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Resource Conservation Through Recycling Paper Waste: A Study of a Class-I Town in Eastern India and Policy Recommendation for Sustainable Development

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Abstract:
Solid waste management is considered necessary globally, nationally, and locally. Preserving the earth's resources is essential for ensuring humankind has a sustainable future. Recycling has always been a crucial component in achieving sustainable development. The present study was conducted in Kharagpur municipality based on a primary field survey with a structured survey schedule done by snowball sampling. The total waste paper collected by rag pickers and itinerant waste buyers is nearly 5144.92 metric tons yearly. Among that, 35.96% is collected by rag pickers, and itinerant waste buyers collect the rest. The average collection of rag pickers and itinerant waste buyers is 28.91 and 51.48 metric tons annually. The p-value of ANOVA analysis is (0.002) significant. Study reveals that recycling waste paper can save lots of natural resources approximately, save more than 11 lakh trees, 24lakh thousand litres of water, 13 thousand Electricity (mWh), 12 thousand Barrel of Oil (Petroleum), 22 thousand m^3 landfill space and reduce above 2678 ton of air pollutant, & 250 ton of solid waste that, if the entire procedure is repeated to create the same quantity of new paper each year, will be generated. These recycling techniques reduce the further need for resource extraction from nature.

Keywords: Waste paper, Natural resource conservation, Sustainable development goal, Rag pickers, Itinerant waste buyers.

1. Introduction:

If we estimate solid waste generation globally, it will exceed 2200 million tons annually by 2025, which is more catastrophic (Tyagi et al., 2018). India produces over 62 million tons (mt) of solid trash yearly from municipal sources(Samaddar & Bandyopadhyay, 2018). By 2030 it is likely to reach 165 mt by 2030, and it will be 450 mt by 2045(Samaddar & Bandyopadhyay, 2018). Most of the emerging countries in the world suffer in serious issues 'of solid waste management' (Anilkumar & Chithra, 2016; U., et al, 2005 ; Erdogan, R., et al., 2008). Before the broadcast of the Management and Handling Rules 2000, Municipal solid waste management was often ignored nationwide (K. N. Kumar & Goel, 2009). Based on the CPCB reports, in 2014-15, Only 27% of the 91% of solid garbage collected was processed; the remaining 73% was dumped at landfills(Samaddar & Bandyopadhyay, 2018). Based on current data, India will need a landfill of approximately 88 square kilometers, nearly the size of Bengaluru, to accommodate all of its

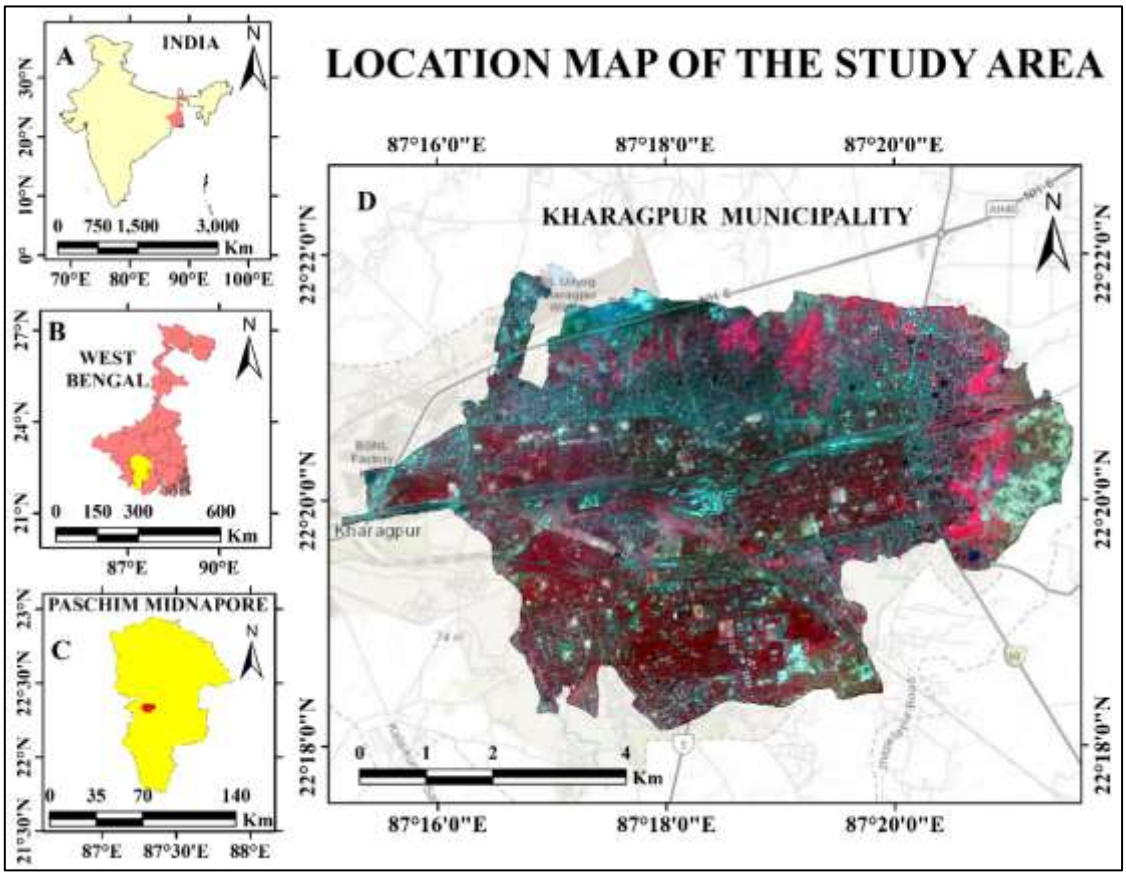
waste by 2030(Samaddar & Bandyopadhyay, 2018). Nowadays,, paper recycling is one of the most well-established schemes that apply to waste material (Pivnenko et al., 2015). Recycled paper is an important raw material for the pulp and paper industry (CEPI 2013b). Although the pulp and paper industry (PPI) significantly contributes to the world economy, it also presents a problem for trash management because it produces many different types of waste (Abushammala et al., 2023). India's recycling rates are much lower than the worldwide average for packaging paper, and they're only 27%, while average recycling rates in Scandinavia are 90%(Samaddar & Bandyopadhyay, 2018). In France, the paper and cardboard recycling industry sector is well developed. About 66% of the production comes from recovered waste (Lobianco et al., 2016; Lorang et al., 2023). Additionally, the paper pulp sector is closely linked to the world forest sector, essential to mitigating climate change (Lorang et al., 2023). Sustainable development is continuously gaining popularity, and it is expected to influence the formulation of social and economic policies significantly (Finnveden & Ekvall, 1998).The realization of sustainable development is contingent upon three essential elements: safeguarding the environment, conserving resources, and advancing social and economic advancement (Petek & Glavic, 1996; Pati et al., 2008). In the context of waste paper, the most popular methods for sustainable waste management prioritize reduction, reuse, and recycling because of their favorable effects on the environment (Bahrami & Jafari, 2020). Moreover, the principal objective of sophisticated waste management is to effectively derive energy from garbage prior to its safe disposal (Dominczyk et al., 2014). The environment is highly affected by paper production. The use and handling of raw materials have several negative effects on the environment (Cabalova et al., 2011). The consumption rate of paper is increasing daily due to faster rate of population growth and innovation in technology; because of this, waste paper recovery rate is also quickly rising. which is vital for the environment and less expensive than wood cellulose (TUTUŞ et al., 2018). According to recent research initiatives, the balance between protecting the environment and maximizing economic aspects has received much attention in waste management system planning.(Pati et al., 2008).In this context, recycling waste paper is a crucial strategy for waste management (Chakraborty, 2015). Because paper recycling helps to reduce natural resource usage and also lowers the amount of hazardous substances released into the environment (Čabalová et al., 2011).The main benefit of recycling lies in reducing environmental loads in two ways, a process known as impact mitigation of the environment. First, natural resources are preserved during the manufacturing process's input stage. Secondly, during manufacturing, the amount of hazardous substances discharged into the surroundings decreases as production proceeds (Čabalová et al., 2011). Recycling paper also conserves the environment and reduces the emissions of greenhouse gases by lessening need for cutting trees, resulting in enhanced absorption of CO_2 via photosynthesis process. Furthermore, costs related to the production of paper will reduce as some processes become necessary (Gemechu et al., 2013; Berglund & Soderholm, 2003).The demand of recycled paper applications has diverse uses, including, but not restricted to, cardboard, insulation, office and printing paper, newspapers, and envelopes. The utilization of recycled fiber is contingent upon the final product's quality requirements (Abushammala et al., 2023). Mainly waste recycling carried out by marginalized informal worker (Wilson et al., 2006). However, a major barrier to their engagement is the lack of appropriate laws. In the waste management system, these informal workers contribute through their vigorous role, such as waste collection, sorting of valuable solid waste, recovery & reprocessing (Khanal et al., 2023). They are rag pickers and itinerant waste buyers, not officially registered, but they sort most dump-sided waste. Recycling materials are separated by rag pickers who sell each component to different Junk shops. Traveling waste buyers obtain valuable recyclable materials such as paper, e-waste, glass, plastic, textiles,

