLVIII	1.90	XXXVIII	1.96	XL	2.00	XXXV
40		2.46	XX	2.53	XII	2.70	V	2.00	XXIX	1.90	XLVIII
41		2.76	VI	2.70	VII	2.01	XXI	1.90	XLII	2.75	V
42		1.96	XXXIX	2.00	XXVIII	2.00	XXV	2.70	VI	2.01	XXIX
43		2.70	XI	1.90	XLII	2.70	V	2.00	XXIX	2.40	XXII
44		1.90	XLIV	2.76	III	2.40	XIV	2.00	XXIX	2.50	XVIII
45		2.83	IV	2.20	XXII	2.50	XII	2.01	XXV	2.53	XVII
46		2.20	XXVIII	2.60	VIII	2.00	XXV	2.40	XVI	2.60	XV
47		2.60	XIV	1.90	XLII	1.90	XXXVIII	2.00	XXIX	1.90	XLVII
48		1.96	XXXIX	2.00	XXVIII	2.60	VIII	2.50	XII	2.70	XI
49		1.93	XLIII	1.90	XLII	1.75	XLV	2.70	VI	1.96	XLI
50		1.60	L	2.75	V	2.33	XVII	2.40	XVI	2.75	V

Experts' preferences for screen printing designs for preferred products i.e curtain, table mat, cushion cover, *mudha* cover and ladies shirt are presented in table no. 34. For curtain, preferred design was design no. 17 with 2.90 weighted mean score and ranked 1st. The other developed designs obtained in declining trends as design no. 10 (2.88,II), 24 (2.86,III), 45 (2.83, IV), 36 (2.80,V), 34 and 41 (2.76,VI), 18 (2.73, VIII), design no.5 and 21 (2.72, IX), 43 (2.70, XI), 12 and 38 (2.66, XII), design no.7, 30 and 47 (2.60, XIV), design no. 8, 14 and 22 (2.50, XVII), 27 and 40 (2.76, XX), design no. 2, 3 and 15 (2.40, XXII), 19, 20 and 23 (2.33, XXV), design no. 1, 11, 28 and 46 (2.20, XXVIII), design no. 4, 12 and 29 (2.16,

XXXII) , 31(2.13, XXXV), 32 (2.10, XXXVI) , 9 and 33, (2.00, XXXVII), design no. 25, 26, 42, and 48 (1.96, XXXIX), 49 (1.93, XLIII), design no.6, 16, 35, 37 and 44, (1.90, XLIV), 39 (1.76, XLIX). The least preferred design for curtain was design no. 50 with wms 1.60 and ranked fifty.

For table mat, preferred design was design no. 21 with wms (2.83) ranked Ist. The other developed designs obtained in declining trends as design no. 9 (2.80, II), 1 and 44 (2.76, III), 50 (2.75,V), 15 (2.72,VI) , 41(2.70,VII) , design no. 3, 8 and 46, (2.60,VIII) , 16 (2.56, XI) , 40 (2.53, XII) , design no. 11, 18 and 34 (2.50, XIII), design no. 20, 24 and 36 (2.40, XVI) , design no. 19, 22 and 25 (2.33, XIX) , 45 (2.20, XXII) , design no. 7, 14, 23, 26 and 30 (2.01, XXIII) , design no. 5,12, 17, 28, 33, 35, 37, 42 and 48 (2.00, XXVIII), 6 and 31(1.98,XXXVII), design no. 2, 13 and 32 (1.96, XXXIX), design no. 4, 27, 29, 43 and 49 (1.90, XLII), 39 (1.80, XLIII), 10 and 38(1.75, XL IX) respectively.

For cushion cover, preferred design was design No. 24 with weighted mean score 2.80 and ranked Ist. The other developed designs obtained in declining trends as design no. 21, 32 (2.76, II) , 5 (2.75, IV) , design no. 36, 40 and 43 (2.70, V) , design no. 6, 11, 38 and 48 (2.60, VIII) , 10 and 45 (2.50, XII), design no. 19, 34 and 44 (2.40, XIV) , 17 and 50 (2.33, XVII) , 25 (2.20, XIX), 4 (2.10, XX), design no. 9, 20, 33 and 41(2.01, XXI), design no. 1, 14, 22, 26, 30, 37, 42 and 46 (2.00XXV), 29 (1.98, XXXIV), 13 and 18 (1.96XXXV), 31 (1.95, XXXVII), design no. 2, 7, 15, 28, 39 and 47 (1.90, XXXVIII), 35 (1.80 XLIV), design no. 8, 23, 27 and 49 (1.75, XLV), 3 (1.60, XLIV). The least preferred was design no. 16 with 1.50 weighted mean score and ranked fifty.






For *mudha* cover, preferred design was design No.7 with weighted mean score 2.86 and ranked Ist . The other developed designs obtained in declining trends as design no. 12 (2.80, II), 19 (2.76, III), 3 and 15 (2.75, IV), design no. 2, 11, 32, 38, 42 and 49 (2.70, VII), design no. 6, 23 and 48 (2.50, XII), 13 (2.45, XV), design no. 9, 33, 46 and 50 (2.40, XVI), design no. 1 and 10 (2.33, XX), 22 (2.20, XXII), 29 and 34 (2.10, XXIII), 25 (2.03, XXIV), design no. 5, 14, 37 and 45 (2.01, XXV), design no. 4, 8, 17, 20, 31, 35, 40, 43, 44 and 47 (2.00, XXIX), 28 (1.98, XXXIX), 30 (1.96, XL), 30 (1.95, XLI), design no. 21, 27, 36 and 41 (1.90, XLII), design no. 16, 18 and 24 (1.75, XLVI). The Design No. 26 score 1.70 and ranked fifty was least preferred for *mudha* cover.

For ladies shirt, preferred design was design No.1 with weighted mean score 2.90 ranked Ist. The other developed designs obtained declining trends as design no. 7 (2.88, II), 8 (2.81, III), 4 (2.78, IV), design no. 5, 9, 3, 7, 38, 41 and 50 (2.75, V), 12, 15, 16 and 48 (2.70, XI) , design no. 36 and 46 (2.60, XV), 45 (2.53, XVII), design no. 21, 25 and 44 (2.50, XVII),

13 (2.45, XXI), design no. 23, 26, 34 and 43 (2.40, XXII), design no. 3, 18 and 24 (2.33, XXVI), design no. 6, 14, 17, 29, 35 and 42 (2.01, XXIX), design no. 2, 19, 22, 28, 31 and 39 (2.00, XXXV), design no. 10, 20, 27, 32 and 49 (1.96, XLI), 30 (1.95, XLVI), 11, 40 and 47 (1.90, XLVII). The design No. 33 was least preferred with 1.75 weighted mean score and ranked fifty.

Thus it is clear that design no. 17 for curtain, design no. 21 for table mat, design no. 24 for cushion cover, design no. 7 for *mudha* cover and design no.1 for ladies shirt were the selected designs for screen printing (Plate- 15).


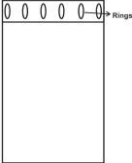



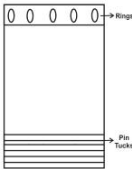


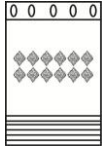
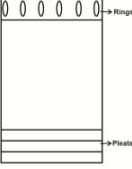

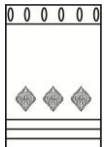
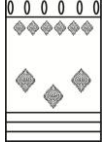
Plate 15: Selected screen printing designs for selected products

Design No	Product	Design	WMS	Ranks
17	Curtain		2.90	I
21	Table mat		2.83	I
24	Cushion cover		2.80	I
7	<i>Mudha</i> cover		2.86	I
1	Ladies shirt		2.90	I


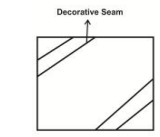
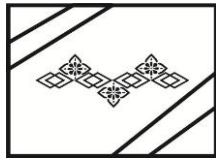
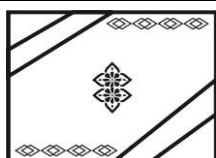
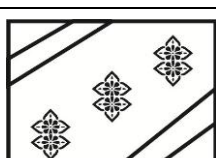
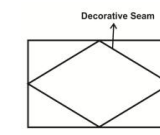
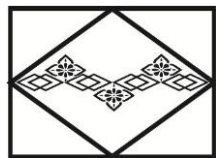
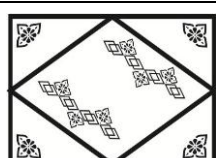
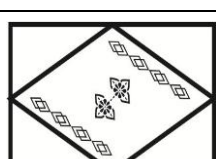
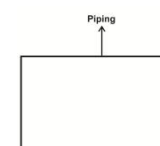
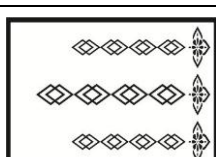
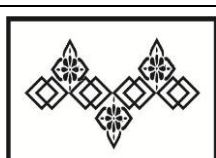
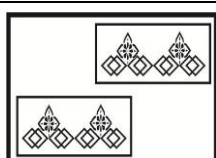
4.8.2 Creation of design placements: Three design placements of each selected design for each selected constructional shape of the selected product were created as per the suitability of design and selected constructional shape of the product. Hence, total 45 design placements were created that is five products with three selected constructional shapes with three design placements.

4.8.3 Selection of design Placements: The print out of prepared design placements were taken and got evaluated by thirty experts. Out of the three design placements of each selected constructional shape of the product, one design placement was selected for one selected constructional shape of the product. Hence, total fifteen design placements were selected for product development.

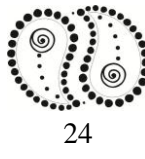
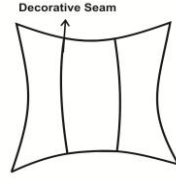
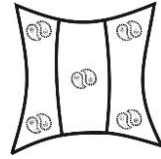
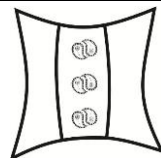
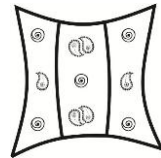
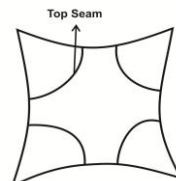
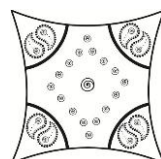
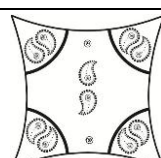
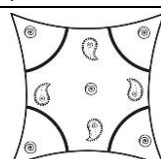
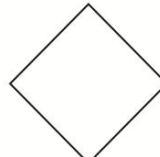
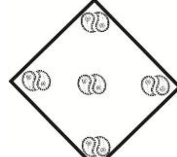
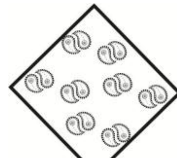
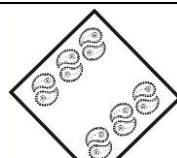
Table 35: Placements of selected screen printing designs for selected products n=30

Screen printing design	Placement of curtain					
	Product design and no.	Placements and no.	WMS	Ranks		
 17	1 ranked I st		I		2.00	III
			II		2.15	II
			III		2.78	I
	4 ranked II nd		I		2.15	I
			II		2.01	II
			III		1.75	III
	9 ranked III rd		I		1.96	III
			II		2.20	I
			III		2.15	II


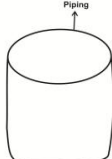



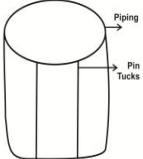
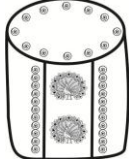


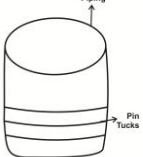



Contd...

Screen printing design	Placement of table mat					
	Product design and no.		Placements and no.		WMS	Ranks
 21	6 ranked I st		I		1.75	III
			II		2.33	I
			III		2.01	II
	7 ranked II nd		I		2.50	II
			II		2.73	I
			III		1.75	III
	9 ranked III rd		I		1.75	III
			II		1.96	II
			III		2.00	I














Contd...

Screen printing design	Placement of Cushion cover					
	Product design and no.	Placements and no.	WMS	Ranks		
 24	4 ranked I st	 Decorative Seam	I		2.00	II
			II		2.75	I
			III		1.76	III
	7 ranked II nd	 Top Seam	I		2.10	I
			II		1.96	III
			III		2.01	II
	8 ranked III rd		I		2.00	III
			II		2.40	II
			III		2.50	I

Contd...

Screen printing design	Placement of <i>mudha cover</i>					
	Product design and no		Placements and no.		WMS	Ranks
 7	1 ranked I st		I		2.00	III
			II		2.10	II
			III		2.70	I
	3 ranked II nd		I		2.00	II
			II		2.40	I
			III		1.90	III
	7 ranked III rd		I		2.76	I
			II		2.20	III
			III		2.50	II

Contd...

Screen printing design	Placement of ladies shirt					
	Product design and no.	Placements and no.	WMS	Ranks		
 1	4 ranked I st	 <small>Straight Yoke with Piping</small>	I		2.10	III
			II		2.50	I
			III		2.20	II
	6 ranked II nd	 <small>Semi Curved Yoke with Piping</small>	I		2.10	II
			II		1.75	III
			III		2.60	I
	9 ranked III rd	 <small>Piping</small>	I		2.40	II
			II		2.76	I
			III		2.01	III

Placements of selected screen printing designs as per the selected product was done to get the preferred design placement of selected product designs, three design placements for each design of selected product were done (table 35). For screen printing design no. 17 was selected for 'curtain' (design no. 1, design no. 4, design no. 9) by the experts. The data indicated that the most preferred placement for 'curtain' design no.1 was placement III scoring highest mean score 2.78 followed by placement II (2.15) and placement I (2.00). The most preferred placement for 'curtain' design no.4 was placement I scoring highest mean score 2.15 followed by placement II (2.01) and placement III (1.75). The most preferred placement for 'curtain' design no.9 was placement II scoring highest mean score 2.20 followed by placement III (2.15) and placement I (1.96).

Screen printing design no. 21 was selected for 'table mat' (design no. 6, design no. 7, design no. 9) by the experts. The most preferred placement for 'table mat' design no.6 was placement II scoring highest mean score 2.33 followed by placement III (2.01) and placement I (1.75). The most preferred placement for 'table mat' design no.7 was placement II scoring highest mean score 2.73 followed by placement I (2.50) and placement III (1.75). The most preferred placement for 'table mat' design no.9 was placement III scoring highest mean score 2.00 followed by placement II (1.96) and placement III (1.75).

Screen printing design no. 24 was selected for 'cushion cover' (design no.4, 7 and 8) by the experts. Data revealed that the placement II had the highest score 2.75 followed by placement I (2.00) and placement III (1.76) for 'cushion cover' design no. 4. The most preferred placement for 'cushion cover' design no. 7 was placement I (2.10) followed by placement III (2.01) and placement II (1.96). The most preferred placement for 'cushion cover' design no. 8 was placement III (2.50) followed by placement II (2.40) and placement I (2.00).

Screen printing design no. 7 was selected for '*mudha* cover' (design no. 1, 3 and 9) by the experts. It was clearly observed from the data that the placement III was most preferred (2.70) followed by placement II (2.10) and placement I (2.00) for design no.1. The placement II was most preferred (2.40) followed by placement II(2.00) and placement III(1.90) for design no.3 and the placement III was most preferred (2.50) followed by placement II(2.40) and placement I (2.00) for design no.9.

Screen printing design no. 1 was selected for 'ladies shirt' (design no.4, 6 and 9) by the experts. Data revealed that the placement II had the highest score 2.50 followed by placement II (2.20) and placement I (2.10) for 'ladies shirt' design no. 4. The most preferred placement for 'ladies shirt' design no. 6 was placement III (2.60) followed by placement I (2.10) and placement II (1.75). The most preferred placement for 'ladies shirt' design no. 9 was placement II (2.76) followed by placement I (2.40) and placement III (2.01).

It was concluded that selected design placements for ‘curtain’ were placement III (design 1), placement I (design 4) and placement II (design 9) was selected. The selected design placements for ‘table mat’ were placement II (design 6 &7) and placement III (design 9) was selected. The selected design placements for ‘cushion cover’ were placement II (design 4), placement I (design 7) and placement III (design 8) was selected. The selected design placements for ‘mudha cover’ were placement III (design 1), placement II (design 3) and placement I (design 7) was selected. The selected design placements for ‘ladies shirt’ were placement I (design 4), placement III (design 6) and placement II (design 9) (Plate- 16).

Plate 16: Selected design placement for selected product designs for product development

Selected product	Selected constructional design no.	Selected design placement no.	WMS	Rank
Curtain	1	III	2.78	I
	4	I	2.15	I
	9	II	2.20	I
Table mat	6	II	2.33	I
	7	II	2.73	I
	9	III	2.00	I
Cushion cover	4	II	2.75	I
	7	I	2.10	I
	8	III	2.50	I
Mudha cover	1	III	2.70	I
	3	II	2.40	I
	7	I	2.76	I
Ladies shirt	4	I	2.10	I
	6	III	2.60	I
	9	II	2.76	I

4.8.4 Selection of embellishment materials: To find out the preference for enrichment materials, a list that included beads, sequins, piping, *got*/band, lace, ribbon, mirror and button was prepared. Experts’ preferences were sought for embellishment materials for each product.

Data is presented in table 36 regarding experts’ preferences for embellishment materials i.e. beads, sequins, piping, *gote*/band, lace, ribbon, mirror and button for preferred products. Lace was the trimming most preferred for curtain with weighted mean score 2.60 followed by button (2.54 II), piping (2.50 III), ribbon (2.23 IV), beads (2.06 V), mirror (1.94 VI) sequins (1.86 VII). *Gote*/band was least preferred with 1.80 weighted mean score ranked VIIIth.

Table 36: Experts' preferences for embellishment materials of preferred products n=30

Sr. no.	Embellishment materials	Selected products									
		Curtain		Table mat		Cushion cover		<i>Mudha</i> cover		Ladies shirt	
		WMS	Rank	WMS	Rank	WMS	Rank	WMS	Rank	WMS	Rank
1	Beads	2.06	V	1.86	VIII	1.70	VIII	2.00	V	1.82	VIII
2	Sequins	1.86	VII	2.33	IV	2.20	VI	1.92	VII	2.00	V
3	Piping	2.50	III	2.35	III	2.50	I	2.46	I	2.50	I
4	<i>Gote/</i> Band	1.80	VIII	2.76	I	1.96	VII	2.00	V	2.13	III
5	Lace	2.60	I	2.03	V	2.36	III	2.33	III	2.03	IV
6	Ribbon	2.23	IV	2.00	VI	2.33	IV	1.86	VIII	2.00	V
7	Mirror	1.96	VI	1.90	VII	2.00	V	2.23	IV	1.92	VII
8	Button	2.54	II	2.50	II	2.41	II	2.38	II	2.33	II

Gote/Band was the most preferred for table mat with 2.76 weighted mean score ranked 1st followed by button (2.50 II), piping (2.35 III), sequins (2.33 IV), lace (2.03 V), ribbon (2.00 VI), mirror (1.90 VII), beads (1.86 VIII).

Piping was the most preferred for cushion cover with WMS 2.50 ranked 1st followed by button (2.41, II) Lace (2.36 III), ribbon (2.33 IV), mirror (2.00 V), sequins (2.20 VI), *gote/band* (1.96 VII), beads (1.70, VIII).

Piping was the most preferred for *mudha* cover with WMS 2.46 and ranked 1st followed by button (2.38, II), lace (2.33 III), mirror (2.23 IV), *gote /band* and beads (2.00 V) each, sequins (1.92 VII) ribbon (1.86 VIII).

Piping was the most preferred for ladies shirt with 2.50 WMS ranked 1st followed by button (2.33 II), *gote/band* (2.13 III), lace (2.03 IV), sequins and ribbon (2.00 V) each, mirror (1.92 VII), beads (1.82 VIII).

It was concluded that the selected embellishment materials for the products development was lace for curtain, *gote/ band* for table mat and piping for cushion cover, *mudha* cover and ladies shirt.

4.9 Development of Products and Their Cost Estimation:

4.9.1 Development of products: Selected top ranked five products i.e. curtain, table mat, cushion cover, *mudha* cover, ladies shirt in top ranked three constructional designs were developed. The products were enriched with selected screen printing designs and design placements. The screen printed designs were enhanced by doing running stitch using embroidery threads in contrast colour. Hence, total fifteen products were developed. The developed products are presented in (Plate 17 to 21).

4.9.2 Cost estimation:

Table 37: Estimated sample cost of the developed products

n=30

Developed products	Fabric cost (Rs.)	Embellishment cost(embroidery+ accessories) (Rs.)	Stitching charges (Rs.)	Total cost (Rs.)
Curtain	625	120	120	865
Table mat	125	45	70	240
Cushion cover	125	45	50	220
Mudha cover	250	90	50	390
Ladies shirt	625	90	250	965

*Screen cost is excluded because it is one time investment

The sample cost of developed products was calculated on the basis of fabric cost, embellishment (embroidery +accessories) and stitching. Screen preparation cost was excluded because it is one time investment. It was concluded that the cost of developed product was towards higher side as it was sample preparation cost. The cost is reduced when the products produced on commercial level.

4.10 Assessment of Developed Products:

An exhibition was put up in the department of Textile and Apparel Designing, I.C. College of Home Sciences CCS HAU, Hisar. The developed products were evaluated on various parameters such as texture, design, utility and appearance. Thirty consumers who visited the exhibition were selected randomly. The data pertaining to the assessment of developed products on different parameters is shown in tables 38-45 (Plate- 22).

Consumers' opinion for assessment of developed products on different parameters

Consumers' opinion for developed curtain

Curtains were assessed by the consumers on various parameters viz. texture, design, utility, appearance and the results presented in table 38. It was envisaged from the data regarding 'texture' of the fabric for the curtain design no. 1 was 'suitable as per the product design' with ranked Ist (WMS 2.90) followed by 'suitable as per the surface enrichment technique used' ranked IInd (WMS 2.88), 'thickness of fabric is appropriate' ranked IIIrd and (WMS 2.85), 'used accessories enhanced the look' ranked IVth (WMS 2.70) and 'constructional designing features are appropriate as per the design and texture' ranked Vth (WMS 2.60).

Consumers' opinions regarding the 'texture' of the fabric for the curtain design no. 4 was 'suitable as per the product design' ranked Ist (WMS 2.88), followed by 'suitable as per the surface enrichment technique used' ranked IInd (WMS 2.80), 'used accessories enhanced the look' with ranked IIIrd (WMS 2.78), 'constructional designing features are appropriate as per the design and texture' ranked IVth (WMS 2.75) and 'thickness of the fabric is appropriate' ranked Vth (WMS 2.65).

Table 38: Consumers' opinion for developed curtain

n=30

Sr. No.	Curtain Parameters	Design no.		
		1	4	9
1	Texture	WMS RANK	WMS RANK	WMS RANK
	Thickness of fabric is appropriate	2.85 III	2.65 V	2.55 IV
	Suitable as per the product design	2.90 I	2.88 I	2.50 V
	Suitable as per the surface enrichment technique used screen printing+ Hand embroidery)	2.88 II	2.80 II	2.60 III
	Constructional designing features are appropriate as per the design and texture	2.60 V	2.75 IV	2.70 I
	Used accessories (piping, ribbon) enhanced the look	2.70 IV	2.78 III	2.68 II
2	Design			
	Attractive	2.80 I	2.65 I	2.75 I
	Construction designing features are suitable	2.79 II	2.50 IV	2.70 II
	Suitable as per the selected technique (screen printing + hand embroidery)	2.75 IV	2.62 II	2.55 IV
	Used embellishment materials give new look	2.72 V	2.55 III	2.68 III
	Harmonize with fabric	2.78 III	2.41 V	2.50 V
	Colour combination is appropriate	2.60 VI	2.33 VI	2.41 VI
3	Utility			
	Suitable for the its purpose	2.70 II	2.60 I	2.70 II
	It is suitable for congenial usage	2.68 III	2.45 IV	2.50 IV
	An innovative idea to reuse waste cloth into new form	2.75 I	2.55 II	2.72 I
	Good market potential	2.50 IV	2.50 III	2.65 III
4	Appearance			
	Attractive	2.76 I	2.56 II	2.72 I
	As per the trend	2.55 IV	2.50 III	2.40 IV
	Innovative	2.65 III	2.44 IV	2.50 III
	Appealing overall appearance	2.70 II	2.72 I	2.70 II

Consumers' opinions regarding the 'texture' of the fabric for curtain design no. 9 was 'constructional designing features are appropriate as per the design and texture' ranked Ist (WMS 2.70) followed by used 'accessories enhanced the look' ranked IInd (WMS 2.68), 'suitable as per the surface enrichment technique used' ranked IIIrd (WMS 2.60), 'thickness of the fabric is appropriate' ranked IVth (WMS 2.55) and 'suitable as per the product design' ranked Vth (WMS 2.50).

Consumers' opinions regarding the 'design' for curtain design no.1 was 'attractive' ranked Ist (WMS 2.80) and followed by 'constructional designing features are suitable' ranked IInd (WMS 2.79), 'harmonize with fabric' ranked IIIrd (WMS 2.78), 'suitable as per selected technique' ranked IVth (WMS 2.72), 'used embellishment material give new look' ranked Vth (WMS 2.72) and 'colour combination is appropriate' ranked VIth (WMS 2.60).

