RESOURCE RECOVERY AND VALUE ADDITION OF WASTE PAPER INTO HANDMADE CONSUMER PRODUCTS

BY

D. GAYATHRI

A THESIS SUBMITTED TO THE AVINASHILINGAM UNIVERSITY FOR WOMEN, COIMBATORE – 641 043.

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN RESOURCE MANAGEMENT

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Certified as bonafide research work

Signature of the
Head of the Department &
Dean of Home Science

Signature of the Guide

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INTRODUCTION

In this world, nothing is a waste, everything has got its own use

But, to take its advantage someone has to realize its value

- *Adi Sankara*

Paper generally considered as a waste after use is one of the important economic indicators of a country and is recognized as the touchstone of economic growth in developing countries. Paper is a source to preserve the knowledge for the posterity. Every economic and human activity is likely to come to a halt if paper becomes absent from the world. It is the main source of formal education to the population, (NIIR Report) and is responsible for important technical, social and economic impacts of a country (Upadhye and Laga, 2003). Paper and paperboards in one or the other form are an essential input, irrespective of the nature of industrial and consumer activities state, Selvakumar and Mahesh (2006).

People all over the world depend on this paradoxical material. Little can happen in modern life without paper or board (a particular form of paper) and millions of tonnes of it are made and used each year. Printing technology rapidly developed and created an ever-increasing demand for paper (http://hq_papermaker.com). The fact is, world consumption of paper has grown four hundred per cent in the last 40 years. Now, nearly 4 billion trees or 35 per cent of the total trees cut around the world are used in paper industries in all continents (http://www.ecology.com/feature_stories/paper_chase/index.html). Paper was valued for its innate sensual qualities - an appreciation which deeply respects the materials used, the skill of the artisan and the unique quality of the finished product (http://www.hq_papermaker.com/paper_history). The early European papers were made from recycled cotton and linen and a huge trade quickly developed around the trading of old rags. (http://hq_papermaker.com/paper_history). Until 1843 ground-wood, or pulp harvested from trees was the papermaker's material of choice (http://www.ecology.com/feature_stories/paperchase/index.html).

Paper got its name from ‘Papyrus’, or paper rush. Paper as we know it today came into being in China in 150 BC and is often cited as the year in which paper was invented. So it moved on from China to Vietnam, Tibet, Korea and Japan where, on special occasions, they make handmade paper even today (An Environmental Education Program of the Prague Post Endowment Fund, 2003). Paper is made from fibers. The fibers suspended in water are known as pulp. The procedures for obtaining pulp are different for different fiber sources states, Rao (2003). The raw material of papermaking is wood pulp, which comprises vegetable, mineral and man-made fibres (http://www.woodland_trust.org.uk/campaigns/briefingsmore/paperrecycling .htm). The Indian paper industry can be broadly classified into paper and paperboards, and newsprints. The paper and paperboards segment consists of cultural, industrial and special paper. In India, the first mill was commissioned in 1832 (Ramprasad and Kumar, 2005).

Paper is not considered environment-friendly and increase in use is supposed to lead to deforestation. Paper once used is often discarded as ‘waste’ (except official documents). The word “waste” projects a vision of a material with no value or useful purpose (Report of the NIIR Board of Consultants and Engineers). The term “waste paper” covers newspapers, paper of all kinds, brochures, cardboard boxes and corrugated board(http://www.umwelt-schewiz.ch/buwal/eng/fachgebiete/fg_abtall/anlagen/recycling/papier/inde.html#.top), which are further classified as ‘solid wastes’.

Solid wastes include domestic refuse and other discarded soil materials and contain increasing amounts of paper, card board, plastics, glass and

other packaging materials, but decreasing amounts of ash. Solid waste disposal has adverse effects on land values, constitutes a public nuisance, and thus contributes to the deterioration of the environment. Paper products still represent the top waste category in terms of both disposal and recycling, as well as one of the main waste reduction and disposal niches. Paper is a biodegradable material. This means that when it goes to landfill, as it rots, it produces methane, which is a potent greenhouse gas (20 times more than carbon dioxide). It is becoming increasingly accepted that global warming is a reality, and that methane and carbon dioxide emissions have to be reduced to lessen its effects (Printing Review, 2006).

There is a growing awareness that recycling conserves natural resources and reduces the solid waste burden. In the developing and third world countries, recycling of waste paper becomes an absolute necessity due to scarcity of raw materials (NIIR Report). It is an increasingly important alternative to dumping which can serve to reduce the amount of waste accumulation, and also allow the reuse of materials, and decrease the drain on our shrinking resources. It can, not only help reduce the quantities of solid waste deposited in landfills, which have become increasingly expensive, but also reduce the pollution of air, water and land resulting from waste disposal. (Encyclopaedia Britannica, 2007). When an item is recycled, it is first destroyed; then it is treated in some manner to extract its useful raw materials. Used paper can be utilized for many purposes, of which, the making of new paper is the most important (Pento, 1998). Thus old papers and newspapers can also be repulped and converted to new paper (Turk, 1989).

Recycling means converting waste materials to useful forms. The term "paper recycling" typically refers to converting waste paper back into usable paper products (http://en.wikipedia.org/wiki/paper_recycling). That the world's first piece of paper was made from recycled material may sound surprising. Around 200 BC, the Chinese used old fishing nets to make the world's very first piece of paper. So, the process has been around as long as paper itself. Paper companies have always recognized the environmental and economic benefits of recycling. In recent years, considerable interest in wastepaper recycling in the interest of ecology has become popular, as a way to help protect the environment by reusing resources and conserving landfill space. Converters of paper to paperboard have also turned to new materials combined with paper and paperboard to give their products special characteristics (Printing Review, 2006). Almost any household paper can be recycled, including used newspapers, cardboard, packaging, stationery, direct mail, magazines, catalogues, greeting cards and wrapping paper (http://www.bir.org/aboutrecycling/paper.asp.top), in an effort to curtail environmental pollution. Most recycled paper is defined under terms like pre-consumer and recovered paper.

Recycling is environmentally favorable for a variety of reasons. First, it conserves material resources. Second, it conserves fuel. It is twice as costly in energy to make paper from trees, as it is to recycle used paper. In most cases, recycling operations also emit less pollution than the original processes. Significant qualities of pollutants are released when paper is manufactured from wood pulp (Turk, 1989). The depletion of forests, especially in the tropics, makes uncertain the provision of an adequate wood supply to satisfy the anticipated need. One of the efforts to stop the reduction

of Earth's best cover is recycling of paper. Resources saved per ton of paper recycled are: 17 trees, 275 pounds of sulphur, 350 lbs of limestone, 9000 lbs of steam, 60,000 gal of water, 225 Kwh and 3.3 cubic yards of land fill space (http://www.treecycle.com/papers/alt_fiber.html). The economics of recycling is thus closely associated with the economics of energy (Turk, 1989).

Recycling is a true alternative to the highly destructive and polluting virgin paper industry (http://www.treecycle.com/papers /alt_fiber.html). There are three major factors, which favour utilization of waste paper for recycling to paper products. They are world wide shortage of raw materials, increasing consciousness for cleaner environment and control of 'soil pollution', and valuable benefits of recovering a ready made fiber from waste (NIIR Report).

Environmental awareness and resource management to check wastage are not just modern concerns. Identifying and implementing programmes and processes to reduce waste generation increase the percentage of material recycled, and increase the proportion reused in the manufacture of products and other applications opines, Reggs (1999). The most efficient way to conserve resources is to use goods for longer periods of time or to reuse them after they have served their original functions (Turk, 1989), thus paving way for **'recovering the lost resource'**. Bulk paper making is a huge industry consuming whole forests of trees every year, so making old paper products new again is important. (www.bir.org/ aboutrecycling/apaer.asp.top). For this, it is necessary to **'recover the resource'** out of the waste. Paper recycling is the process of converting waste paper **(post-consumer)** or scrap paper **(pre-consumer)** into a usable

product. There are two broad types of recycling operations: internal and external. Internal recycling is the reuse in a manufacturing process of materials that are a waste product of that process. External recycling is the reclaiming of materials from a product that has been worn out or rendered obsolete. An example of external recycling is the collection of old newspapers and magazines for repulping and their manufacture into new paper products (Encyclopaedia Britannica, 2007 and http://search.eb.com/ eb/article-9051374). The former is called **pre consumer** paper and the latter is **post consumer paper**. Pre consumer recovered paper consists of trimmings and scraps from printing, carton manufacturing, and other converting processes that are re-processed in the mill without reaching the final consumer. The latter is called **post consumer** recovered paper. (http://www.tappi.org/paperu /all_about_paper/earth-answers/whyrec3.htm).

The two conventional principles of waste management were: **'Dilute and Disperse'** or **'Concentrate and Contain'**. But the modern concept is based on the **three 'R's of: Reduce, Reuse and Recycle**. All wastes have potentials, for recycling, if possible affirm, Muralikrishna and Rao, (1998). A paramount principle of conservation is that the use of any resource requires consideration of the impacts of its use on associated resources, and on the environment as a whole. Modern conservation is defined as the management of the human use of the environment (a resource) to yield the greatest sustainable benefit to present generations, while maintaining its potential to meet the needs and aspirations of future generation (Manorama Year Book, 2000). Through managerial decisions and actions, resources are added to the stock or are taken from the stock, state, Deacon and Firebaugh (1988). Albeit, educational Institutions are being setting examples of

efficient management of resources, they are yet again the major storehouse and contributors of paper waste. Being a conservationist and an environment sensitive student of Resource Management and having come to know about the possibilities for recovery and recycling of paper waste into useful products, and knowing that it is not much popular among the public aroused a genuine interest in the investigator to launch on this study entitled, **" Resource Recovery and Value Addition of Waste Paper into Handmade Consumer Products",** with the following objectives:

1. **Assess the Post Consumer Paper Generated in Selected Institutions**
2. **Examine the Potentials for Recovery of the Latent Resource in Used up Paper**
3. **Learn the Techniques of Paper Making**
4. **Recycle Paper from Selected Wastes**
5. **Recover Recycled Paper as Value Added Consumer Items**
6. **Create Awareness Among Public on Paper Recycling and Recovery.**

Resources crunch becomes a serious problem unless resources are also generated from waste materials. Therefore, it is time that human beings start believing in this following adage and act accordingly to reduce waste, but **'recover the resources in waste'**.

Waste is a wealth potential

Waste is a threat to environment and life

Waste is a nuisance to the society, but

Waste is also a challenge to meet.

II. REVIEW OF LITERATURE

The literature pertaining to the study on **"Resource Recovery and Value Addition of Waste Paper into Handmade Consumer Products"** is reviewed under the following broad heads:

Origin of Paper

Uses of Paper

Raw Materials Used for Making Paper

Method of Paper Making

Malefics and Benefics of Paper Production

Economic and Environmental Sense of Recycling – Recovered Recycled Paper

A. Origin of Paper

Written communication has been the center of civilization for centuries. Although writing has been around for a long time, paper hasn't. For centuries, people tried to discover better surfaces on which to record their thoughts. Almost everything imaginable was tried. Wood, stone, ceramics, cloth, bark, metal, silk, bamboo, and tree leaves were all used as writing surface at one time or another (www.wipapercouncil.org/ invention.htm).

Egyptians used trimmed reed to write on. Prior to using fibre paper, the Europeans had been writing on parchment, but its production was costly and time consuming. After fibre had been introduced in Europe, the material most commonly used for paper production became old rags. It wasn't until 1769, however, that the first

tree was felled to serve as paper source (An Environmental Education Program of the Prague Post Endowment Fund, 2003). Thus, wood is a material of great economic importance, it is, throughout the world and is a renewable resource (Encyclopaedia Britannica, 2007; and http://www.search.eb.com/ebarticle_216127).

The word "paper" is derived from the word "papyrus", which is a plant (www.wipapercouncil.org/invention.htm). Although papyrus sheets were similar to paper in terms of function, being laminated sheets they were technically more like a mat and therefore not the same as the papers of today (http://www.hq_papermaker.com/paper_history). About 5,000 years ago, Egyptians created "sheets" of papyrus by harvesting, peeling and slicing the plant into strips (www.wipapercouncil.org/ invention.htm). It was here that a marsh grass called Cyperous Papyrus flourished. They cut thin strips from the plant's stem and softened them in the muddy waters of the Nile. These strips were then layered in right angles to form a kind of mat. The mat was then pounded into a thin sheet and smoothened to make a flat, uniform sheet and left in the sun to dry. The resulting sheets were ideal for writing on, lightweight, portable and thus became the writing medium of choice of Egyptians, Greeks and Romans for record keeping, spiritual texts and works of art. (http://www.hq-papermaker.com/paper-history). The person credited with inventing paper is TS'ai Lun from China. By the 12th Century, papermaking reached Europe. (www.wipapercouncil.org/invention.htm). What was discovered was that plant fibers, separated and suspended in water, would form their own woven mats called paper (http://www.tappi.org/paperu/all_about_paper/paperHistory.htm). The technique eventually reached Tibet around 650 AD and then to India after 645 AD. By the time Huang Tsang from China arrived in India in 671 AD, paper

was already widely used there. By 740 AD, the first printed newspaper was seen in China. The first paper industry in the North America was built in Philadelphia in 1690. In India, the art of paper making was introduced by the Muslim rulers during the 10th Century, thus making handmade paper more than 1000 years old (Selvakumar and Mahesh, 2006).

