

PAPER WASTE RECYCLING IN INDIA: CURRENT SCENARIO AND FUTURE PROSPECTS



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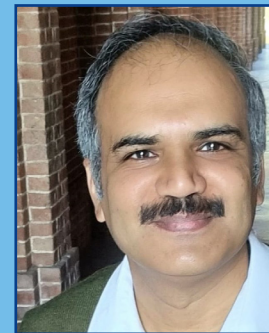
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Abstract:

India, with its ever-expanding population and paper consumption, faces both opportunities and challenges in the realm of paper recovery and processing. Paper waste recycling stands at the intersection of environmental conservation and resource sustainability, and its significance in a developing country like India cannot be overstated. The challenges associated with waste paper collection and processing of the recovered papers are enormous but there exists a plethora of hidden opportunities and potential changes that can be implemented.

The Indian pulp and paper industry is one of the most burgeoning industries. The consumption of paper in India is estimated to mount up by 6-7% in the upcoming five years which will reach at 30 million tonnes per annum in the year 2026-2027 as compared to the current consumption of 16 million tonnes per annum. Increased consumption of paper will certainly generate huge amount of waste that needs to be further recycled for the production of paper and paper products. At present, there is no developed systematic and sustainable waste collection mechanism that may properly reuse the underutilized waste paper to a greater extent. Considering the shortcomings associated with the current collection system, the objectives of the study are to review and analyse the existing paper waste recycling and management system in India and to explore the most promising dynamics for efficient waste paper recovery system.

In view of the above, efforts were undertaken to assess the current state of paper recycling in India, a nation grappling with the challenges of balancing rapid industrialization with sustainable resource management, and to explore the promising avenues for improving paper recycling. The paper delves into the paper recovery

and utilization by carrying out a comprehensive review of current state of affairs to enhance recovery rates. The paper spotlights innovations that not only boost recovery efficiency but also elevate the quality of recycled paper, thereby outlining promising prospects. The insights provided herein would serve as a guiding compass for policymakers, technocrats, industry players, and stakeholders to foster collaborative endeavours that will shape a more sustainable and responsible waste recycling practice. With the adoption of cutting-edge technologies, circular economy principles and increased public awareness, the Pulp and Paper industry is poised to make significant strides in achieving sustainable paper waste recycling practices in addition to better quality and yield

Keywords: Paper recycling, Recovery, Circular economy, Resource sustainability, Pulp and Paper

1. Introduction

The processes of accelerated population growth and unprecedented levels of urbanization in India have translated into massive increase in consumption and subsequently, generation of a greater volume of waste. The immense needs of India's growing population can only be met through adopting resource offsetting measures that are necessary to reduce environmental pollution and overcome climate change effects. The dual challenge of waste management and increasing resource requirements can be converted into an opportunity only through recycling approach. Recycling i.e. re-use and reclamation of waste, is not a novel concept and the developed as well as the developing countries have been practicing it for many decades as they are regarded as ecofriendly practices that lead to decreased environmental stress as they lower down the use of natural resources (Sharma et al., 1997). The benefits of paper waste recycling

are shown in Figure 1. The chief advantage of recycling is a double decrement in environment loading, known as an environmental impact reducing (Cabalova, 2011) fostering the dominant paradigm of sustainable development which has emerged as a macro trend in the Indian Pulp and Paper Industry. Waste paper is a versatile resource that can be repurposed for multifarious applications other than papermaking such as construction and manufacturing, fuel, moulded packaging, modified cellulose and many other value-added products (Joshi et al. 2015; Joshi et al. 2017; Joshi et al. 2019; Lei et al. 2018; Yue et al. 2022).