Consumers' opinions regarding the 'design' for curtain design no. 4 was 'attractive' ranked Ist (WMS 2.65) and followed by 'suitable as per selected technique' ranked IInd (WMS 2.62), 'used embellishment material give new look' ranked IIIrd (WMS 2.55), 'constructional designing features are suitable' ranked IVth (WMS 2.50), 'harmonize with fabric' ranked Vth (WMS 2.41), and 'colour combination is appropriate' ranked VIth (WMS 2.33).

Consumers' opinions regarding the 'design' for curtain design no. 9 was 'attractive' ranked Ist (WMS 2.75) followed by 'constructional designing features are suitable' ranked IInd (WMS 2.70), 'used embellishment material give new look' ranked IIIrd (WMS 2.68), 'suitable as per selected technique' ranked IVth (WMS 2.55), 'harmonize with fabric' ranked Vth (WMS 2.50), and 'colour combination is appropriate' ranked VIth (WMS 2.41).

Consumers' opinions regarding the 'utility' for curtain design no.1 was 'an innovative idea to reuse the waste cloth into new form' ranked Ist (WMS 2.75) followed by 'suitable for the purpose' ranked IInd (WMS 2.70), 'it is suitable for congenial usage' ranked IIIrd (WMS 2.68), and 'good market potential' ranked IVth (WMS 2.50).

Consumers' opinions regarding the 'utility' for curtain design no. 4 was 'suitable for the purpose' ranked Ist (WMS 2.60) 'an innovative idea to reuse the waste cloth into new form' ranked IInd (WMS 2.55), 'good market potential' ranked IIIrd (WMS 2.50) and 'it is suitable for congenial usage' ranked IVth (WMS 2.45).

Consumers' opinions regarding the 'utility' for design no. 9 was 'an innovative idea to reuse the waste cloth into new form' ranked Ist (WMS 2.72) followed by 'suitable for the purpose' ranked IInd (WMS 2.70), 'good market potential' ranked IIIrd (WMS 2.65) and 'it is suitable for congenial usage' ranked IVth (WMS 2.50).

Consumers' opinions regarding the 'appearance' for curtain design no. 1 was 'attractive' ranked Ist (WMS 2.76) followed by 'appealing overall appearance' ranked IInd (WMS 2.70), 'innovative' ranked IIIrd (WMS 2.65) and 'as per the trend' ranked IVth (WMS 2.55).

Consumers' opinions regarding the 'appearance' for curtain design no.4 was 'appealing overall appearance' ranked Ist (WMS 2.72) followed by 'attractive' ranked IInd (WMS 2.56), 'as per the trend ranked' IIIrd (WMS 2.50) and 'innovative' ranked IVth (WMS 2.44).

Consumers' opinions regarding the 'appearance' for curtain design no.9 was 'attractive' ranked Ist (WMS 2.72) followed by 'appealing overall appearance' ranked IInd (WMS 2.70), 'innovative' ranked IIIrd (WMS 2.50) and 'as per the trend' ranked IVth (WMS 2.40).

Consumers' opinion for developed table mat

Table mat were assessed by the consumers on various parameters viz. texture, design, utility, appearance and the results presented in table 39. It was envisaged from the data regarding 'texture' of the fabric for the table mat design no. 6, was 'suitable as per the surface enrichment technique used' ranked Ist (WMS 2.90) followed by 'used accessories enhanced the look' ranked IInd (WMS 2.85), 'suitable as per the product design' with ranked IIIrd (WMS 2.80) 'thickness of fabric is appropriate' ranked IVth (WMS 2.75), and 'constructional designing features are appropriate as per the design and texture' ranked Vth (WMS 2.72).

Consumers' opinions regarding 'texture' of the fabric for the table mat design no. 7, was 'suitable as per the surface enrichment technique used' ranked Ist (WMS 2.56) followed by 'constructional designing features are appropriate as per the design and texture' ranked IInd (WMS 2.55), 'used accessories enhanced the look' ranked IIIrd (WMS 2.41) that 'suitable as per the product design' ranked IVth (WMS 2.34) and 'thickness of the fabric is appropriate' ranked Vth (WMS 2.23).

Consumers' opinions regarding 'texture' of the fabric for table mat design no. 9 was 'constructional designing features are appropriate as per the design and texture' ranked Ist (WMS 2.75) followed by 'suitable as per the surface enrichment technique used' ranked IInd (WMS 2.55), 'suitable as per the product design' ranked IIIrd (WMS 2.34), 'used accessories enhanced the look' ranked IVth (WMS 2.26), 'thickness of the fabric is appropriate' ranked Vth (WMS 2.23).

Consumers' opinions regarding the 'design' for table mat design no.6 was 'attractive' ranked Ist (WMS 2.90) and followed by 'colour combination is appropriate' ranked IInd (WMS 2.67), 'constructional designing features are suitable' ranked IIIrd (WMS 2.50), 'used embellishment materials give new look' ranked IVth (WMS 2.48), 'harmonize with fabric' ranked Vth (WMS 2.42) and 'suitable as per selected technique' ranked VIth (WMS 2.33).

Consumers' opinions regarding the 'design' for table mat design no.7 was 'suitable as per selected technique' ranked Ist (WMS 2.72) followed by 'colour combination is appropriate' ranked IInd (WMS 2.45), 'harmonize with fabric' ranked IIIrd (WMS 2.56), 'constructional designing features are suitable' ranked IVth (WMS 2.50), 'attractive' ranked Vth (WMS 2.45) and 'used embellishment materials give new look' ranked VIth (WMS 2.43).

Table 39: Consumers' opinion for developed table mat

n=30

Sr. No.	Table mat	Design no.		
	Parameters	6	7	9
1	Texture	WMS RANK	WMS RANK	WMS RANK
	Thickness of fabric is appropriate	2.75 IV	2.23 V	2.23 V
	Suitable as per the product design	2.80 III	2.34 IV	2.34 III
	Suitable as per the surface enrichment technique used(screen printing+ Hand embroidery)	2.90 I	2.56 I	2.55 II
	Constructional designing features are appropriate as per the design and texture	2.72 V	2.55 II	2.75 I
	Used accessories (piping, ribbon) used to prepare article are enhancing look	2.85 I	2.41 III	2.26 IV
2	Design			
	Attractive	2.90 I	2.45 V	2.75 I
	Construction designing features are suitable	2.50 III	2.50 IV	2.55 VI
	Suitable as per the selected technique (screen printing + hand embroidery)	2.33 VI	2.72 I	2.63 III
	Used embellishment materials give new look	2.48 IV	2.43 VI	2.59 IV
	Harmonize with fabric	2.42 V	2.56 III	2.56 V
	Colour combination is appropriate	2.67 II	2.60 II	2.67 II
3	Utility			
	Suitable for the its purpose	2.67 I	2.66 II	2.63 II
	It is suitable for congenial usage	2.40 III	2.50 III	2.50 IV
	An innovative idea to reuse waste cloth into new form	2.50 II	2.70 I	2.65 I
	Good market potential	2.23 IV	2.45 IV	2.55 III
4	Appearance			
	Attractive	2.78 I	2.70 I	2.66 I
	As per the trend	2.50 IV	2.50 IV	2.41 IV
	Innovative	2.70 III	2.67 II	2.56 III
	Appealing overall appearance	2.75 II	2.63 III	2.60 II

Consumers' opinions regarding the 'design' for table mat design no. 9 was 'attractive' ranked Ist (WMS 2.75) followed by 'colour combination is appropriate' ranked IInd (WMS 2.67), 'suitable as per selected technique' ranked IIIrd (WMS 2.63), 'used embellishment materials give new look' ranked IVth (WMS 2.59), 'harmonize with fabric' ranked Vth (WMS 2.56) and 'constructional designing features are suitable' ranked VIth (WMS 2.55).

Consumers' opinions regarding the 'utility' for tablemat design no.6 was 'suitable for its purpose' ranked Ist (WMS 2.67) followed by 'an innovative idea to reuse the waste cloth into new form' ranked IInd (WMS 2.50), 'it is suitable for congenial usage' ranked IIIrd (WMS 2.40), and 'good market potential' ranked IVth (WMS 2.23) .

Consumers' opinions regarding the 'utility' for table mat design no. 7. was 'an innovative idea to reuse the waste cloth into new form' ranked Ist (WMS 2.55) followed by 'suitable for its purpose' ranked IInd (WMS 2.66), 'it is suitable for congenial usage' ranked IIIrd (WMS 2.50) and 'good market potential' ranked IVth (WMS 2.45).

Consumers' opinions regarding the 'utility' for table mat design no. 9 was 'an innovative idea to reuse the waste cloth into new form' ranked Ist (WMS 2.65) followed by 'suitable for its purpose' ranked IInd (WMS 2.63), 'good market potential' ranked IIIrd (WMS 2.55) and 'it is suitable for congenial usage' ranked IVth (WMS 2.50).

Consumers' opinions regarding the 'appearance' for table mat design no. 6 was 'attractive' ranked Ist (WMS 2.78) followed by 'appealing overall appearance' ranked IInd (WMS 2.75), 'innovative' ranked IIIrd (WMS 2.70) and 'as per the trend' ranked IVth (WMS 2.50).

Consumers' opinions regarding the 'appearance' for table mat design no. 7 was 'attractive' ranked Ist (WMS 2.70) followed by 'innovative' ranked IInd (WMS 2.67) 'appealing overall appearance' ranked IIIrd (WMS 2.63), and 'as per the trend' ranked IVth (WMS 2.50).

Consumers' opinions regarding the 'appearance' for table mat design no. 9 was 'attractive' ranked Ist (WMS 2.66) followed by 'appealing overall appearance' ranked IInd (WMS 2.60), 'innovative' ranked IIIrd (WMS 2.56) and 'as per the trend' ranked IVth (WMS 2.41).

Consumers' opinion for developed cushion cover

Cushion cover were assessed by the consumers on various parameters viz. texture, design, utility, appearance and the results are presented in table 40. It was envisaged from the data regarding 'texture' of the fabric for cushion cover design no. 4, was 'thickness of fabric is appropriate' ranked Ist (WMS 2.85) followed by 'suitable as per the product design' ranked IInd (WMS 2.85), 'used accessories enhanced the look' ranked IIIrd (WMS 2.78) , 'suitable as per the surface enrichment technique used' ranked IVth (WMS 2.75), and 'constructional designing features are appropriate as per the design and texture' ranked Vth (WMS 2.67).

Table 40: Consumers' opinion for developed cushion cover

n=30

Sr. No.	Cushion cover	Design no.		
	Parameters	4	7	8
1	Texture	WMS RANK	WMS RANK	WMS RANK
	Thickness of fabric is appropriate	2.85 I	2.55 IV	2.50 IV
	Suitable as per the product design	2.88 II	2.45 V	2.41 V
	Suitable as per the surface enrichment technique used(screen printing+ Hand embroidery)	2.75 IV	2.80 I	2.60 III
	Constructional designing features are appropriate as per the design and texture	2.67 V	2.60 III	2.75 I
	Used accessories (piping, ribbon) enhanced the look	2.78 III	2.75 II	2.65 II
2	Design			
	Attractive	2.85 III	2.88 I	2.64 V
	Construction designing features are suitable	2.70 VI	2.75 IV	2.50 VI
	Suitable as per the selected technique (screen printing + hand embroidery)	2.88 IV	2.85 II	2.72 I
	Used embellishment materials give new look	2.72 V	2.78 III	2.67 IV
	Harmonize with fabric	2.75 IV	2.66 VI	2.70 III
	Colour combination is appropriate	2.90 I	2.70 V	2.71 I
3	Utility			
	Suitable for the its purpose	2.90 I	2.82 II	2.65 II
	It is suitable for congenial usage	2.88 II	2.88 I	2.55 III
	An innovative idea to reuse waste cloth into new form	2.85 III	2.78 III	2.70 I
	Good market potential	2.75 IV	2.75 IV	2.41 IV
4	Appearance			
	Attractive	2.67 II	2.85 III	2.70 III
	As per the trend	2.55 IV	2.88 II	2.72 II
	Innovative	2.62 III	2.70 IV	2.50 IV
	Appealing overall appearance	2.77 I	2.90 I	2.85 I

Consumers' opinions regarding the 'texture' of fabric for the cushion cover design no. 7, was 'suitable as per the surface enrichment technique used' ranked Ist (WMS 2.80) followed by 'used accessories enhanced the look' ranked IInd (WMS 2.75), 'constructional designing features are appropriate as per the design and texture' ranked IIIrd (WMS 2.60), and 'thickness of the fabric is appropriate' ranked IVth (WMS 2.55) and 'suitable as per the product design' ranked Vth (WMS 2.45).

Consumers' opinions regarding the 'texture' of fabric for cushion cover design no. 8 was 'constructional designing features are appropriate as per the design and texture' ranked Ist (WMS 2.75) followed by 'used accessories enhanced the look' ranked IInd (WMS 2.65), 'suitable as per the surface enrichment technique used' ranked IIIrd (WMS 2.60), 'thickness of the fabric is appropriate' ranked IVth (WMS 2.50), 'suitable as per the product design' with weighted mean score ranked Vth (WMS 2.41).

Consumers' opinions regarding the 'design' for cushion cover design no.4 was 'colour combination is appropriate' ranked Ist (WMS 2.90) followed by 'suitable as per selected technique' ranked IInd (WMS 2.88), 'attractive' ranked IIIrd (WMS 2.85), 'harmonize with fabric' ranked IVth (WMS 2.75), 'used embellishment materials give new look' ranked Vth (WMS 2.72) and 'constructional designing features are suitable' ranked VIth (WMS 2.70).

Consumers' opinions regarding the 'design' for cushion cover design no. 7 was 'attractive' ranked Ist (WMS 2.88) and followed by 'suitable as per selected technique' ranked IInd (WMS 2.85), 'used embellishment materials give new look' ranked IIIrd (WMS 2.85), 'constructional designing features are suitable' ranked IVth (WMS 2.75), 'colour combination is appropriate' ranked Vth (WMS 2.70) and 'harmonize with fabric' ranked VIth (WMS 2.66).

Consumers' opinions regarding the 'design' for cushion cover design no. 8 was 'suitable as per selected technique' ranked Ist (WMS 2.72) and followed by 'colour combination is appropriate' ranked IInd (WMS 2.71), 'harmonize with fabric' ranked IIIrd (WMS 2.70), 'used embellishment materials give new look' ranked IVth 2.67(IV), 'attractive' with weighted mean score ranked IVth 2.64(V) and 'constructional designing features are suitable' with weighted mean score 2.50 ranked VIth.

Consumers' opinions regarding the 'utility' for cushion cover design no.4 was 'suitable for its purpose' ranked Ist (WMS 2.90) followed by 'it is suitable for congenial usage' ranked IInd (WMS 2.88), 'an innovative idea to reuse the waste cloth into new form' ranked IIIrd (WMS 2.85), and 'good market potential' ranked IVth (WMS 2.75).

Consumers' opinions regarding the 'utility' for cushion cover design no.7 was 'it is suitable for congenial usage' ranked Ist (WMS 2.88) followed by 'suitable for its purpose' ranked IInd (WMS 2.88), 'an innovative idea to reuse the waste cloth into new form' ranked IIIrd (WMS 2.78), and 'good market potential' ranked IVth (WMS 2.75).

Consumer's opinions regarding the 'utility' for cushion cover design no.8 was 'it is suitable for congenial usage' ranked Ist (WMS 2.88) followed by 'suitable for its purpose' ranked IInd (WMS 2.82), 'an innovative idea to reuse the waste cloth into new form' ranked IIIrd (WMS 2.78), 'and 'good market potential' ranked IVth (WMS 2.75).

Consumers' opinions for regarding the 'appearance' for cushion cover design no. 4 was 'appealing overall appearance' ranked Ist (WMS 2.78) followed by 'attractive' ranked IInd (WMS 2.67), 'innovative' ranked IIIrd (WMS 2.70) and 'as per the trend' ranked IVth (WMS 2.50).

Consumers' opinions for regarding the 'appearance' for cushion cover design no. 7 and 8 that 'appealing overall appearance' ranked Ist (WMS 2.90 and 2.85) followed by 'as per the trend' ranked IInd (WMS 2.88, 2.72), 'attractive' ranked IIIrd (WMS 2.85, 2.70) and 'innovative' ranked IVth (WMS 2.70 and 2.50).

Consumers' opinion for developed *mudha* cover

Mudha cover were assessed by the consumers on various parameters viz. texture, design, utility, appearance and the results presented in table 41. It was envisaged from the data regarding 'texture' of the fabric for *mudha* cover design no. 1, was 'thickness of fabric is appropriate' ranked Ist (WMS 2.90) followed by 'suitable as per the surface enrichment technique used' ranked IInd (WMS 2.85), 'constructional designing features are appropriate as per the design and texture' with ranked IIIrd (WMS 2.80), 'used accessories enhanced the look' ranked IVth (WMS 2.75), 'suitable as per the product design' ranked Vth (WMS 2.75).

Consumers' opinions regarding the 'texture' of fabric for the *mudha* cover design no. 3, was 'suitable as per the product design' ranked Ist (WMS 2.70) followed by 'thickness of the fabric is appropriate' ranked IInd (WMS 2.55), 'constructional designing features are appropriate as per the design and texture' ranked IIIrd (WMS 2.50), 'used accessories enhanced the look' ranked IVth (WMS 2.41) 'suitable as per the surface enrichment technique used ranked Vth (WMS 2.50).

Consumers' opinions regarding the 'texture' for the *mudha* cover design no. 7, was 'suitable as per the product design' ranked Ist (WMS 2.50) followed by 'thickness of the fabric is appropriate' ranked IInd (WMS 2.41), 'suitable as per the surface enrichment technique used' ranked IIIrd (WMS 2.40), 'constructional designing features are appropriate as per the design and texture' ranked IVth (WMS 2.25) and 'used accessories enhanced the look' ranked Vth (WMS 2.15).

Consumers' opinions regarding the 'design' for *mudha* cover design no.1 was 'attractive' ranked Ist (WMS 2.55) followed by 'suitable as per selected technique' ranked IInd (WMS 2.50), 'harmonize with fabric' ranked IIIrd (WMS 2.41), 'colour combination is appropriate' ranked IVth (WMS 2.33), 'constructional designing features are suitable' ranked Vth (WMS 2.25), 'used embellishment materials give new look' ranked VIth (WMS 2.20).

Table 41: Consumers' opinion for developed *mudha* cover

n=30

Sr. No.	<i>Mudha</i> cover	Design no.		
	Parameters	1	3	7
		WMS RANK	WMS RANK	WMS RANK
1	Texture			
	Thickness of fabric is appropriate	2.90 I	2.55 II	2.41 II
	Suitable as per the product design	2.75 V	2.70 I	2.50 I
	Suitable as per the surface enrichment technique used(screen printing+ Hand embroidery)	2.85 II	2.33 IV	2.40 III
	Constructional designing features are appropriate as per the design and texture	2.80 III	2.50 III	2.25 IV
	Used accessories (piping, ribbon) enhanced the look	2.78 IV	2.41 IV	2.15 V
2	Design			
	Attractive	2.55 I	2.50 I	2.60 I
	Construction designing features are suitable	2.25 V	2.40 III	2.41 V
	Suitable as per the selected technique (screen printing + hand embroidery)	2.50 II	2.30 IV	2.55 II
	Used embellishment materials give new look	2.20 VI	2.15 VI	2.33 VI
	Harmonize with fabric	2.41 III	2.25 V	2.45 IV
	Colour combination is appropriate	2.33 IV	2.41 II	2.50 IV
3	Utility			
	Suitable for the its purpose	2.50 II	2.50 II	2.45 III
	It is suitable for congenial usage	2.45 III	2.41 III	2.30 IV
	An innovative idea to reuse waste cloth into new form	2.70 I	2.65 I	2.55 I
	Good market potential	2.30 IV	2.33 IV	2.50 II
4	Appearance			
	Attractive	2.50 I	2.56 I	2.70 I
	As per the trend	2.15 IV	2.41 II	2.40 IV
	Innovative	2.25 III	2.40 III	2.55 III
	Appealing Overall appearance	2.44 II	2.33 IV	2.65 II

Consumers' opinions regarding the 'design' for *mudha* cover design no. 3 was 'attractive' ranked Ist (WMS 2.50) followed by 'colour combination is appropriate' ranked IInd (WMS 2.41), 'constructional designing features are suitable' ranked IIIrd (WMS 2.40), 'suitable as per selected technique' ranked IVth (WMS 2.30), 'harmonize with fabric' ranked Vth (WMS 2.25), and 'used embellishment material give new look' ranked VIth (WMS 2.15).

Consumers' opinions regarding the 'design' for *mudha* cover design no.7 was 'attractive' ranked Ist (WMS 2.60) followed by 'suitable as per selected technique' ranked IInd (WMS 2.55), 'colour combination is appropriate' ranked IIIrd (WMS 2.50), 'harmonize with fabric' ranked IVth (WMS 2.45), 'constructional designing features are suitable' ranked Vth (WMS 2.41), 'used embellishment materials give new look' ranked VIth (WMS 2.23).

Consumers' opinions for regarding the 'utility' for *mudha* cover design no.1 and 3 was 'an innovative idea to reuse the waste cloth into new form' ranked Ist (WMS 2.70 and 2.65) followed by 'suitable for its purpose' ranked IInd (WMS 2.50) each, 'it is suitable for congenial usage' ranked IIIrd (WMS 2.45, 2.41) and 'good market potential' ranked IVth (WMS 2.30, 2.33).

Consumers' opinions for regarding the 'utility' for *mudha* cover design no.7 was 'an innovative idea to reuse the waste cloth into new form' ranked Ist (WMS 2.55) followed by 'good market potential' ranked IInd (WMS 2.50), 'suitable for its purpose' ranked IIIrd (WMS 2.45) and 'it is suitable for congenial usage' ranked IVth (WMS 2.30).

Consumers' opinions for regarding the 'appearance' for *mudha* cover design no. 1 was 'attractive' ranked Ist (WMS 2.50) followed by 'appealing overall appearance' ranked IInd (WMS 2.44), 'innovative' ranked IIIrd (WMS 2.25) and 'as per the trend' ranked IVth (WMS 2.15).

Consumers' opinions for regarding the 'appearance' for *mudha* cover design no. 3 was 'attractive' ranked Ist (WMS 2.56) followed by the 'as per the trend' ranked IInd (WMS 2.44), 'innovative' ranked IIIrd (WMS 2.25) and 'appealing overall appearance' ranked IVth (WMS 2.33).

Consumers' opinions for regarding the 'appearance' for *mudha* cover design no. 7 was 'attractive' ranked Ist (WMS 2.70) followed by 'appealing overall appearance' ranked IInd (WMS 2.65), 'innovative' ranked IIIrd (WMS 2.55) and 'as per the trend' ranked IVth (WMS 2.40).

Consumers' opinion for developed ladies shirt

Ladies shirt were assessed by the consumers on various parameters viz. texture, design, utility, appearance and the results presented in table 42. It was envisaged from the data regarding 'texture' of the fabric for ladies shirt design no. 4, was 'suitable as per the surface enrichment technique used' ranked Ist (WMS 2.20) followed by 'suitable as per the product design' ranked IInd (WMS 2.15), 'constructional designing features are appropriate as per the design and texture' with ranked IIIrd (WMS 2.01), 'thickness of fabric is appropriate' ranked IVth (WMS 2.00), and 'used accessories enhanced the look' ranked Vth (WMS 1.90).

Table 42: Consumers' opinion for developed ladies shirt

n=30

Sr. No.	Ladies shirt Parameters	Design no.		
		4	6	9
		WMS RANK	WMS RANK	WMS RANK
1	Texture			
	Thickness of fabric is appropriate	2.00 IV	2.00 V	2.01 V
	Suitable as per the product design	2.15 II	2.05 III	2.20 III
	Suitable as per the surface enrichment technique used(screen printing+ Hand embroidery)	2.20 I	2.15 I	2.41 I
	Constructional designing features are appropriate as per the design and texture	2.01 III	2.06 II	2.25 II
	Used accessories (piping, ribbon) to prepare article are enhanced the look	1.90 VI	2.03 IV	2.04 IV
2	Design			
	Attractive	1.90 VI	1.75 VI	1.65 VI
	Construction designing features are suitable	2.05 III	2.01 V	1.70 V
	Suitable as per the selected technique (screen printing + hand embroidery)	2.06 II	2.24 I	2.00 III
	Used embellishment materials give new look	2.03 IV	2.03 IV	1.90 IV
	Harmonize with fabric	2.00 V	2.20 II	2.01 II
	Colour combination is appropriate	2.13 I	2.06 III	2.05 I
3	Utility			
	Suitable for the its purpose	2.60 I	2.40 I	2.50 I
	It is suitable for congenial usage	2.33 IV	1.75 IV	2.33 II
	An innovative idea to reuse waste cloth into new form	2.45 II	2.00 II	2.01 IV
	Good market potential	2.41 III	1.90 III	2.41 II
4	Appearance			
	Attractive	2.00 I	2.03 I	2.00 II
	As per the trend	1.70 IV	2.00 III	1.95 III
	Innovative	1.75 III	1.90 IV	1.90 IV
	Appealing overall appearance	1.90 II	2.01 II	2.40 I

Consumers' opinions regarding the 'texture' of fabric for the ladies shirt design no. 6 and 9, were 'suitable as per the surface enrichment technique used' ranked Ist (WMS 2.15 and 2.41) followed by 'constructional designing features are appropriate as per the design and texture' ranked IInd (WMS 2.06, 2.25), 'suitable as per the product design' ranked IIIrd (WMS 2.05, 2.20), 'used accessories enhanced the look' ranked IVth (WMS 2.03, 2.04) weighted mean score and 'thickness of the fabric is appropriate' ranked Vth (WMS 2.00, 2.01 each).