used cement bags, etc. Then, they sell these goods to scrap dealers (Ogwueleka Chibueze & Naveen B. P, 2021). After recovering such sturdy recyclable items, they transport them to a local junk dealer for sale, who then resells them to recycling firms (Nwosu & Chukwueloka, 2020). Recycling rates increase by their participation it is two-way benefit: one is it is essential for their livelihood, and the second benefit is it will reduce the waste management associated expenses in urban areas (S. Kumar et al., 2017).parallelly their significant efforts in recycling activities leads to a substantial decreases of greenhouse gas emissions, which is essential for reducing the consequences of climate change(Chaturvedi, 2014). This practice reduces waste and creates a a livelihood for the urban deprived people (Suthar et al., 2016). In urban locations where generating income is the key motivator, they offer opportunities for immigrants and degraded individuals (Ojeda-Benitez et al., 2002; S. Kumar et al., 2017). Recycling rates in India are pitifully low. Three reasons are responsible for this: Firstly, recycling as a way of life is not supported by enough political will or a strong social consciousness. Secondly, Scrap contamination results from a mainly disorganized trash collection and segregation system. And lastly, Municipal infrastructure is outdated and insufficient for scarp yards and collection transportation (Samaddar & Bandyopadhyay, 2018). Every municipality face the problem of solid waste management and they have not proper management infrastructure to manage this problem properly, in such a situation rag pickers and itinerant waste buyer significantly contribute to solid waste management. Kharagpur is the class I town also famous industrial and transportational town so Kharagpur municipality generates more amount of waste. within the district there is a pulp and paper recycling industry (Unitech paper mill) in Debra. This industry use waste paper and cardboard as an industrial raw material. This paper aims to investigate the rag pickers and itinerant waste buyers' contribution to resource conservation through recycling paper waste in class I town in west Bengal.

2. Study area:

Kharagpur lies in the district of Paschim Midnapore of waste Bengal with the coordinates of 22° 21'00" North and 87°20'06" East. It is renowned for possessing the world's largest train platform, measuring 1.0725 km (K. N. Kumar & Goel, 2009). After Kolkata, Durgapur, and Asansol, Kharagpur is the fourth most populous city in West Bengal in terms of area. It is also the fifth most populated city in West Bengal after Kolkata, Asansol, Siliguri, and Durgapur. It is one of the most essential multiethnicity and railway cities in India. In Paschim Midnapore district, Kharagpur is a class I town, Kharagpur Municipality consisting 35 no. of wards with a total population of 207604 (census 2011). Kharagpur town consists of the Kharagpur municipality and railway settlement area (without ward no., it is a census town). The total area of the municipality is 35.53 square km. The vegetation cover is mainly deciduous, and this town experiences a tropical wet and dry climate. Some parts of the Municipality are under the south easter railway (Fig 1). Kharagpur is home to sizable, historically significant railway villages along the railway lines. The town's population also increases, so daily waste generation increases parallelly. As Kharagpur is an industrial and transportation town, an excellent transportation system has been built. So, many daily commuters visit Kharagpur for different purposes, and the level of waste generation in the Municipality has also increased. Kharagpur Municipality is formally responsible for managing municipal waste. But they have no such solid waste management system.

Figure 1: Location Map of the Study Area.



3. Materials and methods

3.1 Database:

The study generally emphasized India and the world but examined at the municipality level. The entire area of the Kharagpur municipality is divided into 35 wards or subzones. We visited the office of Kharagpur Municipality to collect the Municipality Map and interview the municipality's sanitary officer information about the municipalities & formal waste management system. For this study, different data were collected by primary field surveys. The amount of waste collected by rag pickers and itinerant waste buyers, junk shops, and paper waste recycling value was taken from recycle-based paper mills (Unitech paper mill) and worldwide freely available data of different recycling (Paper) industries. We have surveyed and interviewed 774 rag pickers, 693 itinerant waste buyers, and 75 junk yards in Kharagpur Municipality in Kharagpur municipality.