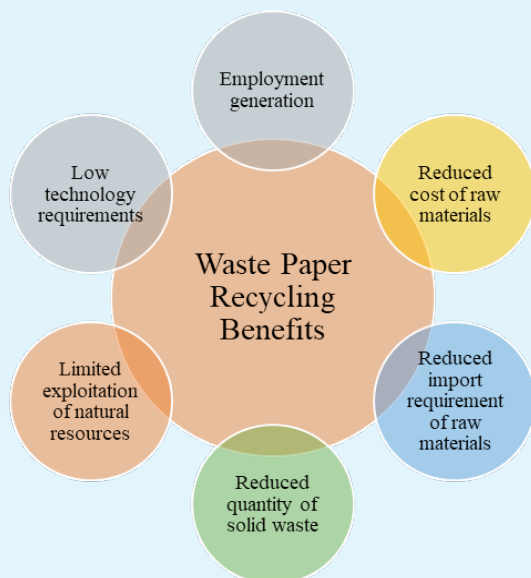


Figure 1. Benefits of waste paper recycling (Sharma et al., 1997).

The ramifications of the global phenomena called urbanization are more severe and pronounced in developing nations like India where waste management is a mammoth task. India, with its ever-expanding population and paper consumption, faces both opportunities and challenges in the realm of paper recovery and processing. Paper waste recycling stands at the intersection of environmental conservation and resource sustainability, and its significance in a developing country like India cannot be overstated. The need of the hour is therefore a development model that solves the issues related to waste paper recovery and utilization. At present, there is no developed systematic and sustainable waste collection mechanism that may properly reuse the large proportion of waste paper that is unable to reach the premises of the paper mill for recycling and reprocessing.

In the backdrop of the above, this article focuses on developing a roadmap for implementing circularity principles in paper waste management and help in identifying the regulatory, infrastructural and government as well as citizen-centric interventions in paper waste collection, segregation, sorting, processing and recovery for reuse, thereby reducing the reliance on import of waste paper and the use of virgin raw material for paper making.

2. Waste Paper Reutilization trends in India: Current Scenario

The Indian pulp and paper industry is one of the most burgeoning industries across the globe. It is the fourth largest paper producer in the world producing around 5.7% of the total paper and paperboard being produced globally which signifies an annual production of 24 million tonnes of paper and paperboard (Aggarwal, 2022). The majority of the share of production is from recycled fibres. According to the Indian Pulp and Paper Technical Association, 80% of the domestic pulp production is based on recycled paper, 6.38% on agricultural residues, and 13.61% based on wood. The breakdown

of the share of India's raw material in paper production is shown in the Figure 2. The domestic market consumption of paper is over 22 million tonnes per annum (Indian pulp and paper sector, 2021). The per capita consumption of paper in our country is a mere 15 kgs which is quite low in comparison to the developed nations which have more than 200 kgs and the global average of 57 kgs.

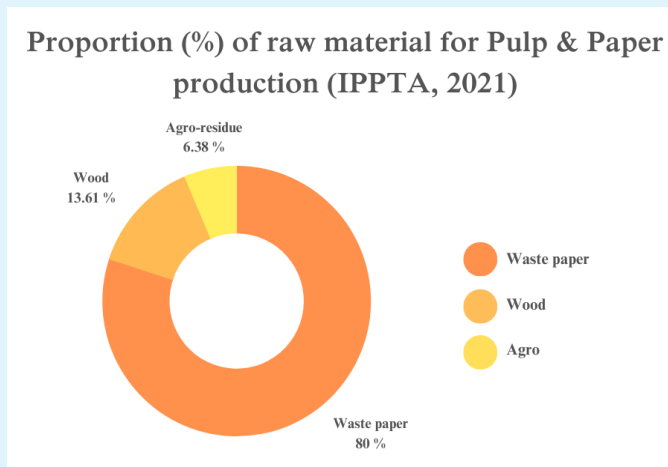


Figure 2. Proportion (%) of Raw Material used for Pulp and Paper production (Source: IPPTA)

Moreover, the consumption of paper in India is estimated to mount up by 6-7% in the upcoming five years which will reach at 30 million tonnes per annum in the year 2026-2027 as compared to the current consumption of 16 million tonnes per annum. Increased consumption of paper will certainly lead to mammoth generation of waste that needs to be further recycled for the production of paper and paper products. India currently generates approximately 1.45 Lakh metric tonnes of solid waste, 35% of which is dry waste which comprises of 21% paper and cardboards waste (Circular Economy in municipal solid and liquid waste, 2021). Therefore, it can be inferred that waste from paper and paperboard-based substrates accounts for about 0.1 lakh metric tonnes of municipal solid waste generated in India annually and despite being a rich source of lignocellulosic biomass, over-all only a small percentage is being recycled.