Consumers' opinions regarding the 'design' for ladies shirt design no.4 was 'colour combination is appropriate' ranked Ist (WMS 2.13) followed by 'suitable as per selected technique' ranked IInd (WMS 2.06), 'constructional designing features are suitable' ranked IIIrd (WMS 2.05), 'used embellishment materials give new look' ranked IVth (WMS 2.03), 'harmonize with fabric' ranked Vth (WMS 2.00) and 'attractive' ranked VIth (WMS 1.90).

Consumers' opinions regarding the 'design' for ladies shirt design no. 6 was 'suitable as per selected technique' ranked Ist (WMS 2.24) followed by 'harmonize with fabric' ranked IInd (WMS 2.20), 'colour combination is appropriate' ranked IIIrd (WMS 2.06), 'used embellishment material give new look' ranked IVth (WMS 2.03), 'constructional designing features are suitable' ranked Vth (WMS 2.01), and 'attractive' ranked VIth (WMS 1.75).

Consumers' opinions regarding the 'design' for ladies shirt design no.9 was 'colour combination is appropriate' ranked Ist (WMS 2.05) followed by 'harmonize with fabric' ranked IInd (WMS 2.01), 'suitable as per selected technique' ranked IIIrd (WMS 2.00), 'used embellishment materials give new look' ranked IVth (WMS 1.90), 'constructional designing features are suitable' ranked Vth (WMS 1.70) and 'attractive' ranked VIth (WMS 1.65).

Consumers' opinions regarding the 'utility' for ladies shirt design no.4 and 6 were 'suitable for its purpose' ranked Ist (WMS 2.60 and 2.40) followed by 'an innovative idea to reuse the waste cloth into new form' ranked IInd (WMS 2.45 and 2.00) each, 'good market potential' ranked IIIrd (WMS 2.41 and 1.90), 'it is suitable for congenial usage' ranked IVth (WMS 2.33, 1.75).

Consumers' opinions regarding the 'utility' for ladies shirt design no.9 was 'suitable for its purpose' ranked Ist (WMS 2.50) followed by 'good market potential' ranked IInd (WMS 2.41), 'it is suitable for congenial usage' ranked IIIrd (WMS 2.33) and 'an innovative idea to reuse the waste cloth into new form' ranked IVth (WMS 2.01).

Consumers' opinions regarding the 'appearance' for ladies shirt design no. 4 was 'attractive' ranked Ist (WMS 2.00) followed by 'appealing overall appearance' ranked IInd (WMS 1.90), 'innovative' ranked IIIrd (WMS 1.75) and 'as per the trend' ranked IVth (WMS 1.70).

Consumers' opinions regarding the 'appearance' for ladies shirt design no. 6 was 'attractive' ranked Ist (WMS 2.03) followed by 'appealing overall appearance' ranked IInd

(WMS 2.01), ‘as per the trend’ ranked IIIrd (WMS 2.00) and ‘innovative’ ranked IVth (WMS 1.90).

Consumers’ opinions regarding the ‘appearance’ for ladies shirt design no. 9 was ‘appealing overall appearance’ ranked Ist (WMS 2.40) followed by ‘attractive’ ranked IInd (WMS 2.00), ‘as per the trend’ ranked IIIrd (WMS 1.95) and ‘innovative’ ranked IVth (WMS 1.90).

Table 43: Consumers’ overall acceptance for different parameters for the developed products n=30

Products	Texture WMS	Design WMS	Utility WMS	Appearance WMS	Average WMS Score	Rank
Curtain	2.03	1.90	1.75	2.10	1.94	IV
Table mat	2.35	2.78	2.10	2.39	2.40	III
Cushion cover	2.56	2.34	2.77	2.70	2.59	I
Mudha cover	2.60	2.56	2.85	2.66	2.66	II
Ladies shirt	1.60	1.62	1.60	1.66	1.62	V

Highly acceptable = 2.34-3.00, Acceptable = 1.67-2.33, Least acceptable = 1.00-1.66

The data in table 43 indicated overall acceptance of consumers for the developed products on different parameters of texture, design, utility, appearance. It was found that cushion cover, *mudha* cover and table mat with 2.59, 2.66 and 2.40 average weighted mean scores were highly acceptable. Curtain with 1.94 average WMS was acceptable and the ladies shirt with 1.62 average WMS was least acceptable by the consumers.

Table 44: Cost acceptability of the developed products n=30

Developed products	Total cost (Rs.)	Cost acceptance	
		High	Appropriate
Curtain	865	12(40)	18(60)
Table mat	240	6(20)	24(80)
Cushion cover	220	15(50)	15(50)
Mudha cover	390	4(13.33)	26(86.66)
Ladies shirt	965	23(76.66)	7(23.33)

*Screen cost is excluded because it is one time investment

Regarding the cost of developed products, majority of the consumers opined appropriate for *mudha* cover by (86.66%), table mat (80.00%), curtain (60.00%) and cushion cover (50.00%). The cost of ladies shirt was considered to be higher by 76.66% consumers. It is thus concluded from the data that majority of the consumers rated the cost of developed products as appropriate except ladies shirt.

Table 45: Consumers' opinion on general acceptability of shoddy products n=30

Sr. No.	Statements	WMS	Rank
1	Recycling generate new idea	2.70	V
2	The product developed with recycled material is innovative source for small scale entrepreneurs	2.56	VI
3	Recycling is eco friendly process	2.75	III
4	Recycled fabric is appropriate for reuse into different forms	2.80	I
5	Acceptance of such developed products will increase employments in shoddy industry	2.76	II
6	Blended recycled textiles is a good option for economic buyers	2.40	X
7	Shoddy products are low cost and eco-friendly	2.50	VIII
8	Surface enrichment techniques enhances the look of the products	2.72	IV
9	It is creative idea for further research work	2.50	VIII
10	Like to purchase shoddy blended products	2.55	VII

Consumers' opinions were studied on general acceptability of shoddy products. The data in the table 45 indicated that consumers had high opinion as they strongly agreed to all the opinion statements as indicated by the weighted mean scores ranged from 2.40-2.80 as almost similar WMS were obtained with very little difference for each opinion statement. It is indicated that consumers' were strongly agreed for each parameter of assessment.

4.11 Preparation of design catalogue

A design catalogue was prepared with the help of suitable CAD software i.e. CorelDRAW-12 to develop a repository of design. It comprised (50) constructional designs of developed product, (50) screen printing designs and (45) design placements.

The present study was carried out to develop the products using cotton blended shoddy yarns. The chapter presents the discussion regarding the findings of the research study. The results of the present study have been discussed under the following sections:

- 5.1 Existing status of shoddy industries
- 5.2 Usage pattern of shoddy industries
- 5.3 Selection of yarn for product development
- 5.4 Physical testing of shoddy yarn
- 5.5 Selection of products, preparation of fabric and physical testing of shoddy fabric
- 5.6 Creation of designs for selected products
- 5.7 Selection of surface enrichment techniques
- 5.8 Creation and selection of design and design placement
- 5.9 Development of products and their cost estimation
- 5.10 Assessment of developed products
- 5.11 Preparation of design catalogue

5.1 Existing status of shoddy industries: The information about the existing status of shoddy industries was gathered from selected ten shoddy industries of Panipat and were studied with respect to personal profile of the owners, place of the unit, establishment year of unit, nature of unit, size of the unit, ownership pattern, factory premises, work experience, employee profile, facilities provided to the employees and health problems faced by owners/representative and the employees.

In the present research it was found that majority of the owners (70.00%) was in age group of above 50 years and was graduate. The owners might not go for higher studies because of ancestral business and at young age joined their family business. Majority of the owners (80.00%) were married, had nuclear family type and small family size (60.00%) each. Majority of the owners (80.00%) had above 30 years work experience in that field. The owners had good working experience in shoddy industry being family business.

Saini et al. (2018) studied the existing status of twenty woollen shoddy industries of Panipat (yarn & product manufacturing, ten each). The results indicated that the owners of 40 percent of yarn manufacturing units belonged to age group between 31-70 years whereas in product manufacturing units, 50 percent owners belonged to age group of 55-70 years. It was found that in yarn manufacturing units, 70 percent of the owners were graduate and only 30 percent owners were post graduate whereas in product manufacturing units 60 percent owners were graduate and 40 percent were post graduate.

Rathi (2017) stated that there were around 600 to 700 shoddy yarn and textile manufacturers in Panipat until 2012 and the numbers of units were decreasing yearly. Around 30,000 to 40,000 kg of old clothes comes to factory every day. Many organizations like the UN, non-profits organization, government organization, the army, hospitals and even prisons buy shoddy blankets.

The selected ten cotton blended shoddy industries in Panipat were established from 1970 onwards. Twenty percent industries established during the years 1970-80 followed by 40.00 percent established between the years 1981-90. Majority of the industries (70.00%) were started with amount Rs. 30 to 50 lac as capital investment followed by 20.00 percent industries were started with amount below Rs. 30 lac and 10.00 percent industries were started with capital investment of above Rs. 50 lac. Half of the industries (50.00%) had annual turnover of Rs. 50 lac to 1 crore followed by below Rs.50 lac (30.00%) and 20.00 percent shoddy industries had annual turnover of above Rs.1 crore.

Gupta and Saggi (2015) elicit the general information regarding shoddy units of Ludhiana and Amritsar districts of Punjab. The results revealed that the shoddy units were established during the year 1981-1990 with an initial capital investment limit of Rs 5-10 crore (67%) followed by Rs 10-15 crore (33%).

Crang et al. (2013) stated that textile recyclers promote themselves as green businesses, reducing waste, supporting government targets and supplying export markets with affordable clothing. They found the second hand clothing economy is a profitable and rapidly expanding secondary market controlled largely by recyclers and brokers with international networks of buyers and efficient sorting systems.

Norris (2011) reported that up to 15% of all the worn clothing collected in the UK is sold for fibre recycling. A major portion is sold to recycling factories in India. The town of Panipat, in Haryana, north India, is the centre of the global shoddy industry, which recycles worn clothing by reclaiming their fibres and spinning them into regenerated yarn. Over 300 mills in Panipat import about 100,000 tonnes of used clothing each year, cast off by consumers from the US, UK, Germany and the Far East. The industries destroy the garments completely, reducing them to a tangled mess of fibres that can be transformed into yarns and woven into fabric.

Regarding the manpower employed in the industries resulted that there were about 2040 total employees including managers, supervisors and other skilled, semi-skilled and unskilled workers in all the selected industries. It was found that there were more skilled male workers (410) as compared to female workers (115). There was approximately equal number of male (215) & female (200) workers working as semi skilled worker. Majority of the female workers were under the categories of unskilled workers (600) as compared to male (460). It was found that no child worker was found in any of the industry.

Anonymous (2012) reported that most textile recycling firms were small, family-owned businesses with less than 500 employees. Majority of the industries employ between 35 to 50 workers, many of whom were semi-skilled or marginally employable workers. These results were also supported by **Gupta and Saggi (2015)** studied that maximum numbers of workers were unskilled males in shoddy units of Ludhiana and Amritsar.

Results regarding the facilities provided in selected ten shoddy industries indicated that medical facilities, sanitary facility, changing room and canteen facilities were provided by all the industries (100.00% each). Majority of industries (80.00%) gave bonus on festivals in form of gifts, sweets and clothes etc.

Different problems faced in the industries resulted that managerial problems i.e. price inflation of raw materials, lack of govt. support and technical problem i.e. electricity faced by all of the owners/representative (100.00%). Problems faced by the employees were studied on randomly selected respondents resulted that allergy problem reported by unskilled workers (100.00%) and supervisors (33.00%). Breathing problems reported by unskilled and semi-skilled workers and supervisors (100.00% each). Skin problem reported by unskilled (70.00%), semiskilled (64.00%) and skilled workers (40.00%). Uncomfortable environment reported by unskilled and semi-skilled workers (50.00% each). Administrative problems like parking problem reported by skilled (80.00%) and semi-skilled workers (60.00%). Electricity and lack of employees with technical experience problems were reported by managers in all the selected industries (100.00%).

5.2 Usage pattern of shoddy industries: Information on existing usage pattern from selected ten shoddy industries was collected with respect to sources of procurement of raw material, form of raw material procured, storage facility, techniques and production processes for making yarns and fabrics, purchasing factors considered for raw materials, type of rags, blend proportions of cotton blended shoddy yarn, yarn count, ply of yarn, type of weaves used for fabric preparation, selection of colour of rags and products, test performed, accessories used for product development, method of labeling on product, distribution channels and marketing of products.

Regarding the sources of procurement of raw materials resulted that fifty percent raw material was purchased from the industries as number of handloom & mills are located in Panipat city followed by 40.00 percent from the scrap shops, 20.00 percent from the vendors. From the other places of Haryana state, the raw material was purchased through marketing channel (70.00%). Fifty percent of raw materials purchased from the other countries and twenty percent from other places of India.

Handique (2017) reported that second hand garments from the West have created a thriving business in India as cheap clothing for millions of the country's poor. The trendies lots routinely resurface in urban flea markets such as Sarojini Nagar in New Delhi and

Linking Road in Mumbai, where fashionable college goers and their mothers pluck bargains at lower rates. But now a huge amount of discard from well-heeled consumers in the US, Canada and South Korea are ending up in Panipat.

Pant and Nagpal (2016) reported that shoddy is a well renowned industry of Panipat mainly focus on recycling of rags through yarn making in which rags were imported from western society and studied that the strength of imported rags was higher as compared to India.

Regarding the form of raw material procured in the shoddy industries resulted that 100.00 percent industries procured in the form of rags and leftover from handloom & mills leftovers followed by cuttings of old rags (90.00%) and tailor waste (20.00%). Factors considered for purchasing raw material were quality of rags (100.00%) followed by price of rags and colour of rags and as per the requirement of product preparation.

Gupta and Saggi (2015) supported these results that colour was highly preferred for procuring the raw materials and quality of spinning while making the products from shoddy yarn in Ludihana. In Amritsar preference regarding the procurement of the raw material were same as in Ludihana as grade of wool was highly preferred for making the textile products from shoddy yarn.

Sule *et al.* (2012) studied that at least 3-4% of the weft yarn including catch ends is unavoidable waste in every type of weaving machine. The catch selvedge yarn strip was sold at throw away price. The fibres were separated by the garnetter which used them for stuffing of pillows and quilts. Some used this waste for making fancy composites for floor covering. By using 100% wool yarn as weft or polyester-wool blended yarn, the wool rich catch selvedge can be rag to recover fibres to feed to the woollen cards to produce blankets which had a market in cooler regions. This was found cost-effective solution and provided the wool rich raw materials needed for producing blankets.

Selected industries (100.00%) used different types of rags as raw material to make cotton blended shoddy yarn viz. cotton/ cotton blends and wool/ wool blends (100.00%), acrylic/acrylic blends (80.00%), polyester/ polyester blends (70.00 %) and nylon/ nylon blends (40.00%).

The results were supported by Saini *et al.* (2018) studied the status and usage practices of shoddy woolen industries resulted that wool, polyester and acrylic were used by as raw material followed by cotton in less.

Verma (2017) studied the selected shoddy industries of Panipat. Cotton pants and T-shirts was used to make mats and around 30 units produce 500 tones of recycled yarn a day.

Leonas (2017) stated that recycled materials used in textile and apparel products can be obtained throughout the textile and apparel supply chain and post-consumer collection methods. The use of recycled raw materials aligned with the larger movements of global

industries toward a circular economy (vs. linear) and working to achieve a closed-loop production cycle.

Anonymous (2013) studied the up-cycling designing techniques and observed that million of tones of textiles are wasted during textiles and garment production, before the clothes even reach to the consumers. It was estimated that approximately 15% of textiles intended for clothing ends up on the cutting room floor.

Anonymous (2012) reported that approximately 500 million pounds of textiles collected are used by the collecting agency, with the balance sold to textile recyclers, including used clothing dealers and exporters, wiping rag graders, and fiber recyclers.

Yeboah (2011) studied that the waste fabrics comprised pieces of linen, cotton, acetate, nylon, polyester and wool fabrics from cutting floors of garment manufacturers and old cloths that are no more of use to their owners, were combined with paper mulberry inner back in the ratio of 30% paper mulberry and 70% waste fabrics to produce handmade papers.

Kaplan (2008) investigated that wool, discarded woollen garments, new pieces of woollen fabrics, and rags were used which included old scraps of cloth like men's and women's worn out garments, suiting, coats, sweaters, stockings, etc. were taken as the primary raw material which normally were imported from Australia, Belgium, New Zealand, Argentina and United Kingdom. Locally available wool was used for manufacturing of blankets, lining of flasks, etc. to some extent. Woollen shoddy was normally used for making readymade garments, whereas, synthetic shoddy was mainly suited for blankets.

Selected industries prepared the cotton blended shoddy yarn in different blends proportion resulted that 100 percent industries manufactured cotton with acrylic blend (above 20-40%), cotton with polyester blend (below 20 %) in 2.5s, 4s, 6s, 8s & 10s and cotton with acrylic blend (below 20%) in 4s, cotton with polyester blend (above 20-40%) in 2.5s, cotton with nylon blend (below 20 %) in 2.5 and 4s. Seventy to sixty percent industries manufactured shoddy yarn of cotton with acrylic blend (below 20%) in 10s, cotton with nylon blend (below 20%) in 6s, 8s & 10s, cotton with other fibre blend (below 20%) in 2.5s (70% industries). Cotton with acrylic blend (below 20%) in 2.5s, 6s, 8s, cotton with nylon blend (above 20-40%) in 2.5s were manufactured by (60% industries). Fifty percent industries manufactured cotton with polyester blend (above 20-40%) in 4s, cotton with nylon blend (above 20-40%) in 4s, 6s & 8s, cotton with other fiber (below 20%) in 4 & 6s. Cotton with other fibre blend (below 20%) in 8 & 10s were manufactured by 40% industries. Twenty and ten percent industries manufactured shoddy yarn of cotton with polyester blend (above 20-40%) in 6 & 10s (20%) and in 8s (10 %).

Research study conducted by **Saini et al. (2018)** resulted that selected shoddy unit of Panipat (100%) used acrylic, polyester and wool fibres in the form of waste pieces/ rags for manufacturing of blended shoddy yarn of different fibre compositions. The composing of

acrylic and polyester fibres was varied from 5 to 40 percent. Seventy percent shoddy units used cotton fibre for blending with other fibres from 5 to 10 percent for preparation of recycled shoddy yarns of different blend composition.

Results regarding the type of ply, colour of rags and test performed for shoddy yarn/fabric indicated that all the selected industries (100.00%) manufactured the 2 ply cotton blended shoddy yarn whereas (20.00%) manufactured 4 ply cotton blended shoddy yarn as per the requirement of the product to be prepared.

Results indicated that all industries (100.00%) tested the yarn count, blend test, twist per inch (TPI) and yarn strength & elongation of prepared cotton blended shoddy yarn. It was studied from the data that all the industries (100.00%) tested the fabric count, fabric weight and tensile strength of prepared shoddy fabric for preparing textile products. Majority of the industries (70.00%) tested the fabric thickness and 50.00 percent industries tested bending length.

Regarding the colour criteria for shoddy fabric in the industries resulted that as rags were sorted according to the colour. Therefore, shoddy fabric was prepared as per the availability of colour of rags in all industries (100.00%). During collection of data it was found that prepared fabric was of dark colour in half of the industries and light colour in 40.00 percent industries as per the available rags. Shoddy fabric prepared according to buyers' order in their colour preferences available in the industry (60.00%).

Regarding the type of weaves used, defects in prepared fabric & prepared products in different counts indicated that all the industries (100.00%) made fabrics with plain weave and twill weave followed by rib weave and dobby weave (30.00%) each. Twenty percent industries also made fabrics with the jacquard weave for making different products from cotton blended shoddy fabrics in the industries as per the requirement of the products to be made. Numbers of defects were reported i.e. uneven yarn thickness, slippage of yarn, use of uneven yarn and mismatch of colour in shoddy industries. All the industries reported the slippage of yarn followed by uneven yarn thickness (80.00%), use of uneven yarn (70%) and mismatch of colour (50.00 %).

Regarding the products prepared using cotton blended shoddy fabrics in the industries resulted that shoddy fabrics with 2.5 counts was used to make rugs, foot mats, *khes*, stool mat (100.00%) followed by beach towel (40.00%), contour (20.00%). Shoddy fabrics with 4 counts was used to make rugs, foot mat, stool mat (100.00%) followed by *khes* (90.00%), *durries* (70.00%), beach towel (40.00%) and contour (20.00%). Shoddy fabrics with 6 counts was used to make *khes*, stool mat (100.00%) followed by foot mat (90.00%) and *durries* (60.00%). Shoddy fabrics with 8 counts was used to make *khes* (60.00%) followed by *durries* and beach towel (50.00%) each. Shoddy fabrics with 10 counts was used to make *khes* (70.00%) followed by beach towel (60.00%) and *durries* (50.00%).

Saini et al. (2018) studied that different apparel and house hold textiles like carpets, rugs, mats were manufactured from woollen blended yarn with acrylic, polyester and cotton.

Sharma and Gupta (2012) conducted a study on best out of waste and developed home furnishing articles like bed spread, furnishing fabrics, curtains, *durries*, table covers and many more articles by using old discarded saris. Results revealed that people were highly interested in articles made by utilizing the waste textile materials.

Ravasio (2013) reported that shoddy industry of Panipat which is also known as the global textile recycling capital is feasibly one of the most effective, successful and relatively oldest industrial textile recycling practices in India. Bulk amount of textile wastes especially second hand clothing is used as raw material to generate low quality products like blankets, shawls, carpets etc.

Wood (2011) conducted a study on sustaining crafts and livelihoods: handmade in India. The study revealed that many Indian craft enterprises are adapting traditional skills to create eco products, by reclaiming waste, recycling it and extending the life of a material, and, by ‘up-cycling’ discarded material to create new products. Often, recycled crafts, have emerged as a result of the creative use of waste in urban areas, and provide work to craft innovators.

Thiry (2009) said that reused and recycled into brand new products, recycling old things and makes new again. Consumer’s growing demand for “green” products has driven brands and retailers to offer these items in their product lines. One way to go “green” and still offer the performance properties of synthetic fibres, non-woven fabric is recyclable and reusable to fabricate functional product with high additional value. Non woven fabric selvedge is used for filling toys.

According to **All India Woollen and Shoddy Mills’ Association** bathroom mats made by recycled cotton yarn is a Rs 2,000 crore industry. The business of using recycled acrylic and woollen threads for blanket manufacturing has annual revenues of Rs700-1,000 crore in Panipat alone.

Regarding the accessories used on developed products resulted that all industries used frills, *gote*/band followed by piping/ taping for development of the products.

Priyetta (2011) conducted a study to develop footwear tops using underutilized textile resources. Velvet, brocade, sateen, denim, cotton, silk, knitted macramé, shimmer and jute of underutilized fabrics were top ten favored textile materials to prepare foot wears for casual & formal wears i.e. sandals and baileys respectively using embellishment materials i.e. beads, button, buckles and embroidery on footwear tops.

Regarding the method of labeling on products resulted that removable labels were used by 70 percent industries followed by stitched labels and disposable labels on the prepared products. Regarding the factors considered for calculating the cost of products

resulted that 100 percent industries considered the manufacturing cost, utility of the product followed by overall appearance and texture. Regarding the distribution channels used for marketing of the products resulted that 100 percent marketing of products was done through agents and wholesalers followed by personal contacts and retailer. Hundred percent industries marketed the products in the local market. Majority of the industries (80.00%) marketed the products all over India and 40.00 percent industries export the products through different channels.

Necf *et al.* (2013) conducted a study on recycling the fabric scraps in apparel manufacturing industry with the objective to investigate the usability of recycled garments that are produced from the fabric scraps generated in cutting process of clothing companies. Recycled cotton –polyester (28.50%- 50%) yarns were produced from the scraps. The results indicated that there were no distinctive differences between recycled and virgin garments quality. It was concluded that recycled garments produced from the fabric scraps can be used in apparel manufacturing industry.

5.3 Selected yarn for product development: Selection of yarn for product development was done by collecting the available samples of cotton blended shoddy yarn and fabric samples of different ply i.e. 2ply & 4ply, count i.e. 2.5, 4, 6, 8, 10 and blends proportions i.e. cotton+ acrylic, cotton + polyester, cotton + nylon and cotton + other fibre from the selected shoddy industries. Selection of yarn was done on the basis of experts' preferences for yarn count, ply and blend proportions and fabric samples through physical observations. It was found that cotton with polyester blended (70+30%) in 10s and 2 ply yarn was selected for product development.

5.4 Physical testing of shoddy yarn: The mean twist value of 10s cotton blended shoddy yarn of 2 ply was 13-15 with fibre composition as cotton 70 percent, polyester 30 percent, yarn strength was 18.0+ CN/TEX and CSP(count strength product) value of 10s cotton blended shoddy yarn was 2250±.