For many centuries, European paper was made by hand from rags and straw, but as the world demand for paper grew, ground wood chips became the main source of fibre. With the introduction of mechanized paper making machines in the 18th century, paper became a cheap and readily available material. (http://www.nowaste.act.gov.au/implementingthenowastestrategy/ programs/schools/factsheets/paperrecycling). The development of paper industry until the early nineteenth century was affected by the shortage of wood in the country. But in 1914, the development of a process based on bamboo lead to rapid growth of the domestic industry.

B. Uses of Paper

In 1448, Johannes Gutenberg, was credited with inventing the printing press. This method of printing in large quantities led to a rapid increase in the demand for paper (www.wipapercouncil.org/invention.htm). Paper has many roles in everyday life, such as writing paper, packaging boxes and banknotes. Throughout history people have used paper to make a whole variety of products. Paper made from the paper mulberry (Broussonetia), was a type of paper first used in China for both ornamental and functional forms, and later introduced in Japan in 610 AD. The Japanese perfected the method, using this paper for everything from seats and pocket books to delicate hair ornaments and oiled hats (www.wipapercouncil.org/invention.htm). It is paper and not papyrus, which has come to touch just about every

aspect of our lives, from term papers and books, to money and personal care products. Traditionally, the demand for paper was dictated by factors like literacy levels, per-capita income and the pace of economic activity. In addition, packaging, export thrust and innovative use of paper in non-traditional applications have contributed to an optimistic demand for various grades of papers in time to come. There are certainly many types of paper. Of the total demand for various varieties of paper, the share of cultural (writing and printing) paper was 46 per cent, industrial paper, 48 per cent, the balance being accounted for by the special papers (Selvakumar and Mahesh, 2006). Art paper, for example, is loaded with china clay to provide a smooth and shiny surface suitable for images. (http://www.writerservices.com /WBS/care_history_paper.htm). Laid paper is made by hand in a mold, where the wires used to support the paper pulp emboss their pattern into the paper. Laid paper often has a watermark. Woven paper is made by machine on a belt and lacks the laid lines. False laid lines can be added to machine made paper. (www.donaldheald.com/glossary/glossary01 .php). The various categories of paper products include newsprint, fine papers, tissue paper, corrugated cardboard and sheet carton. Their characteristics differ according to the type of tree they are made from, the length of wood fibres, their strength and their color.

Rag papers are used extensively for bank note and security certificates, life insurance policies and legal documents, for which permanance is of prime importance; technical papers such as tracing paper, vellums and reproduction papers; high grade bond, letterheads, which must be impressive in appearance and texture; light weight specialists such as cigarette, carton, and bible papers; and high grade stationery, in which beauty, softness, and fine texture are desired (Printing Review 2006) are all made of different types of paper sources. Corrugated

cartons are most suitable for packaging of fruits and vegetables as compared to other type of packaging as they are more acceptable due to their lighter weight, easily foldable character and the resultant ease in storage. (Shaikh and Varadarajan, 2006). Paperboard is used and preferred for packaging as they are inexpensive and unlike plastics are eco-friendly due to their biodegradable nature and also because they provide endless options for constructing creative shapes; the choice is determined by the end-use application (Agarwal, 2004). Papers made in this tradition are durable, flexible and extremely versatile. They can be used by anyone for gift wrapping, writing, drawing and painting. They are also used by craft makers to produce books and binding, stationery and greeting cards, boxes, picture frames and so on. Paper also has many applications in architecture and interior design such as wallpaper, screens, blinds and lampshades.

By using techniques such as moulding and papier-mache one can make almost anything like vases, trays, jewellery, furniture and utilitarian products such as cartons and packaging. In Europe and America, the mass-production of paper and thriving industry supply huge volumes of paper for the production of paper products (http://www.hq_papermaker.com/paper_ history).

Although the history of papermaking is associated closely with printing, there are many other uses to which paper may be put. For example, it is commonly used for all types of packaging. This includes making paper bags, tissue paper, decorative wrapping paper, and corrugated cardboard. The brown paper bag for carrying groceries is still a reasonably common sight today. Paper is used to decorate houses as wallpapers too (Encyclopaedia of Technology and Applied Sciences, 2000). The use of waste paper in non-paper fibre products has a relatively

limited application. Some of them are particle boards, bricks, insulation, pipe, hardboard, and simulated wood and cement panels. (NIIR Report). Papermaking companies around the world turn wood from trees into pulp, pulp into paper, and paper into products we all use, which can again be recovered and recycled. If not recycled, it can prove harmful to the total environment.

C. Raw Materials Used for Making Paper

In ancient times writing was generally on bamboo or a piece of silk, which were then called ji. But as silk became expensive and bamboo heavy, these materials were not convenient. Then TS'ai Lun thought of using tree bark, hemp, rags and fishnets. In Europe, the use of papyrus had dropped out in the 9th century. The preferred medium for the artists was the smooth and lustrous parchment. However, parchment made from animal skin – was extremely expensive. In fact, it has been estimated that a single bible hand written on parchment required the skins of 300 sheep. Later Johann Gutenburg perfected movable type and printed his famous bible in 1456. The birth of the modern paper and printing industry is commonly marked from this date (http://www.hq_papermaker.com/paper_history), it is believed.

By the 10th century, Arabians were substituting linen fibers for wood and bamboo, creating a finer sheet of paper. Today most paper is made from wood pulp, but many plant fibres can be used instead. Paper-matted or felted sheet is usually made of cellulose fibres, formed on a wire screen from water suspension (The New Encyclopaedia Britannica). The Economic Botany Collections at Kew Gardens have used nearly 50 plant families

and over 100 genera. Specimens include paper from banana and palm leaves, rice paper, papyrus and paper from mulberry. Earlier paper was made only from rags (www.wipapercouncil.org/invention.htm).

For centuries Japanese had been making paper called “Kozo” from the inner bark of the mulberry tree Broussonetia Papyrirfera (L) Vent (http://www.hq_papermaker.com/paper_history). The traditional Asian paper which is often referred to as “rice paper” is not made from rice fibres at all. More commonly it is made from the versatile mulberry tree varieties. In Thailand the mulberry tree known as “Sa” – grew in abundance and the Japanese demand for maps, banknotes and other documents caused, Sa paper production to flourish. In Thailand Sa papers incorporating petals and leaves and original paper sheet designs using bougainvillea petals and tamarind leaves, for example, are still hugely popular internationally (http: // www.hq-papermaker.com / paper-history).

In Europe, old clothes and rags were used almost exclusively. The early 1800’s brought a short-lived usage of hemp, flax, tree bark, and straw to make paper in England. Cloth rag fiber appeared to be easier and better and the others were abandoned. Starting in 1840, hemp was used to make “manila” paper in the US. Hemp and Kenaf are being touted as great environmental alternatives to using trees for making paper. Another great source of fiber paper is agricultural byproducts. (http://www.treecycle.com / papers/alt_fiber.htm).

Paper and paperboard making is primarily a raw material based industry and most of the paper mills are located close to cellulose obtained from wood pulp. The favoring factors of the location of paper mills were availability of coal, port facilities and the large demand for paper prominently in educational and cultural centers in India

(Selvakumar and Mahesh, 2006). Any material containing natural cellulose fiber such as wood, cloth, paper and sugarcane stalks can be beaten, pulped and made into paper (Turk, 1989). The main constituent of paper is cellulose. Paper is made of all sorts of vegetarian things like soft wood, hardwood, grasses, straws, cotton linters, cotton rags, linen, hemp, manila, sisal, hemp, and waste paper state, Ramprasad and Kumar (2005). Coniferous softwoods such as spruce, pine, birch and cedar produce fibres which are long (average fibre length is 3 mm) and are used to make papers which have a lot of strength. Hard woods such as birch and aspan do not grow as fast as softwoods and produce short fibres (average fibre length 1 mm) which are used for bulky papers such as writing paper and fluting, which is the middle part of cardboard. (http://www.wasteonline.org.uk/resources/informationsheets/ paper.htm). Hard woods (broad-leafed species) tend to have greater wood densities than soft woods (conifers), meaning they have more fiber per cubic foot of wood. (www.tappi.org/paperu/ all_about_paper/earth-answers/ howmuch3.htm).

Whole trees, which the industry calls round wood, only trees smaller than 8 inches in diameter, or larger trees not suitable for solid wood products, typically are harvested for papermaking (http://www.tappi. org/paperu/all-about-paper/earth-answers/howmuch2.htm). The “leftovers” - residue-wood chips and scraps left behind from forest and sawmill operations would probably be burned or discarded if not used by the paper industry. Although wood has become the major source of fibre for papermaking, rag fibres are still used for paper of maximum strength, durability and permanence (The New Encyclopaedia Britannica). Paper industry utilizes renewable resources like wood and bamboo whereas mini paper mills in the country are based on agricultural

residues of rice/wheat, fibers like waste paper and cotton waste. Bagasse differs from bamboo and hard woods in chemical composition. (Upadhye and Laga, 2003).

The raw materials for the papers are either cotton rags, jute rags (Rao, 2003), tropical crop residual fibre (banana leaf, sugar cane) or renewable fibre. There is no wood pulp in any of the Khadi papers. Some paper makers are finding that agri-pulp paper makes fine stationery. The availability of agro raw materials is estimated at more than 250 lakh tonnes per year in India. If straw and bagasse are used for the manufacture of paper, it would amount to 50-60 lakh tonnes for the manufacture of paper. Bagasse has already been proved to be a suitable fibre for papermaking. (Selvakumar and Mahesh, 2006). It is estimated that around 15 million tonnes of cotton plant stalk is generated in our country, annually. At present it is not being used for any commercial purposes, except as fuel by the rural people, while the bulk of stalk produced is disposed off by burning in the field itself (Shaikh and Varadarajan, 2006). Knowhow had been developed at CIRCOT to prepare pulp and paper from cotton plant stalks. Utilizing the same knowhow, attempts have been made to prepare soda and Kraft pulp and paper suitable for preparation of corrugated boards and boxes.

Gunny paper is made from recycled jute sacking, bagasse paper from waste sugar cane fibre, banana paper from the leaf fibre of the banana plant. Other papers are made with rice straw, tea dust, wool fibres and green strands of algae. Variety of other materials such as grasses, straw, waste paper, or even elephant dung, virgin paper,

ie., paper which have no recycled content (http://www.wasteonline.org.uk/resources/informationsheets/paper.htm#1), can be handy for paper production.

Agarwal (2004) has tried bhindi fibres for reinforced paper lamination. Elephant dung was found suitable for making paper. An elephant spends most of its day eating (it eats about 250 kg of food in a day). It has a very ineffective digestive system that causes a lot of its intake to be passed through. Undigested pachyderm paper is hand made using 75 per cent elephant dung and 25 per cent waste paper. (Sivadas, 2006). Some paper, particularly speciality items are made from synthetic fibres. Most of paper is made from virgin pulp, but recycled paper accounts for 38 per cent of the world's total fiber supply and non-wood fibers from plants like hemp or kenaf make up seven per cent. (http://www.ecology.com/ feature.stories / paper_chase / index.html).

Waste is a great alternative fiber from which paper could be made (Meis, 2006).Waste paper is the most important raw material for the domestic paper and board-making industry. (http://www.umwelt_schweiz.ch/buwal/eng/fachgebiete/fg_abfall/anlagen/recycling/papier/index.html#top). Around 80% of the waste paper is used in the manufacture of paperboards. Waste paper was actually used in making paper as early as the 11th Century AD in Japan (www.treecycle.com/papers /alt.fiber.html). Small scale units depend almost entirely on waste paper as raw material. In India, the use of recycled fibre is only 20% compared to 40% in developed countries. Waste paper is being used as a secondary source for many centuries although in a very small scale. Waste paper is classified into categories as mixed waste paper, corrugated waste, direct entry, deinking grades,

newspapers, and prohibitive or unusable material such as soiled or dirty paper. Paper mills have always used their own waste – trimmings from cutters and rejected paper known as broke. Paper making method is the same.