3.2 Method:

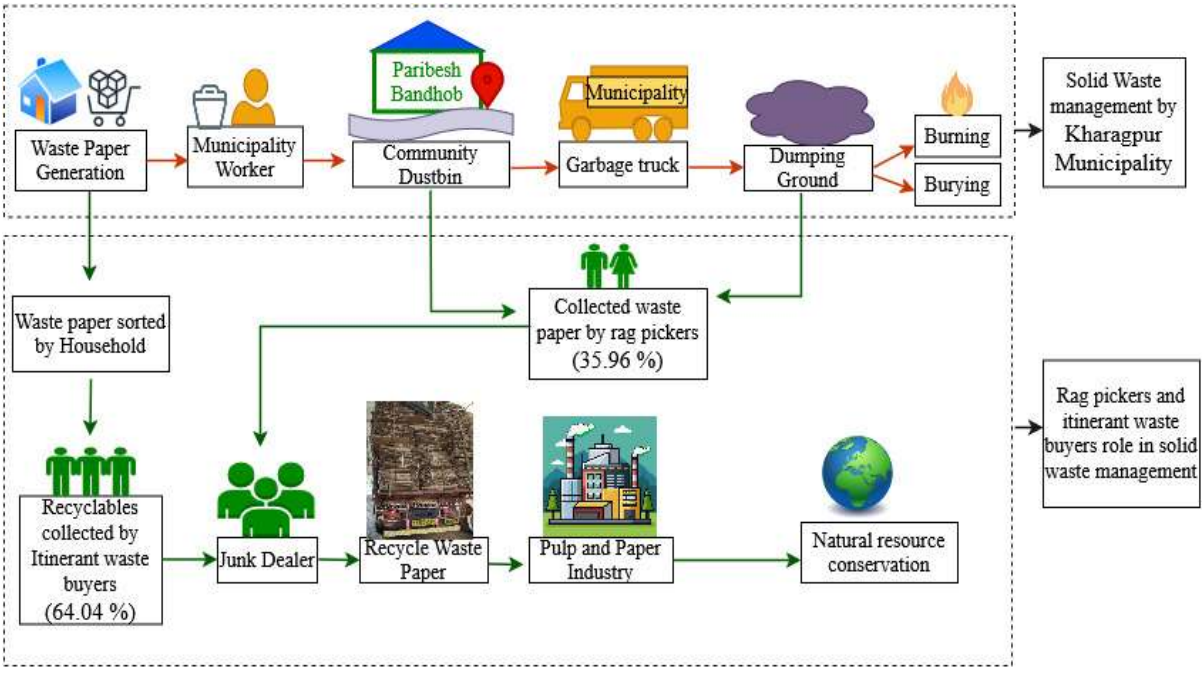
This study used the primary field survey method, a snowball sampling method with structured questionaries for formal authorities and workers. & interview method also followed, and statistical techniques were used to analyse the collected data.

3.2.1 Conceptual framework in the context of paper waste recycling and environmental resource conservation towards sustainable development goals (SDGs)

Every waste has a positive and negative effect on the environment globally. Every day, huge tons of waste are generated due to population increases and the changing lifestyles of people with continued

developmental activity in society. Municipality waste is mixed with discarded plastic, paper, glass, scrap metal, polyethene, etc. Municipalities or legal bodies cannot handle those enormous amounts of waste, especially in periphery areas where dustbins in the city are not clear regularly. We can recover resources from the waste material, and then we say that all waste is not fully valued less; by recycling this type of solid waste, we can conserve our natural resources. Rag pickers and itinerant waste buyers collect valuable solid waste and contribute to the recycling chain by selling it to regional junk dealers, mediating between the recycling industry and collected solid waste. Among all types of solid waste, waste paper recycling is a good approach to achieving the UN's sustainable development goal. Rag pickers and itinerant waste buyers are the primary regulators of the solid waste management system of any municipality, mainly waste paper because the paper is biodegradable, so the municipality waste has a high chance of degrading its quality if it is unable to segregate at source and its primary stage of waste papers life cycle. Ragpickers collect it from dustbins, and itinerant waste buyers collect waste paper from households; the waste paper and its recycling and conservation of natural resources towards sustainability are conceptually expressed in this study. However, a conceptual model of the normal waste management process of the municipality of Kharagpur and the rag pickers and itinerant waste buyers' role in solid waste management in the city (Fig 2).

Figure 2: Conceptual Framework of Solid Waste Management System of Kharagpur Municipality and Rag Pickers and Itinerant Waste Buyer's Role in Waste Paper Recycling.



4. Result:

In this study area, 64 Jank Yard deals with recyclable waste paper. Rag pickers collect 35.96 % of paper waste annually, and itinerant waste buyers contribute the remaining part. The average collection by rag pickers is 28.91 metric tons yearly, and itinerant waste buyers' average collection is 51.48 metric tons. The yearly average collection for both of them is 80.39 metric tons. Using the F-statistics, the analysis of variance (one-way ANOVA) table computes the p-value at the 0.002 significance level (Table 1) clearly

shows a significant difference between collected waste paper amount by the rag pickers and itinerant waste buyers.

Table 1: Summary Table of ANOVA

Groups	Count	Sum	Average	Variance
Rag pickers	64	1850.112	28.908	1083.429
Itinerant waste buyers	64	3294.81	51.48141	7436.233
Both	64	5144.922	80.38941	11900.72

Table 2: Result of ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	85238.75	2	42619.37	6.2613	0.002328	3.043722
Within Groups	1286484	189	6806.793			
Total	1371723	191				

4.1 Contribution of paper waste in solid waste in Kharagpur municipality:

In Kharagpur Municipality, only 17 % of paper and paperboard waste contributes to recycling from Kharagpur municipality. Waste category-wise percentages are shown in the diagram (Fig 3), which also mentions collected amounts, types, and waste characteristics. Rag pickers and itinerant waste buyers collect this amount of paper waste from different parts of Kharagpur and then resell it to a regional junk shop (Fig 4). Then junk dealers re-trade it to the recycled paper-based industry. From Kharagpur, waste paper is transported to 3 different places: Jhargram (Jhargram Paper Mill), Debra (Unitech Paper Mill Pvt. Ltd), and Kolkata (mainly to Emami Paper Mill Limited, Supreme Paper Mill Limited). Paper waste transported as secondary raw materials is 25%,30%, and 40%, respectively (Fig 5).

Figure 3: Characteristics of Solid Waste in Kharagpur.

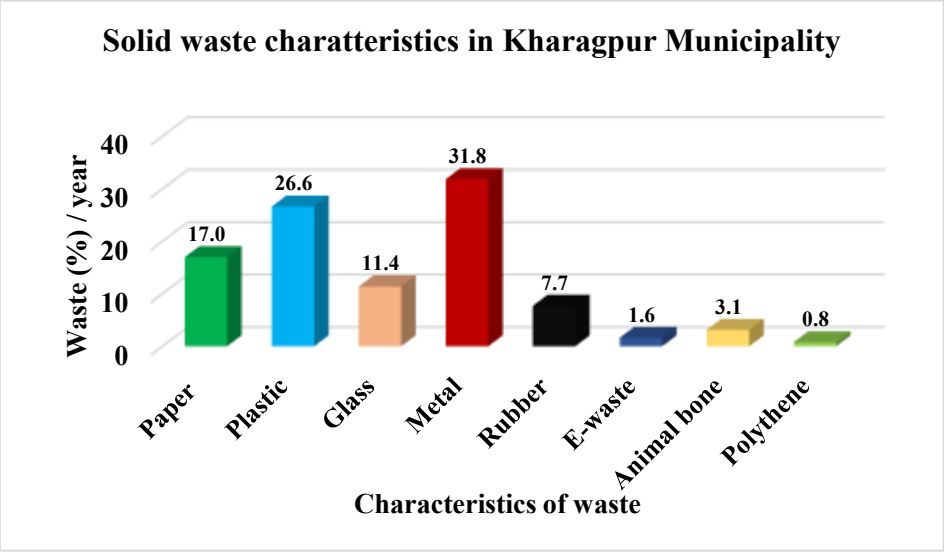


Figure 4: Spatial Distribution of Junk Shops in Kharagpur Municipality.