Necf *et al.* (2013) conducted research study to investigate the usability of recycled garments that were produced from recycled cotton –polyester (28.50%- 50%) yarns, the fabric scraps generated in cutting process of a clothing companies. The results indicated that there were no distinctive differences between recycled and virgin garments quality. It was concluded that recycled garments produced from the fabric scraps can be used in apparel manufacturing industry.

Mariana ICHIM (2016) research was conducted to evaluate the spinnability of blends containing recycled cotton fibres. Results indicated that as waste percent increases, yarn tenacity and breaking elongation decreased, while yarn tenacity irregularity and mass irregularity on short terms increased.

5.5 Selection of products, preparation of fabrics and physical testing of fabrics:

Selection of products was done by preparing an exhaustive list of products keeping in mind the selected yarn in 10 count and 2 ply yarn. Top ranked five products i.e. curtain, table mat, cushion cover, *mudha* cover and ladies shirt were selected. Out of the collected colour swatches, selected colour listed at serial no. were as 6 for curtain, 3 for table mat and cushion cover, 8 for *mudha* cover and 5 for ladies shirt.

Results regarding the physical properties of fabric indicated that the fabrics were got prepared from Panipat in one of the shoddy industry as per selected specifications i.e. cotton with polyester 70:30 blend proportion, 2ply and 10 count in selected colour for different products. The selected prepared fabric was tested for fabric count, fabric weight, thickness, tensile strength & elongation and bending length using standard test methods.

The mean value of the fabric count was 10 x 9.9 for warp and weft. The mean value of fabric wt. in GSM (gram per square) was 16.4 and fabric thickness was 0.47 mm of 10 count fabric. The mean value of tensile strength was 24.30 and 22.45kg for warp and weft respectively. Warp elongation was 3.9% and weft elongation was 4.5%. The bending length was 1.7 cm and 1.9 cm for warp and weft respectively.

Gupta (2016) studied that development of value added products was done using the shoddy yarn of two counts i.e. 10Nm and 12Nm that was collected from Ludihana and Amritsar for preparing the fabric. These lines were also supported by **Saini *et.al.***, studied that that shoddy woolen yarn of two counts i.e. 10Nm and 12Nm that was selected through weave combination designs for the development of value added products.

Sanches *et al.* (2015) conducted research study on characteristics of knitted fabrics produced from recycled fibres. Recycled knitted fabrics used for clothing manufacture should offer comfort, protection, ease of maintenance, strength and aesthetics. It was found that the 80% polyester-20% recycled polyester yarns was best to produced knitted fabrics because of more resistant, have less dimensional change and absorb moisture better than 50% recycled polyester- 50% cotton fabrics.

Berkalp *et al.* (2013) studied the effect of abrasion on woven twill fabric. After the abrasion of about 3000 cycles the texture of fabric was lost and the fabric surface appears to become fuzzy.

Zhou and Ghosh (2011) reported that the bending length values differentiate from stiff to limp fabrics. Bending length was large for fabrics that were comparatively stiff for their weight and small for fabrics that were comparatively flexible for their weight.

Cheng and Wong (2010) studied that the tearing strength of 2/2 twill was of the greatest value in both the warp and weft direction as tearing strength of fabrics is related to the yarn mobility. 2/2 twill in structure and the interlacing of yarn was less than that of plain

or 2/1 twill. So this fabric exhibits the highest tearing strength regardless of the different dosages of softener used in pre-treatment.

5.6 Creation of constructional designs for selected product: Out of created ten constructional designs for each product, three preferred constructional designs for each product were selected. Hence, fifteen preferred constructional designs were selected. It was found that top three preferred designs for each product were design no.1, 4, 9 for curtain, design no. 9,7,6 for table mat, design no. 4,7,8 for cushion cover, design no. 1,3,7 for *mudha* cover and design no. 4,6,9 for ladies shirt.

Saini et al. (2018) studied the fabric designing for product development by combination of weaves through CAD. Different weave patterns were created through Corel DRAW. Out of eleven different weaves created, top ranked three weaves were selected for creation of weave combination designs. Out of thirty weave combination designs, top ranked six designs were selected on the basis of experts' preferences for preparation of fabrics with different weave combination designs and color combination suitable for the development of the products.

Devi (2015) developed trimmings using underutilized textile materials. Ten designs of laces, borders and twenty designs for tassels were created, out of that four top preferred designs of laces and borders and eight top preferred designs of tassels were used for developing the trimmings using different designing and surface embellishment techniques. It was inferred that the borders, laces and tassels developed using underutilized textile materials were appreciated by majority of the consumers in terms of design, suitability of material, designing techniques and innovative creativity.

Komal (2012) directed study on the development of designs for home textiles from hosiery waste fabrics. Patch work was preferred for developing products from hosiery waste fabrics. Thirty designs were developed through CAD (Corel Draw X4) and total 120 colour schemes created for preferred products were finally used for preparing products by using hosiery waste fabrics having various defects. Bolsters and cushion covers had significantly high commercial viability. The designed products were highly appreciated.

Seema (2011) conducted a study on creative use of discarded textiles. Design developed for each preferred ten articles was done using Corel Draw12. The top ranked design of each article that is children almirah, table mat, laundry bag, runner, multipurpose kit, apron, wall pocket, sports bag, hand towel, bed sheet and baby sleeping bag were prepared using different designing techniques.

Priyanka (2011) conducted a study on creative use of discarded garments. Discarded garments were reused for making ten top ranked products that is bed cover, jewellery box, partition curtain, *saree* storage kit, reversible jacket, laptop bag, wall pocket, gift packing (*potli*), skirt and decorative hanging. These articles were embellished with lace, *sitara* and

sequins work, coloured thread. The prepared articles were found useful and attractive by the consumers.

Sharma (2010) conducted a study on diversified use of empty fertilizer bags. Empty fertilizer bags were reused as a top surface and as an interlining material for making various diversified products i.e. shopping bag, wall pocket, mobile cover, hand fan, foot mat. The surface of the products was enriched with canvas embroidery and appliqué work. The prepared articles were cost effective as very less cost was involved and were found very useful.

Aniet (2009) conducted a research on recycling of textile waste through textile collage, with the objective of contributing to the development of new eco-friendly technologies, with reduction in manufacturing waste and introducing innovation through new visuals as differentiation factors in products of fashion design.

5.7 Selection of surface enrichment techniques: Preferences for surface enrichment technique was studied by preparing a list that included patchwork, appliqué work, screen printing, stencil printing, block printing, fabric painting, spray painting and embroidery was prepared. Top preferred screen printing surface enrichment technique was used for product development and the second preferred hand embroidery technique using running stitch was used to enhance the beauty of the surface enrichment designs.

Saxena (2012) detected that designing had been subjected to various modes of expressions like buildings, canvas, walls, floors etc. One of such field is fabric surface enrichment, which always attracted the attention of the viewers. Surface enrichment refers to the structural or applied designing for textile materials achieved by dyeing, printing, finishing, embroidery and weaving.

5.8 Creation & selection of design & design placements: Out of created 50 Screen printing designs, top ranked design for each product was selected for screen printing surface enrichment technique. The selected designs were design no. 17 for curtain, design no. 21 for table mat, design no. 24 for cushion cover, design no. 7 for *mudha* cover and design no.1 for ladies shirt.

Out of total 45 design placements created, fifteen design placements were selected for product development. It was clearly resulted that for ‘curtain’ placement III (design 1), placement I (design 4) and placement II (design 9) was selected. For ‘table mat’ placement II (design 6 &7) and placement III (design 9) was selected. For ‘cushion cover’ placement II (design 4), placement I (design 7) and placement III (design 8) was selected. For ‘*mudha* cover’ placement III (design 1), placement II (design 3) and placement I (design 7) was selected. For ‘ladies shirt’ placement I (design 4), placement III (design 6) and placement II (design 9) was selected.

Kavita (2016) conducted a study on adaptation of traditional canvas embroidery motifs for fabric painting. Forty five designs were developed using nine selected motifs and three possible placements of selected four designs. The top ranked placements of selected four designs were worked in canvas embroidery and replicated in fabric painting for making the *kurti*. All the designs of developed embroidery and painted *kurtis* was highly accepted by consumers.

Chouhan (2016) studied the Madhubani motifs to develop designs for shawls. Selected motifs were used to develop ten shawl placements and best five placements were selected for development of Madhubani painted shawls. It was revealed that developed products being inspired from traditional folk art of Madhubani painting were found totally fresh and unique by the respondents.

Sharma (2016) revived traditional craft of appliqué of India through stencil and digital printing further embellished with hand, machine and digital embroidery. Twenty motifs were selected as per preferences of experts for simulation of designs with the help of CAD software. Forty five saris i.e. nine saris of each selected design were developed of organdie fabric in light yellow colour through appliqué, stencil and digital printing and embellished with hand, machine and digital embroidery as per preferred placements and colour ways of selected five designs to produce the effect of appliqué work.

Sunita (2016) developed digital embroidered products using designs created from traditional motifs of Haryana. The identified motifs were categorized in five categories viz. geometrical, floral and foliage, animal and bird, human and religious motifs. A total of sixty designs, twenty for each category of products i.e. apparel, home textiles and utility articles were developed using selected motifs. The design placements and colour ways of selected designs were simulated with the help of CAD software. Twelve products, two of each were developed through digital embroidery technique using most preferred placement and colour way of selected twelve designs.

The colour for screen printing designs was selected as per the suitability of the fabric colour. The colour of the embroidery threads were selected in contrast to screen printing design colour of each product. The selected embellishment materials for the products development was lace for curtain, *gote/ band* for table mat and piping for cushion cover, *mudha cover* and ladies shirt.

Sapra (2015) studied the development of product adapting traditional motifs of Kutch region of Gujarat using digital embroidery technique. A total of thirty three designs were developed in CorelDRAW software using selected sixteen motifs for selection of top preferred five designs for placement on bed covers. Out of created twenty five design placements, one best design placement of each design was selected for preferences of colour ways. All the five developed bed covers were found very appealing and accepted by

consumers for suitability of digital embroidery technique in design development to broaden the design base for textile products.

Rani et al. (2013) developed thirty one screen printing designs for sari using selected Chinese motifs. Five top ranked motifs selected from each category i.e. geometrical, floral and animal motifs and were used for development of twenty two designs suitable for application through screen printing. Out of twenty two designs, six designs were finally selected for application on sari with all possible design arrangements. Placement of designs on border with scattered motifs was most preferred followed by overall placement and border placement.

Pant and Gahlot (2013) developed ready to use borders using screen printing. The selected fifteen *Aipan* motifs were used to develop designs for designer borders and a total of eight combinations each of two motifs were made. For each combination of motifs, five border arrangements were made. In this way forty designs were prepared for borders. The five best designs were selected to develop ready to use borders using screen printing technique. Surface enrichment of borders was done with embroidery, beads, stones and laces.

5.9 Development of products and their cost estimation: Selected top ranked five products i.e. curtain, table mat, cushion cover, *mudha* cover, ladies shirt in top ranked three constructional designs were developed. The products were enriched with selected screen printing designs and design placement. The screen printed designs were enhanced by doing running stitch using embroidery threads in contrast colour. Hence, total fifteen products were developed. The sample cost of developed products was calculated on the basis of cost of raw material, embellishment and stitching. Screen preparation cost was excluded because it is one time investment. It was concluded that the cost of developed product was towards higher side as it was sample preparation cost. The cost is reduced when the products were produced on commercial level.

Regarding consumers acceptability for cost of developed products indicated that majority of consumers opinioned appropriate for *mudha* cover (86.66%), table mat (80.00%), curtain (60.00%) and cushion cover (50.00%). The cost of ladies shirt was considered to be higher by 76.66% consumers. It is thus concluded from the data that majority of the consumers rated the cost of developed products as appropriate except ladies shirt.

Gupta (2016) studied the development of value added products from shoddy yarn. Twenty four prototype samples were designed, from which six most preferred designs was obtained for development of value added products from developed fabric and consumer acceptability were assessed and found that majority of the respondents preferred the developed products. These lines also supported by **Gupta and Saggi, in 2015** that suitability to utility was the most preferred factors for calculating the cost of production in Ludhiana and Amritsar districts of Punjab.

Sunita (2016) developed digital embroidered products using designs created from traditional motifs of Haryana and were assessed on different parameters. The cost of the digital embroidered products was rated appropriate by half of the consumers. All the developed products were found highly appreciated and well accepted by consumers for digital embroidery technique on apparels, home textiles and utility articles.

Sharma (2016) found that stencil and digital printed saris embellished with digital embroidery gave illusion of appliqué work. Thus traditional motifs of appliqué work can be revitalized at low cost through digital embroidery.

Kishore, 2013 found cost of woven saris and dress materials developed using Indian monumental designs was quite high due to weaving of one single piece of a design. Bulk production of these articles will lead to reduced cost as graph making and card punching cost will remain same for single piece and for successive pieces.

5.10 Assessment of developed products: All the developed products were adjudged by the consumers very suitable in terms of texture, design, utility and appearance as depicted by their weighted mean scores values (above 2.33). Results clearly indicated that consumers had high opinion regarding the general acceptability of shoddy products as they were strongly agreed with all the opinion statements with WMS ranged from 2.40-2.80.

The result regarding assessment of developed products on the basis of overall acceptance on different parameters of texture, design, utility, appearance indicated that cushion cover, *mudha* cover and table mat with 2.59, 2.66 and 2.40 average weighted mean scores were highly acceptable. Curtain with 1.94 average WMS was acceptable and the ladies shirt with 1.62 average WMS was least acceptable by the consumers.

Vedika et al. (2014) screened out suitable *Warli* motifs and adapted for development of thirty designs, ten for each apparels including kurti, suits and saris with the help of CAD software. The two most preferred designs for each apparel were applied using prepared blocks of selected designs. All the prepared products were highly appreciated and well accepted with regards to colour combination, suitability of designs for the end products, surface enrichment technique used overall appearance and cost effectiveness. It was concluded that *Warli* motifs were successfully adapted for designing the apparels using block printing and has paved the way for the plethora of product diversification that could lead to a flourishing market.

Pant and Gahlot (2013) developed ready to use borders using screen printing. The consumer acceptability of prepared borders was assessed on three design parameters i.e. embroidery, embellishment and overall appearance. The results of the study showed that all the prepared borders were liked by the consumers on all the design parameters and most of the respondents stated that they would definitely purchase these borders if available in the market.

Kaur, 2011 developed the designs for children draperies and bed linen. The results showed that most of the respondents found design line of draperies to be very good. The quoted prices of the articles were found to be adequate by the sixty-three per cent of the respondents and profit margin ranged from 26.87 to 27.83 per cent.

5.11 Preparation of design catalogue: A design catalogue comprised 50 constructional designs of developed product, 50 screen printing designs and 45 design placements was prepared with the help of suitable CAD software i.e. CorelDRAW to develop a repository of design. This design catalogue will provide an idea about the constructional design of products, surface enrichment technique designs and placements for preferred products.

Sharma and Paul (2015) reported that CAD technology opens the avenues for the designers to fulfill the ever changing demands of consumers especially for those who hunt for the cultural motifs in designs in their attire and other textile products and to preserve these designs by developing a repository, which could be accessed as and when needed.

Vaishnav (2015) emphasized that emerging CAD technology is capable of facilitating the preservation, diffusion and generation of new designs based on traditional forms, and also offers enhanced capabilities in terms of colour variety and colour differentiation. It provides at a glance the customers an idea about the application of motifs in different colour ways, placements and usage on different textile products. It can also facilitate outsourcing business in the form of the design ideas and product development.

Naik and Byadgi (2010) stated that in the present state of affairs of fast life style, designs with assistance of CAD has not only prolonged horizon of designing but also can create any number of designs that could be saved in the library to apply as and when required. CAD systems are more advantageous with respect to the speed, pattern creation, editing, repeating, flexibility, variety, colour ways and cost effective.

Textile industries are accused of being one of the polluting industries, not only at production but at consumption also. Textile recycling is advantageous for environmental and economic conditions, reducing demand for textile chemicals, reduction of landfill space, consumption of less energy and reducing of water wastage. Indian textile industry is not only the oldest industry in the country but also one of the most important industries providing employment and fetching foreign exchange for the country. Average lifetime of any clothing is considered to be about three years, after which, they are thrown away as old clothes. Sometimes even 'not so worn garments' are also useless as they become out-of-date or undesirable (Sakthivel 2012). Industrialization, contemporary lifestyle, problem of over consumption, rapid change in fashion, easy and cheap availability of textiles, lack of consumer awareness about environment friendliness, lenient government policies, lack of classic designs, low popularity of second hand clothing, lack of consumer's textile care knowledge and lack of systematic pipeline of textile recycling are some of the major causes of textile waste generation. There are two types of waste or input that can be used for recycled fibres for apparel: post-consumer waste from used and discarded clothing product and post-industrial waste from material collected during the product manufacturing stage. Post industrial also known as pre- consumer waste. One of the biggest problems on earth is management of solid waste. Like other wastes, textile waste disposal through landfill and incineration has been responsible for global warming. To counter the problem of textile waste, industry has taken many procedures for reducing its negative contribution towards environment. One such measure is textile recycling of the used clothes and industrial textile waste into a reuse as well as reproduction of fibers from textile waste. Shoddy is a term used for the category of recycling that "opens" textile waste and used clothing and returns them to fibrous form. Waste textiles are called rags. Rags are used by shoddy industries for making shoddy yarn which are used in making low cost products. The process of reuse of rags is called recycling. The method of reprocessing the used clothing, fibrous material and clothing scraps from the manufacturing processes has already been adopted by the shoddy units. The recycling of products in Panipat is the biggest textile recycling industrial cluster in India (Norris, 2012). It was estimated that total solid waste generated by 217 million people living in urban areas are expected to increase from 83.8 million tons in 2015 to 221 million tons in 2030. This ignites thinking for waste management. 5 R's of textile waste management (rethink, reduce, reuse, recycle and reintroduce) are very important tools to overcome the problem of textile waste by conserving natural resources, landfill spaces and energy (Agrawal *et al.*, 2015).

Many products are prepared from the recycled yarn such as shawls, mufflers, doormats, prayer rugs, blankets, bed linen etc. Shoddy yarns are prepared by using the used and discarded clothes resulted to poor strength that is why these are prepared by adding new and unused fibres. Blending is the process which can improve the quality, look as well as strength of the shoddy yarn by mixing the other fibres such as polyester, acrylic etc. Good quality of yarn can be prepared by blending process. Blending is done to increase strength, durability, aesthetic value of recycled yarn/ product. Very few people are aware about shoddy yarn so there is need to create awareness among people about good quality of shoddy yarn. However, creating awareness among people about reuse of rags for making usable products will be benefited for society and shoddy industry, which will be affordable for everyone because of low cost. These shoddy products are enhanced using different surface enrichment techniques and embellishment materials. Screen printing is one of the best techniques for enhancing the outlook of any product.

The conventional method of designing is monotonous, time consuming and laborious thus resulting in non-competitive market products. In globally competitive environment, time compressive strategies in the product development are of significant important. CAD system is more advantages with respect to speed, pattern creation, editing, repeating, flexibility, variety and cost. The CAD/CAM processes give consumer satisfaction on timely delivery, variety of designs and colours and rapid transmission of designs to customers.

Recycling is becoming more and more relevant in today society in search for economy and minimal wastage of the resources. The present study was an attempt for diversified use of cotton blended shoddy yarn. The purpose of the study was to overcome the problem of environmental pollution through recycling of old or discarded rags and creates awareness among peoples about the recycled low cost products. Thus the present study was planned with the following objectives:

- 1 To study the existing industry status and usage of cotton blended shoddy yarn
- 2 Creation of designs using software for product development and study preferences
- 3 To study physical parameters of the developed products & their assessment

To attain the stated objectives, a systematic method was followed. Ten shoddy industries making cotton blended shoddy yarn and products were purposively selected with the help of District Industries Centre, Panipat. Existing status of selected ten shoddy industries was studied with respect to personal profile of the owners, place of the unit, establishment year of unit, nature of unit, size of the unit, ownership pattern, factory premises, work experience, employee profile, facilities provided to the employees and health problems faced by owners/ representative and the employees in the industries. Information on existing usage pattern from selected ten shoddy industries was collected with respect to sources of procurement of raw material, form of raw material procured, storage facility, techniques and

production processes for making yarns and fabrics, purchasing factors considered for raw materials, type of rags, blend proportions of cotton blended shoddy yarn, yarn count, ply of yarn, type of weaves used for fabric preparation, selection of colour of rags and products, test performed, accessories used for product development, method of labeling on product, distribution channels and marketing of products. Five samples of cotton blended shoddy yarns of different ply, yarn count and blend proportions and fabric samples available at the time of research study in available colours were procured from the selected shoddy industries. The selection was done by the panel of thirty experts on the basis of yarn count, ply, blend proportions, texture and visual appearance of yarn and fabric samples. The top preferred one yarn was selected for fabric preparation and product development. The selected one yarn was tested for various parameters i.e. yarn strength, yarn twist (TPI) and count strength product (CSP) using standard test methods. An exhaustive list of different products which can be prepared using selected cotton blended shoddy yarn was prepared. For the selection of products, selected yarn sample and available fabric samples were shown to the experts and their preferences were sought using self structured preferential choice index. On the basis of mean scores, ranks were assigned and most preferred five top ranked products were selected for further work. Ten colour swatches of yarn samples in different colours available in the shoddy industries during the course of procurement and study were collected for selection of colour for preparation of fabrics for product development. The collected colour samples were shown to the experts for their colour preferences for the selected products. On the basis of mean scores, ranks were assigned and most preferred colour was selected individually for selected products. The experts' preference was sought through self developed preferential choice index. The fabrics were got prepared from one of the selected shoddy industry at Panipat as per the selected yarn specifications and preferred colours for each product. The prepared fabric was tested for fabric count, fabric weight, thickness, tensile strength, and elongation and bending length using standard test methods. A scaled outline of each selected product was drawn and created using corelDRAW-12 software incorporating designing and constructional features varied as per the selected product. Total fifty constructional designs i.e. ten for each selected product were created and out of that top preferred three constructional designs were selected for each product. Hence, total fifteen designs were selected. A list of surface enrichment techniques that included patch work, appliqué work, screen printing, stencil printing, block printing, fabric printing, spray printing and embroidery was prepared on the basis of their suitability to the selected products and created constructional designs. Experts' preference for surface enrichment techniques were obtained on a preferential choice index. Top two surface enrichment techniques which were found highly suitable were selected. Top preferred surface enrichment technique was used for product development and the second preferred technique was used to enhance the beauty of

the surface enrichment designs. Fifty designs for top preferred selected surface enrichment technique were created with help of CorelDRAW software. Out of the created fifty designs, five designs i.e. one most preferred design for each product were selected for application on the selected products. Three design placements of each selected design for each constructional design of the selected product were created as per the suitability of design and shape of the product. Hence, total 45 design placements were created i.e. five products with three constructional shapes with three design placements. Out of three design placements of each shape of the product, one design placement was selected for one shape of the product. Hence, total fifteen design placements were selected for product development. The colour for surface enrichment designs for each product was selected on the basis of the base colour of the fabric. Embroidery thread and their colour for outlining of surface enrichment design were selected in contrast colour for the surface enrichment designs and according to the fabric colour for each product.

A list of embellishment materials was prepared on the basis of suitability of design and product. Experts' preferences were sought for surface embellishment materials for each product. Selected top ranked five products were developed with top ranked three constructional designs of each product. The developed products were enriched with surface enrichment technique in selected design and design placements. The surface designing was enhanced using running stitches with embroidery thread of contrast colour. Total fifteen products were developed. The developed products were evaluated on various parameters such as texture, design, utility, appearance and sample cost. Thirty consumers who visited the exhibition were selected randomly assessed the developed products using self developed assessment index. A design catalogue was prepared using suitable textile designing software for documentation.

The major findings of the study are summarized as follows:

Existing status of shoddy industries: Results of the study pertaining to existing status of shoddy industries indicated that maximum number of the owners were in the age group of above 50 years, graduate, married, had nuclear family type having below five family members and had above 30 years of work experience. The owners had good working experience in shoddy industry being family business. The selected ten cotton blended shoddy industries in Panipat were established from 1970 onwards and between the years 1981-90. All the industries were registered. Fifty percent industries each were being run on single proprietors and in rented building and fifty percent each were running in partnership and in own factory premises. There were about 2040 total employees including managers, supervisors and other skilled, semi-skilled and unskilled workers in all the selected industries during research study. There were more skilled male workers as compared to female workers. There was approximately equal number of male and female workers working as semi skilled worker.

Majority of the female workers were under the categories of unskilled workers as compared to male. No child worker was found in any of the industry.

Different problems faced in the industries resulted that managerial problems i.e. price inflation of raw materials, lack of govt. support and technical problem i.e. electricity by all of the owners/representative. Problems faced by the employees were studied on randomly selected respondents resulted that allergy problem reported by unskilled workers (100.00%) and supervisors (33.00%). Breathing problems faced by unskilled and semi-skilled workers and supervisors (100.00% each) and skin problem faced by unskilled (70.00%), semiskilled (64.00%) and skilled workers (40.00%) in all the selected industries. Uncomfortable environment reported by unskilled and semi-skilled workers (50.00% each) and parking problem reported by skilled (80.00%) and semi-skilled workers (60.00%). Electricity and lack of employees with technical experience problems were reported by managers/ representatives (100.00%) in all the selected industries.