D. Method of Paper Making

Paper is a thin flat material produced by the compression of fibres which are usually natural and based upon cellulose. (http://en.wikipedia.org/wiki/paper-recycling). TS'ai Lun took the inner bark of a mulberry tree and bamboo fibers, mixed them with water, and pounded them with a wooden tool. He then poured this mixture onto a flat piece of coarsely woven cloth and let the water drain through, leaving only the fibers, on the cloth. Once dry, Lun discovered that he had created a quality-writing surface that was relatively easy to make and light weight. This knowledge of paper making was used in China before word was passed along to other countries. Still paper is made using that same basic formula of wood fiber + water + energy = paper. Variation is introduced only in the kinds of wood fiber and energy used and the techniques of bringing it all together, to get the desired kind of paper (www.wipapercouncil.org/invention.html).

Whether using recycled materials or fresh organic matter, the process starts by shredding the material into small strips and soaking them overnight to loosen the fibres. Next, the fibres are boiled for 2-6 hours, being turned every so often. When finished, the fibres are washed with fresh water to remove impurities and then small particles or specks are removed by hand. Although there are many subtleties which affect the quality of a paper, papermaking in essence is a simple process. Wood consists of various compounds such as lignin, hemicellulose,

natural resin or fatty acid. But the one compound essential to paper making is basic cellulose, or wood pulp. The fibre in the pulp must be separated, washed, filtered and dried (http:// www.hq_papermaker.com / paper_history).

The fibres are beaten in a blender or by hand to a creamy pulp. The beating shortens the fiber, increases the swelling act of water to produce a softened and plastic fiber, and fibrillates or frays the fiber to increase its surface area. All of these actions contribute to better formation of the paper sheet, closer contact between fibers, and the formation of interfiber bonding that gives the paper strength and coherence.

When trees are harvested for papermaking, the limbs are removed and the trunk is transported to a pulp mill. At the mill, the bark is removed and burned for fuel or processed to use as garden mulch. The wood is often chipped into small pieces about the size of a quarter, and then broken down further into individual fibers in a process called **pulping**. The pulping method influences the amount of fiber the wood yields (http:// www.tappi.org/paperu/all_about_paper/earth_answers/howmuch3. htm).

Mechanical Pulping: Pulping is efficiently done mechanically by pressing and grinding the wood to separate the fibers. Up to 95% of the dry weight of the wood is converted into pulp. The first machine for grinding wood to pulp was patented in 1844 (http://www.writersservices.com/WBS/care_history_ paper.htm).

Most newsprint is made from the mechanical pulp. **Pulp made mechanically is called Ground wood**. Ground wood is the least expensive pulp. Paper made from mechanical pulp is opaque and has good printing properties, but it is weak, discolors easily and deteriorates when exposed to light due to the residual lignin in the

pulp. Lignin is a natural wood chemical that holds fibers together (http://www.tappi.org/paperu/all_about_paper/ earth-answers/ howmuch3.htm). The outcome of this complicated process is raw material for unbleached paper (An Environmental Education Program of the Prague Post Endowment Fund, 2003). For this reason it is used for disposable products such as newspapers, inexpensive magazines and paper towels. These articles do not need to have a long life (Walker, 1986).

Chemical Pulping: A second pulping method is chemical pulping, To make pulp chemically, cleaned and debarked logs go through a chipper (Walker, 1986) in which a chemical / water solution dissolves the lignin to help separate the fibers. The absence of lignin means that paper made from chemical pulp is stronger and less prone to discoloration. The pulp yield from chemical pulping is much lower, since the lignin has been removed. Chemical pulps are used to make paper and other products requiring strengths.(http://www.tappi.org/paperu/all_about_paper/earth_answers/how much3.html). At this stage, dyes are added to create colored papers.

The pulp is poured into a large tub and the fibres are suspended in the water. The artisan dips a framed screen into the water and with great skill, lifts it to the surface catching the fibres onto the screen. The screens can either be left in the sun to dry or be transferred to boards, pressed, smoothened and then dried (http://www.hq-papermaker.com/ paper_history).

The demand for paper also created the need for greater efficiency in production. In the late 18^{th} century the labours of Nicholas Luis Robert resulted in the creation of a machine that could produce a seamless length of paper on a endless wire mesh with squeeze rollers at one end. Using a moving screen belt, paper was made one sheet at a time by dipping a frame or mold with a screen bottom into a vat of pulp. Perfected and marketed by the Fourdrineir brothers, the new machine made papers soon replaced traditional single sheets made by hand. In 1809 John Dickinson invented the first cylinder machine. (http://www.hq-papermaker.com/ paper_history).

On the paper machine, yet further water is added to produce a fibre suspension of as little as 1 to 10 parts fibre to 1000 parts water and the resulting mixture is passed into a head-box which squirts it through a thin, horizontal slit across the full machine width (typically 2-6m) on to a moving, endless wire mesh. The water is then removed on this wire section by a mixture of gravity and suction in a process known as sheet formation where the fibres start to spread and consolidate into a thin mat, which is almost recognizable as a layer of paper on top of the wire mesh. This web of wet paper is then lifted from the wire mesh and squeezed between a series of presses where its water content is lowered to about 50%. It then passes around a series of cast iron cylinders, heated to temperatures in excess of 100^0 C, where drying takes place. Here the water content is lowered to between 5% and 8%, its final level. Throughout its passage from the wire mesh to the drying operation, the paper web is supported on various types of endless fabric belts moving at the same speed. After drying some papers may also undergo surface treatments like sizing and calandering. The latter process consists of smoothening the surface of the paper

by passing it between a series of rotating, polished, metal rollers. It is then wound into a reel.(http://search.eb.com/eb/article - 90513747).

Paper can also be made by **recycling**. Here again the process includes sorting, repulping and screening and pulp to paper. Waste paper may be classified into four main catergories: high grades, old corrugated boxes, printed news and mixed paper (Printing Review 2006).

Most paper recycling is performed by using a variation of the same basic process. The paper is separated into its component fibers in clean water which creates a pulp slurry material. This stage is called resuspension. The slurry undergoes a chemical cleaning process to remove nonfibrous contaminants, which often includes a detergent washing. Sometimes a third process is included, which is de-inking of the fiber by sodium hydroxide or sodium carbonate. To produce white paper, an additional bleaching stage is used that uses peroxides or hydro sulfites to remove bits of colour from the pulp. Lastly, this bleached, clean, manufacture- ready fiber is made into a new recycled paper product, either by mixing it with virgin fibers from trees in varying proportion or simply creating 99% recycled paper material. The process of forming actual sheets of paper is then the same as that of new paper. (http://en.wikipedia.org/wiki/paper_recycling). In the recent past, chlorine was used to bleach paper, but as its usage represents major risks to the environment it is being replaced by other means, one of which is chlorine oxide. (An Environmental Education Program of the Prague Post Endowment Fund, 2003). Use of chemicals in paper production eventually leads to a lot of environmental problems. The only alternative, then, is to go in for handmade paper sheet which is eco-friendly and chemical free.

Although almost all steps in papermaking have become highly mechanized, the basic process has remained essentially unchanged (The New Encyclopaedia Britannica).

E. Malefics and Benefics of Paper Production

Paper making has its own advantages and disadvantages

Malefics: Paper manufacturing represents a major burden to the environment. The paper industry contributes to global deforestation, contaminates water, soil and air, has its share in the loss of biodiversity. Increase in the demand for paper has meant the loss of valuable wildlife habitats and ecosystems, as old forests have been replaced by managed plantations, usually of fast growing conifers. The lack of tree species, and diversity in managed forests has a direct impact on the biodiversity of the whole forest. Paper is an organic material. Because its biodegradation time in landfills depend on the ambient conditions, it can contribute to the production of odors, explosive gases and cause contamination of the leachates discharged by sanitary landfills. When not properly treated, leachates carrying suspended solids and organic compounds can contaminate drinking water supplies and aquatic ecosystems.

Large scale tipping of printing paper strains land fill capacity, which is in short supply in many locations. It also wastes valuable raw material and energy (Pento, 1998). Tiedemann (1992) shows that recycling paper saves energy, because the manufacture of pulp from used paper requires only 13 to 16 Gigajoules tonne, compared with 29 to 37 Gigajoules tonne required for manufacturing virgin mechanical pulp.

Benefics: Some of the disadvantages of paper turn out to be long term advantages. Paper is not very stable and hence biodegradable unlike plastics. Being imperfect in formation it is not as transparent as it could be, hence can be printed on both sides. It has high porosity and allows a quicker drying of ink than pore-free plastics. It is not rigid, hence, can be easily folded unlike metals. It is easy to make semi-permanent documents and it is also amenable to many modes of security. Alternates to printing on paper are very expensive and not portable. All this and more gives paper a very unique place as a medium of communication (Rao, 2003).

In terms of environmental pollution and energy consumption, recovered paper compares favourably with the production of wood-based pulp made by chemical or mechanical means. As fresh wood fibres are needed to guarantee paper recycling, so recovered paper and forest products complement each other both ecologically and economically. (http://www.bir.org/about recycling/paper.asp#top).

F. Economic and Environmental Sense of Recycling – Recovered Recycled Paper

According to U.S. Toxic Release Inventory report published by the U.S. Environmental Protection Agency (EPA), pulp and paper mills are among the worst polluters to air, water and land then any industry in the country. The World Watch Institute offers similar statistics for the rest of the world. Each year millions of pounds of highly toxic chemicals are released into the air and water from paper making plants around the world. Post-consumer wastepaper is chocking our landfills or is going to incinerators. They are accumulating in the environment demanding space, posing health hazards and causing nuisance and is expanding all over the world to frightening dimensions. Economic gains too motivate recycling to some extent. Life cycle assessments

clearly indicate that recycling is more environmentally sound than producing paper from virgin fibre. Paper fibres can be recycled several times. Recycling means converting waste materials to useful forms. This has become necessary today.
(http://www.umwelt_schweizch/buwal/engt/fachgebiete/fg_abfall/anlagen/recycling/papier/index.htm#top). Recycling a single press run of Sunday New York Times would save 75,000 trees (Sastri, 1996). Some paper recycling has real environmental and economic benefits. A lot depends upon the type of recovered paper being used and the type of recycled paper being produced. (http://www.tappi.org/paperu/all_about-paper/earth_answers/whyrec1.htm).

Recycling, of course, is not a new phenomenon. However, interest in resource conservation waned during the prosperous 1950s and 1960s and only revised with the emergence of the ecology movement and the energy crisis of the 1970s. At that time increased emphasis on recycling was promoted primarily for its very real ecological benefits (Karen, 1995).

Recycling is not a new concept because for certain grades of paper it is important to use fibres recovered from old paper, rags or cardboard. The quality of the waste determines the end quality of the recycled paper. It is not possible to recover all paper because it may be destroyed in use, be in permanent use (books) or be contaminated. It has been estimated that paper can be recycled on an average four to six times, depending to some extent on the paper grade in question. Therefore, primary fibers are added to maintain strength and other qualities. (http://www.bir.org/aboutrecycling/paper.asp # top).

To recycle makes **environmental sense** because, it reduces pressure for landfill sites, reduces pressure on natural forests by encouraging planting of managed commercial plantations. (http://www.woodland_trust.org.uk /campaigns/ briefingsmore/paperrecycling.htm).

By recycling the paper into new paper, the amount of waste requiring disposal will be reduced, fewer trees will be cut down for paper production, less energy will be used to produce new paper, less pollution will be emitted into the air and water in the production of new paper, green house gas emissions will be reduced and thus saving disposal space, conserving energy and depleting natural resources, and may be saving on the disposal costs as well. (http://dep.state.ct.us/wst/recycle/whitepaper.htm).

Environmental benefits of recycling highlight reductions in energy use (30-55%), solid waste (130+%) and air pollution (75%). The prospects for the recovery of paper from the organic fraction of waste are improving. Recycled paper still has a calorific value. The definition of gross energy requirement of a process includes the calorific value of the products. Thus, the gross energy saving due to recycling one tonne of waste paper is the sum of the energy savings from recycling that is about 10GJ/t, and the calorific value still in the paper, about 15GJ/t, that is a total of about 25GJ/t. (Wilson et.al., 1980). Resource savings and waste/emissions reduction from paper recycling ranges from 23 to 74% of energy, 74% of atmospheric gases, 55% of liquid waste and 58% of water reduced. (Pollock, 1987).

While tree farms or plantations help feed the demand for wood, they can’t provide the plant and animal diversity found in natural forests. (http://www.ecology.com/feature.stories/paper_chase/index.html).

The main types of paper in every day use which can be recycled are office white paper, newspapers, magazines, telephone directories and pamphlets, cardboard, mixed or coloured paper and computer printout paper (http://www.wasteonline.org.uk/resources/informationsheets/paper.htm#).