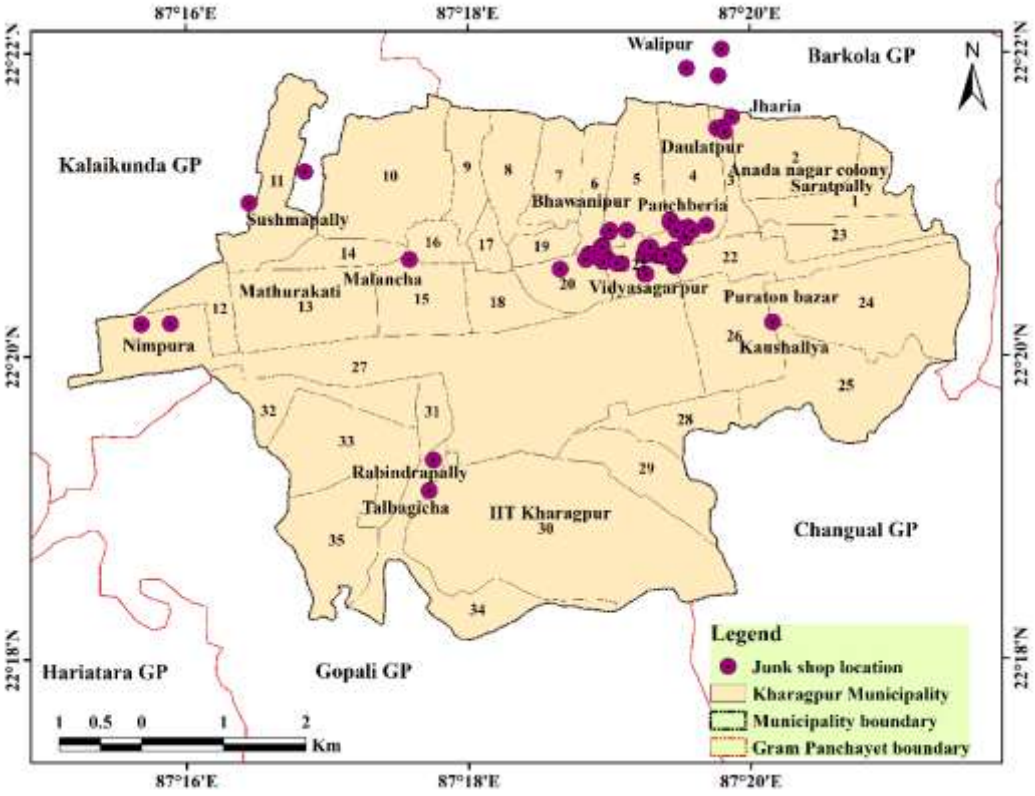
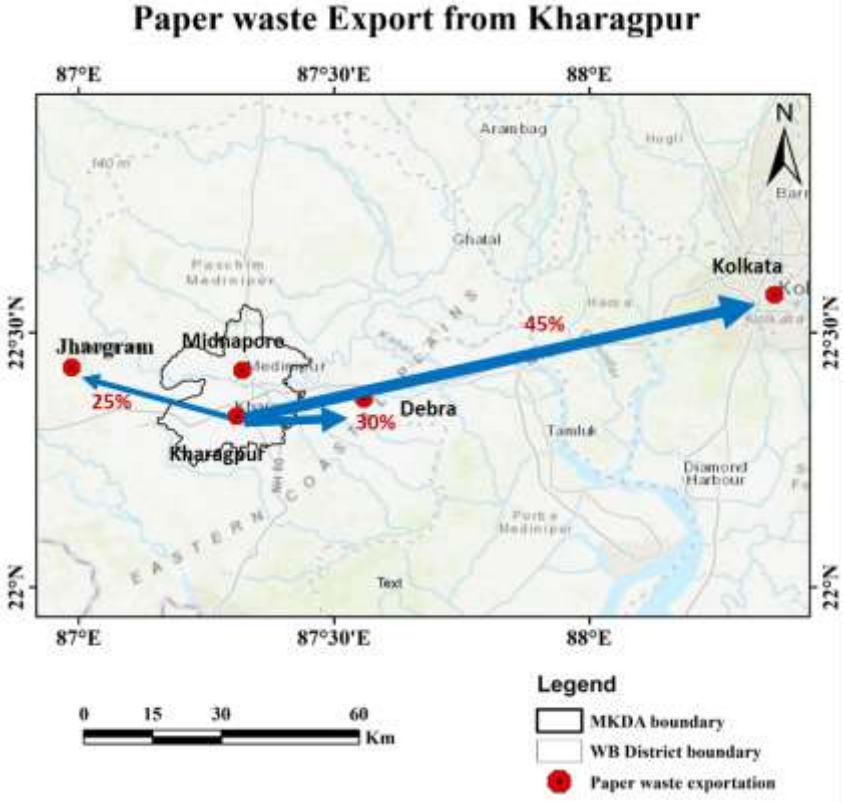


Figure 5: Paper Waste Exported from Kharagpur Municipality to Jhargram, Debra, and Kolkata for Recycling the Waste Paper and Parallel use as Secondary Raw Materials.



4.2 Rag pickers and itinerant waste buyers' contribution to resource conservation

Rag pickers and itinerant waste buyers are the bottom-level actors in solid waste management and resource conservation processes. All over the world, especially in India, they are not registered. They have contributed to the solid waste management system in recycling and conserving natural resources. In the study area**,** Kharagpur is the fourth most populous city in West Bengal, with the largest railway platform and famous IIT in Kharagpur. Based on rag pickers and itinerant waste buyers' collection junk dealers of Kharagpur, the recyclable paper waste is mainly in three places as the secondary raw materials of the pulp and paper industry (Fig 5). Approximately 45% of waste paper is transported to Kolkata, followed by Debra (30%) and Jhargram (25%).

Figure 6: Waste paper category in Kharagpur Municipality

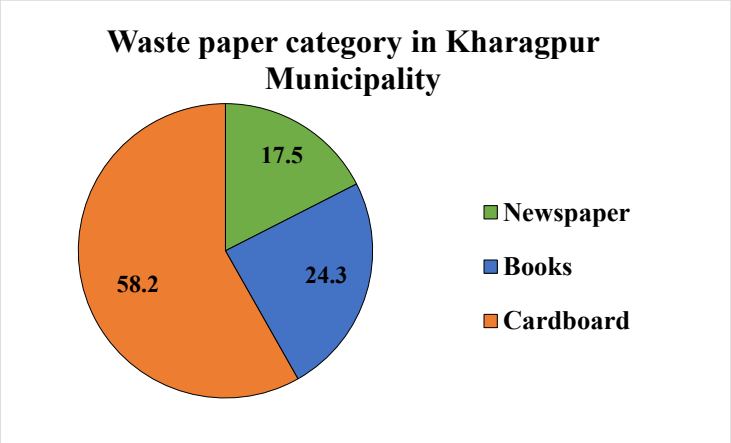


Figure 7: Rag Pickers and Itinerant waste buyers' Contribution in Waste Paper Collection in Kharagpur Municipality.