Usage pattern of shoddy industries: It was found that the raw material was purchased from different procurement sources. Fifty percent purchased from handloom & mills located in panipat city followed by scrap shops (40.00%) and the vendors (20.00%). The raw material was purchased from the other places of Haryana state (70.00%), from the other countries (50.00%) and from other places of India (20.00%) through marketing channel. In the shoddy industries raw material procured in the form of rags and leftover from handloom & mills leftovers (100.00% each) followed by cuttings of old rags (90.00%) and tailor waste (20.00%). Different factors considered for purchasing raw material were quality of rags (100.00%) followed by price of rags (70.00%) and colour of rags (20.00%) as per the requirement of product preparation in all the industries.

Shoddy industries partially used the cover space and partially used open space for storage of raw material. Selected industries used different types of rags as raw material to make cotton blended shoddy yarn viz. cotton/ cotton blends and wool/ wool blends, acrylic/acrylic blends, polyester/ polyester blends and nylon/ nylon blends. Selected industries prepared the cotton blended shoddy yarn in different blends proportion. Cotton with acrylic blend (above 20-40%), cotton with polyester blend (below 20 %) in 2.5s, 4s, 6s, 8s & 10s and cotton with acrylic blend (below 20%) in 4s, cotton with polyester blend (above 20-40%) in 2.5s, cotton with nylon blend (below 20 %) in 2.5 and 4s. Majority of the industries manufactured shoddy yarn of cotton with acrylic blend (below 20%) in 10s, cotton with nylon blend (below 20%) in 6s, 8s & 10s, cotton with other fibre blend (below 20%) in 2.5s and cotton with acrylic blend (below 20%) in 2.5s, 6s, 8s and cotton with nylon blend (above 20-40%) in 2.5s. Half of industries manufactured cotton with polyester blend (above 20-40%) in 4s, cotton with nylon blend (above 20-40%) in 4s, 6s & 8s, cotton with other fiber (below 20%) in 4 & 6s. All the industries manufactured the 2 ply and 4 ply cotton blended shoddy

yarn as per the requirement of the product to be prepared. Physical parameters of yarn i.e. yarn count, blend test, twist per inch (TPI) and yarn strength & elongation of prepared cotton blended shoddy yarn and fabric count, fabric weight and tensile strength of prepared shoddy fabric tested by all the selected industries. Majority of the industries (70.00%) tested the fabric thickness.

Regarding the colour criteria for shoddy fabric in the industries resulted that as rags were sorted according to the colour. Therefore, shoddy fabric was prepared as per the availability of colour of rags in all industries. During collection of data, half of the industries were prepared fabric in dark colour and rest in light colour as per the available rags. Shoddy fabric also prepared according to buyers' order in their colour preferences available in the industry. Numbers of defects were reported i.e. uneven yarn thickness, slippage of yarn, use of uneven yarn and mismatch of colour in selected shoddy industries. All the industries reported the slippage of yarn (100.00%) followed by uneven yarn thickness (80.00%), use of uneven yarn (70.00%) and mismatch of colour (50.00%). Regarding the products prepared using cotton blended shoddy fabrics in the industries resulted that shoddy fabrics with 2.5s was used to make rugs, foot mats, *khes*, stool mat (100.00%) followed by beach towel (40.00%), contour (20.00%). Shoddy fabrics with 4s was used to make rugs, foot mat, stool mat (100.00%) followed by *khes* (90.00%), *durries* (70.00%), beach towel (40.00%) and contour (20.00%). Shoddy fabrics with 6s was used to make *khes*, stool mat (100.00%) followed by foot mat (90.00%) and *durries* (60.00%). Shoddy fabrics with 8s was used to make *khes* (60.00%) followed by *durries* and beach towel (50.00%) each. Shoddy fabrics with 10s was used to make *khes* (70.00%) followed by beach towel (60.00%) and *durries* (50.00%).

Regarding the accessories used on developed products resulted that all industries used frills, *gote/band* (100.00%) followed by piping/ taping (30.00%) for development of the products. Regarding the method of labeling on products resulted that removable labels were used by 70.00 percent industries followed by stitched labels (20.00%) and disposable labels (10.00%) on the prepared products. Regarding the factors considered for calculating the cost of products resulted that all the industries considered the manufacturing cost, utility of the product (100.00% each) followed by overall appearance (80.00%) and texture (50.00%). Regarding the distribution channels used for marketing of the products resulted that 100 percent marketing of products was done through agents and wholesalers followed by personal contacts(70.00%) and retailer(10.00%).

Selected yarn for product development: Selection of yarn for product development was done by collecting the available samples of cotton blended shoddy yarn and fabric samples of different ply i.e. 2ply & 4ply, count i.e. 2.5s, 4s, 6s, 8s and 10s and blends proportions i.e. cotton+ acrylic, cotton + polyester, cotton + nylon and cotton + other fibre from the selected

shoddy industries. Selection of yarn was done on the basis of experts' preferences for yarn count, ply and blend proportions and fabric samples through physical observations. Cotton with polyester blended (70+30%) in 10s and 2 ply yarn was selected for product development.

Physical testing of shoddy yarn: The mean twist value of 10s cotton blended shoddy yarn of 2 ply was 13-15 with fibre composition as cotton 70 percent, polyester 30 percent, yarn strength was 18.0+ CN/TEX and CSP(count strength product) value of 10s cotton blended shoddy yarn was 2250±.

Selection of products, preparation of fabrics and physical testing of fabrics: Top ranked five products i.e. curtain, table mat, cushion cover, *mudha* cover and ladies shirt were selected. Out of the collected colour swatches, selected colour listed at serial no. were as 6 for curtain, 3 for table mat and cushion cover, 8 for *mudha* cover and 5 for ladies shirt. The fabrics were got prepared from Panipat in one of the shoddy industry as per selected specifications i.e. cotton with polyester 70:30 blend proportion, 2ply and 10 count in selected colour for different products. The selected prepared fabric was tested for fabric count, fabric weight, thickness, tensile strength & elongation and bending length using standard test methods. The mean value of the fabric count was 10 x 9.9 for warp and weft. The mean value of fabric wt. in GSM (gram per square) was 16.4 and fabric thickness was 0.47 mm of 10 count fabric. The mean value of tensile strength was 24.30 and 22.45kg for warp and weft respectively. Warp elongation was 3.9% and weft elongation was 4.5%. The bending length was 1.7 cm and 1.9 cm for warp and weft respectively.

Selection of constructional designs for selected product: Top three preferred constructional designs for each product were selected. The fifteen constructional designs were selected i.e. design no.1, 4, 9 for curtain; design no. 9,7,6 for table mat; design no. 4,7,8 for cushion cover; design no. 1,3,7 for *mudha* cover and design no. 4,6,9 for ladies shirt.

Selection of surface enrichment techniques: Results of the preferences of experts' inferred that top two surface enrichment techniques which were found highly suitable were selected. Top preferred screen printing surface enrichment technique was used for product development and the second preferred technique i.e. hand embroidery using running stitch was used to enhance the beauty of the screen printing designs.

Creation & selection of design & design placements: Experts' preferences for top ranked design for screen printing for each product were studied. Regarding the selection of screen printing design resulted that design no. 17 for curtain, design no. 21 for tablemat, design no. 24 for cushion cover, design no. 7 for *mudha* cover and design no.1 for ladies shirt were the selected design for creation of design placements.

Results of the preferences of experts for design placements of selected products resulted that for 'curtain' placement III (design 1), placement I (design 4) and placement II (design 9) was selected. For 'table mat' placement II (design 6 &7) and placement III (design

9) was selected. For 'cushion cover' placement II (design 4), placement I (design 7) and placement III (design 8) was selected. For '*mudha* cover' placement III (design 1), placement II (design 3) and placement I (design 7) was selected. For 'ladies shirt' placement I (design 4), placement III (design 6) and placement II (design 9) was selected. Thus, these fifteen design placements were used for preparation of products.

The colour for screen printing designs was selected as per the suitability of the fabric colour. The colour of the embroidery threads was selected in contrast to screen printing design colour and base colour of each product. The selected embellishment materials for the products development was 'lace' for curtain, '*gote/* band' for table mat and 'piping' for cushion cover, *mudha* cover and ladies shirt.

Development of products and their cost estimation: Selected top ranked five products were developed in top ranked three constructional designs using the most preferred design placement. The products were enriched with the screen printed designs and enhanced by doing running stitch using embroidery threads in contrast colour. Hence, total fifteen products were developed. The cost of developed product was calculated on the basis of fabric cost, embellishment and stitching cost. Screen preparation cost was excluded because it is one time investment. The cost of developed products ranged from Rs.220 to Rs.965. the cost was highest for ladies shirt at Rs. 965 and lowest for cushion cover at Rs. 220.

Assessment of developed products: The developed products were got evaluated by the consumers on various parameters. All the developed products were adjudged very suitable in terms of texture, design, utility and appearance as depicted by their weighted mean scores values (above 2.33). Results clearly indicated that consumers had high opinion regarding the general acceptability of shoddy products as they were strongly agreed with all the opinion statements with WMS ranged from 2.40-2.80.

The result regarding assessment of developed products on the basis of overall acceptance on different parameters of texture, design, utility, appearance indicated that cushion cover, *mudha* cover and table mat with 2.59, 2.66 and 2.40 average weighted mean scores were highly acceptable. Curtain with 1.94 average WMS was acceptable and the ladies shirt with 1.62 average WMS was least acceptable by the consumers.

Regarding consumers acceptability for cost of developed products indicated that majority of consumers opinioned appropriate for *mudha* cover (86.66%), table mat (80.00%), curtain (60.00%) and cushion cover (50.00%). The cost of ladies shirt was considered to be higher by 76.66% consumers. It is thus concluded from the data that majority of the consumers rated the cost of developed products as appropriate except ladies shirt.

Preparation of design catalogue

A design catalogue was prepared with the help of suitable CAD software i.e. CorelDRAW to develop a repository of design. It comprised 50 constructional designs of developed product, 50 screen printing designs and 45 design placements. This design catalogue will provide an idea about the constructional design of products, surface enrichment technique designs and design placements for selected products.

It is thus concluded that screen printing played an important role in creating matchless contemporary designs. It fulfills the needs of the designers for innovative creativity and thus helps in creation and application of unique designs on apparel and textile products.

The use of CAD has helped in creating new and variety of designs and reduced the time involved in the whole process. The application of developed designs on diversified products enhanced the look within less time span. All the developed products using cotton blended shoddy yarn were very well acceptable with regards to texture, design, utility and appearance etc. it is clearly elucidated that there are endless experimentation that can be done with the use of cotton blended shoddy yarn and surface enrichment technique for creating marvelous effect on products.

The recommendations on the basis of the finding of the present study are:

- ❖ The use of cotton blended shoddy yarn for textile products is recommended.
- ❖ Developed designs can be applied through other techniques of surface enrichment like printing, painting, embroidery and its combination is recommended for development of variety of products.
- ❖ The developed products can be given to entrepreneurs for mass production to establish micro enterprise under the banner 'Made in India'.

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ANNEXTURE-1

Interview schedule

A. Information regarding existing status of Shoddy industry in Panipat

1. Personal profile of the owner of the unit (respondent)

Name of the owner :

Age :

Education :

- Undergraduate
- Graduate
- Post graduate

Marital status :

- Married
- Unmarried

Family type :

- Joint
- Nuclear

Family size :

- Small (up to 5)
- Medium (5 to 10)
- Large (Above 10)

Work experience :

- Below 10
- 10-30
- Above 30

2. Status of shoddy industry

Establishment year of industry:

Place:

Nature of the industry:

- Registered
- Unregistered

Size of industry (on the basis of no. of employees):

- Small (Below 150)
- Medium (151-250)
- Large (Above 250)

Ownership patterns:

- Single proprietors
- Partnership

Factory premises (building):

- Own
- Rented

Work pattern:

- Job work
- Own production

Capital investment:

Annual turnover:

Manpower employed in the shoddy industry:

Manpower employed	Male (Frequency)	Female (Frequency)
Managerial post		
Manager		
Supervisor		
Worker		
Skilled		
Semi skilled		
Unskilled		

Facilities provided to employees in the industries :

- Bonus on festivals
- First aid facilities (medical facilities)
- Parking
- Children play-way
- Sanitary facility
- Drinking water
- Changing room
- Canteen
- Rest room
- Any other

Do you find some problems in this industry? Yes/No, If yes

Problems		Owners	
		Yes	No
Managerial Problems	Price inflation of raw material		
	Lack of quality raw material		
	Lack of govt. support		
Technical Problems	Electricity		
	Skilled labour		
	Lack of employees with technical experience		
Health Problems	Allergy		
	Breathing problems		
	Skin Problems		
General Problems	Toilet facility		
	Medical facility		
	Safety for women		
	Uncomfortable environment		
	Safe drinking water	-	

Problems faced by employees in industry

Problems	Employees				
	Managers	Supervisors	Unskilled	Semi-skilled	Skilled
Physical problem					
Allergy					
Breathing problem					
Skin problem					
Uncomfortable environment					
Administrative problem					
Parking					
Electricity					

Lack of employees with technical experiences					
--	--	--	--	--	--

B. Usage pattern of shoddy industries
Source of procurement of raw material

Source		Yes	No
Local market	Vendors		
	Industries (handloom & mills)		
	Scrap Shops		
Other places	State		
	National		
	International		

In which form you procured raw material in the industry?

- Rags
- Tailoring waste
- Industry waste (handloom and cloth mills)
- Cutting of old rags

What are the factors considered while purchasing the raw material?

- Price
- Quality
- colour

How raw material is stored after procurement?

- Open space
- Covered space

Which type of rag used in the industry?

- | | Pure/ Blend | % proportion used | counts used |
|-------------|-------------|-------------------|-------------|
| • Cotton | | | |
| • Acrylic | | | |
| • Polyester | | | |
| • Nylon | | | |
| • Wool | | | |

Which type of yarns (ply) are manufactured in the industry?

1. 2ply
2. 4ply
3. 6ply
4. 8ply
5. Any other

Which type of weaves used for making of shoddy fabrics in the industry ?

- Plain weave
- Twill weave
- Rib weave
- Dobby weave
- Jacquard weave

Whether yarn is tested or not? If yes which types of test?

- Yarn count
- Yarn strength & elongation
- Twist per inch
- Any other

Whether shoddy fabric is tested or not? If yes which types of test?

- Fabric count
- Weight
- Bending length
- Thickness
- Drape ability
- Tensile strength & Elongation
- Any other

What are colour criteria for shoddy fabric?

- Dark colour
- Light colour
- According to availability of rags
- According to buyers order

Defects in fabrics manufactured in shoddy industries?

- Uneven yarn thickness
- Slippage of yarn
- Use of uneven yarn
- Mismatch of colour

Different products are manufactured in the industry:

Products

Counts

- Rugs
- Contour(Toilet rug for seat cover)
- Foot mat
- *Khes*
- Stool mats
- Durries
- Prayer mats
- Beach towel
- Any other

Which type of accessories used on developed products?

- Frills
- Lace
- Buttons
- Piping
- *Got/ band*
- Any other

Method of labelling on products:

- Stitched
- Disposable
- Removable/Detachable
- woven
- Any other

Which factors considered for calculating the cost of product?

- Utility
- Texture
- Overall appearance
- Manufacturing cost

Which the distribution channels used in industry?

- Personal contacts
- Agents
- wholesalers
- Exhibitions
- Any other

Marketing of products:

- All over India
- Local market
- Exported

ANNEXURE—II

Selection of cotton blended shoddy yarn blend

Sr. no.	Blend proportions	Highly suitable	Suitable	Least suitable
1	Cotton + Acrylic (60+40)			
2	Cotton + Polyester (70+30)			
3	Cotton + Nylon (60+40)			
4	Cotton + other fibre (60+40)			

Selection of yarn count

Sr. no.	Diameter (s)	Highly suitable	Suitable	Least suitable
1	2.5			
2	4			
3	6			
4	8			
5	10			

Selection of yarn type

Yarn type	Highly suitable	Suitable	Least suitable
2ply			
4ply			

Preferences of experts' for the products made from cotton blended shoddy yarn

Sr. no.	Products	Highly suitable	Suitable	Least suitable
1	Foot mat			
2	Stool mat			
3	Prayer mat			
4	Curtain			
5	Table mat			
6	Cushion cover			
7	Skirts			
8	<i>Mudha</i> cover			
9	Sofa cover			
10	Wall hanging			
11	Settee cover			
12	Diwan cover			
13	Bed runner			
14	Shopping bag			
15	Ladies shirt			
16	Jacket			
17	Hand bag			
18	Mobile Phone cover			
19	Saree cover			
20	Wall pocket			
21	Wall key holder			
22	Computer cover			
23	A.C. cover			
24	Washing machine cover			
25	Stitching machine cover			
26	Hand Fan			

27	Magazine holder			
28	Table Cover			
29	File cover			
30	Cover for water bottle/thermos			
31	Cotton picking bag			
32	Purse			
33	Laundry bag			
34	Jewellery kit			
35	Pen/ Pencil holder			
36	<i>Chakla</i>			
37	Bangle box			
38	Shoe wrapper			
39	<i>Duchie set / bosters</i>			
40	School bag			
41	Coasters			
42	<i>Bander wall</i>			

H.S- Highly suitable, S- Suitable, L.S- Least Suitable

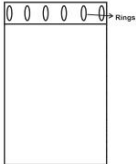
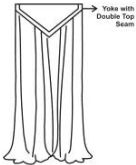
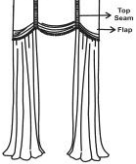
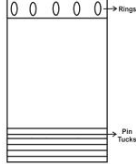
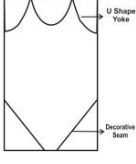
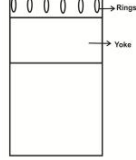
ANNEXURE—III

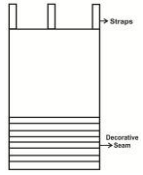
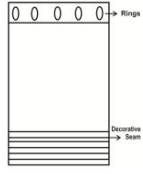
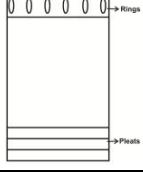
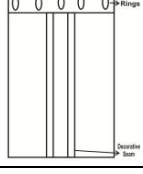
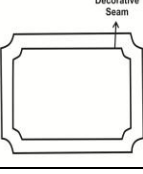
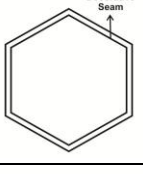
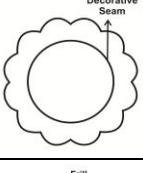
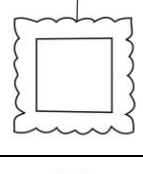
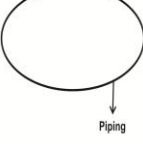
Preference of experts' for suitable colour for preferred products

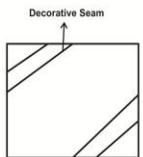
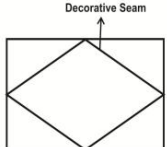
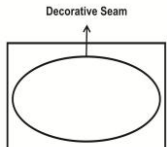
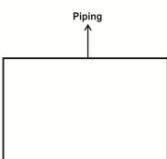
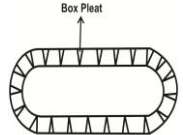
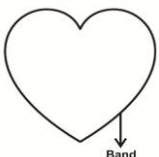

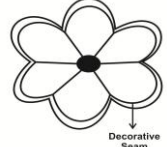
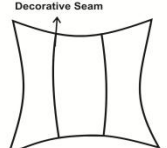

Colour swatches of samples no.	Products														
	Curtain			Table mat			Cushion cover			Mudha cover			Ladies shirt		
1	H.S	S	L.S	H.S	S	L.S	H.S	S	L.S	H.S	S	L.S	H.S	S	L.S
2															
3															
4															
5															
6															
7															
8															
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10															

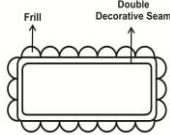
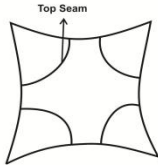
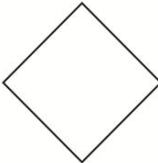
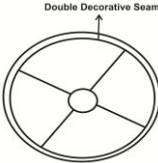
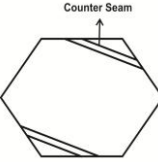
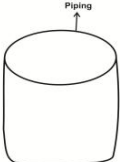
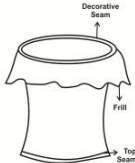
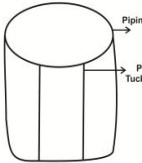
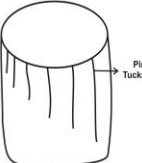
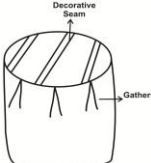
H.S= Highly suitable, S=Suitable, L.S=Least suitable

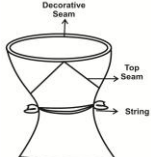
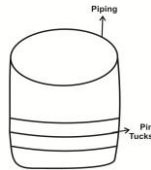
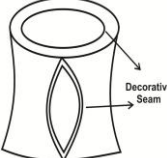
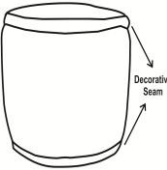
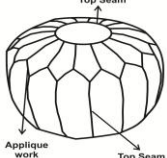



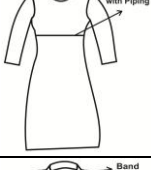

Preference of experts' for constructional designs of preferred products


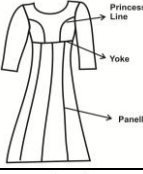


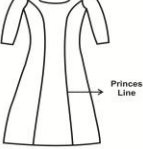
Product No.	Products	Design no. and shape with construction features	Designing features	H.S	S	L.S	
4 ranked 1 ST	Curtain	1		Rings on the top portion for hanging			
		2		V shaped yoke with double top seam			
		3		Curved shaped flap with top seam			
		4		Horizontal pin tucks in the bottom and rings for hanging			
		5		U shaped yoke on top portion and diagonal decorative seam in the bottom			
		6		Rectangle shaped yoke on top portion with rings for hanging			

Product No.	Products	Design no. and shape with construction features	Designing features	H.S	S	L.S	
		7		Horizontal decorative seams lines in the bottom half portion and straps for hanging			
		8		Horizontal decorative seam lines in the 1/3 bottom portion with rings for hanging			
		9		Horizontal pleats in the bottom portion and ring on the top portion for hanging			
		10		Vertical decorative seam lines in the centre and ring on the top portion			
5 ranked II nd	Table mat	1		Rectangular shape with shaped corners and decorative seam			
		2		Hexagon shape with decorative seam			
		3		Outer scalped shape and inner round shape with decorative seam			
		4		Square shape with frill			
		5		Oval shape finished with piping			

Product No.	Products	Design no. and shape with construction features	Designing features	H.S	S	L.S
		6 	Rectangle shape with diagonal decorative seam on corners			
		7 	Outer rectangle shape with inner diamond shape with decorative seam			
		8 	Outer rectangle shape and inner oval shape with decorative seam			
		9 	Rectangle shape with piping			
		10 	Box pleat strip on outer edge			
6 ranked III rd	Cushion cover	1 	Heart shape with band			
		2 	Star shape with decorative seam			
		3 	Flower shape with decorative seam			
		4 	Semi rectangular shape with decorative stitch in centre			
		5 	Triangle shape with decorative seam and piping			

Product No.	Products	Design no. and shape with construction features	Designing features	H.S	S	L.S	
		6		Rectangular shape with frill and double decorative seam			
		7		Semi rectangular shape with curved decorative stitch finished with piping on the corners			
		8		Diamond shape with piping			
		9		Circular shaped with double decorative seam on outer edges			
		10		Hexagon shape with counter seams			
8 ranked IV th	Mudha cover	1		Top finished with piping			
		2		Top is designed with frill and decorative seam and top seam on bottom line			
		3		Vertical pin tucks all around and top finished with piping			
		4		Vertical pin tucks in ascending order all around			
		5		Gathers on body and diagonal decorative seams on the top portion			

Product No.	Products	Design no. and shape with construction features	Designing features	H.S	S	L.S
		6 	Decorative seam on the top edge. Inverted 'v' shape with top seam on upper portion, centrally tied with string			
		7 	Horizontal pin tucks in the lower half portion and upper portion is finished with piping			
		8 	Decorative seam on the top portion and oval shape curve with decorative seam all around			
		9 	Decorative seam on the top and on bottom line			
		10 	Top and body designed with v- shaped applique work with top seam			
15 ranked V th	Ladies shirt	1 	Designed with yoke with vertical false centre opening from bust level to bottom with button, 3/4 sleeve length			
		2 	Designed with yoke with slit opening and band collar. Flared silhouette and half sleeve			
		3 	Designed with band color with shoulder opening, straight silhouette with centre slit opening, 3/4 sleeve length			
		4 	Straight waist level yoke with piping, straight silhouette, 3/4 sleeve length			
		5 	Band color neckline, slit opening with shaped patch work till waist level, straight silhouette, 3/4 sleeve length			

Product No.	Products	Design no. and shape with construction features	Designing features	H.S	S	L.S
		6 	Designed with semi curved shaped yoke with piping, straight silhouette, ¾ sleeve length			
		7 	Yoke designed with princess line, panelled shirt, ¾ sleeve length			
		8 	Designed with false centre front opening with decorative buttons, straight silhouette, ¾ sleeve length			
		9 	Simple shirt finished with piping on the neck and sleeve with straight silhouette, ¾ sleeve length			
		10 	Designed with princess line, A-line silhouette, ¾ sleeve length			