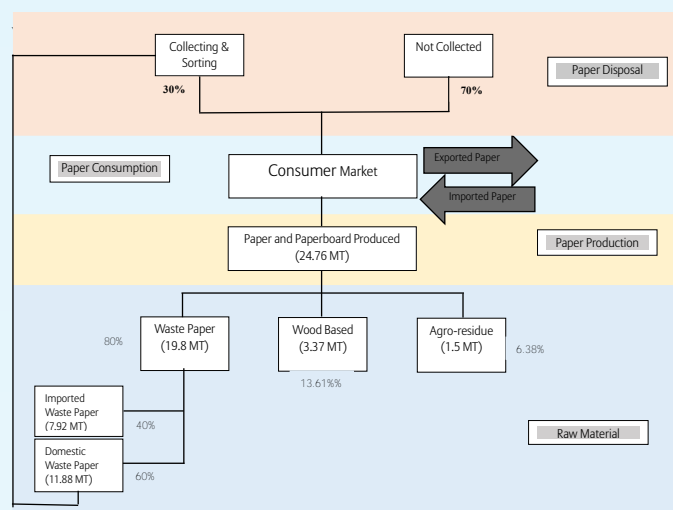


Figure 3. Flow of paper from raw material to end user

India's average waste paper utilisation rate is low in comparison to the global average because the recovery rate is low. India recovers only 25-28% (Indian Agro and Recycled Paper Mills Association) of its total paper consumption in contrast to the global recovery rate of 58% (Ozola et al. 2019). This means only about 27% of the total paper

and paperboard consumed in India is reintroduced into the system annually. India imported around 2 million tonnes of paper and paperboard in the year 2022-2023 as per Indian Paper Manufacturers Association. It is also theoretically estimated that even in case of benchmarking situations only 40-45% recovery of the wastepaper can be made, 20-25% of which is utilized for other competing uses (Indian pulp and paper sector, 2021). The remaining demand for waste paper is fulfilled through imports. The flow of paper from raw material to the end user and its data has been depicted in Figure 3. The developed countries in contrast show promising recycling rates where Europe stands at the first position with North America at the second, while the lowest recycling rates are shown by Asia, Latin America and Africa (Ozola et al. 2019). The recycling rates of certain developed countries viz. USA, Austria, Belgium, Germany, Finland and China are 68.2%, 83.5%, 92.9%, 87.1%, 100% and 46.5% respectively (Bandara and Indunil, 2022).

Waste paper is the prime raw material for making paper in India contributing to about 80% on the raw material basis. The major portion is utilized for the production of packaging grade paper as shown in Figure 4. But, the abysmal state of collection, sorting and grading system of waste paper has reduced the recovery rate and

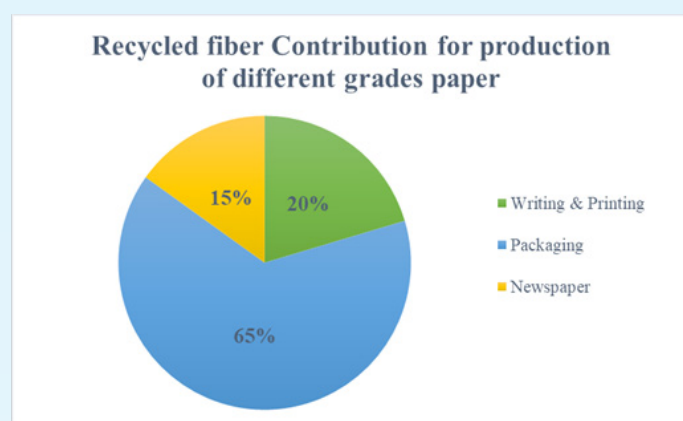


Figure 4. Contribution of recycled fibres for producing different grades of paper (Indian pulp and paper sector, 2021)

forced the paper industries to rely on the imported waste papers to supplement their raw material demands as India is a fibre deficient country. Since indigenous waste paper collection systems are poor, out of the total demand of recycled fibre for production of paper and paperboard, only 60% is sourced domestically and rest 40% has to be imported from developed countries per year. According to Rastogi (2022), the whole demand of about 20 million tons of recovered paper encompasses 13 million tons domestic collections and the remaining 7 million tons is met through imports from USA, Middle East and Europe.