Post consumer waste is a source of raw material not being used efficiently. It requires 55% less water to process than virgin wood pulp, help reduce water use and toxic pollutants.
(http://www.treecycle.com/papers/ alt-fiber.html).

Landfill-bound waste paper is an excellent “alternative” fiber. Forty per cent of our garbage is paper. Newspaper is recycled back into newsprint , game boards, egg cartons, gift boxes, animal bedding, insulation and packaging materials. (http://www.wasteonline.org.uk/resources/ information sheets/paper.htm#).

Office paper is recycled into office paper, tissue paper, paper towels and toilet paper. Corrugated cardboard is recycled into new card board and cereal boxes. (www.treecycle.com/papers/alt_fiber.html).

While our forest resources are abundant, adding recycled fiber is a good way to stretch our forest resources. Recovered paper supplies over 38 per cent of the total fiber needed to produce our country’s paper products.
(http://www.tappi.org/paperu/all_about_paper/earth_answers/whyrec1.htm).

Some advantages, post consumer recyled paper has over the intentional crop alternative fibers are that they are still land based, growing them requires water, fertilizers and pesticides.

Most recovered paper is recycled back into paper and paperboard products. With a few exceptions, recovered paper is generally recycled into a grade similar to, or of lower quality than, the grade of the original product. (http://www.tappi.org/paperu/all_about_paper/earth_ answers/whyrec1.htm).

The problem associated with recycling are either technical or economical. In recycled paper, the fibers are weakened and it is difficult to control the colour of the recycled product. Recycled paper is banned for use in food containers to preserve the possibility of contamination. It vary often costs to transport raw paper pulp than scrap paper. Collection, sorting and transport accounts for about 90% of the cost of paper recycling (Bharucha, 2005).

Increased recycling raises the average "age" (which equals to the number of recycling rounds) of papers (Pento, 1998). Recycled paper is not usually rebleached and where it is, oxygen rather than chlorine is usually used. This reduces the amount of dioxins which are released into the environment as a by-product of the chlorine bleaching processes (http://www.wasteonline. org.uk/resources/information sheets/paper.htm).

To recycle makes **economic sense** because although it may not be cheaper than ordinary paper, as it is made by not importing new pulp, does saves on disposal costs, and provides employment for a large work force as waste management including paper collection is a major industry.

For every tonne of paper used for recycling the savings are at least 30,000 litres of water, 3000 – 4000 Kwh electricity (enough for an average 3 bedroom house for 1 year) and 95% of air pollution (www.tappi.org/ paperu/all_about_paper/earth_answers /whyrec5.htm).

III. DESIGN OF THE STUDY

The experimental procedure pertaining to the study on **"Resource Recovery and Value Addition of Waste Paper into Handmade Consumer Products"** was carried out under the following headings:

A. Estimation of Waste Paper Generated

B. Action Program

C. Creating Awareness on Handmade Paper

A. Estimation of Waste Paper Generated

The rapid increase in population and the fast development in technological advancement had increased the consumption pattern which ultimately produces waste material in abundance. Among the solid wastes generated paper holds a major share. Hence estimating the quantum of waste generated was taken as a part of the study, which included:

1. Selection of Locale and Sample

The broad area selected for the study was Coimbatore City. Paper being the prime throw away material from educational institutions and offices, the specific areas selected for the study were short listed to a School, University premises, women's hostel and a nationalized Bank.

In accordance, all the buildings in the premises of Sri Avinashilingam Higher Secondary School, Avinashilingam University for Women, Saradalaya hostel and Indian Bank (within the campus) were chosen adopting convenience sampling. Since the whole University was involved, the entire student community and faculty were considered as sample. Hence the sampling procedure was naturally "convenient" as the investigator had chosen all the closest live persons as respondents as suggested by Basotia and Sharma (2002).

2. Procedure for Recovery of Paper Waste

Collections of used up paper or post consumer paper for use as a raw material for a similar product is called 'recovery'. Recovery means 'return to an original state' (http://edugreen.teri_res.in/EXPLORE/solwaste/recycle.htm). As the procedure of the study required collection of waste paper, this aspect of the study involved the following phases:

a. Interaction With the Students: The investigator visited all the class rooms and hostel rooms in person and requested the inmates to throw away, used up stationery paper waste alone in carton boxes left exclusively for this purpose in each floor of all buildings. Specific instructions were given not to discard newsprint or food packages into the junk.

b. Collection of Paper Waste: Large size carton boxes were left in the floors of all the buildings at specific places.

c. Instructing Sweepers: Sweepers were specifically instructed to leave all throw away stationery papers in the specified carton boxes and were reported not to take away the carton boxes for disposal for a specific period of time.

d. Collection from Bank: The Chief Manager of the Bank within the University premises was approached and the objectives stated. He agreed to comply with the request but stated to be willing to give away only 'throwable' paper for confidential reasons, which was accepted. A box was left in the bank premises too.

3. Conduct of the Study

Special instructions were given as the collection process was scheduled for five consecutive days phased over two weeks, summing up for a total of ten days. The waste was collected everyday evening on all the ten specified days. Assistance was requested from the sweepers in collecting the waste floor wise (Plate.1).

4. Quantifying the waste collected

The daily waste generated from each premise (School, University, hostel and Bank) was pooled individually and the quantum of waste generated per day was quantified using a standard digital scale. The procedure was repeated for all the days and the total quantum of waste generated (mean value) from all the buildings for a period of five days was quantified. Findings of the study are presented under Chapter IV.

B. Action Program

An action programme aims at the promotion of education, or improvement in health, or introduction of new skills and/or occupations etc, so that the programme as a whole, can raise the community to a higher level of economic organization and arouse enthusiasm for new knowledge and improved ways of living (Dahama and

Bhatnagar, 1987). As the study warranted on action program, this part of the study was streamlined to include the following sections:

1. **Resource Recovery from Post - Consumer Paper**
2. **Recovery of Resource by Recycling**
3. **Value Addition**

1. Resource Recovery from Post – Consumer Paper

Post consumer recovered paper (like old corrugated boxes, newspapers, magazines and office paper) is the paper that was already used by the ultimate consumer, and was then returned to the mill for recycling (http://www.tappi.org/all-about-paper/earth-answers/whyrec1.htm).

Post consumer paper is generally thrown away that pollutes the environment or is burnt away to ash. To curtail this, an action oriented project was devised to recover the wasted resource. Accordingly, the plan of action for this part of the study was channelised on the following lines:

a. Making Handmade Paper Using Conventional Method

Most supermarkets and high street stationers now sell a range of recycled products, such as writing paper, notebooks, file paper, diaries with recycled content, calendars, paper table cloths and napkins, tissues, toilet rolls, kitchen paper and other items (www.wasteonline.org.uk/resource/ informationsheetspapper.htm). As recycled paper products are on sale in the market and also because from time immemorial it has been a practice to try

making handmade paper in non-scientific household conditions an attempt was made to produce paper by pulping waste paper in the laboratory premises.

i. Selection of Locale: The study was carried out in the Resource Management laboratory of Avinashilingam University for Women, Coimbatore, adopting convenience sampling, as, the locale complied with Kothari's (2004) viewpoint that, when population elements are selected for inclusion in the sample based on the ease of access it is called convenience sampling.

ii. Selection of Sample: The greatest proportion (about 50% by weight and 70% by volume) of household waste is paper, and this is one of the most important sources of pulp for paper production, reports, The New Illustrated Science and Invention Encylopaedia, (1989). The main raw material used in hand made paper making are cotton rags, waste paper and agro wastes the essential ingredients for papermaking which are rich in cellulose. Accordingly, the waste paper generated from the University campus and cotton wastes from power loom industries and banana wastes from banana plantations (as supplements and as trial samples) were selected as sample raw materials for the process to make both recycled paper and non-paper fibre paper.

Caution was exercised mainly in the choice of waste paper that was not contaminated with food or newsprint, such that the primary objective of the project to produce eco friendly handmade paper will not be lost.

iii. Procedure: The procedure deployed for making handmade paper involved two different methods.

- **Making Handmade Paper Using Conventional Method**
- **Making Handmade Paper in a Paper Plant**

- **Making Paper Using Conventional Method: involved**

*** Pulping:** Waste paper collected from the campus was torn up into very small pieces and soaked overnight in hot water. Then the soaked paper was ground well to make paper pulp. **The ground materials to which water is added is called pulp or the recovered resource from waste**.

*** Making Handmade Paper:** The ground pulp was poured into a large basin filled with hot water and mixed thoroughly. A household sieve was placed into the basin and moved around, slowly, so that a layer of fiber gathers on the surface of the sieve. The sieve was retrieved and allowed to dry. Then the sheet was transferred from the sieve to old newspaper or cloth to take out remaining moisture (Plate 2).

*** Value Addition:** Mixing agricultural by products with post consumer recycled fibre has been recommended as an excellent solution to gain both waste stream reduction and fibre strength. So, other ingredients were added to waste paper. (http://www.treecycle.com/papers/alt_fiber. html). In this instance banana and cotton rag wastes or non-paper fibre waste were tried.

For addition of banana waste, it was first soaked and cooked and then ground before adding to the paper waste materials. Cotton rags were dethread and cut into small pieces and added to paper pulp.

- **Making Handmade Paper in a Pilot Paper Plant:** This aspect of the action programme included:

*** Selection of Locale:** The locale selected for the study was Varapalayam where the Avinashilingam University for Women has an extended campus for the Faculty of Engineering. The specific area selected within the premise was the paper plant affiliated to the Department of Printing Technology of the faculty adopting purposive sampling

(Plate.3). Though Pillai and Bagavathi (1999) refer to sample as a convenient slice of population, this area was specifically selected by virtue of having installed a paper plant in the premises.

*** Selection of Sample:** Waste paper generated from Avinashilingam University and banana waste from banana plantations were selected as sample for making paper. As plantation waste like banana stem, sheath and leaves are rich source of fiber and laboratory trials have shown that these wastes can be a good source of strong unbleached pulp for making paper (NIIR Board), banana was also selected for the purpose adopting purposive sampling. Purposive sampling is also called "deliberate" or "judgement sampling", where the researcher deliberately selects certain units for study from the universe (Gupta, 2002).

*** Procedure:** The process of paper production using a mechanical method involved a high degree of experimentation, as the exercise was a maiden effort for the investigator. Experimental method implies a controlled observation of a succession of events where the aim is to search for causal

connection, state, Bedkar (2003) and also because it is a sophisticated technique for problem solving (Agarwal, 1985). Hence a crash training programme on using the paper plant to make paper was undergone by the investigator for two days. Training was imparted by the team from Sri Bannariamman Engineering, Coimbatore. The procedure taught and adopted for the study involved the following phases:

- **Components and Functions of the Paper Plant:** The paper plant chosen for the experimental study composed of the following components : Hollander Beater, Autovat, Hydraulic Press, Calendaring machine and Cutting Machine. Plate.4 portrays the components of the paper plant

- **Process :** The process involved the following steps: As the process cannot be performed single handed, three men were deployed to assist in the process of paper making from Sri Bannariamman Engineering, Coimbatore who are dealing with the manufacture of paper plant machinery.
- **Sorting:** A measured amount of waste paper was sorted for foreign material and torn into very small bits prior to feeding it into the Hollander beater.
- **Beating:** A definite amount of water was filled within the beater. The beater of 3 HP capacity, consisting of a multi toothed rolling wheel was connected to a power supply unit. Power connection was given. In beating, the mixture of torn paper and water roll inside the beater and pulp was obtained. In the case of banana wastes, the wastes were soaked and cooked well. It was then fed into the beater along with 50 gms of caustic soda.

- **Lifting and Couching:** Autovats are used to prepare the boards or sheets. It is a mechanical device made of wood to be filled with water. A measured quantity of pulp was poured into the wiremould, after giving adequate stirring, is lifted giving a shake. Lifting was aided by a manual pedal operation. The sheet so formed was transferred to a gada cloth. The amount of pulp poured depended on the required thickness of the sheets.
- **Pressing:** For pressing, a hydraulic press fitted with a motor of one HP was used. The press helps to drain the excess water by squeezing it out, retaining the wet paper.
- **Drying:** The wet sheets were dried in the sun for about 6 hours to remove the remaining water by evaporation. After drying, the sheets were peeled from the gada cloth.