H.S- Highly suitable, S- Suitable, L.S- Least Suitable

ANNEXURE—IV



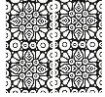





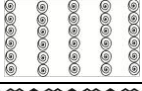








Experts' preferences for surface enrichment technique for preferred products

Techniques	Products														
	Curtain			Table mat			Cushion cover			<i>Mudha</i> cover			Ladies shirt		
	H.S	S	L.S	H.S	S	L.S	H.S	S	L.S	H.S	S	L.S	H.S	S	L.S
Patchwork															
Appliqué work															
Screen printing															
Stencil printing															
Block printing															
Fabric painting															
Spray painting															
Hand embroidery															
Any other															

H.S- Highly suitable, S- Suitable, L.S- Least Suitable

ANNEXURE—V

Experts' preference for screen printing designs for preferred products

Sr. no.	Screen Designs	Products														
		Curtain			Table mat			Cushion cover			<i>Mudha</i> cover			Ladies shirt		
		H.S	S	L.S	H.S	S	L.S	H.S	S	L.S	H.S	S	L.S	H.S	S	L.S
1																
2																
3																
4																
5																
6																
7																
8																
9																
10																
11																
12																
13																
14																
15																
16																
17																

Sr. no.	Screen Designs	Products															
		Curtain			Table mat			Cushion cover			<i>Mudha</i> cover			Ladies shirt			
		H.S	S	L.S	H.S	S	L.S	H.S	S	L.S	H.S	S	L.S	H.S	S	L.S	
18																	
19																	
20																	
21																	
22																	
23																	
24																	
25																	
26																	
27																	
28																	
29																	
30																	
31																	
32																	
33																	
34																	
35																	
36																	
37																	
38																	
39																	

Sr. no.	Screen Designs	Products														
		Curtain			Table mat			Cushion cover			<i>Mudha</i> cover			Ladies shirt		
		H.S	S	L.S	H.S	S	L.S	H.S	S	L.S	H.S	S	L.S	H.S	S	L.S
40																
41																
42																
43																
44																
45																
46																
47																
48																
49																
50																

H.S- Highly suitable, S- Suitable, L.S- Least Suitable

Experts' preferences for embellishment materials of preferred products

Embellishment material	Products															
	Curtain			Table mat			Cushion cover			<i>Mudha</i> cover			Ladies shirt			
	H.S	S	L.S	H.S	S	L.S	H.S	S	L.S	H.S	S	L.S	H.S	S	L.S	
Beads																
Sequins																
Piping																
<i>Got</i> / Band																
Lace																
Ribbon																
Mirror																
Button																
Any other																

H.S- Highly suitable, S- Suitable, L.S- Least Suitable

ANNEXURE—VI

Placements of selected screen printing designs for selected products

Screen design no.	Products	Product design no.	Placement		
			I	II	III
17	Curtain	1			
		4			
		9			
21	Table mat	6			
		7			
		9			
24	Cushion cover	4			
		7			
		8			
7	<i>Mudha</i> cover	1			
		3			
		7			
1	Ladies shirt	4			
		6			
		9			

H.S- Highly suitable, **S-** Suitable, **L.S-** Least Suitable

ANNEXURE VII

Assessment of prepared products on different parameters

Name of the respondent:

Age:

Department:

Give your opinion for developed products on different parameters of texture, design, utility and appearance:

Consumers' opinion for assessment of developed products

Product.1 Curtain		Design no.								
		1			4			7		
		H.S	S	L.S	H.S	S	L.S	H.S	S	L.S
Sr. No.	Texture									
1	Thickness of fabric is appropriate									
2	Suitable as per the product design									
3	Suitable as per the surface enrichment technique used(screen printing+ Hand embroidery)									
4	Constructional designing features are appropriate as per the design and texture									
5	Used accessories (piping, ribbon) to prepare article are enhanced the look									
	Design									
1	Attractive									
2	Construction designing features are suitable									
3	Suitable as per the selected technique (screen printing + hand embroidery)									
4	Used embellishment materials give new look									
5	Harmonize with fabric									
6	Colour combination is appropriate									
	Utility									
1	Suitable for the its purpose									
2	It is suitable for congenial usage									
3	An innovative idea to reuse waste cloth into new form									
4	Good market potential									
	Appearance									
1	Attractive									
2	As per the trend									
3	Innovative									
4	Appealing overall appearance									

Product.2 Table mat		Design no.								
		6			7			9		
		H.S	S	L.S	H.S	S	L.S	H.S	S	L.S
Sr. No.	Texture									
1	Thickness of fabric is appropriate									
2	Suitable as per the product design									
3	Suitable as per the surface enrichment technique used(screen printing+ Hand embroidery)									
4	Constructional designing features are appropriate as per the design and texture									

5	Used accessories (piping, ribbon) used to prepare article are enhancing look									
	Design									
1	Attractive									
2	Construction designing features are suitable									
3	Suitable as per the selected technique (screen printing + hand embroidery)									
4	Used embellishment materials give new look									
5	Harmonize with fabric									
6	Colour combination is appropriate									
	Utility									
1	Suitable for the its purpose									
2	It is suitable for congenial usage									
3	An innovative idea to reuse waste cloth into new form									
4	Good market potential									
	Appearance									
1	Attractive									
2	As per the trend									
3	Innovative									
4	Appealing overall appearance									

Product.3 Cushion cover		Design no.								
		4			7			8		
		H.S	S	L.S	H.S	S	L.S	H.S	S	L.S
Sr. No.	Texture									
1	Thickness of fabric is appropriate									
2	Suitable as per the product design									
3	Suitable as per the surface enrichment technique used(screen printing+ Hand embroidery)									
4	Constructional designing features are appropriate as per the design and texture									
5	Used accessories (piping, ribbon) enhanced the look									
	Design									
1	Attractive									
2	Construction designing features are suitable									
3	Suitable as per the selected technique (screen printing + hand embroidery)									
4	Used embellishment materials give new look									
5	Harmonize with fabric									
	Colour combination is appropriate									
	Utility									
1	Suitable for the its purpose									
2	It is suitable for congenial usage									
3	An innovative idea to reuse waste cloth into new form									
4	Good market potential									
	Appearance									
1	Attractive									
2	As per the trend									

3	Innovative								
4	Appealing overall appearance								

Product.4 <i>Mudha cover</i>		Design no.								
		1			3			7		
		H.S	S	L.S	H.S	S	L.S	H.S	S	L.S
Sr. No.	Texture									
1	Thickness of fabric is appropriate									
2	Suitable as per the product design									
3	Suitable as per the surface enrichment technique used(screen printing+ Hand embroidery)									
4	Constructional designing features are appropriate as per the design and texture									
5	Used accessories (piping, ribbon) enhanced the look									
	Design									
1	Attractive									
2	Construction designing features are suitable									
3	Suitable as per the selected technique (screen printing + hand embroidery)									
4	Used embellishment materials give new look									
5	Harmonize with fabric									
	Colour combination is appropriate									
	Utility									
1	Suitable for the its purpose									
2	It is suitable for congenial usage									
3	An innovative idea to reuse waste cloth into new form									
4	Good market potential									
	Appearance									
1	Attractive									
2	As per the trend									
3	Innovative									
4	Appealing Overall appearance									

Product.5 <i>Ladies shirt</i>		Design no.								
		4			6			9		
		H.S	S	L.S	H.S	S	L.S	H.S	S	L.S
Sr. No.	Texture									
1	Thickness of fabric is appropriate									
2	Suitable as per the product design									
3	Suitable as per the surface enrichment technique used(screen printing+ Hand embroidery)									
4	Constructional designing features are appropriate as per the design and texture									
5	Used accessories (piping, ribbon) to prepare article are enhanced the look									
	Design									
1	Attractive									

2	Construction designing features are suitable											
3	Suitable as per the selected technique (screen printing + hand embroidery)											
4	Used embellishment materials give new look											
5	Harmonize with fabric											
	Colour combination is appropriate											
	Utility											
1	Suitable for the its purpose											
2	It is suitable for congenial usage											
3	An innovative idea to reuse waste cloth into new form											
4	Good market potential											
	Appearance											
1	Attractive											
2	As per the trend											
3	Innovative											
4	Appealing overall appearance											

Consumers' overall acceptance for the developed products

Products	Texture			Design			Utility			Appearance		
	H.S	S	L.S	H.S	S	L.S	H.S	S	L.S	H.S	S	L.S
Curtain												
Tablemat												
Cushion cover												
Mudha cover												
Ladies shirt												

Tick mark the estimated sample cost of developed products

Developed products Cost/piece	Fabric cost Rs.	Embellishment cost(embroidery+ accessories) Rs.	Stitching charges (Rs.)	Total cost(Rs.)	Cost acceptance		
					Appropriate	High	Low
Curtain	625	120	120	865			
Tablemat	125	45	70	240			
Cushion cover	125	45	50	220			
Mudha cover	250	90	50	390			
Ladies shirt	625	90	250	965			

* Screen cost is excluded because it is one time investment

Consumers' opinion on general acceptability of shoddy products

Sr. No.	Statements	H.S	S	L.S
1	Recycling generate new idea			
2	The product developed with recycled material is innovative source for small scale entrepreneurs			
3	Recycling is eco friendly process			
4	Recycled fabric is appropriate for reuse into different forms			
5	Acceptance of such developed products will increase employments in shoddy industry			
6	Blended recycled textiles is a good option for economic buyers			
7	Shoddy products are low cost and eco-friendly			
8	Surface enrichment techniques enhances the look of the products			
9	It is creative idea for further research work			
10	Like to purchase shoddy blended products			
11	Recycling generate new idea			
12	The product developed with recycled material is innovative source for small scale entrepreneurs			
13	Recycling is eco friendly process			

H.S- Highly suitable, S- Suitable, L.S- Least Suitable

ABSTRACT

Title of thesis : **Diversified use of cotton blended shoddy yarn**
Full name of the degree holder : Bharti Sharma
Admission No. : 2013HS9D
Title of Degree : Doctor of Philosophy
Name and address of major advisor : Dr. Nirmala Yadav, Professor & Head
Dept. of Textile & Apparel Designing
I.C. College of Home Sciences, CCS Haryana Agricultural University,
Hisar-125004, Haryana
Degree awarding University : CCS Haryana Agricultural University, Hisar
Year of award of degree : 2018
Major subject : Textile and Apparel Designing
Total No. of pages in thesis : 117+iv+XXI
Number of words in the abstract : Approx. 595

Keywords: Diversified, rags, designs, placements, screen printing, hand embroidery.

The present study entitled 'Diversified use of cotton blended shoddy yarn' was conducted. Information on existing status and usage pattern of ten selected shoddy industries located in Panipat, Haryana producing cotton blended shoddy yarn and products were collected using self structured interview schedule and supplemented through observations. Maximum no. of the owners were in the age group of above 50 years, graduate, married and had above 30 years of work experience. The selected shoddy industries were established from 1970 onwards and were registered. Majority of the industries were started with amount Rs. 30 to 50 lac as capital investment. Manpower employed were managers, supervisors and other skilled, semi-skilled and unskilled workers. Male were employed on managerial & supervisor post. There were more skilled male workers whereas more number of female workers were under the categories of unskilled workers. All of the owners faced the managerial problems like price inflation of raw materials, lack of govt. support and technical problem like electricity. The raw material was procured from the local market, other state of India & other countries in the form of rags. Quality of rags was considered while purchasing raw material as per the requirement of product preparation. Selected industries prepared the cotton blended shoddy yarn in different blends proportions i.e. cotton with acrylic, polyester, nylon and cotton with other fibre in 2.5s, 4s, 6s, 8 & 10s and 2 & 4 ply in available colour. The prepared shoddy yarn and fabric were tested for physical parameters. Numbers of defects were reported i.e. uneven yarn thickness slippage of yarn, use of uneven yarn & mismatch of colour in majority of the industries. The products prepared were rugs, foot mat, *khes*, stool mat, beach towel in different counts and decorated using frills, *got*/band. Manufacturing cost and utility of the product considered for calculating the cost in all the industries. The five samples of cotton blended shoddy yarns and their fabric samples of different ply, count and blend proportions procured from the selected shoddy industries to get the preferences for yarn count, ply and blend proportions for product development. The preference was done using preferential choice index by the experts. The selected yarn was cotton with polyester blended (70+30%) in 10s and 2 ply. The fabrics were got prepared in selected colour in one of the selected shoddy industry as per the selected specifications. The prepared fabric was tested for physical parameters.

Top five ranked products i.e. curtain, table mat, cushion cover, *mudha* cover and ladies shirt were selected out of the prepared list of products that can be made using selected yarn. Top three constructional designs for each product were selected out of ten constructional designs for each product developed with the help of CorelDRAW-12 for product development. Top preferred one design for screen printing was selected for each product for placement, out of fifty screen printing developed designs. One best design placement for each selected product designs was selected, out of created forty five placements. Five products in three constructional designs were developed, enriched with selected screen printing designs and selected design placement enhanced by doing running stitch using hand embroidery threads in contrast colour selected colour of screen printing design and base colour of fabric. Hence, total fifteen products were developed. All the developed products were adjudged by the consumers very suitable in terms of texture, design, utility and appearance. On the basis of overall acceptance cushion cover, *mudha* cover and table mat were highly acceptable. Curtain was acceptable and the ladies shirt was least acceptable by the consumers. A design catalogue was prepared.

MAJOR ADVISOR

SIGNATURE OF THE STUDENT

HEAD OF THE DEPARTMENT



CURRICULUM VITAE

- a) Name of the Student : Bharti Sharma
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Senior Secondary	HBSE	2002	65.0	Hindi, English, Home Science, Physical Education, Sanskrit
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M.S (Home Sci.)	I.C. College of Home Sciences, CCS HAU, Hisar	2010	71.8	Clothing and Textiles
B.Ed	KUK	2011	63.3	All recommended subjects
P.hD	I.C. College of Home Sciences, CCS HAU, Hisar	2018	76.2	Textiles and Apparel Designing

k) Co-curricular activities

- Attended NCC camp in CCS HAU Hisar, 2004
- 60 days Rural Home Science Work Experience for village attachment under B.Sc. (Hons) Home Science Degree Programmed 2006
- Inplant training in Global Exchanges, Gurgaon, 2006
- Attended 7 days training on Richpeace fashion & textile CAD in CCS HAU Hisar, 2015
- Attended workshop on scientific / Technical writing in CCS HAU Hisar, 2017
- Attended knowledge workshop on scientific writing, e-Books and publication process in CCS HAU Hisar, 2017

l) Medals/Honours received

- Qualified **HTET** June 2016 for Post Graduate Teacher (PGT).
- Qualified **HTET** December 2017 for (TGT).

List of publications

- Sharma B, Yadav N, Yadav S .2018. Reduce the environment pollution through shoddy cotton. *Abstract*, (poster presentation) International Conference on Sustainable Agriculture, Energy, Environment & technology, Maharshi Dayanand University , Rohtak 24-25february 2018 P: A-373.
- Sharma B, Yadav N, Yadav S .2018. Reduce the environment pollution through cotton blended shoddy yarn products. (*Abstract*) National seminar on trends and advances in wool and specialty hair, 16-17 March,2018, organized by the department of clothing of textiles, college of Home Science, G.B Pant University of Agriculture & Technology, Pantnagar.P:34.
- Sharma B, Yadav N, Yadav S .2018. Empolyment generating through cotton blended shoddy yarn. *Abstract*, (Oral Presentation) International Conference on women's work & Occupational Health- Emerging Issues, Challenges & Policy Measures in the Unorganized Sector. Arya P.G College, Panipat, 24-25 march 2018.P:135.
- Sharma B, Yadav N, Yadav S .2018. Usage pattern of cotton blended shoddy yarn for product development in industry. *International Journal of Chemical Studies*, 6(2):3353-3355

Bharti Sharma

UNDERTAKING OF THE COPYRIGHT

I, **Bharti Sharma**, Adm. No. **2013HS9D**, undertaken that I give copy right to the CCS HAU, Hisar of my thesis entitled, '**Diversified use of cotton blended shoddy yarn**'. I also undertake that, patent, if any, arising out of the research work conducted during this programme shall be filed by me only with due permission of the competent authority of CCS HAU, Hisar.

(Bharti Sharma)
Signature of student

DESIGN CATALOGUE
ON
PRODUCT DEVELOPMENT

Bharti Sharma
Dr. Nirmal Yadav
Dr. Saroj Yadav



Department of Textile and Apparel Designing
I.C. College of Home Sciences
CCS Haryana Agricultural University
Hisar

2018

CONTENTS

CHAPTER NO.	DESCRIPTION	PAGE NO.
I	Preface	1
II	Constructional Designs of Selected Products	2-16
III	Created Screen Printing Designs	17-21
IV	Created Design Placements on Selected Products	22-26

PREFACE

Designing textiles is an ancient craft of India which is one of the most challenging fields as it is having good scope of imagination. Over a period of time, it has become more of an intellectual endeavour to create original designs. CAD is powerful user friendly tool which plays a vital role in facilitating the creation of new designs, improving existing designs and fast production process.

Very few people are aware about shoddy yarn so there is need to create awareness among people about good quality of shoddy yarn. However, creating awareness among people about reuse of rags for making usable products will be benefited for society and shoddy industry, which will be affordable for everyone because of low cost. Many agencies and stake holders has been making efforts to contribute towards the aim for saving in resources of raw materials, energy water etc. and reducing the impact on environment for sustainable development. In future, textile recycling would be as important industrial activity as textile manufacturing.

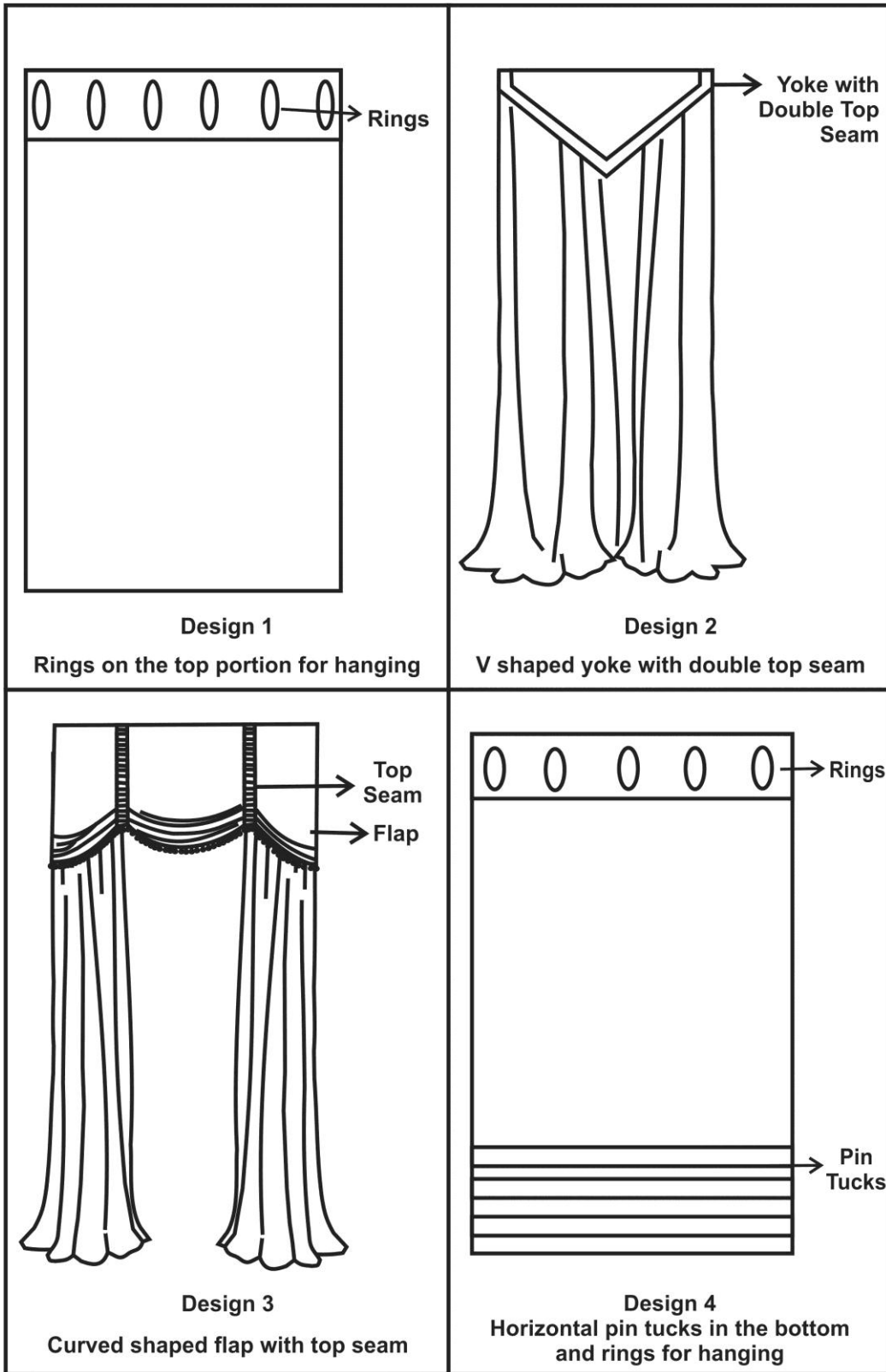
Keeping in mind constructional and enrichment technique designs (screen printing) are designed by the researcher for curtain, table mat, cushion cover, *mudha* cover and ladies shirt. Ten design of each product that is fifty constructional designs and total fifty designs for screen printing is made by the researcher using Corel DRAW-12 with mentioning designing features.

This catalogue will provide an idea to consumers about the constructional designs, screen printing designs and arrangement of designs in different placements for each selected products. This is an attempt to preserve designs by developing a repository in the form of design catalogue which can be assessed and needed in different form and fulfill the consumers' demand with a new designing approach as well as to satisfy the need of designer to create something new.