3. Importance and benefits of recycling paper waste

The utilization of recovered paper has become a vital segment in the pulp and paper industry globally. The Indian paper industry is using recovered paper as a raw material in all its segments in order to keep pace with the increment in the hike in consumerism and demands for varied paper products (Tandan et al., 2005). Utilization of recycled fibres serves dual distinguishable benefits, the first being an infinitesimal ecological footprint and the other being requirement of only a fraction of energy required to make virgin paper (Indian pulp and paper sector, 2021).

The advantages of using recycled waste paper for paper production are many. Recycling waste paper is a powerful strategy to counteract the negative effect of deforestation which directly translates to the preservation of trees. This also encourages sustainable paper production practices which promotes circular economy principles. Substantial amounts of energy and water are saved by shifting towards recycling waste paper which is a more energy efficient and environment friendly alternative. Apart from wide array of environmental advantages, recycling processes also offer economic benefits to the paper industries.

It has been reported in the studies that recycled paper production consumes 50% lesser water and reduces air pollution by 74% when compared to virgin paper production. Furthermore, it is estimated that recycling of one ton of newspaper and printing or copying paper saves about one and two tons of wood respectively (Bandara and Indunil, 2022). The Table 1 given below illustrates the environmental advantages of using recycled paper.

Table 1. Environmental benefits of using recycled grade paper

Description	1 ton virgin fiber paper	1 ton 100% recycled paper	Environmental savings from recycled content
Trees	24 trees	0 trees	100%
Energy	33 million BTUs	22 million BTUs	33%
Greenhouse Gases released – CO ₂ equivalent	5601 pounds	3533 pounds	37%
Wastewater	22853 gallons	11635 gallons	49%
Solid Waste	1922 pounds	1171 pounds	39%

Source: paperwork.org

An estimate suggests that an increment of 1% in recovery rate of waste paper will result in savings of 0.2 million tonnes raw material, 0.16 million tonnes coal, 2750 Mega Watt power and 7.7 million m³ water. Additionally, it will help in reduction of 0.02 million tonnes of greenhouse gas emissions and lowering of import bills by 25 million USD (Tandon et al., 2013). It clearly states the imperativeness for an improved recycling system.

4. Waste Paper Collection Mechanism in India

One of the prime challenges that Indian Pulp and Paper Industry faces is the raw material availability in ample quantities and at globally competitive prices for the paper product to be cost efficient considering the fact that the raw material is the most significant cost component of the paper production process. The demand for recycle fibre for paper production is met primarily by adopting recycling process through domestic collection of pre- and postconsumer waste paper in conjugation with imports. The quality of the recovered process is dependent upon the collection and the sorting mechanisms involved (Vikoje and Rosic, 2018). The waste paper collection system in India is under the aegis of unorganized collectors and distributors (Aggarwal, 2022).

Collection of waste paper is the first and the foremost step in the recycling process. The waste paper can either be collected from direct or indirect sources. The direct sources include household, office premises, schools, religious bodies, hospitals, shops, paper vendors (distributors), printing press and publishing houses while the indirect sources comprise rag pickers and scrap dealers (locally called as kabadiwalas or pheriwalas) (Indian pulp and paper sector, 2021). The different sources, collected items as well as their gatherers are shown in Table 2. The present collection system recovers an extensive fraction of the recyclable matter from the waste stream. Households, itinerant waste merchants and garbage collectors in India jointly recover 1.2–2.4 million tonnes of newspapers, 2.4–4.3 million tonnes of cardboard and mixed paper (Nandy et al., 2015).