- **Calendaring:** This is meant for polishing boards and papers. Paper was polished by plate calendaring by passing the paper in between the rolls.
- **Cutting :** The papers were cut to the desired size using a calendaring machine. The procedure adopted is explained through Plate.5

2. Recovery of Resource by Recycling

'Any productive use of what would otherwise be a waste material requiring disposal is broadly referred to as resource recovery'. Hence, this part of the study included finding details on the following.

a. **Nature of Waste Recovered**
b. **Quantum of Pulp Obtained or Recovered**
c. **Details on Paper Recycled**
d. **Waste Recovered as Resource**
e. **Quality Assessment of Recovered Recycled Paper**

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COLLEGE

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a. Nature of Waste Recovered: The sample (waste) used for the study was post consumer stationery paper, banana waste (sheath, and trunk etc) and cotton waste from hosiery units. The sample wastes were either used alone or were combined and used in various permutation combinations. For resource recovery using paper plant only paper waste and banana waste were combined.

b. Details on Pulp Obtained: The quantum of pulp obtained by grinding wastes in different permutation combinations were measured after grinding in both the techniques.

c. Details on Paper Recycled: By using the pulp obtained from waste, paper was produced as per the procedure explained under heading 'B' of the 'Design of the Study', adopting both the techniques.

In the conventional method additives in the form of natural dyes like turmeric, pomegranate rind, tea dust, bougainvillea, rose petals, hibiscus, Henna and beetroot were added to bring in variety. In the mechanical method, chemical dyes were added. Though the investigator was not willing to involve any chemicals, this exercise was forced upon to enable her to compare the product obtained with those papers made by paper mills. Addition of silk yarn, bougainvillea petals, leaves and varnish paper were also tried to enrich the appearance of the hand made paper produced. Use of bleaches and starch were strictly avoided, so as to obtain a natural raw material- based paper.

d. Waste Recovered as Resource: The quantum of paper realized from, recycling known weight of waste used, adopting both the techniques was quantified. This was done to estimate the amount of recoverable components in

the waste used. Similarly it was also done to establish that other non-paper fibre wastes could also be successfully used to produce paper contributing both to resource use and conservation of forestry.

e. Quality Assessment of Recovered Recycled Paper : Quality of paper produced adopting both the techniques was evaluated. A structured score card was used for the same, for deriving information on gsm of paper and printability. Sample recycled papers, were given to Saradalaya press. For judging the other qualities a panel of judges from within the University campus was selected adopting convenience sampling. They were selected according to the convenience of the resources such as nearness and ease in availability of data, as highlighted by Thanulingam, (2001).

The score card along with the recycled paper was displayed in a specific area, and the judges were requested to evaluate them on a specified date, and time informed to them earlier. The details on nature of waste used, pulp obtained recycled, paper realized, resource recovered and quality of recycled paper produced are discussed under Chapter IV.

3. Value Addition:

The trend today is for value added products which would otherwise be wasted and would become a burden to the earth. Hence an attempt at value addition of the recycled paper was also attempted on the following basis as a part of the study. Value addition is mainly done in the case of paper to improve its suitability and its process capabilities inorder to decide the best product mix. (http://www.value_addition.com/app-pulp-paper.htm). From the paper realized from both the techniques, commercially viable and acceptable consumables or consumer goods were

made. The products were made considering their end use and marketability of the items. The details on the products made are explained under Chapter IV.

C. Creating Awareness on Handmade Paper

Any product introduced in the market should focus on market trend, cost and popularity of the products among consuming public and naturally it is directly related to awareness of the public regarding the issue under consideration. Hence this part of the study included:

1. **Market Survey**
2. **Campaigning for Awareness Generation**

1. Market Survey: This part of the study comprised of :

a. Selection of Locale and Sample: A sample of five paper marts dealing with sale of handmade paper located within Coimbatore City were chosen deliberately for conducting the study. Purposive sampling is also called 'deliberate' or 'judgement sampling', where the researcher deliberately selects certain units for the study from the universe (Gupta, 2002). A paper mill producing handmade paper also was visited to obtain relevant information.

b. Selection of the Method: The method opted was direct personal interview. According to Pillai and Bagavathi (1999), in an interview, the investigator has to be a keen observer, and be tactful and courteous in behaviour. As the study warrants these and as Young, (2003) reflects that personal interview is an effective

informal, verbal and non-verbal conversation, initiating for specific purpose and focused on certain planned content areas, this method was chosen to decipher the required information from the dealers.

c. Selection of Tool and Conduct of the Study: A structured check list was administered on the dealers to comprehend the information needed by the investigator. A checklist is, as the name implies a listing of specific factors, which are applicable to a process or to more specific procedures, opine, Herman and Zaccarelli (1991). Samples of some products were procured from the shop and photographs of other products sold were taken to enable the investigator to compare the hand made paper and paper products made by her to those available in the market.

The study was conducted during lean hours of the day when the shops were not thronged by customers and when the dealers were less busy with their schedules. The checklist was administered on the sample to record their responses then and there. A sample of the tool used for the study is presented under Appendix I.

2. Campaigning for Awareness Generation

Campaign is an intensive teaching activity undertaken at an opportune time for a brief period with a focussed attention in a concerted manner on a particular problem, with a view to stimulate the widest possible interest in a community, block or other geographical area (Reddy, 2001). Since the matter to be disseminated included a wider population, adopting, one method of info-transfer, may not be successful. Different media has to be adopted. Hence, based on the media and sample on whom focus was laid, this part of the study included:

a. **Awareness Generation Among School Children**

b. **Campaigning Through Print Media**

a. Awareness Generation Among School Children

Children are the backbone of a nation and imparting education to them on a vital topic can have a good impact on the way they approach the problem. Hence school children were selected as one type of the sample for the study. The procedure included:

*** Selection of Method:** The method adopted was method demonstration and Result demonstration, as it can leave an indelible imprint on the minds of the younger generation. Method demonstration is a relatively short time demonstration given before a group to show how to carry out an entirely new practice or an old practice in a better way (Reddy, 2001). A Result Demonstration is a method of teaching designed to show by example the practical application of a fact, or group of related facts. In other words, it is a way of showing people the value or worth of an improved practice where success has been established on the research station.

*** Selection of Sample:** Considering convenience of the investigator a group of school children belonging to Sri Avinashilingam Higher Secondary School, Coimbatore were selected for the study as they were available within the same campus.

*** Conduct of the Study:** A demonstration on handmade paper was imparted after procuring permission from the concerned authorities and, at a later date the same group was approached to be given a Result demonstration. Visual aids in the form of charts and models helped to supplement the lecture cum demonstration. While charts are

visual symbols for summarizing, comparing, contrasting or performing other services in explaining subject matter (Reddy, 2001), objects and models enhance the function of definition and example by appealing to the audience's sense of sight and touch. (Gouran et al., 1994). Details on the conduct of the programmes are delineated under Chapter IV.

b. Campaigning through Print Media

The print media are the oldest vehicle for mass communication. Society to date, has been basically print oriented. The mass media network was exclusively print (Black and Whitney, 1988).

As knowledge and awareness regarding resource recovery of paper waste and other wastes and value addition of the same should reach the consuming public too, it was felt, print media would be the right choice, as information could be printed, and published and circulated among a large literary population who are solely responsible for throwing away paper as waste, and in the most irresponsible manner. To this effect, **a monograph**, an **article form in a regional journal** and an **article in a popular Newspaper** were written, published, brought out and circulated among University students. Specimen copies of the same are presented under Chapter IV.

Recycling of waste is the conversion of waste into reusable forms as resources, such that the waste is no longer a 'waste' but a 'resource', said Nambiar (1995). It is hoped that this Philosophy would have percolated among the literary population, atleast to a small extent.

IV RESULTS AND DISCUSSION

The findings of the Study on **"Resource Recovery and Value Addition of Waste Paper into Handmade Consumer Products"** are analysed under the following broad heads:

A. Quantum of Waste Generated

B. Recovery of Resource From Waste Paper

C. Awareness Generation on Paper Recycling

A. Quantum of Waste Generated

Details on the amount of waste generated within the selected premise was collected and quantified and the details are presented under Table 1 and Plate.6

Table : 1 Quantum Of Waste Generated

Day of Collection	Premise	Total/Day (Kgs)
	Post consumer paper collected (in Kgs)	

	College buildings	**School**	**Bank**	**Hostel building**	
1st Day	20.5	33	1.50	12.75	67.75
2nd Day	18.5	36	0.75	11.50	66.75
3rd Day	17.0	35	2.00	10.50	64.50
4th Day	21.0	37	1.50	10.00	69.50
5th Day	19.0	34	0.50	9.50	63.0
Total	96.0	17.5	6.25	54.25	331.00
Mean	19.5	35	1.25	10.85	66.60

The study revealed that on an average 19.5 Kgs of waste was generated from the college premises, 35 Kgs from school campus, 1.25 Kgs from bank, and 10.85 Kgs from hostel buildings. The mean post consumer paper waste thrown away was to the tune of approximately 65.70 Kgs.

Probably a rough estimate would project a dumping waste amounting to 1350 Kgs/month and 13,240 Kgs in an academic year. This is an estimate of non-contaminated, newsprint-free paper alone. If other types of paper wastes were considered the figure would have gone up multifold.

Most of the paper produced has a value and is an asset only when it is in its pre-consumer stage. Once it becomes post consumer paper, it becomes a waste and a liability to the society and burden to Mother Earth. If an institution produces more than 10,000 Kgs of paper waste, it is understandable how the waste from all sources within a city would pollute the environment. To curtail the same, **wealth within the waste has to be recovered and recycled** and made more useful to the public. The following section of the Results throws light on a viable solution to this massive problem, and, that is, making handmade paper.

B. Recovery of Resource from Waste Paper

Basel Convention has urged people to be aware of the need to continue the development and implementation of environmentally sound low-waste technologies, recycling options, good housekeeping and management systems with a view to reducing to a minimum the generation of wastes (The Hindu, Survey of the Environment, 2006). Hence this attempt at reducing paper waste by recovering its latent wealth was ventured. This part of the study therefore, is delineated under:

1. **Repulping**
2. **Recycling to Recover a Resource - Paper**
3. **Quality of Recycled Paper**
4. **Value Addition of Recycled Paper**
5. **Economics of Recycling Paper**

1. Repulping: Repulping of post consumer waste and other wastes selected for the action programme (namely banana and cotton waste) was done following numerous permutation combinations in terms of resource use and quantum used. This differed between the techniques used too. Table 2 presents details on the same.

Table : 2 Quantum of Waste Used and Pulp Obtained

Technology adopted	**Waste Used**	**Quantum of waste used (in gms)**	**Water used (in litre)**	**Pulp obtained (in Kgs)**
Conventional	Post consumer paper	2 Kgs	28 litres	34 Kgs
	Banana	2 Kgs	10 litres	23 Kgs
	Paper + banana	30 gm	300 ml	515 gm

	Paper + cotton+ banana Paper + cotton Cardboard box Brown sheet	15 gm 10 gm 50 gm 25 gm	150 ml 100 ml 700 ml 350 ml	250 gm 166 gm 850 gm 430 gm
Mechanical	Waste paper Banana + Paper	10 Kgs 12 ½ Kgs	140 litres 100 litres	170 Kgs 130 Kgs

The study revealed that the pulp obtained from use of post consumer paper with other wastes in different combinations proved very functional and fruitful, as the pulp generated was quite considerable in both the technologies. It was found that in the domestic environment itself even cardboard boxes and brown sheet could be repulped successfully.

2. Recycling to Recover a Resource - Paper

Recycling of waste is the conversion of waste into reusable forms, such that the waste is no longer a waste, but a resource used for optimum productivity (Dwivedi, 1979). With this viewpoint the pulp obtained was recycled to produce paper again. This part of the study therefore highlights the following details:

a. **Quantum of Recycled Paper Realized**
b. **Shape of Paper Produced**
c. **Details of Recycled Paper**
d. **Waste to Recycled Paper Ratio**

a. Quantum of Recycled Paper Realized

This part of the study is analysed under quantum of recycled paper realized in the conventional method and mechanical method. The following Tables 3 and 4 give details on the quantum of recycled paper realized.

Table: 3 Quantum of Recycled Paper Realised (Conventional Method)

Permutation combination of waste used	Quantity of Recovered waste	Number of paper produced	Weight of Recycled Paper	Per cent of recovery

Post consumer paper	2 Kgs	65	1.67 Kgs	83.5
Banana	2 Kgs	15	1.2 Kgs	60
Paper + banana	15gm +15gm	5	20 gm	66.6
Paper + cotton+ banana	5gm +5gm + 5gm	5	10 gm	66.6
Paper + cotton	5gm + 5gm	2	6 gm	60
Cardboard box	50 gm	5	40 gm	80
Brown sheet	25 gm	5	15 gm	60

As the study pertains to value addition of waste, post consumer waste chosen was mixed with other kinds of non – paper fibre waste. Studies have proved that almost 80 per cent of the paper can be recovered from post consumer paper in the process of repulping, as recovered paper contains some fibers which have become too small to be recycled into paper.