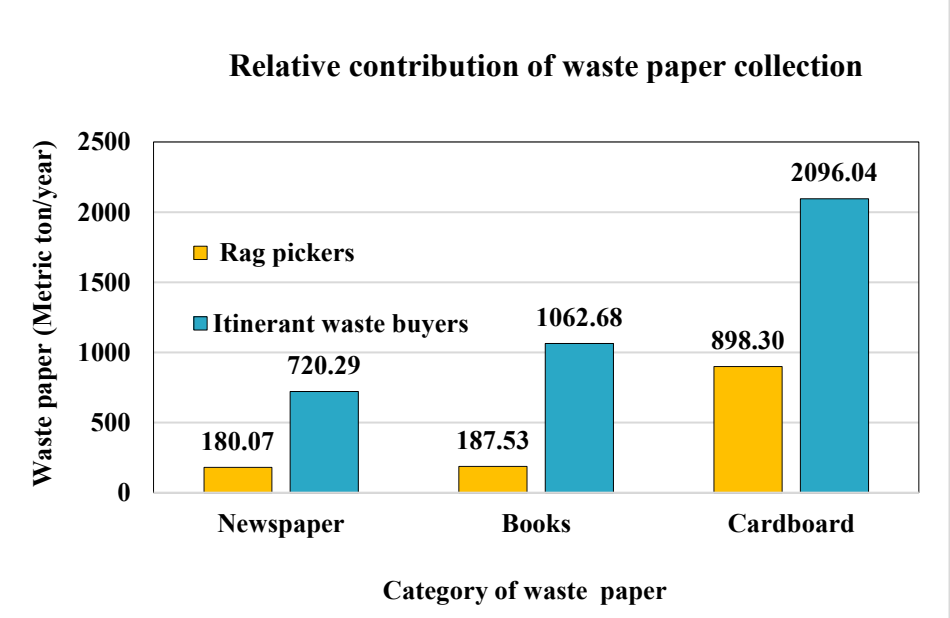
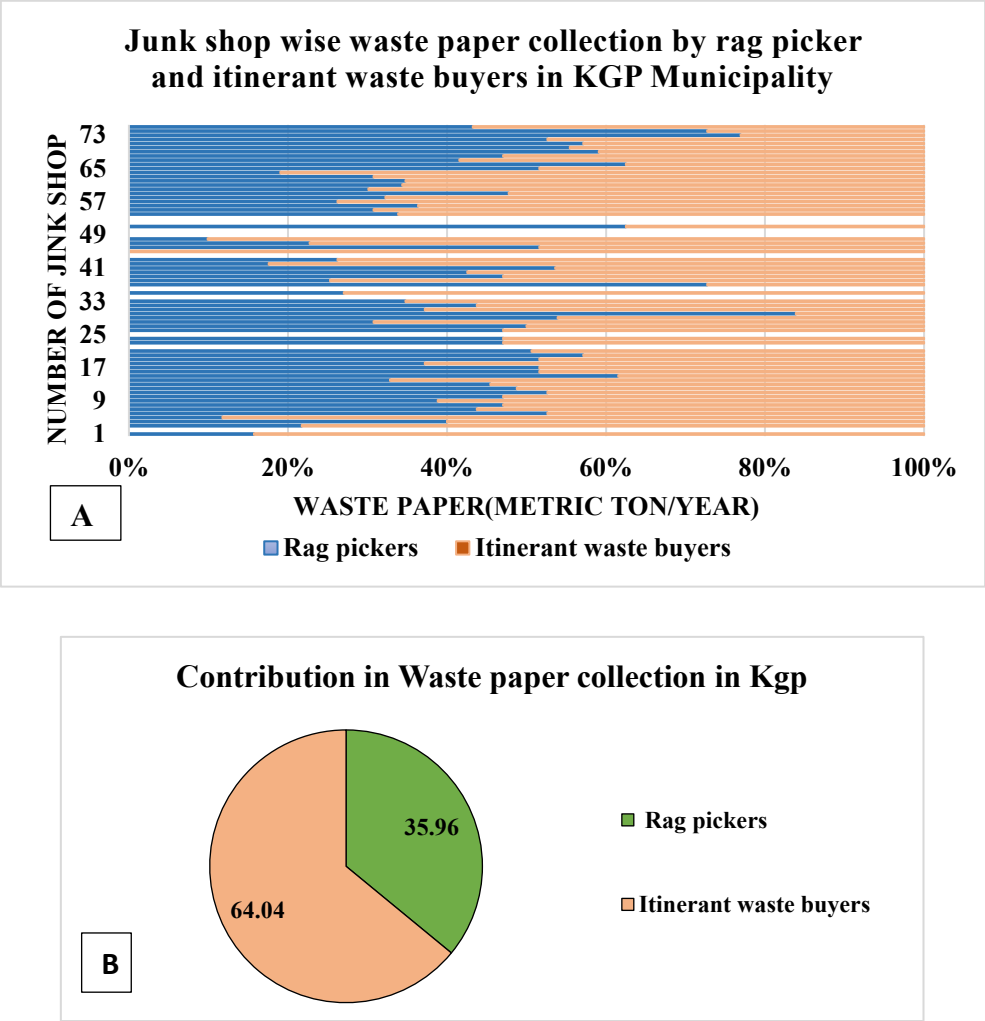


Figure 8: Subcategory of Paper Waste (A) and the Relative Contribution of Rag Pickers and Itinerant waste buyers in Kharagpur Municipality(B).



4.2.1 Environmental value

Recycling reduces the amount of land used and aids in the preservation of natural resources(Misman & Sharifah Rafidah Wan Alwi, 2008). Reducing the amount of paper you use helps the environment and can save the organization money. Forty-two percent of all trees cut down for industrial purposes are used to make paper. In most developed countries, the pulp and paper sector are also the biggest industrial user of water, the biggest polluter, and the third highest emitter of pollution related to global warming. (NRDC, 2006). In Kharagpur municipality, rag pickers and itinerant waste buyers save 17 % of waste paper of all generating solid waste, saving approximately 22681.76 m3 land space annually.

4.2.2 Resource conservation value

One ton of recycled paper saves approximately 17 trees,2.5 barrels of oil,4100 kWh of Electricity, 4 cubic meters of landfill, and 31,780 liters of water over the production of virgin paper from wood (Samaddar & Bandyopadhyay, 2018). Every ton of recycled paper save the cutting of 17 adult trees, improving the protection of forest resources.52 people's daily oxygen needs are satisfied by one adult tree (TUTUŞ et al., 2018).The problem of environmental contamination will be lessened by gathering waste paper. Additionally, there will be a decrease in the expense of cleaning it and the risk of environmental pollution of the waste residues(TUTUŞ et al., 2018). Regarding environmental impact recycle paper is better than

virgin paper for all paper goods (Kinsella, 2012). 320 kg of CO_2 equivalent is reduced by 1 ton of recycled paper (Sevigné-Itoiz et al., 2015; Abushammala et al., 2023). Recycling a single ton of paper save 24 trees, 3223.78 kWh of energy, save 4244.75 Liters of water, reduce, 938.029 kg of GHG emitted (equal to CO2), and save 40.65 kg of solid waste (Kinsella, 2012). Based on all of this previously published research, the author identifies the amount of conservation of natural resources like trees, wood, water, Electricity, oil (petroleum), and landfill space and reduces the Air pollutants and solid waste amount. The author considers the average value of these resources saved by a single ton of recycled waste paper and calculates the amount of resource conservation. Rag pickers and itinerant waste buyers save 5144.92 metric tons of paper waste per year from Kharagpur Municipality. We calculate the resource conservation value of that amount of paper waste, considering the average value of natural resources saved by recycling a single ton of waste paper (Table 2).