Table 2. Conventional waste paper collection mechanism in India (Bajpai, 2014)

Source	Items Collected	Collected by
Collection from households	Old newspaper & Magazines	Weekend hawkers
	Notebooks & textbooks	
Annual scrap contracts of printers, publishers & converters	Paper trimmings, print rejects, overprint/misprint sheets and other waste	Contractors
Scrap contracts with industries, office, libraries	Old corrugated cartons, examination answer sheets, old office and library records etc	Contractors

There are two categories of recovered waste papers i.e. pre-consumer recycled fibre and post-consumer recycled fibre. The collection performed by small vendors comprises of 70% post-consumer waste and 30% pre-consumer waste (Rastogi, 2022). The two categories of waste along with their recovery potential have been shown in Table 3.

Table 3. Recovery potential of different grades of paper (Bajpai, 2014)

Grades of paper	Potential source of generation	Generation/Consumption (%)	Types of waste	Collection rate (%)
Writing/Printing				
Copier paper	Offices Business Establishment Others	50 40 10	Post Consumer	20
Cream wove	Printing House Paper Traders	20 05	Pre-Consumer	100
	House holds Schools/Colleges Offices Business Establishment Others	20 10 25 10 10	Post Consumer	20
Packaging Paper	Converting House	15	Pre-Consumer	100
	House holds Offices Business Establishment Others	20 05 50 10	Post Consumer	50
Newspaper	Publishing house Distributors	20 05	Pre-Consumer	100
	House holds Offices Business Establishment Others	40 10 15 10	Post Consumer	30

The table above indicates the potential for sizeable enhancement of recoveries, particularly for copier paper from offices, and newspaper and packaging from households.

Pre-consumer waste mainly consists of either trimmings produced during the manufacturing or conversion process of paper or rejected and obsolete products and represents a relatively clean source of fibre for papermaking. Post-consumer waste is the paper that is recovered after use by the consumer and is usually the most contaminated. The entire value chain consists of direct collectors responsible for collection of waste from different extremities, small shops where foremost sorting of waste into separate classes is done followed by zonal segregation centres, possessed by semi-wholesalers, where material is collected, baled and dispatched to ultimate users. Large traders fund the complete value chain. The schematic diagram of the collection and reutilization mechanism is shown in Figure 5.

Sorting of recovered papers into compatible grades is a requisite before subjecting it to recycling as highly sorted paper streams will help in achieving high-quality end products. Table 4 indicates the difference between the quantity consumed and recovered for different paper grades, thereby, indicating the low recovery percentage in the country.