The present study has also proved the same. It was found that almost 1.67 Kgs of paper could be recycled from 2 Kgs of post consumer paper; 1.2 Kgs from 2 Kgs of banana waste; 20 gms from 30 gms of paper +banana mix; 10 gm from 15 gm paper + cotton + banana mix; 6 gms from 10gms of paper +cotton; 40gms from 50gms of

card board box, and 15 gms of paper from 25 gms of brown sheets. Plate.7 exhibits the type of paper obtained from various types of waste.

Hand made paper produced in the laboratory level was by a crude technique utilizing ordinary domestic tools (sieve, basin, ordinary blender etc) from the kitchen. If the process could be conducted under standardized, mill conditions, it is believed that the recovery of resource could be more sumptuous and satisfactory. To adopt a better practice the exercise was repeated in the paper plant using selected wastes. The following Table gives details on the quantum of recycled paper realized in the mechanical method

Table : 4 Quantum of Recycled Paper Realised (Mechanical Method)

Permutation Combination used	**Quantity of Recovered Waste used**	**Number of paper produced**	**Weight of Recycled paper**	**Per cent of recovery**
Post consumer paper	10 Kgs	55	8.1 Kgs	81
Banana + Waste Paper	12 ½ Kgs	170	8.6 Kgs	68.8

It was found that almost 8.1 Kgs of paper could be recycled from 10 Kgs of post consumer paper and 8.6 Kgs of paper from 10 Kgs of paper + 2 ½ Kgs of banana. This part of the study brought to light that only waste

TEARING

SOAKING

SIEVING

paper could be recovered upto 80 per cent. Mixing of banana, a non-paper fibre waste had not enhanced the recovery rate. Plate .8 portrays the paper produced by this method.

b. Shape of Recycled Paper Produced

This part of the study is analysed under

i) Shape of Recycled Paper Produced (Conventional Method)

ii) **Types of Recycled Paper Produced (Mechanical Method)**

i). Shape of Recycled Paper Produced (Conventional Method)

The findings on this score are presented under Table 5

Table : 5 Shape of Recycled Paper Produced (Conventional Method)

Permutation Combination used	**Quantity**	**Shape of paper produced**	**Number of recycled Paper made**
Post consumer paper	2 Kgs	Circular sheets Rectangular sheets	50 15

Banana	2 Kgs	Circular sheets	15
Paper + banana	30 gm	Circular sheets	5
Paper + cotton+ banana	15gm	Circular sheets	2
Paper + cotton	10 gm	Rectangular sheets	3
Cardboard box	50 gm	Rectangular Sheets	5
Brown sheet	25 gm	Rectangular sheets	3

The study revealed that 65 sheets of paper could be recycled from 2 Kgs of waste paper, 15 sheets from 2 Kgs of banana waste, 5 sheets from paper+banana (15 g +15 g), 5 sheets from paper + cotton + banana (5gm + 5gm + 5gm), 2 sheets from paper + cotton (5gm + 5gm), 5 sheets from 50 gm of card board box waste and 5 sheets from 25 gm of brown sheet. Depending upon the sieves used, the shapes of the papers made differed.

The study has focussed light on two important factors. Banana was used on a trial basis to know if it could be pulped under non-standardized conditions using ordinary tools. The study has proved that paper could be produced under commonplace conditions, from banana too, in the first instance and secondly that the paper that could be recovered from post consumer paper is more by total weight (1.67 from 2 Kgs of post consumer waste) compared to virgin sheets and banana (1.2 Kgs from 2 Kgs of banana).

ii) Types of Recycled Paper Produced (Mechanical Method)

The types of recycled paper produced adopting mechanical method is tabulated below.

Table : 6 Type of Recycled Paper Produced (Mechanical Method)

Permutation combination used	**Quantity of recovered paper used**	**Type of paper produced**	**Number of Recycled Paper made**
Waste paper	10 Kgs	Paper Board (like charts	25
Banana + waste paper	10+2 ½ Kgs	Paper Paper Board	30 25

		Paper Paper Writing paper	35 10 100

The study revealed that 55 sheets of paper could be recycled from 10 Kgs of post consumer waste, 170 sheets from paper + banana (10+2 ½ Kgs) mix. As the technique adopted introduced machinery, the pulp realized and the paper recycled was considerably more in number. The type of paper and paper products realized also differed. Apart from chart paper from which boards were made, writing paper also was sieved out from the pulp. Boards were made by laying 14 charts one above the other and glueing them with adhesive. Banana waste proved not to be a better resource for production of paper compared to post consumer wastes. Residual waste was found to be more with banana +paper combination, resulting in reduced recovery and recycling.

c. Details of Recycled Paper

The physical details of the paper realized through recycling is tabulated as given under Table

Table : 7 Physical Details of Recycled Paper

Permutaion Combination	Shape of the paper produced and Total Number	No. of paper produced	Weight of the recycled paper	Girth of paper (mm)	Dimensi-ons of the paper (in mm)
Conventional Method					
Post consumer paper	Circle (50)	20	35 gm each	60	17 dia
		10	25 gm each	45	17 dia
		10	15 gm each	35	17 dia
		10	5 gm each	20	17 dia
	Rectangle (15)	15	35 gm each	80	32X25
Banana	Circle (15)	15	80 gm each	100	19 dia
Paper + banana	Circle (5)	5	4 gm each	30	17 dia

Paper + cotton+ banana	Circle (5)	5	2 gm each	15	17 dia
Paper + cotton	Rectangle (2)	2	3 gm each	20	32X25
Cardboard box		5	8 gm each	35	32X25
Brown sheet	Rectangle (5)	5	3 gm each	20	32X25
	Rectangle (5)				
Mechanical Method					
Post Consumer Paper	Rectangle (55)	25	240 gm each	1.25	50X60
		30	70 gm each	65	25X20
Banana + Paper	Rectangle (170)	25	160 gm each	1.50	50X60
		35	100 gm each	80	50X60
		10	20 gm each	40	50X60

		100	100 gm each	35	25X20

In the conventional method of recycling paper alone, variation in the shape, girth and amount of paper used was introduced and it was found that under domestic condition itself it is possible to produce paper of varying shapes, dimensions, weight and girth.

In the mechanical method, paper was produced to satisfy for standard paper dimensions. This analysis proved that, it is possible for small entrepreneurs to produce paper and boards, if at all, one could marshal resources for establishing the enterprise which can definitely prove profitable.

d. Waste to Recycled Paper Ratio

To prove that recovery of paper material is possible from post consumer paper, this aspect is included under the analysis. It is explained through the Table.

Table : 8 Recovery of Resource From Waste

Techniques Used	**Permutation combination of waste used**	**Quantum of recovered**	**Quantum of recycled**	**Ratio of waste to recycled**

		paper used	**paper**	**paper**
Conventional method	Post consumer paper	2 Kgs	1.67 Kgs	1: 0.835
	Banana	2 Kgs	1.2 Kgs	1: 0.6
	Paper + banana	30 gm	20gm	1: 0.67
	Paper + cotton+ banana	15 gm	10gm	1: 0.5
	Paper + cotton	10 gm	6 gm	1: 0.6
	Cardboard box	50 gm	40gm	1: 0.8
	Brown sheet	25 gm	15 gm	1: 0.6
Mechanical method	Post consumer paper	10 Kgs	8.1 Kgs	1: 0.81
	Paper + Banana	(10 +2 ½) = 12 ½ Kgs	8.6 Kgs	1: 0.68

It was very heartening to note that more than 80 per cent of the paper content in the thrown away paper could be recovered and recycled as new paper. The findings complied with the post consumer paper recovery in the case of cardboard waste recovery too. Only with brown paper waste, recovery was lesser (60%). An earnest effort from all quarters of the society would pave way for fruitfully recovering paper waste into useful paper, paper boards and products for local consumer use.

3. Quality of Recycled Paper

It is clear now that recovery and recycling of post consumer paper material is possible and feasible; but, to address the issue for public consideration the quality of the paper produced has to be understood. Hence this part of the findings are delineated under:

a) **Physical Appearance of Recycled Paper**
b) **Satisfaction of Paper – specific characteristics**

a) Physical Appearance of Recycled Paper

Table 9 presents the details on the physical appearance of recycled paper, as consumers generally are motivated to buy paper only from their looks. This reflects the responses received from the panel of judges to whom an informal score card was given.

Table : 9 Physical Appearance of Recycled Paper

Techniques adopted	**Type of Recycled paper**	**Factors Considered**			
		Details Reported			
		Colour	**Texture**	**Curling**	**Suitability for use**
Conventional	Post consumer paper	White	Matty	Seen	Can write, draw, use sketchpen
	Banana	Light Brown	Matty	Seen	Can write
	Paper + banana	Cream	Matty	Seen	Can write
	Paper + cotton+ banana	Cream	Matty	Seen	Can write and draw

	Paper + cotton	Milky white	Matty	Seen	Can write
	Cardboard box	Dark cream	Matty	Seen	Can write
	Brown sheet	Brown	Matty	Seen	Can write, draw and is foldable
Mechanical	Post consumer paper	White	Matty	Not seen	Can write, draw, use sketchpen
	Paper + Banana	Cream	Matty	Not seen	Can write and draw

It was found that none of the papers, irrespective of their suitability for writing were white in colour. Similarly raw material used also decided the colours of paper. Most of the papers made in conventional technology

had a matty finish and showed curling. Cardboard and brown sheet paper and those made by mechanical techniques did not show curling. All types of papers satisfied the criteria for use as writing paper. Post consumer paper also was found to be feasible for printing. Samples of papers with their suitability for use is presented as Exhibit: 1

b) Satisfaction of Paper - Specific Characteristics

In the higher order of quality assessment paper has to qualify for certain characteristics as per set norms. The details of the status of the hand made paper produced under experimental study are analysed under Table 10

Table: 10 Properties of Handmade Paper

Techniques adopted	**Type of Recycled paper**	**Type of Paper**	**Properties Considered**			
			Gsm	**Formation**	**Absorbency (sizing)**	**Opacity**
Conventional	Post consumer paper	Circular	70	Well formed	1.6 cm in 4 sec	Opaque

		Rectangle	80	Thin spots	1.3 cm in 3 sec	Opaque
	Banana	Circular	30	Well formed	2 cm in 23 sec	Opaque
	Paper + banana	Circular	120	Thin spots	1.5 cm in 5 sec	Opaque
	Paper + cotton + banana	Circular	130	Thick spots	1.00 cm in 2 sec	Opaque
	Paper + cotton	Rectangle	135	Thick spots	0.8 cm in 1 sec	Opaque
	Cardboard box	Rectangle	150	Well formed	0.7 cm in 10 sec	Opaque
	Brown sheet	Rectangle	100	Well formed	1.1 cm in 6 sec	Opaque

Mechanical	Post consumer paper	Paper board (like Chart)	150	Well formed	0.9 cm in 3 sec	Opaque
		Paper	90	Thin spots	1 cm in 3 sec	Opaque
	Paper + Banana	Paper board	150	Thick spots	1.2 cms in 2 sec	Opaque
		Writing paper	85	Thick spots	1.0 cm in 2 sec	Opaque

Basic Weight (GSM): The Basic weight of paper is the weight per unit area. This can be expressed as the weight in grams per square metre (GSM or g/M2), pounds per 1000 sq.ft.

Formation: Formation is an indicator of how the fibres and fillers are distributed in the sheet.

Opacity: Opacity is the measure of how much light is kept away from passing through a sheet (http://www.biltpaper.com/atoz2.asp#20).

Absorbency: Absorbency of paper can be related to both water and oil absorbency. The degree of sizing of paper, is related to water absorbency, since the function of sizing a paper is primarily to render it resistant to penetration by water (www.paperlinx.com.au/cpa/htmcontent.asp? page_id.114).

The tests were conducted in Mayura Cone Factory, Coimbatore, where they have the machinery to do the tests. The tests conducted proved that the paper made by both techniques were of good quality. The personnel from the testing center adjudged that the papers were fool proof and could be used like any other mill made paper.

4. Value Addition of Recycled Paper

Recycled paper from any source can be put to any use as virgin paper or paper from mills. To motivate production among public and to enhance its use and sale, such handmade paper has to be converted

into value added products. The efforts can be channalised on any of the following lines as tried in this study. Trials made pertained to:

a) **Change in Physical Appearance of the Paper**
b) **Conversion into Consumer Goods.**

a) Change in Physical Appearance of the Paper

As the paper made by recycling was not much appealing, the following additives (eco friendly) were incorporated in the pulp. In the conventional method, turmeric powder, pomegranate (rind, cooked and mashed), tea dust (as brew), ground henna, ground red hibiscus (single petal), Myrobalan and ground beetroot were used. Among synthetic colouring agents powdered dyes (pink, violet and liquid blue (used for fabrics) were used. In the mechanical method pink (for Banana+paper) and blue (post consumer paper) dyes alone were used. The samples of papers obtained by incorporating such additives are presented as Exhibits 2 and 3.

b) Conversion into Consumer Goods

Consumers are on the look out for materials which are novel and which can satisfy their multiple needs. The paper that is recycled offers possibility for conversion into many products that are in demand by consuming public. Hence this part of the study vested with the creation of consumer goods as explained under:

i. **End - use Paper Products Using Paper from Conventional Method**
ii. **End - use Paper Products Using Paper from Mechanical Method**

i. End - use Paper Products Using Paper from Conventional Method

Table 11 gives details on the recycled paper products made using paper obtained in the conventional method.