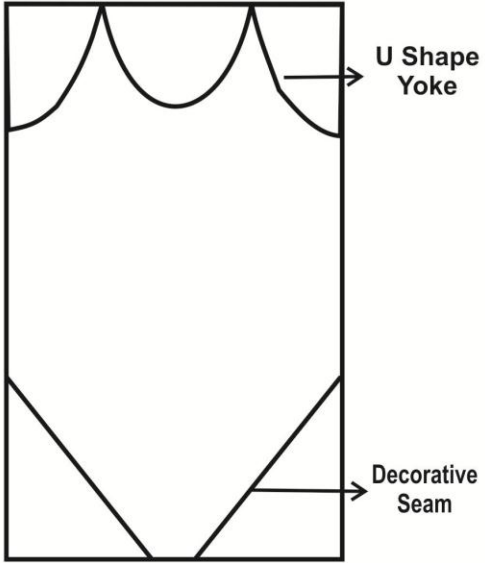
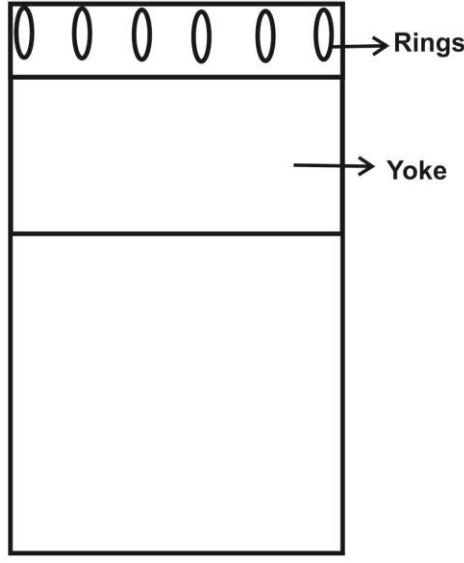
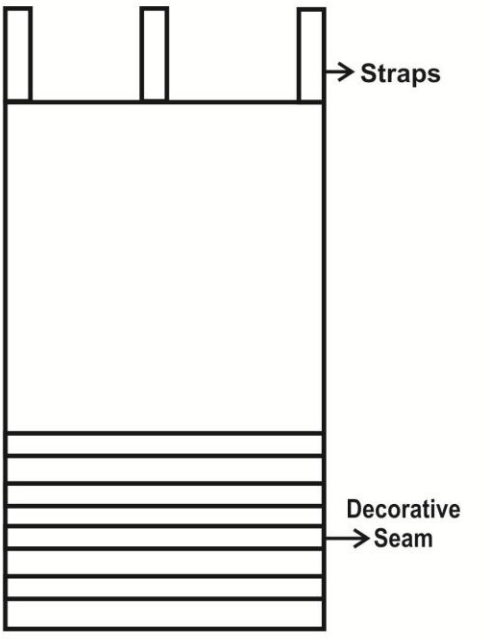
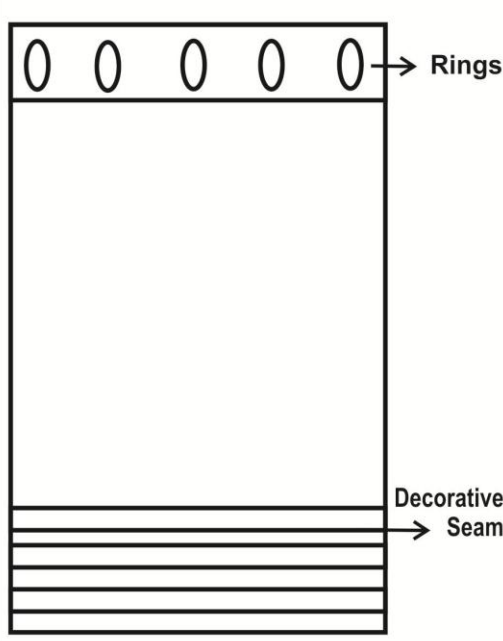
Bharti Sharma

CONSTRUCTIONAL DESIGNS
OF
SELECTED PRODUCTS

Curtain Designs



Curtain Designs

 <p style="text-align: center;">Design 5 U shaped yoke on top portion and diagonal decorative seam in the bottom</p>	 <p style="text-align: center;">Design 6 Rectangle shaped yoke on top portion with rings for hanging</p>
 <p style="text-align: center;">Design 7 Horizontal decorative seams lines in the bottom half portion and straps for hanging</p>	 <p style="text-align: center;">Design 8 Horizontal decorative seam lines in the 1/3 bottom portion with rings for hanging</p>

Curtain Designs

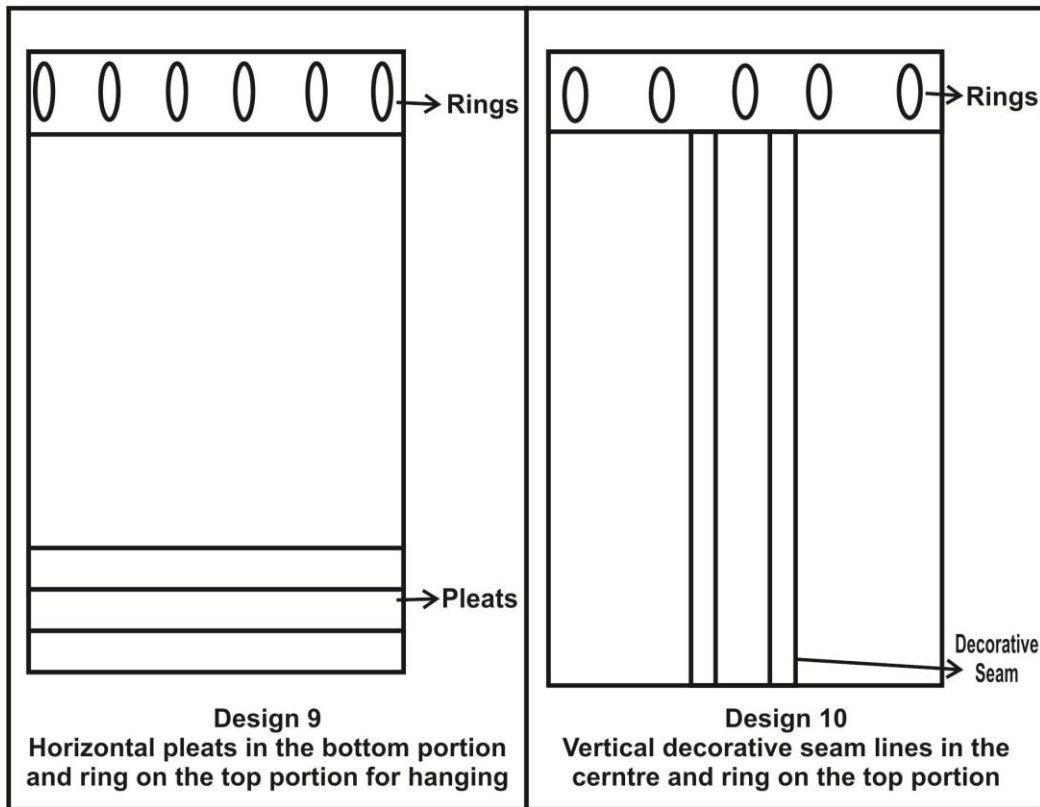
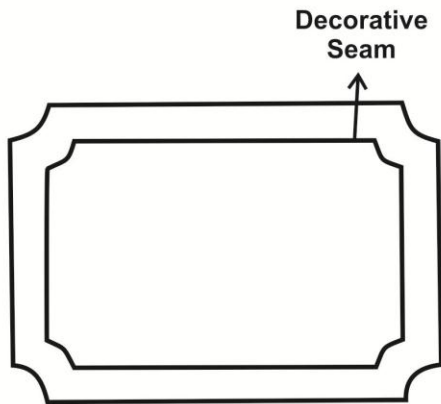
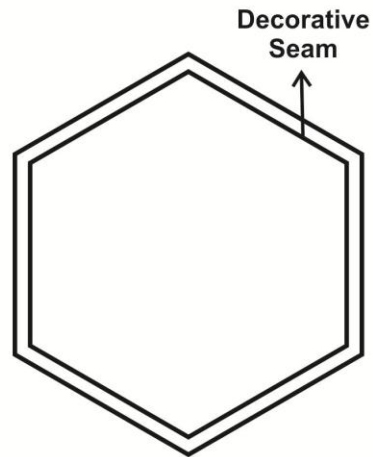


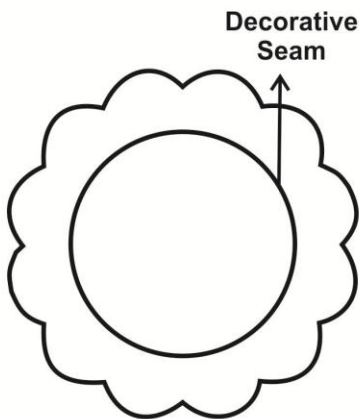
Table Mat Designs



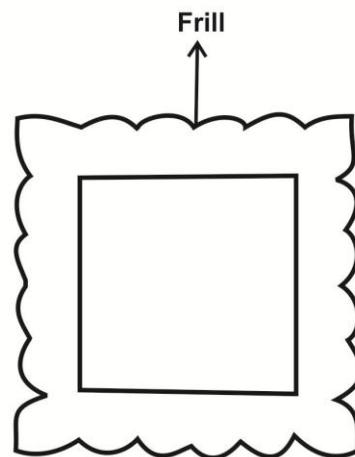
Design 1
Rectangular shape with shaped corners and decorative seam



Design 2
Hexagon shape with decorative seam

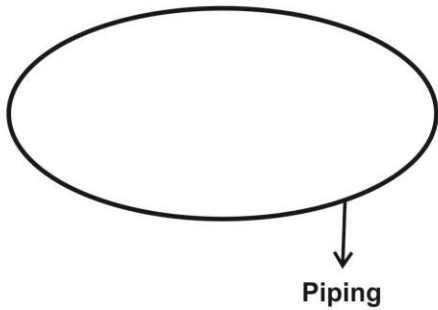


Design 3
Outer scalped shape and inner round shape with decorative seam



Design 4
Square shape with frill

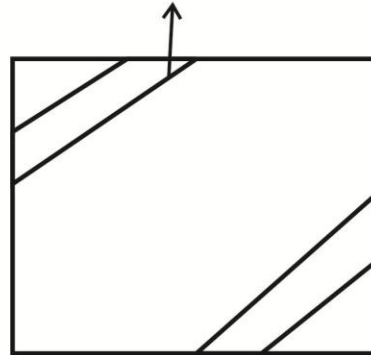
Table Mat Designs



Design 5

Oval Shape finished with piping

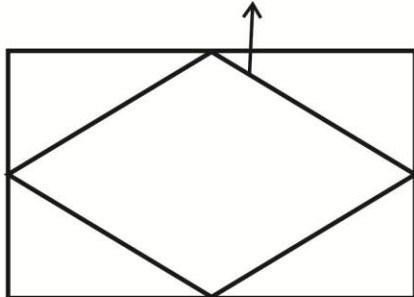
Decorative Seam



Design 6

Rectangle shape with diagonal decorative seam on corners

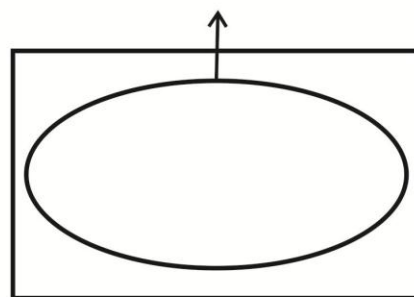
Decorative Seam



Design 7

Outer rectangle shape with inner diamond shape with decorative seam

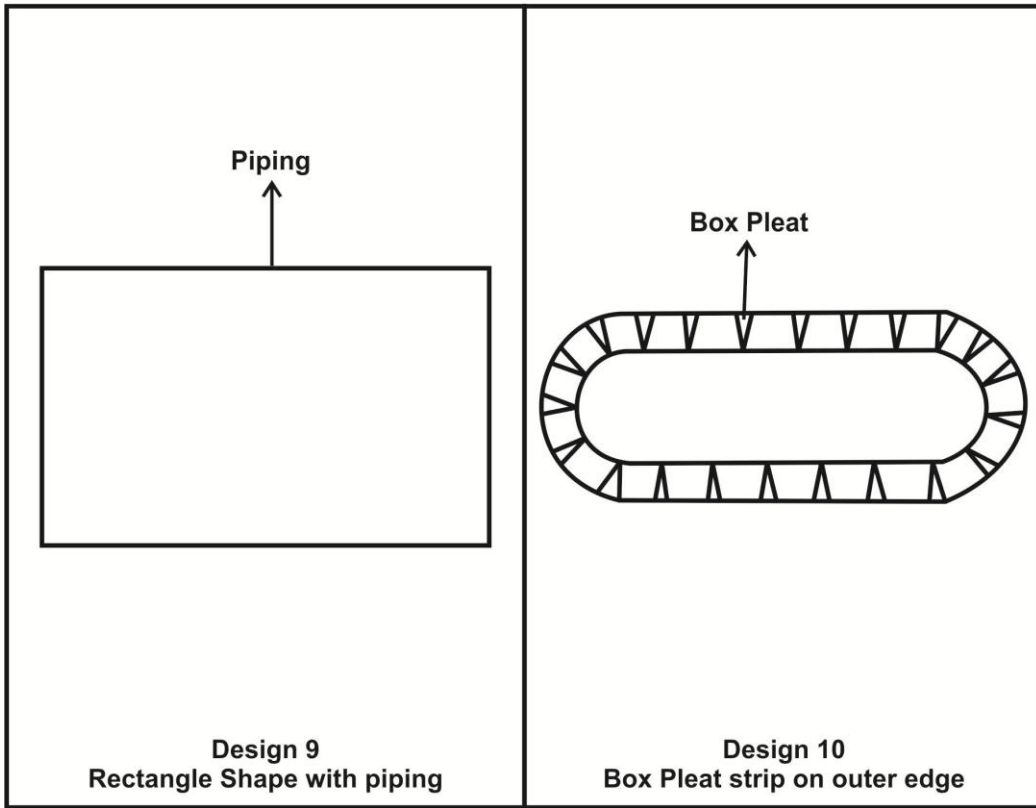
Decorative Seam



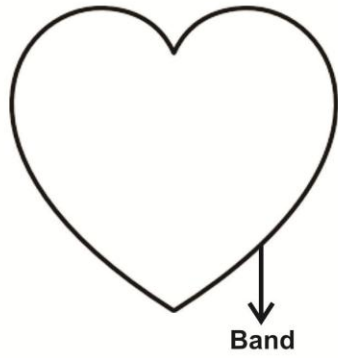
Design 8

Outer rectangle shape and inner oval shape with decorative seam

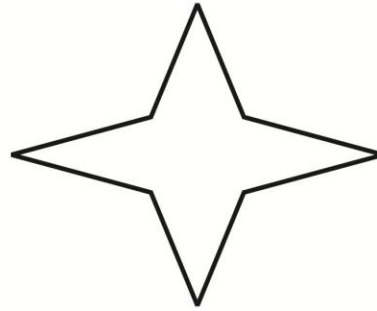
Table Mat Designs



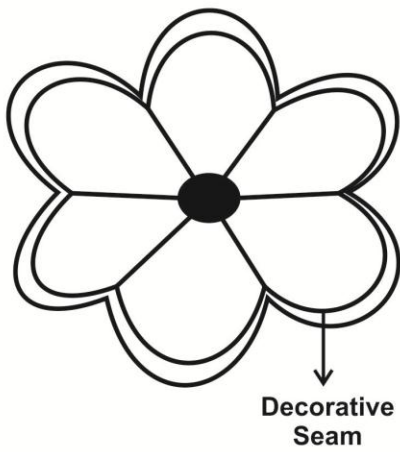
Cushion Cover Designs



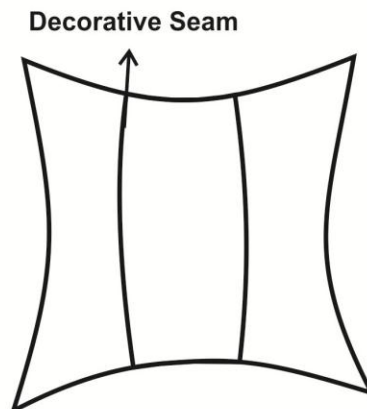
Design 1
Heart Shape with band taping



Design 2
Star Shape with decorative seam

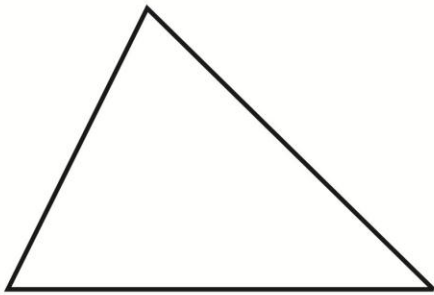


Design 3
Flower Shape with decorative seam

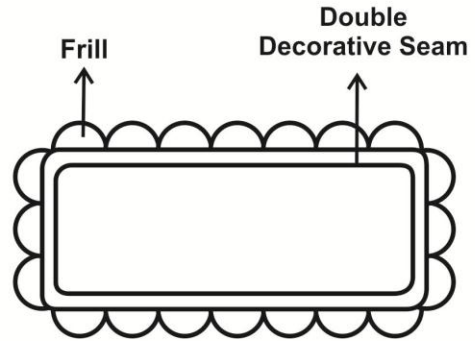


Design 4
Semi rectangular shape with decorative stitch in centre

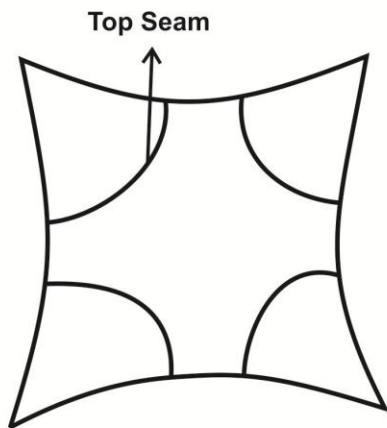
Cushion Cover Designs



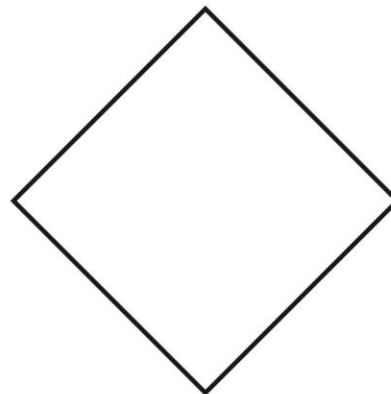
Design 5
Triangle Shape with decorative seam and piping



Design 6
Rectangular Shape with frill and double decorative seam

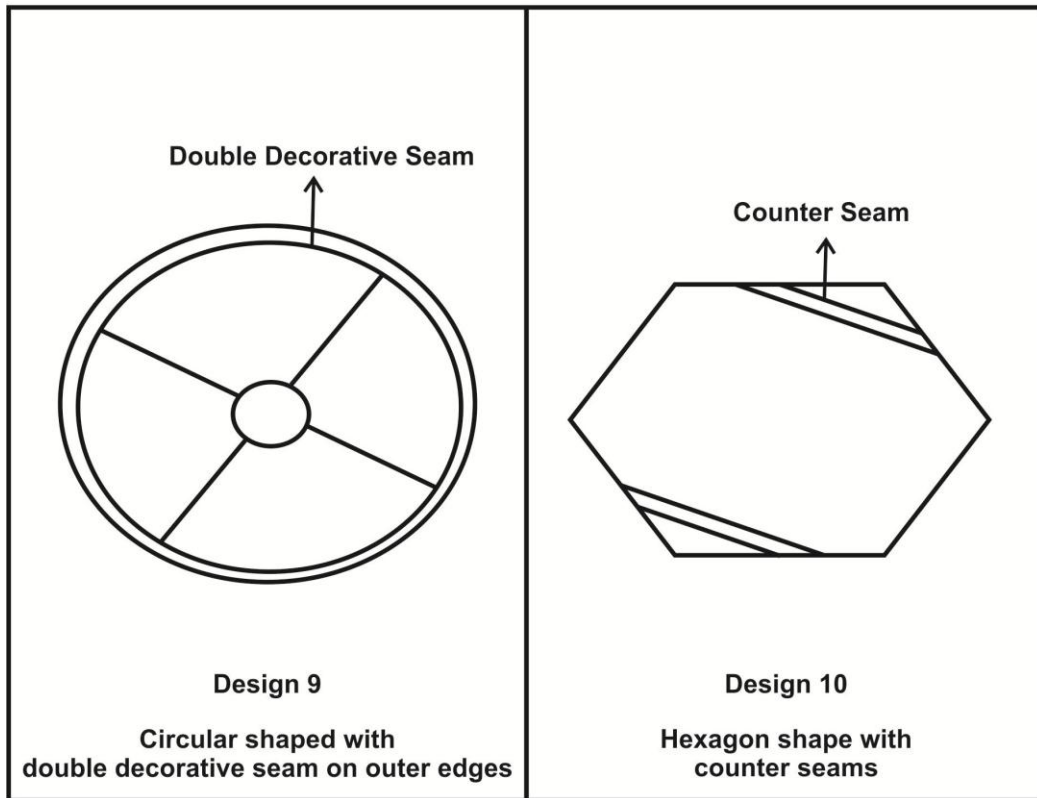


Design 7
Semi rectangular shape with curved decorative stitch finished with piping on the corners

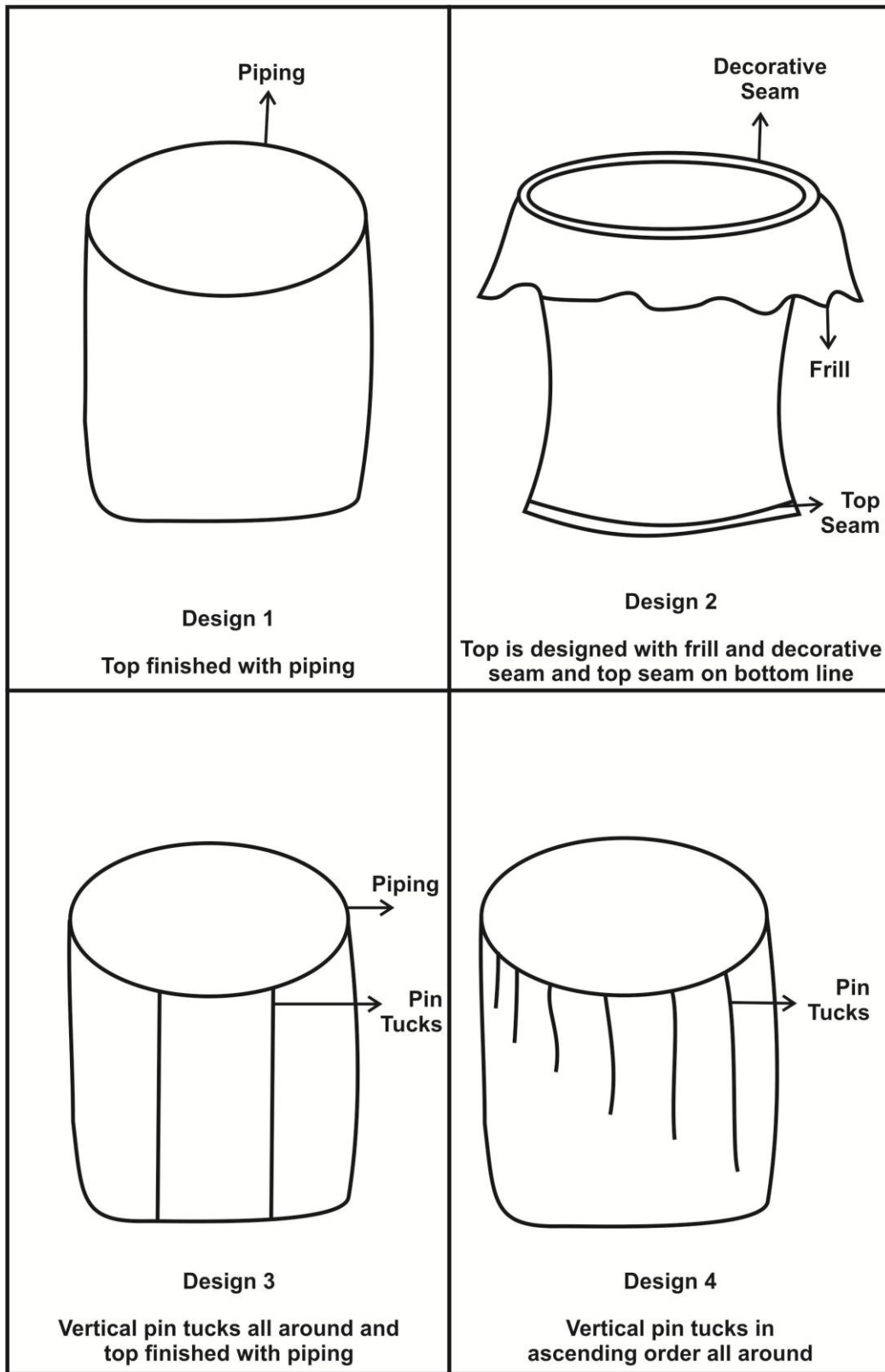


Design 8
Diamond shape with piping

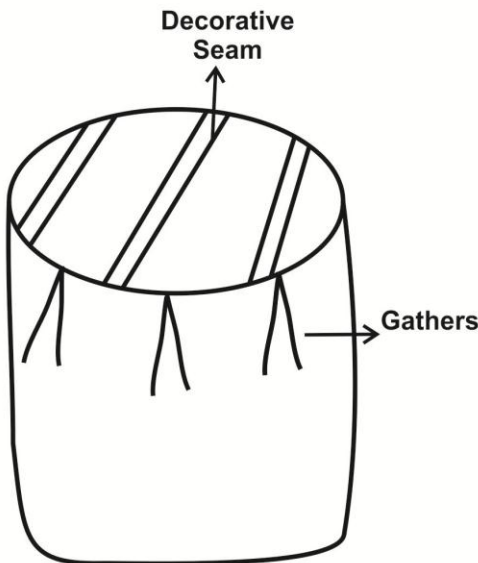
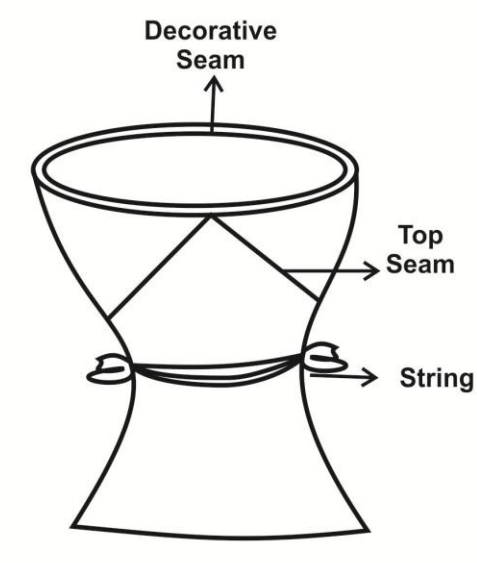
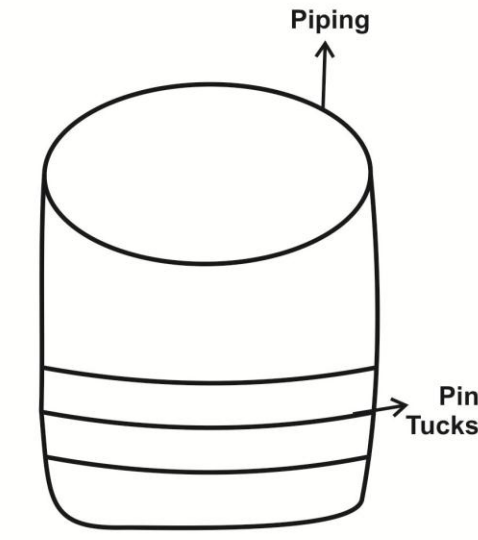
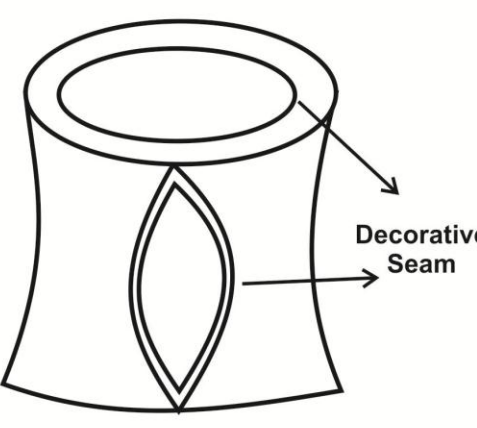
Cushion Cover Designs