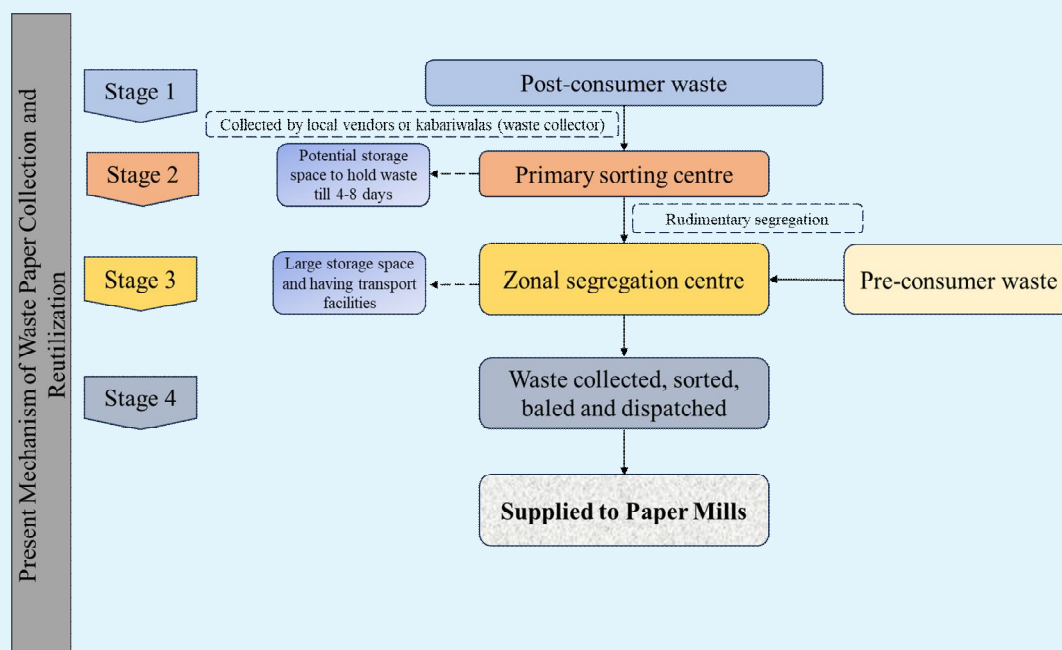


Figure 5. General trends of waste paper collection and reutilization in India

Table 4. Generation and collection of different varieties of paper (Indian pulp and paper sector, 2021)

Paper Grade	Source of generation	Type of waste	End user	Quantity consumed (millions tons/annum)	Quantity recovered (million tons/annum) Estimated
Writing/ Printing	Printing presses and Note book manufacturing units	Press cutting, Copy cuttings, Trimings	Paper mills	~7.18	2.87
	Households, Schools, Universities, Offices etc.	Old books, Copies, Examination sheets, Office records etc.			
Packaging Grade	Printing Presses, Mono carton makers, Corrugated box makers, Households, Departmental stores, Food seller and various shops and Market establishments	Duplex board cutting, Corrugated box cutting, Old boxes, Available out of various packing of household and electronic items, Packing of food and other consumer durables	Paper mills	10.31	6.18
Newsprint	Over issue, Newspapers, Houses, Offices, Market and various readers-across the country	Over issue, Newspapers, Newspaper from houses, Offices and Newspaper reader	Paper mills, packing of fruits, Furniture's, Grocery items, Packing of hardware, Roadside food vendors etc.	2.628	1.84
Speciality	Various manufacturing units, Textile, Polymer convertors and Various industry	Paper sheets and Rolls	Paper mills, Packing of consumer durables, Glass ware crockery items, Roadside food vendors etc.	>1	Data not available

5. Challenges in Paper Recycling in India

Even greater utilization of recycled fibre is expected in the subsequent years. The major issues associated with recycling are drainability of the recycled fibre, stiffening of the polymer structure after drying, thereby, decreased swelling termed as hornification, stickies control and deinking of commingled post-consumer papers (Bajpai, 2010). The low quality of the indigenous waste paper is another limitation

that needs to be overcome. The rationale behind is the improper mixing and handling of recycled furnish, improper segregation and storage systems, a dearth of proper cleaning and unsystematic bailing of various grades of paper or paperboards, soiling and utilization of waste paper for other purposes (Aggarwal, 2022). However, there are several other problems that are associated with the recycling of fibre, some of which are discussed.