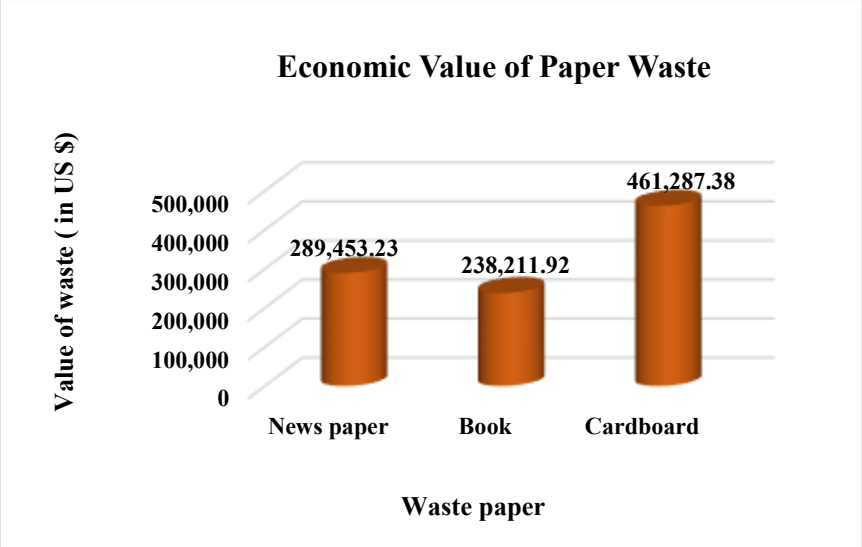
Table 2: Resource Conservation Value of Waste Paper in Kharagpur Municipality.

Amount of paper waste	Natural resource	Average value	Resource conservation value
5144.92(M ton/year) From Kharagpur Municipality	Trees (Number)	20.5	116244
	Wood (Ton)	1.28	7258.163
	Water (1000 liter)	42.6	241560.7
	Electricity (mWh)	2.44	13835.87
	Oil (Petroleum) (Barrel)	2.25	12758.49
	Landfill Space(m^3)	4	22681.76
	Air Pollutant (Kg)	428.41	2429273
	Solid Waste (Kg)	40.65	230503.4

4.2.3 Economic value

Inefficient use of printers, copiers, and fax machines can waste between 1 and 3 per cent of company revenue annually (Gartner Group,2001). Half of all printed documents are discarded within 24 hours, and businesses spend an additional $6 on handling and distribution for every $1 spent on duplicating (Hesseldahl, A. 2008). Approximately 17 per cent of all printed materials are deemed to be garbage (Lexmark International, 2006). In Abuja, scrap traders make between N10,000 ($27.77) and N15,000 ($41.67) per day, while garbage collectors and collectors make between N1500 ($2.8) and N2000 ($5.6) per day (Ogwueleka, Chibueze & P, 2021). Scavengers often make between $7 and $17 per day, depending on the commodities they uncover and the market's health, according to research by Rockson et al. (2013). WPs in Nanjing collect over 505,000 tons of recyclables annually, with an estimated economic value of 78.6–84.7 million USD(Chen et al., 2018). In Kharagpur, rag pickers and itinerant waste buyers save total 5144.92 metric tons per year, so if we calculate subcategory-wise paper waste value, we get value (in US $) of newspaper (17.5%) is $ 2,89,453.23 book (24.3%) is $ 2,38,211.92 and cardboard (58.2%) is $ 4,61,287.38 in every year (Fig 9). (source: field survey 2023, regional junk dealer, Kharagpur).

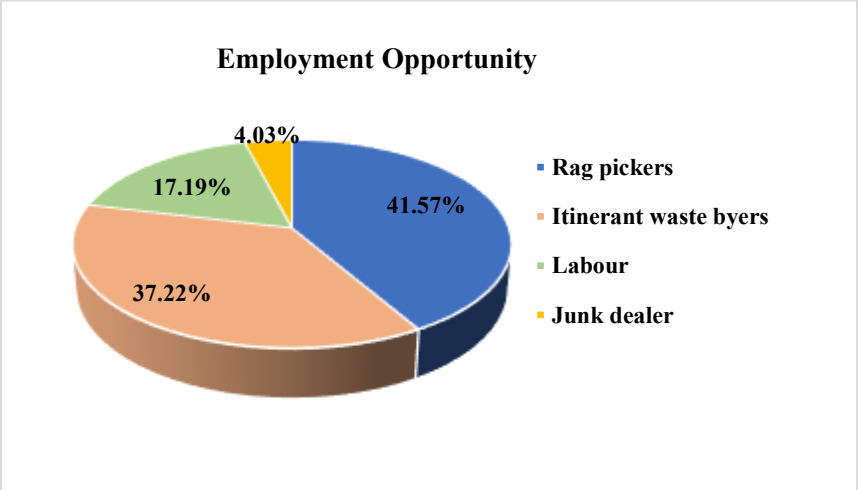
Figure 9: Value of Waste Paper (US $) in Kharagpur Municipality.



4.2.4 Employment Opportunity

Marginal poor people do not see waste as waste because they see it as bread and butter; recyclable waste collection and selling it is an opportunity for them. In Kharagpur municipality, 774 rag pickers and 693 itinerant waste buyers work as informal workers; they contribute to the solid waste management system, and more than 75 junk dealers who buy waste from rag pickers and itinerant waste buyers create opportunity. Apart from that, 320-labour work at different regional junk shops. So, there are approximately 1787 employees in Kharagpur municipality (Fig 10).

Figure 10: Employment opportunity of different actors in solid waste management Kharagpur Municipality.



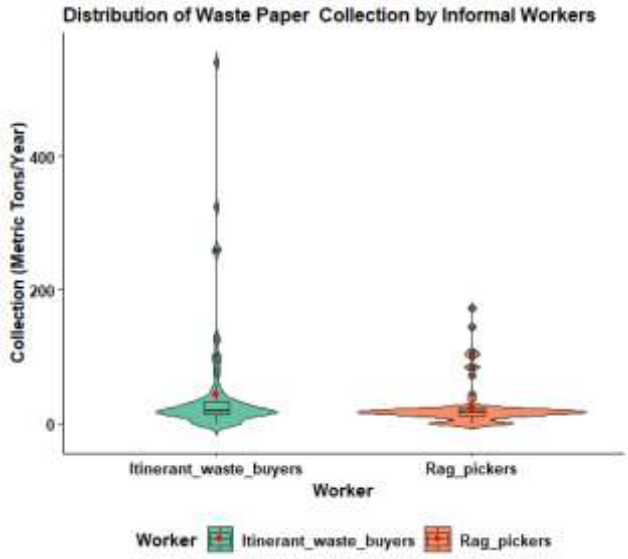
5. Discussion:

Rag pickers and itinerant waste buyers' role in resource conservation is important because they collect and sell it to the regional junk shop. In this study area, Kharagpur, a class I town of West Bengal, this informal actor has not registered officially, but silently, they contribute to solid waste management. There are statistically significant differences between rag pickers and itinerant waste buyers in the collection process and amount of waste collection (Table 2). They contribute to environmental value, economic value,

recourse conservation value, and employment generation. If we focus on their contribution, we must say that only those who work at the grassroots level in the solid waste management system collect and then sell it to regional junk shops from the recycling industry, buy recyclables, and use them as secondary raw materials of industry. From the resource conservation value of waste paper, we revealed that based on their collection per year, they save more than 11 lakh trees, above 7 thousand of wood, more than 24 lakh thousands of water, above 13 thousand of Electricity (mWh), above 12 thousand Barrel of Oil (Petroleum), save more than 22 thousand m^3 landfill space and reduce above 2678 ton of air pollutant, and more than 250 ton of solid waste that, if the entire procedure is repeated to create the same quantity of new paper each year, will be generated. This result also proves that it is not mandatory to plant the same no or a more significant number of trees. Still, we can also save our natural resources, mainly forest, water, and mineral resources, by properly recycling waste material, conserving resources, and reducing pollution. In this way, sustainable waste management is possible by Using a trash hierarchy to manage the waste. We can consider the 6 R's like Reduce, Reuse, Recycle, Recover, Redesign, and Remanufacture. Rag pickers collect waste paper without paying anyone so. Their collection is comparatively less than the itinerant waste buyer (Fig 6). Among the subcategories of waste paper, there are three basic categories of waste paper: newspaper, books, and cardboard; itinerant waste buyers visit door-to-door to buy waste, so they select more valuable recyclables and also collect more amount than rag pickers (Fig:7 & Fig 8) among the subcategory economic value of cardboard is more ($4,61,287.38) followed by the newspaper ($2,89,453.23) and books ($2,38,211.92) in Kharagpur (Fig 9). Seventy-five junkshops we visited and identified that only 64 shops deal with waste paper and other recyclables, and 11 junk shops deal with other recyclable escape paper waste. Due to this reason, we show the spatial distribution map of junkshops in Kharagpur municipality (Fig:4). Still, statistical analysis is done considering the 64 junk shop data (Table:1) so many urban poor or marginal people earn their bread and butter by this activity and also some people work as a junk shop labour, who mainly do packaging the recyclable at the junkyard after rag pickers and waste buyers selling at the junk shop.

In Kharagpur, there are 320 labourers involved in this profession. So, we can say that this activity also generates employment (Fig 10). So, this study makes the unique novelty of the research by the lance of environment, economy, resource conservation, and employment generation. The research finding has a broader impact on society and the environment. In this way, sustainable solid waste management will be possible by motivating rag pickers and itinerant waste buyers and accelerating solid waste management by increasing their skills. In this context, the UN's sustainable development goals are connected. We discuss the implementation of SDGs and the relation of municipal solid waste management, the significance of recycling, and its impact and linkage to the different indicators of SDGs are essential are discussed below.

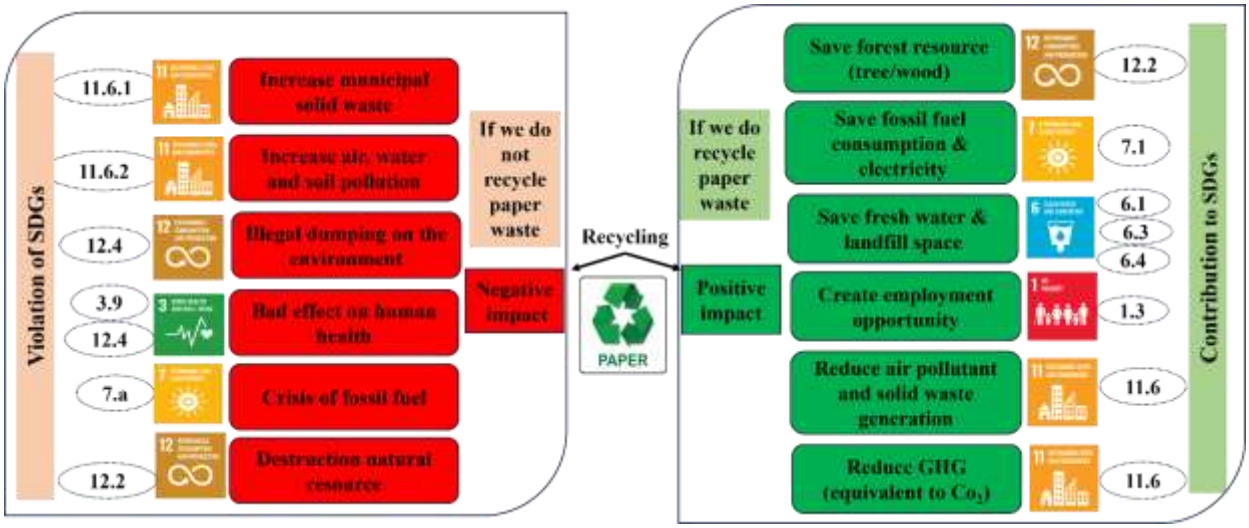
Figure 11: Violin Plot Shows the Distribution of Waste Paper Collection by Rag Pickers and Itinerant waste buyers in Kharagpur Municipality



6. Implementation of sustainable development goal

Paper is used everywhere in large quantities despite going into the digital age. Among all others, solid waste paper waste recycling is generally seven times more easily possible .in the municipality or local organization. Let's look at the link between humanitarian and environmental performance and economic development. The impact of paper recycling will relate to the nearly a dozen impacts that connect the UN Sustainable Development Goals (SDGs). Fig 12 shows the positive impact of recycling paper waste (right side), and the left side expresses the negative impact of recycling paper waste. Paper waste recycling shows positive impacts, such as saving forest resources related to SDG indicator 12.2. We can reduce the consumption of fossil fuels and Electricity (Table 2) by recycling waste paper (SDG 7.1). Recycling can save fresh water and landfill space, contributing to SDGs 6.1,6.3,6.4. Parallelly create employment (Fig 9) related to 1.3 indicators of SDG 1. Recycling reduces air pollutants, GHG (equivalent to Co2), and solid waste generation in new paper production from fresh, natural resources (related to SDG 11.6). On the way, if we do not recycle paper waste, it creates a negative impact on our living environment, as the amount of municipal solid waste will increase, air, water, and soil will be polluted and increase the level of pollution (SDG 11), by illegal dumping on the environment (SDG 12.4), that also creates an adverse impact on human health (SDGs 3.9 & 12.4). Overall, long-term negative impacts are crises of fossil fuel and destruction of fresh natural resources (SDG 7. a &12.2).