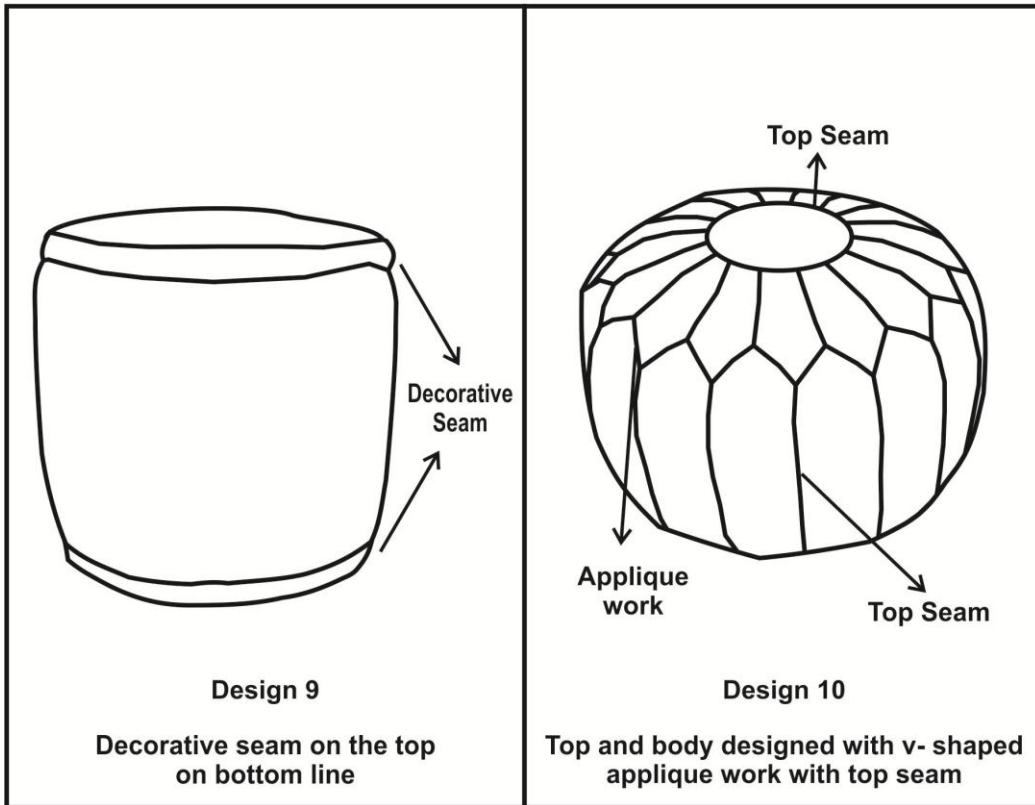
Mudha Cover Designs



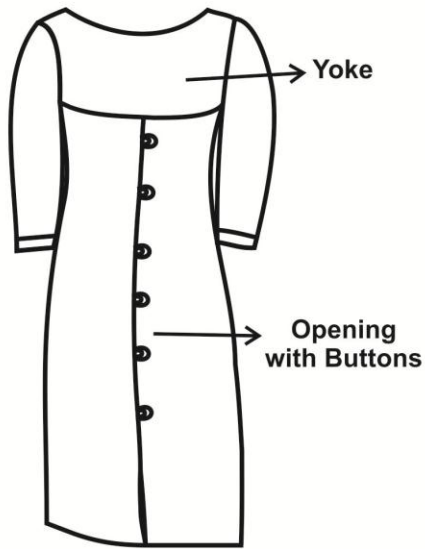
Mudha Cover Designs

 <p style="text-align: center;">Design 5</p> <p style="text-align: center;">Gathers on body an diagonal decorative seams on the top portion</p>	 <p style="text-align: center;">Design 6</p> <p style="text-align: center;">Decorative seam on the top edge. Inverted 'v' shape with top seam on upper portion, centrally tie with string</p>
 <p style="text-align: center;">Design 7</p> <p style="text-align: center;">Horizontal pin tucks in the lower half portion</p>	 <p style="text-align: center;">Design 8</p> <p style="text-align: center;">Decorative seam on the top portion and oval shape curve with decorative seam all around</p>

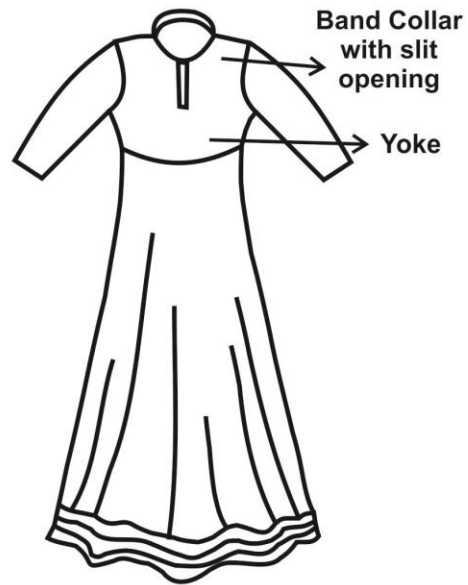
Mudha Cover Designs



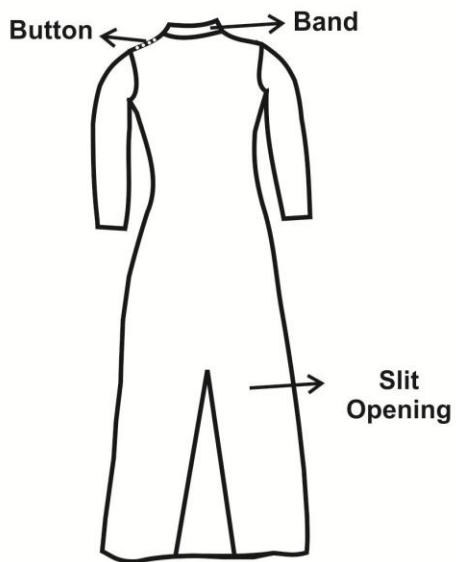
Ladies Shirt Designs



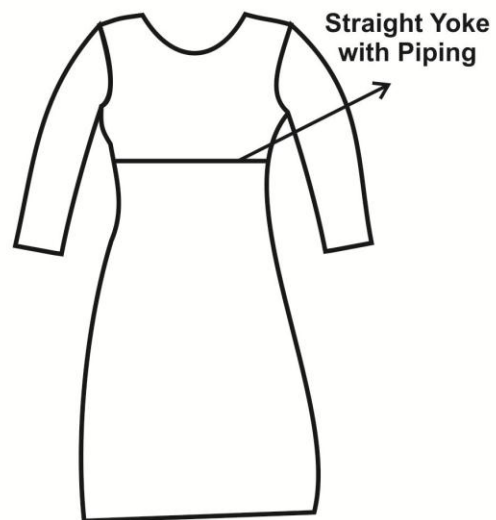
Design 1
Designed with yoke with vertical false centre opening from bust level to bottom with button, $\frac{3}{4}$ sleeve length



Design 2
Designed with yoke with slit opening and band collar, Flared silhouette and half sleeve

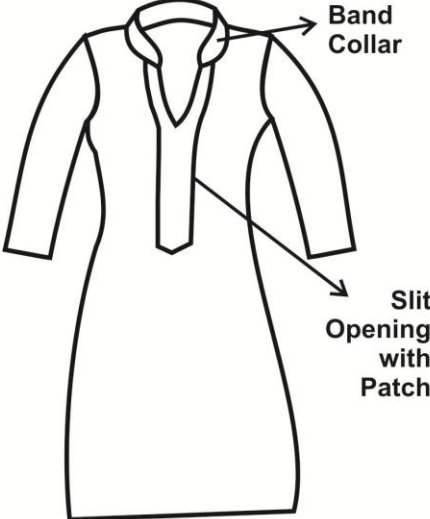
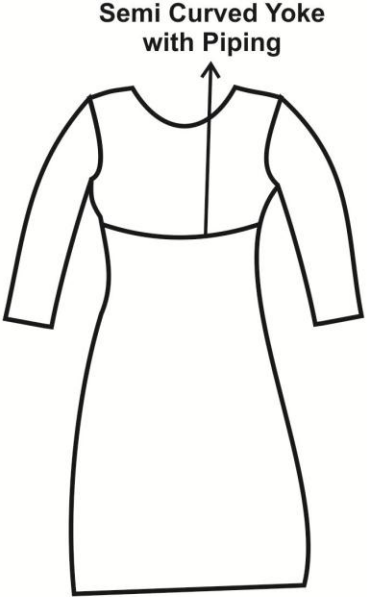
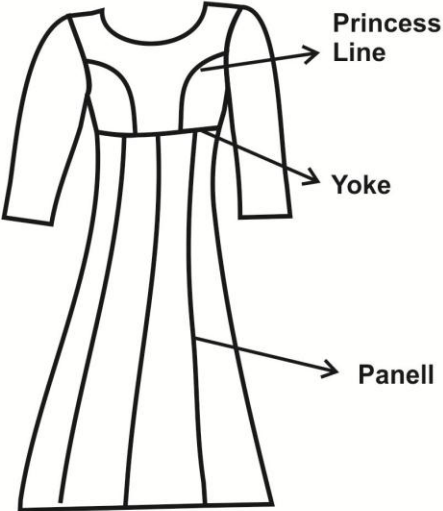
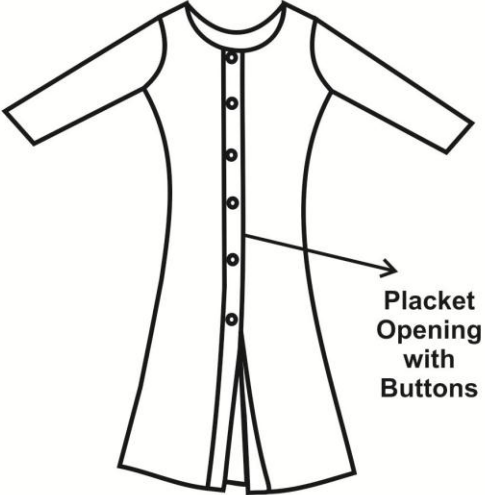


Design 3
Designed with band Collar with shoulder opening, straight silhouette with centre slit opening, $\frac{3}{4}$ sleeve length

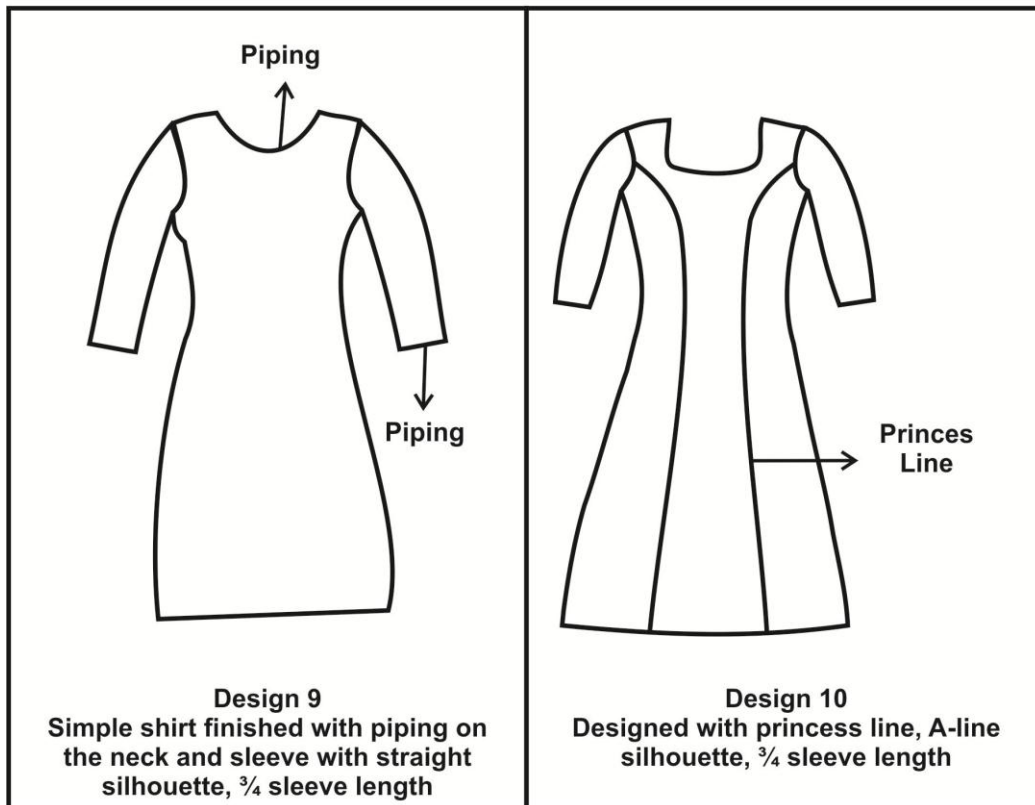


Design 4
Straight waist level yoke with piping, straight silhouette, $\frac{3}{4}$ sleeve length

Ladies Shirt Designs

 <p style="text-align: center;">Design 5 Band collar neckline, slit opening with patch work till waist level, straight silhouette, $\frac{3}{4}$ sleeve length</p>	 <p style="text-align: center;">Design 6 Designed with semi curved shaped yoke with piping, straight silhouette, $\frac{3}{4}$ sleeve length</p>
 <p style="text-align: center;">Design 7 Yoke designed with princess line, Panelled shirt, $\frac{3}{4}$ sleeve length</p>	 <p style="text-align: center;">Design 8 Designed with false centre front opening with decorative buttons, straight silhouette, $\frac{3}{4}$ sleeve length</p>

Ladies Shirt Designs



CREATED SCREEN

PRINTING DESIGNS

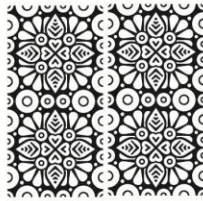
Screen Printing Designs



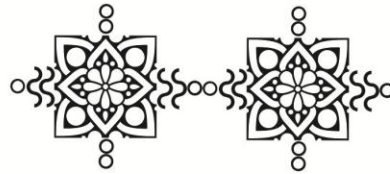
Design 1



Design 2



Design 3



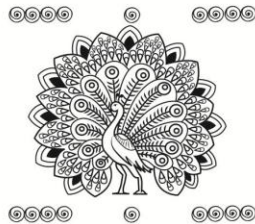
Design 4



Design 5



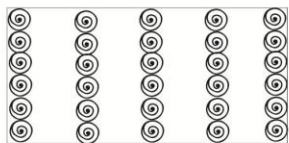
Design 6



Design 7



Design 8



Design 9



Design 10

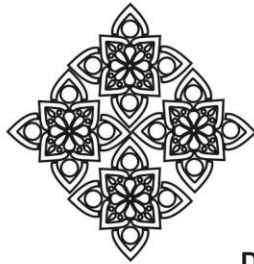
Screen Printing Designs



Design 11



Design 12



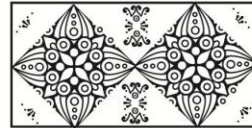
Design 13



Design 14



Design 15



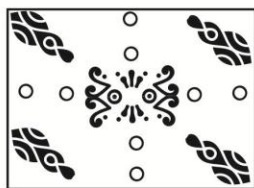
Design 16



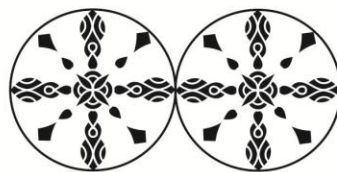
Design 17



Design 18



Design 19



Design 20

Screen Printing Designs



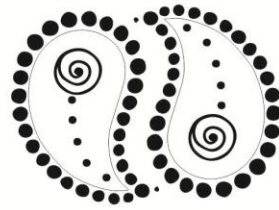
Design 21



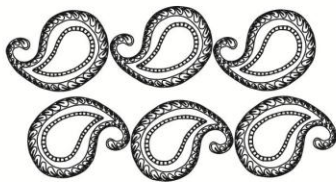
Design 22



Design 23



Design 24



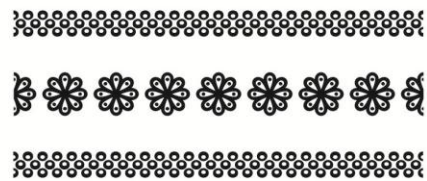
Design 25



Design 26



Design 27



Design 28



Design 29

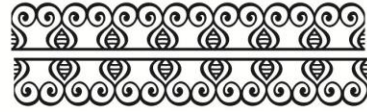


Design 30

Screen Printing Designs



Design 31



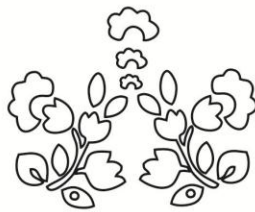
Design 32



Design 33



Design 34



Design 35



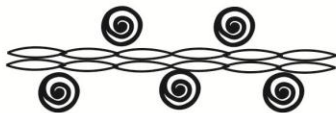
Design 36



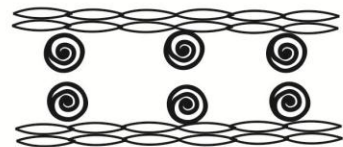
Design 37



Design 38

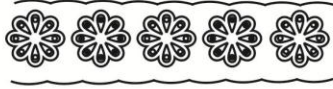


Design 39



Design 40

Screen Printing Designs



Design 41



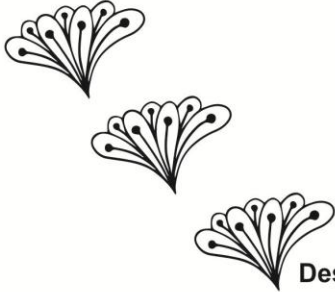
Design 42



Design 43



Design 44



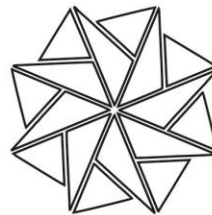
Design 45



Design 46



Design 47



Design 48



Design 49





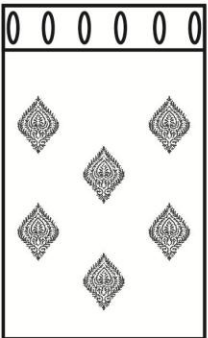


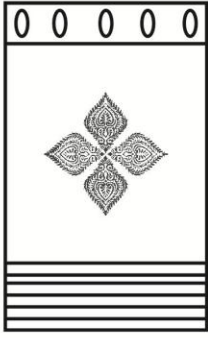
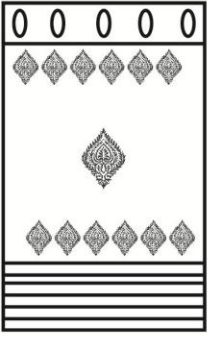
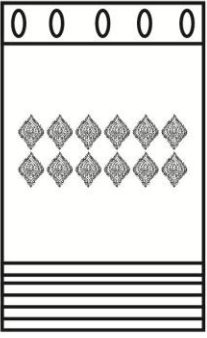



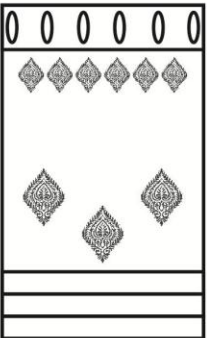
Design 50

CREATED DESIGN PLACEMENTS
ON
SELECTED PRODUCTS

Placements of curtain







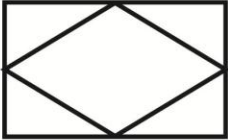
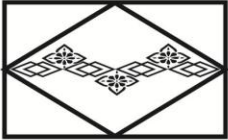
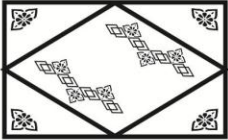
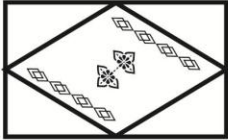

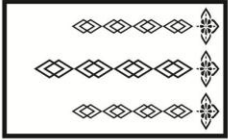

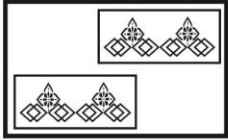
Design 17

 <p>1</p>	 <p>Placement I</p>	 <p>Placement II</p>	 <p>Placement III</p>
 <p>4</p>	 <p>Placement I</p>	 <p>Placement II</p>	 <p>Placement III</p>
 <p>9</p>	 <p>Placement I</p>	 <p>Placement II</p>	 <p>Placement III</p>

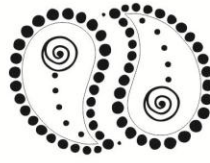
Placements of table mat



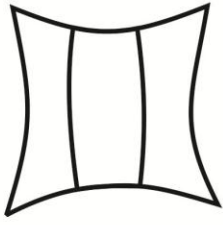
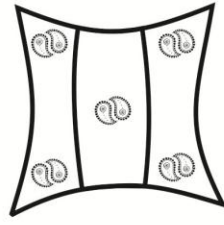
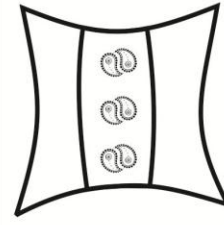
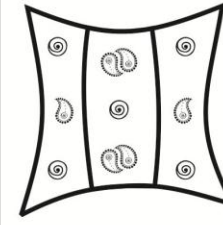
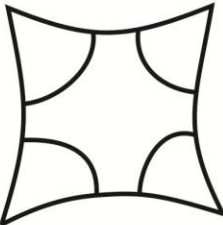
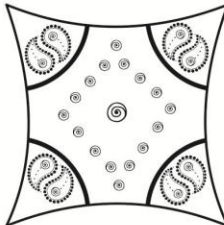
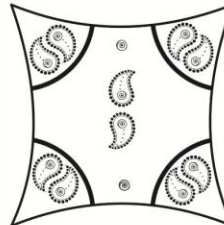
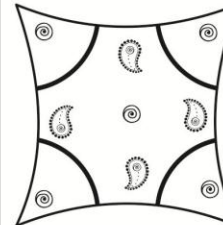
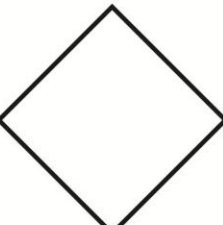
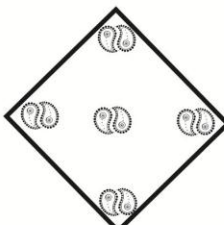
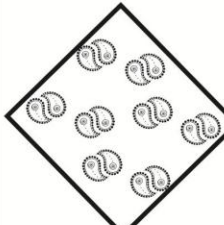
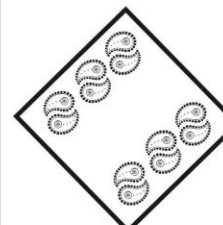
Design 21

 <p style="margin-top: 10px;">6</p>	 <p style="margin-top: 10px;">Placement I</p>	 <p style="margin-top: 10px;">Placement II</p>	 <p style="margin-top: 10px;">Placement III</p>
 <p style="margin-top: 10px;">7</p>	 <p style="margin-top: 10px;">Placement I</p>	 <p style="margin-top: 10px;">Placement II</p>	 <p style="margin-top: 10px;">Placement III</p>
 <p style="margin-top: 10px;">9</p>	 <p style="margin-top: 10px;">Placement I</p>	 <p style="margin-top: 10px;">Placement II</p>	 <p style="margin-top: 10px;">Placement III</p>

Placements of cushion cover



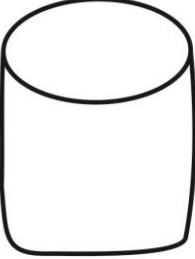



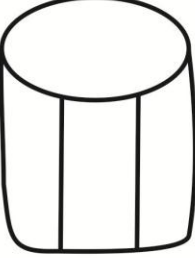
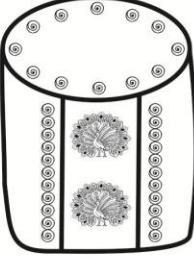
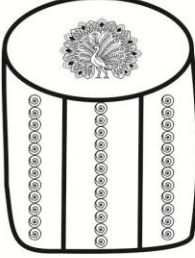
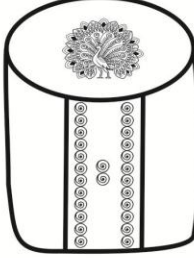
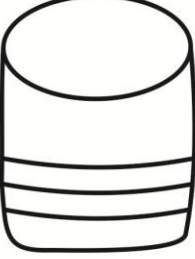



Design 24

 <p>4</p>	 <p>Placement I</p>	 <p>Placement II</p>	 <p>Placement III</p>
 <p>7</p>	 <p>Placement I</p>	 <p>Placement II</p>	 <p>Placement III</p>
 <p>8</p>	 <p>Placement I</p>	 <p>Placement II</p>	 <p>Placement III</p>

Placements of *mudha* cover



Design 7

 <p>1</p>	 <p>Placement I</p>	 <p>Placement II</p>	 <p>Placement III</p>
 <p>3</p>	 <p>Placement I</p>	 <p>Placement II</p>	 <p>Placement III</p>
 <p>7</p>	 <p>Placement I</p>	 <p>Placement II</p>	 <p>Placement III</p>

Placements of ladies shirt



Design 1

<p>4</p>	<p>Placement I</p>	<p>Placement II</p>	<p>Placement III</p>
<p>6</p>	<p>Placement I</p>	<p>Placement II</p>	<p>Placement III</p>
<p>9</p>	<p>Placement I</p>	<p>Placement II</p>	<p>Placement III</p>