Table : 11 End use Paper Products Using Paper from Conventional Method

End use of paper products	Materials made
Educational	Note pad, and book wrappers
Domestic	Greeting cards, invitation cards, Envelope, Napkin, Paper bag, Paper flowers

Production of note pads, and book wrappers which can be of use in the educational field was attempted using the recycled paper. Similarly for domestic use, greeting cards, invitation cards, napkin, Paper bags and paper flowers which have a sustained market were made (Plate 9). It was found that the hand made paper made in the conventional method is quite suitable for making these objects.

ii. End - use Paper Products Using Paper from Mechanical Method

Table 12 gives details on the same

Table : 12 End use Paper Products Using Paper from Mechanical Method

End - use paper products	Materials made
Institutional use	Index cards, pen stand, letter pad and envelope
Domestic use	Shoe box, paper boxes, calender, invitation card, greeting card and tea bag
Decoration	Wall hanger, accessory stand, flower vase,

	craft paper and decorative piece (papier mache dolls)
Educational	Files, folders, book mark and writing pad
Recreational	Board game, mask, doll, cone, kite, paper flowers, art paper, papier mache, collage

In the mechanical method the quantum of waste used and pulp realized was considerable. Hence, the investigator was able to utilize it for making many products which can be of use in institutions, households, recreational and educational purposes and the like. It is concluded that the paper made by both techniques lend themselves for folding, tearing, writing etc, that is, to all stresses to which any paper would be subjected to. Hence, it is recommended that handmade paper surely can be attempted by anybody, be it as a domestic venture or a small scale unit. Plate.10 pictures the products made using recycled hand made paper in the mechanical method.

5. Economics of Recycling Paper

Any project will be complete only with an economic appraisal. Hence this part of the study analyses the findings in terms of :

a. **Market Trend for Handmade Paper**
b. **Cost of Handmade Paper Products Sold**
c. **Resale Value of Post Consumer Paper**
d. **Cost Effectiveness of Hand made Paper Products**
e. **Social Cost Benefit**

a. Market Trend for Handmade Paper

Focussing on the responses received for the check list from the selected shop keepers (based on the survey conducted) dealing with hand made paper products, it was deducible that handmade paper in the form of charts were purchased from a paper mill producing speciality papers in Erode District. The name of the mill was not disclosed for the sake of confidence. The dealers were found to make paper products from the handmade chart paper thus obtained. The objects made and dealt with by them are charts, greeting cards, invitation cards, visiting cards, paper bags etc (Plate. 11). Hence the decision on fixing cost for the paper products vested with the shop keepers. As they agreed to be purchasing chart at the rate of Rs. 10-15/- per sheet depending upon the quantum purchased and used, they had the autonomy to fix prices for the handmade paper products made and sold by them.

The study also revealed that though shop keepers have realized the value of such hand made paper and other products, popularity among the public was comparatively very poor. Not only the customers showed discontent with the cost of paper, they also argued stating that the cost of good quality paper was much less than the recycled

paper. The dealers stated that the disrespect for the hand made paper reflected only their ignorance about handmade paper and hence awareness generation on this aspect could bring in a welcome change not only for consuming public but also for the dealers. Otherwise they said that they endured only a lean market.

b. Cost of Handmade Paper Products Sold

This aspect of the study is presented as a comparative Table showing cost of handmade paper products sold in the market versus cost of objects made by the investigator using the paper made by herself. Table 13 presents details on the concerned matter.

Table : 13 Comparison of Paper Products Sold Vs Products Made

End use	**Items**	**Cost price of the objects made by the investigator (in Rs.)**	**Cost of the product in the market (in Rs.)**
Educational	File	5.00	15.00
	Folder	4.50	30.00
	Book mark	0.50	1.00

	Book wrapper	-	2.00
	Writing pad	2.00	15.00
	Writing sheet	-	0.50
	Chart paper	-	24.00
Institutional	Visiting card	-	1.00
	Index card	2.00	10.00
	Pen stand	1.50	15.00
	Letter pad	3.50	15.00
	Envelopes	-	2.00
Recreational	Board game	-	15.00
	Mask	-	10.00
	Doll	7.50	35.00
	Cone	3.00	15.00

	Paper flower	1.00	3.00
	Kite	-	5.00
	Papier mache	-	10.00
Domestic	Paper napkin	-	1.00
	Paper bags	1.00	10.00
	Shoe box	2.00	10.00
	Sweet box	2.50	10.00
	Calender	3.50	6.00
	Invitation card	3.00	10.00
	Greeting card	5.00	20.00
Decorative	Wall hanger	5.00	25.00
	Accessory stand	2.00	10.00
	Flower vase	1.00	5.00

For making paper in laboratory condition, other than waste paper used (which was available free of cost), the process had incurred overhead expenses in terms of power used (for grinding using mixer in the conventional method and beater in the mechanical method), gas (for cooking banana) and purchase of adhesives, decorative paper etc. So, the total expenses incurred for production of paper considered only expenses on power used. Hence the unit cost of items made using the paper was very low. Papers produced in the lab conditions looked inferior on one score. The commercially sold papers looked smooth and glossy as chemical additives were added to it. Similarly, the products sold commercially were embellished using glitters, printed matter, sparklers, and other paraphernalia. This has enhanced the value addition to their paper. As the paper produced in the lab was eco friendly, with no addition of chemical factors, the commercial products naturally looked superior. Otherwise, the lab made paper products was definitely cost-effective. The much sought after decoration could be given to these products too.

C. Resale Value of Post Consumer Paper

The market trend was found for used up paper of all sorts in Coimbatore City by doing an informal survey of old paper marts. They had fixed a price for post consumer paper based on quality. Newsprints in English were purchased at Rs.7.00/Kg, while Tamil dailies were given only for Rs.5-6.00/Kg. Examination papers were sold around Rs.9.00/Kg. Card board carton boxes were sold at Rs.5.00 each.

Having understood the economic potentials of recycled paper, it was felt necessary to find out the income earned by paper pickers for the waste or old paper picked and sold by them. Paper purchasers generally pick only post consumer unsoiled paper for which they are paid around Rs.4/- per Kg.

Recollecting the quantum of waste generated within the selected locale (Avinashilingam University premises) it can be estimated that it's resale value is equivalent to Rs.1324/- per week approximately. Being an Institution and as examination papers cannot be sold, like throw away paper, (though it may fetch more revenue), the best alternative would be to recover the latent resource in them and recycle them back to usable products, especially as writing paper, paper boards, greeting cards etc for which there is a sustained interest. The post consumer paper thrown away by students can also be recycled and recovered in an eco-friendly manner.

d. Cost Effectiveness of Handmade Paper Products

Paper products of all kinds have a sustained market irrespective of this era going digital day by day. Considering the cost of products sold by commercial dealers, it is evident that making handmade paper in one's own. premises would prove very cost effective. Even after adding the cost of decorative paper, glue, and a nominal amount added to all products (Rs.1.00 to be specific) per item for overhead expenses (power, water and machinery) the cost price of the hand made products did not exceed Rs. 5/- per item. Hence it can be concluded that if taken up as a self employment avenue or a domestic enterprise this would prove a cost effective yet profit promising endeavour.

e. Social Cost Benefit: Recycling of these recovered papers would not only assist the University in resource / revenue generation, but would also curtail expenses on disposal and prevent the much detested 'eye-sore' of strawn paper. It can definitely help us to attain self-sufficiency of paper for regular use.

C. Awareness Generation

To disseminate information on a viable project where in a society can benefit both in terms of a solution for a major waste disposal problem and as a wasted resource not much touched upon, it was felt that awareness on the same has to be generated among selected sections of the public. An attempt on the same was successfully done and is represented as under.

1. **Motivating Young Minds Through Demonstration**
2. **Conscientizing Local People Using Print Media**
3. **Sensitizing Public Through Newsprint**

1. Motivating Young Minds Through Demonstration: As explained under design of the study, young children studying VI standard in Sri Avinashilingam School, Coimbatore were exposed to two sessions of demonstration on handmade paper and products. The details are delineated under:

a. Creating Awareness Through Method Demonstration: A method demonstration on making handmade paper using post consumer waste, was organized on 1.2.07 for the target group (Plate.12). Information on how and how much paper is being thrown away, how it can pose as a problem for disposal, environmental malefics of virgin

paper production in terms of felling forests and chemical effluents were all explained. Advantages of self made paper also was highlighted.

Students and teachers (around 150 members) benefited from the programme. The students were given an opportunity for hands on experience. Feedback from the students proved that the method demonstration had left an indelible imprint in their minds and a considerable number had tried it at home with enthusiasm. To buttress the noble thought and to create a sustained interest in their minds a Result demonstration was organized for the same group again on 9.4.07 (Plate.13). Here, the children were exposed to an array of paper products made with hand made paper. The samples were left awestruck. They had never imagined that this wasted resource could be thus recovered and recycled as quality consumables.

2. Conscientising Local People Using Print Media

As conducting awareness programmes for public was beyond the purview of the investigator, it was decided to write an article in a regional journal. Similarly a monograph on **'"Waste is not for Wasting" - Recycle Post Consumer Waste'** was written and published in a press in Coimbatore. Copies of the monograph was distributed among University students. The objects made using recycled paper also was exhibited for the benefit of the University students (Plate.14). This endeavour helped to disseminate information among teenagers too. A sample copy of the article in the journal and the monograph are presented as Exhibits 4 and 5.

3. Sensitizing Public through Newsprint

To capture a larger section of the society and to sensitize them on this global issue, the newsprint media was resorted to. An article on **"Value Addition to Recycled Paper Products"** was e-mailed to the publication division of "The Hindu", the national daily, much read by people.

The study has proved that a wasted resource could be successfully recovered and recycled into the same old product in the same form. This effort would definitely have far reaching benefits like environmental protection, reduction in felling of trees, reduction in land, air and water pollution and revival of a much forgotten heritage of papermaking in the conventional way. Let us remind ourselves

Waste is a wealth potential

Waste is a threat to environment and life

Waste is a nuisance to the society, but

Waste is also a challenge to meet.

V SUMMARY AND CONCLUSION

This era, nevertheless, being a digital era, cannot imagine facing a 'paper-crunch', a paper-crisis, as paper and paper products in some form have become an integral part of social living. Its environmental impacts have hitherto, never been addressed. Both paper manufacturing and disposal have ended up as major forerunners for global pollution contribution. A check point at some point has to be devised. The Basal Convention has warned people to be mindful of the spirit, principles, aims and functions of the World Charter for Nature adopted by the General Assembly of the United Nations at its 37th session, as the rule of ethics in respect of the protection of the human environment and the conservation of natural resources. The lesson is for everybody to reduce waste, conserve and recover resources and recycle possible wastes. Since a researcher has a role to play in this noble endeavour, and self being a contributor to paper waste accumulation in the Institution, kindled an interest in the investigator to launch on the study on **" Resource Recovery and Value Addition of Waste Paper into Handmade Consumer Products"** with the major broad objectives to estimate and envisage recovery and recycling of waste paper into paper and products and campaign for use of the hand made paper by the public.

The findings of the study are summarized under:

1. **Post Consumer Waste Generated – The Fountain head of Inspiration**
2. **Prospects and Potentials for Recovery of Resource**
3. **Spawnhead for Recycling**

4. **Value Addition of Recycled Paper**
5. **Amplifing the Concept of Recycling**

1. Post Consumer Waste Generated – The Fountain head of Inspiration

- A formal survey conducted, with concurrence from the Institution (Avinashilingam University/School premises) authorities revealed the magnitude of post consumer paper (which is not contaminated with food or newsprint) thrown away from the premises daily.
- Collection was made from specific locale furnished with carton boxes, where the students and sweepers were instructed to discard non-contaminated post consumer paper alone.
- On an average the daily collection amounted to 19.5 kg from University premises, 35 kg from School, 1.25 kg from bank and 10.85 kg from hostel buildings, summing up to approximately 68 kgs per day.
- The annual disposal would touch a projected waste of 13,240 Kgs.
- The waste thus obtained either was incinerated or was sold to old paper marts.
- Thus the quantum of waste thus wasted (its magnitude) emerged as a fountain head of Inspiration, to launch on the study to recover and recycle this waste into a viable resource.