- **Low Recycling Rates:** The recycling rates in India are low as compared to global levels as the collection system is majorly unorganized. Additionally, the secondary uses for which waste paper is diverted leads to decreased availability and poor suitability to be used by paper industries.
- **Infrastructure Gaps:** The current waste paper assortment and isolation framework is in the hands of waste paper dealers. The low recovered paper percentage in India clearly demonstrates that the existing institutional mechanisms are weak and therefore, it leads to considerable leakages in the recycling process.
- **Contamination and Segregation Issues:** The recycled furnish contains wide array of contaminants such as inks, hot melt glues, adhesives, waxes as well as stickies which hamper the papermaking and recycling operations in conjugation to degrading the quality of the end-products (Chacon et al., 2022). Other waste components that can be found are staples, laminated covers, plastic wrapping, metals etc. Printing inks are the most vital non-paper components from which high concentrations of metals (Al, As, Ca, Cd, Cr, Cu, Hg, Pb, Sb, Sn, Nd) may originate and cause contamination (Vikoje and Rosic, 2018). The sorting of recycled fibres is not optimal despite many technical developments that have taken place. It continues to remain predominantly a manual, labour and time-intensive activity, subsequently decreasing the efficiency of the process as the recycled paper is heterogenous and contaminated with non-paper components.
- **Lack of Formalization:** Multitude of stakeholders are associated in the collection of paper waste which is a highly unsystematic system, therefore, there arises a need for re-orientation of the collection system into a more organized manner (Aggarwal, 2022).
- **Technological Limitations:** The paper mills have not kept pace with the technology development. Implications of technology obsolescence are evident from inferior quality of the recycled product and lower economies of scale. Current methods of manual sorting are tedious, slow, expensive, having a very low throughput which can be replaced by state-of-the-art sorting processes.
- **Technological Advancements:** State of the art recycling technologies and innovations can improve the efficiency as well as quality of the recycled paper production, thereby, making Indian paper industry more globally competent. The automated or AI based sorting systems as well as de-inking innovations would improve the economic viability of the processes involved.
- **Circular Economy Integration:** The concept of paper recycling promotes the idea of circular economy, thereby reducing the reliance on virgin fibres and detrimental impacts on the environment, hence benchmarking sustainability. Concisely, for a circular economy in India, there is a necessity for a technology-enabled, quality-assured collaborative supply chain of recycled paper material.
- **Cross-Sector Collaborations:** The integration of the informal sector with the government can be carried out to improve their efficiency and working conditions. Consolidation with international organizations will help adopt best practices and technology.
- **Conscientious protocols:** The optimal utilization of the waste paper can be augmented with the introduction of some rightful solutions such as:
 - i. **Mandatory Recycling Targets:** Implementation and setting of mandatory recycling targets for paper and paper products for consumers and industries would help in enhancing the recycling rates.
 - ii. **Extended Producer Responsibility (EPR):** EPR programs should be expanded and enforced for both paper manufacturers and distributors wherein onus of the end-of-life management of the paper including its recycling and disposal will be on them.
 - iii. **Green Certification Standards:** The establishment of green certification standards for paper and paper products will help the consumers to identify and choose environmentally friendly products thereby promoting an increment in demand for recycled papers.
 - iv. **Research Grants and Infrastructure Investment:** The government should allocate funding for research and development initiatives that are focused on improving paper recycling technologies and processes. It should also aim at investing in improvement of recycling infrastructure.
 - v. **Taxation Policies and Import Regulations:** Incentivization for recycling paper products may be promoted while synchronizing imports to protect domestic paper recycling industry. The policies may be regularly revised and updated to adapt to changing technologies, market conditions and environmental goals. A policy should be framed to bring all visionaries, engineers, scientists and paper making experts under one umbrella competent (Patel, 2022).

6. Future Prospects for Paper Recycling in India

The Indian paper industry is an exclusive relevant user of recovered papers which underlines the importance of undertaking pathbreaking initiatives for improvising recovery of recycled fibre furnish for papermaking. The predicted demand for recovered paper and board is anticipated to grow substantially in the upcoming years, outstripping the quantity of material available by the conventional route; that is why an efficient and robust long-term strategy for recovery of paper is a cornerstone for improving the sustainability of the paper industry.

The challenges associated with waste paper collection and processing of the recovered papers are enormous but there exists a plethora of hidden opportunities and potential changes that can be implemented. Some constructive recommendations that can spearhead a transformation in the present system are as follows-

- **Increased Awareness:** Public awareness campaigns may be launched nationwide to educate citizens about the importance of paper recycling and proper waste segregation to promote a sense of civic allegiance and environmentally responsible behaviour. An extensive public education programme about the importance of waste segregation at source would substantially improve the collection system. Apprehension through social media platforms would also enhance the recovery process.

7. Conclusion

Waste paper is the principal papermaking raw material in India but the inconsistent supply of recovered papers to the paper mills, low recovery and reutilization potential are the thrust areas that need consideration in today's time. A robust remedy to confront these issues is the adoption of a systematic waste collection, grade wise segregation and quality control system. The holistic approach suggested in this article identifies challenges, opportunities and outlines promising prospects. In summary, a combination of robust policies coupled with effective on-ground implementation, adoption of cutting-edge technologies, circular economy principles and increased public awareness and commitment to move towards

a sustainable way of life holds key to future success in achieving sustainable paper waste recycling practices in addition to better quality and yield for Indian Pulp and Paper industry. Moreover, the insights provided herein would serve as a guiding compass for policymakers, technocrats, industry players, and stakeholders to foster collaborative endeavours that will shape a more sustainable and responsible waste recycling practice.

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