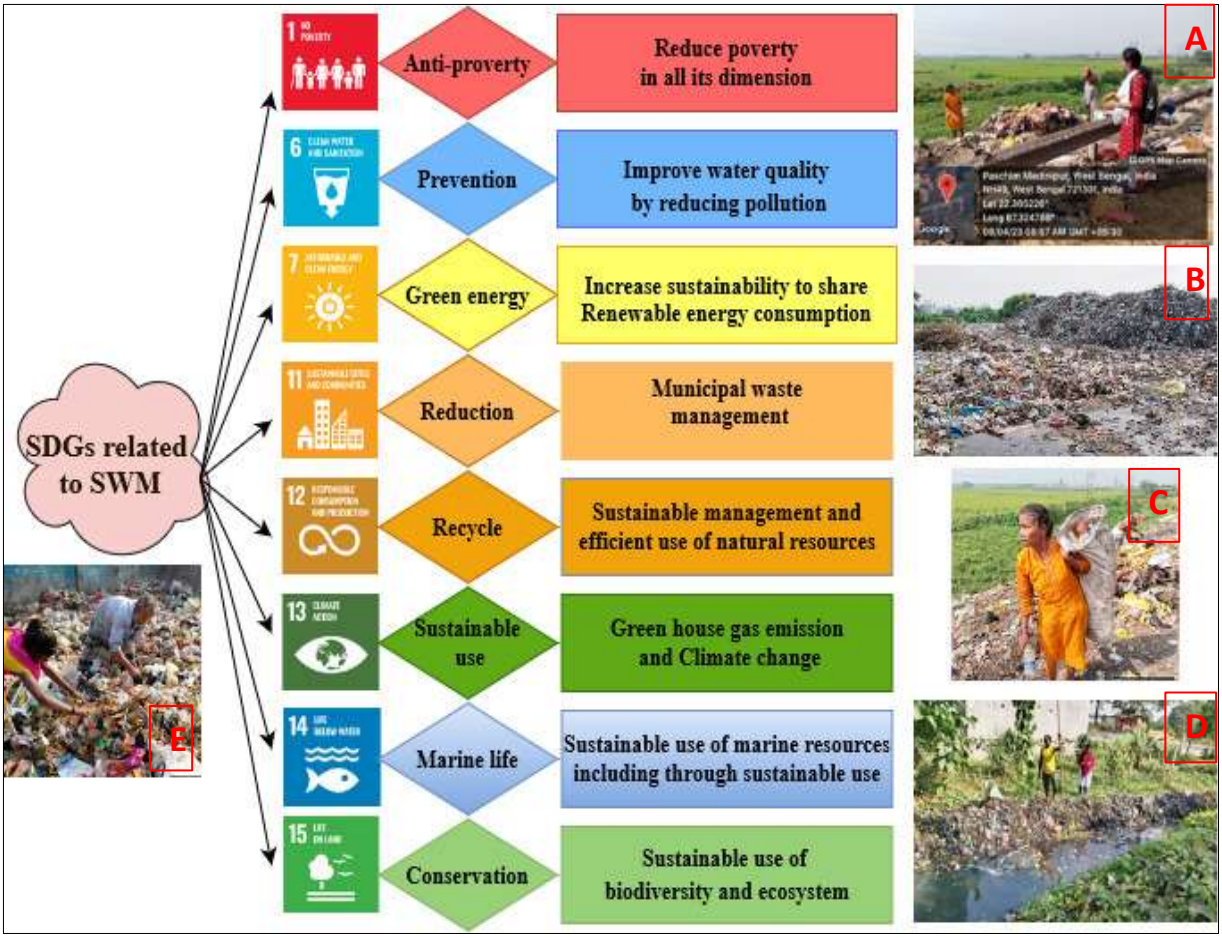
Figure 12: Impact of Waste Paper Recycling and Resource Conservation and Forward to a Sustainable Planet.



7. Policy recommendation for management of paper waste

Municipal waste is increasing daily and has become a headache for every municipality as it manages its enormous waste. People are beginning to explore going paperless in this technological age. However, today, paper is mainly used for packaging purposes. Worldwide consumption of pulp and paper industry is probably two-fold from 2010 to 2060. Waste paper will be the same at this time, and it will also increase paper production. The world's forests are already under a great deal of stress, and things are only going to get worse. More paper production will only make the issue worse. Globally, 386 million hectares of forest were destroyed between 2001 and 2019 (all forest kinds combined). Since 2000, the number of trees has decreased by nearly 10% due to this loss. As 93% of paper comes from trees, we can save the number of trees by recycling paper waste because recycling every tonne saves approximately 1400 litres of oil, 26,500 gallons of water, and 17 trees. Approximately 26% of landfill garbage and 33% of municipal waste are made up of paper. So, commitment needs enhancement in waste paper collection, storage, and recycling. Otherwise, it spreads harmful impacts on the environment, land, and ocean. Considering the adverse implications of waste, which can create an issue of emerging waste amounts at the local and global levels, the government of India should have proper management rules and improve waste collection, storage, and recycling with actionable measures.

Figure 13: Interlinkage Between Solid Waste Management and UN's SDGs



A bottom-up approach to waste recycling might be started through a government awareness campaign. As an outcome, it's all about what can be recycled, who can recycle, and how cost-effective the procedure is, all accessible to everyone. Straightforward rules and guidelines could be enforced. Also, creating inclusive solutions should be the top goal in advancing the UN's sustainable development initiatives. UN's first goal is linked with this study because rag pickers collect solid waste, and by selling it, they survive; in this sense, it is the action of anti-poverty, related to SDG1(Fig:13, Photo plates A, C & E shows the rag pickers who are searching recyclables from the dumpsite and the drain (plate D), dump site (plate B)). Recycling this waste is a sustainable management of solid waste, and the need for natural raw materials will be reduced, so sustainable use of natural resources will be promoted (SDG12). Otherwise, solid waste generation and pollution from it will hamper SDG14 (life below water) and SDG6 (clean water and sanitation); as a result, it also hampers SDG3 related to health and well-being (Mallick et al., 2021). Properly managing and focusing on recycling can save our biodiversity and ecosystem with conservation (SDG16). To reduce waste generation and prevent pollution, every country, particularly emerging countries, should carefully consider waste management (Mallick et al., 2021).

8. Conclusion

This study presents a detailed analysis of resource conservation by recycling paper waste in class I town (Kharagpur) of West Bengal and the linkage of municipal solid waste management with UNs Sustainable

Development Goals (SDGs) and policy recommendations. Statistics show that from environmental, social, and economic points of view, rag pickers and itinerant waste buyers are the bottom-level workers of municipal solid waste management, and their contribution helps to resource conservation like trees, wood, water, Electricity, and reduce various environmental pollution, solid waste and save land space also. Rag pickers collect 35.96 % of paper waste from the Kharagpur Municipality, and itinerant waste buyers collect the rest. As itinerant waste buyers buy recyclables by making payments, they collect only more valuable recyclables, so their economic value contribution is higher than rag pickers. They both sell their collected waste at the regional junk shop, which creates an employment opportunity for them. This study shows a highly significant relationship between urbanization, population, waste generation, waste collection by rag pickers and buyers, and waste management. If the municipality's authority motivates them, they use their workforce for solid waste management and officially register them. In that case, it will be a good opportunity for them and formal authority because their contribution fits into the broader framework of environmentally responsible resource management. Resource recycling is one of the essential processes of waste management. The study shows the resource conservation value of waste paper (Table 2) and the parallel impact of recycling (Fig 11). In this way, the burden of natural resources will be reduced, and natural resources will be conserved. The results of this study may persuade decision-makers, governmental organizations, and other interested parties to express more significant concern about solid waste management, waste, and resource conservation by recycling it. The results of this study can be used to determine the best approaches to lessen paper waste production and its consequences.

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