2. Prospects and Potentials for Recovery of Resource

a. Prospects for Recovery

- The inspiration led to brushing up a heritage tradition of making handmade paper in laboratory conditions (Conventional Method) and using a paper plant (Mechanical Method) already installed in the Faculty of Engineering Premises of the Avinashilingam University (the selected locale) at Varappalayam (for Mechanical method).
- A crash course for two days undergone by the investigator gave a helping hand to take up the study.

Procedure: For the conventional method, post consumer paper collected for the premises was torn to pieces (a known weight) soaked overnight, repulped by grinding using an electric mixer and hand made paper made by 'sieving' paper layers from the pulp and water mix.

- Different permutation combinations of waste paper used and additives added (non-paper fibes like cooked banana waste and shredded cotton fibres) were tried and recycled papers were sieved out.
- The findings proved that handmade paper using post consumer paper waste as a sole input or in combination with banana waste have brighter prospects for recovery.
- Trials were made using 2 kg of post consumer paper, 2 kgs of banana sheath, paper and banana (30 gm), paper +cotton + banana (15 gm), and paper and cotton (10gm). Used up cardboard (50 gm) and brown sheet (25gm) were also repulped.
- The experiments were tried on a large scale using the paper plant (machines) in the mechanical method.

- At a time 10 kg of post consumer waste or paper + banana waste in the ratio 10:2 ½ kg were pulped using the Hollander beater.

Potentials for Pulping

- In the conventional method, using a known volume of water, 2 kg of paper waste was repulped to 34 kg of pulp, 2 kg of banana waste to 23 kg of pulp, 30 gm of paper and banana to 515 gm of pulp, 15 gm of paper + banana + cotton to 250 gm of pulp and 10gm of paper and cotton to 166 gm of pulp. Cardboard (50 gm) could be repulped to 850 gm of pulp and brown sheet (25 gm) to 430 gm of pulp.
- Similarly in this mechanical method 10 kg of paper waste yielded 170 kg of pulp, while the yield from banana plus paper waste (10 + 2 ½ kg) was only 130 kg.

➢ The study has thus proved three aspects

- **Firstly that wastes could be repulped, especially paper and banana, under non standardized, household condition too,**
- **Secondly the wasted Resource in the raw material waste could be successfully recovered by repulping,**
- **Thirdly, the yield of pulp from repulping paper waste exclusively, was more than the pulp obtained from other wastes or additives,**
- **It is concluded that post consumer waste could be successfully repulped for recovery. The potentials for the same are quite bright.**

3. Spawn head for Recycling

a. Total Weight of Recycled Paper

- From the pulp obtained by both the methods (techniques) pape was recycled.
- In the conventional method, 1.67 Kgs of paper could be recycled from 2 Kgs of post consumer paper; 1.2 Kgs from 2 Kgs of banana waste; 20 gms from 30 gms of paper +banana mix; 10 gm from 15 gm paper + cotton + banana mix and 6 gms from 10gms of paper +cotton mix.
- From 50gms of card board box 40gms of paper was recycled, while 15 gms was recycled from 25 gms of brown sheets.
- This was achieved by the crude technique utilizing ordinary domestic tools.
- The trials made in the mechanical method also helped recycle 8.1 kg of paper from 10kg of paper waste and 8.6 kg of paper from banana + paper waste.

➢ The findings here have proved the earlier studies that 80 per cent of the paper can be recovered from post consumer paper by repulping.

➢ The experiment also has proved two other factors

- **Addition of other pulp waste to paper pulp will not enhance the yield of recycled paper by weight**
- **Paper can also be recycled from banana pulp by adding a small proportion of paper waste to it.**

b. Yield of recycled Paper (Conventional Method)

- From 2 kg of post consumer paper, 20 circular pieces of 17 dia could be recycled as paper (35 gm each and 60 mm in girth) along with 10 pieces of 17 dia each of paper varying in weight and girth to the tune of 25 gm each / 45 mm; 15 gm each/35 mm and 5 gm each / 20 mm respectively.
- Fifteen rectangular sheets measuring 32 x 25 mm of weight 35 gm each and 80 mm in girth could also be recycled.
- From banana (2 kg) 15 circular sheets or 19 dia weighing 80 gms each with 100 mm girth were recycled
- From paper and banana mix (30 gm) five circular sheets of 17 dia (4 gm each and 30 mm) were obtained.
- From paper + banana + cotton mix (15 gm) 5 circular sheets of 17 dia (2 gm each and 15 mm girth) were realized.
- Paper and Cotton mix (10 gm) did not prove efficient as only two sheets could be recovered.
- Cardboard waste (50 gm) yielded five rectangle sheets (32 x 25 mm) of 8 gm each and 35 mm girth
- Rectangular sheets (5 in number) measuring 32 x 25 mm of 3 gm each and 20 mm girth were recycled from brown paper waste (25 gm).
- **The study proves that even under domestic conditions paper could be recycled efficiently.**

Mechanical Method:

- Yield of recycled paper from the mechanical method also proved effective and satisfactory

- From 10 kg of paper waste, 55 rectangular sheet were recycled, 25 sheets of 50 x 60 mm weighting 240 gm each and 1.25 mm girth and 30 sheets of 25 x 20 mm, weighing 70 gm each and 65 mm girth.
- From banana + paper mix (12 ½ kg), 170 rectangle sheets each varying in girth, weight and dimensions were recycled to the tune of: 25 sheets of 50X60 mm (160 gm each, 1.50 mm girth); 35; sheets of 50 x 60 mm (100 gm each and 80 mm dia); 10 sheets of 50 x 60 mm (20 from each and 40 mm dia) and 100 sheets of 25x20mm (100 from each and 35 mm dia) were obtained.

➢ **It was found that variation in terms of dimension, girth and weight of paper could be introduced in the mechanical method.**

➢ **Writing sheets could be recycled using this technique (mechanical method) as the mesh used for paper layering could accommodate this provision**.

c. Ratio of Recovery

- The ratio of recovery in both the methods, was quite satisfactory

➢ **Whenever paper waste alone was recycled the recovery was found to be 1:0.8, that is, 80 per cent recovery.**

➢ **When other non-paper fibres were introduced the recovery rate was found to slacken and it was only 1:0.6, proving that unlike paper which could be recovered upto 80 per cent, the other fibres could not be recovered.**

d. Quality of Recycled Paper

- As is expected, the recycled papers obtained adopting conventional method were only off white in colour (except where white writing paper alone was recycled), matty in finish and showed curling.
- The pride of recycling was that, all the papers lend well to writing and drawing which are the prime uses of paper. Those obtained from cardboard box and brown sheet were also foldable.
- Paper (writing paper) obtained by mechanical method was found to be white in colour.

➢ The recycled paper proved viable for use from the physical appearance and use points of view.

➢ As the papers were recycled adopting eco friendly methods, 'whiteness' which is a much sought after feature could not to be obtained. It could be obtained by adding chemical additives.

➢ As far as paper specific properties are concerned, reports obtained from external quality testing center highlighted that the GSM of papers recycled were commendable and satisfied set norms for writing purposes.

➢ The papers also were approved for absorbency (sizing), opacity and formation by the experts from the quality testing center.

➢ **It is concluded that the papers recycled by both the methods satisfy quality stipulations and are quite fool proof**

4. Value Addition of Recycled Paper

- This was attempted in two stages in both the methods
- In the first stage, attempts by adding eco friendly pigments like turmeric, pomegranate, henna etc (in conventional method) and chemical dye powder (in mechanical method) method were tried to enhance the appearance of the recycled paper
- In the second, value added objects were made using the recycled paper(obtained from both the methods)
- From the paper recycled from conventional method, materials having educational (note pad / book wrappers) and domestic use (greeting cards, invitation cards, envelopes, napkins, paper bags, paper flower etc) were made.
- From the paper recycled from mechanical method (as the quality of pulp realized was sumptuous), materials having institutional (index cards, pen stand, letter pad and envelope) domestic (shoe box, paper boxes, calender, invitation card, greeting card and tea bag), decorative (wall hanger, accessory stand, flower vase, craft paper and decorative piece), educational (files, folders, book mark and writing pad) and recreational (board game, mask, doll, cone, kite, paper flowers, art paper, papier mache, collage), end uses were made.

- **Economics of Handmade Paper**
- To understand the market trend for handmade paper and prospects for marketability of hand made paper products a survey was conducted.
- The findings brought to light that there exists mills producing hand made paper; but the shop keepers had to purchase paper (in chart form) from the mills and make value added products like invitation cards, greeting cards, party accessories etc by themselves.
- The cost of one chart paper being Rs. 10-15/- the shopkeepers had the liberty to sell item as chart paper for Rs. 20-25/- or value added products at rates fixed by them
- The hand made paper mills, somehow, felt that they should remain obscure. Naturally as the public were not aware of the mills, those who wished to buy hand made paper resorted to purchase from the selected dealers who sold them at exhorbitant prices
- Comparison of the products on sale with those made under experimental condition for the study revealed the following:

✱ The products made for the study were eco-friendly

✱ The products were cost effective, as making them incurred only a nominal expenditure on power, glue, decorative paper etc.

✱ Attempts on mass production could bring down the cost factor still more.

- The finish obtained for products on sale could not be got for hand made paper made under experimental conditions, as the base paper also was recycled under laboratory condition and not in mills.
- Refinement of the mesh used, and change over to new machinery (as the one available is an old model) would definitely help enhance the quality of paper obtained and its finish.
- The marketability for the products seem to be brighter and an attempt would address and curtail ill effects and social cost benefit of virgin paper production too.
- **Resale value of raw post consumer paper was found to be lucrative. One kg of paper was found to fetch Rs.4/- in the old paper mart.**
- **If the junk could be recycled, it can cater to the paper needs of the Institution's Administration requirements**

5. Amplifying the Concept of Recycling

- The market survey proved that the local public were not much aware of the availability of handmade paper. Attempts to popularize the issue centred around disseminating information
- **Capturing the Young minds:** through a method and result demonstration in a school where Students and teachers (around 150 members) benefited from the programme.
- Publishing an article in regional language in a local journal

- Publishing a monograph highlighting the benefics and malefics of paper production and the methods of making recycled hand made paper
- Reaching a larger literary mass – through an **article sent to a popular English daily** for publication

The attempt proved to be an insurgent effort, vulcanizing the concept of self help. It is hoped that the efforts would, if not totally, but atleast in a small measure create ripples in the minds of people to digest the issue and act appropriately.

It is concluded that if taken up, recycling paper waste and making handmade paper would definitely prove cost effective and eco-friendly. From information that has surfaced from the study, the following recommendations are put forth:

- **Familiarize the Products Among End-users**
- **Promote Entrepreneurship**
- **Motivate SHG, to Venture the Avenue**
- **Introduce the Magic as Work Experience for Students**
- **Encourage Institutions (Educational, banks, offices etc) to Operate their Own Paper Plant – both to destroy confidential papers and recycle paper for personal use.**

It is high time we thought in terms of the “Economics of Permanence”. Synthesizing truly symbiotic and synergistic projects for recycling of waste would pave a long way to reach the goal of **“Recovering Resources from Wastes and Recycling them for Productive Use by Value Addition”**.

Swami Vivekanandha said:

‘An ounce of Practice is better than tones of talk’.

Let us pledge to practice and serve.

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APPENDIX I

AVINASHILINGAM UNIVERSITY FOR WOMEN, COIMBATORE– 43

A CHECKLIST TO ELICIT INFORMATION ON THE SALE AND POPULARITY OF HANDMADE PAPER

1. PLACE OF PROCUREMENT OF HANDMADE PAPER

Coimbaote ☐ Chennai ☐ Erode ☐ Salem ☐ Madurai ☐

2. HANDMADE PRODUCTS DEALT WITH

Charts

Greeting Cards ☐

Birthday Accessories ☐

Letterheads ☐

Writing Paper ☐

Visiting Cards ☐

Invitation Cards ☐

Books ☐

Any other ☐

3. COST OF THE PRODUCTS

Charts	Rs. 1-5/- ☐	Rs. 5 –10/- ☐			
Greeting Cards	Rs. 1 –10/- ☐	Rs.10-20/- ☐	Rs.20-30/- ☐		
Birthday Accessories	Rs. 1-20/- ☐	Rs. 20-40/- ☐	Rs.40-60/- ☐		

Letterheads **Rs. 1-20/-** ☐ **Rs. 20-40/-** ☐

Writing Paper	Rs. 1-5/- ☐	Rs. 5 –10/- ☐

Visiting Card **Rs. 1-5/-** ☐ **Rs. 5 –10/-** ☐

Invitation Cards **Rs. 1 –10/-** ☐ **Rs.10-20/-** ☐ **Rs.20-30/-** ☐

4. POPULARITY

Popular ☐

Not Popular ☐