

Overcoming Barriers to Paper Recycling: A Review of Challenges and Solutions

Mustafa Çiçekler^{1*} and Ahmet Tutuş¹

¹Forest Industry Engineering, Kahramanmaraş Sütçü İmam University, Türkiye

*mcicekler87@gmail.com

Abstract – This study addresses the barriers that hinder paper recycling and explores potential solutions to overcome these challenges. The barriers discussed include a lack of recycling infrastructure, inadequate education and outreach, cultural attitudes towards waste, and a lack of economic incentives. To address these barriers, governments and organizations can implement solutions such as expanding recycling infrastructure, improving education and outreach, addressing cultural attitudes through targeted messaging, and providing economic incentives. Successful implementations of these solutions in other locations or industries are also highlighted. The study emphasizes the importance of addressing these barriers to increase paper recycling rates and reduce the environmental and economic costs of low recycling rates.

Keywords – Paper, Recycling, Barriers, Solutions, Challenges

I. INTRODUCTION

Paper recycling is an integral part of sustainable waste management strategies that can have substantial environmental advantages. Through recycling paper, we are able to save natural resources, reduce energy usage, and prevent pollution. In addition, paper recycling can contribute to climate change mitigation by reducing greenhouse gas emissions (Bogner et al., 2008; Chen & Lo, 2016; Corsten et al., 2013; Pikoń & Gaska, 2010). To begin with, paper recycling can aid in the preservation of natural resources such as trees, water, and energy. Recycling paper is more resource-efficient than creating new paper because it consumes less energy and water and lessens the demand for raw materials (Björklund & Finnveden, 2005; Ekvall, 1999; Schenk et al., 2004; Villanueva & Wenzel, 2007). In addition, paper recycling helps prevent deforestation and its accompanying environmental implications, including habitat loss, soil erosion, and biodiversity decline.

Paper recycling can also aid in preventing pollution and reducing waste. When paper is discarded in landfills, it decomposes and emits

damaging pollutants such as methane and leachate (Hocking, 1991; Koroneos & Nanaki, 2012; Yang et al., 2022). By recycling paper, we are able to divert it from landfills and reduce soil, water, and air contamination. Moreover, paper recycling minimizes the amount of waste that must be carried and disposed of, hence lowering emissions and expenses.

Notwithstanding the environmental benefits of paper recycling, its widespread adoption is hindered by significant barriers. Lack of infrastructure, cultural views, and economic constraints are all examples of potential obstacles. These obstacles must be removed in order to increase paper recycling rates and decrease waste.

A lack of infrastructure, such as insufficient recycling facilities and collection programs, is one of the most significant obstacles to paper recycling. Individuals and businesses may be less inclined to participate in recycling initiatives if recycling solutions are not readily available and convenient. In addition, uncertainty over recyclable materials and how to properly prepare them might also lead to poor participation rates. Moreover, cultural

prejudices might be a substantial barrier to paper recycling. In certain instances, people may not prioritize recycling owing to a lack of knowledge about the environmental benefits or a lack of appreciation for the effort required to participate in recycling programs. In addition, economic issues such as the cost of recycling vs the cost of disposal might be a barrier, especially for firms or groups with limited financial resources.

Overall, eliminating these obstacles is essential for boosting paper recycling rates and achieving sustainable waste management practices. We can overcome these obstacles and build a more sustainable future by enhancing the infrastructure for recycling, educating the public about its benefits, and offering economic incentives.

II. BARRIERS TO PAPER RECYCLING

Paper recycling is an important practice that helps to conserve natural resources and reduce the amount of waste sent to landfills. However, there are several barriers to paper recycling that hinder its effectiveness. One of the main barriers is contamination that occurs when non-recyclable materials such as food, liquids, and plastic are mixed with recyclable paper (Brothers et al., 1994; Ervasti et al., 2016; Pikoń & Gaska, 2010). This can render the paper unusable for recycling, as the contamination can damage recycling equipment and reduce the quality of the recycled paper. To combat contamination, it is important to educate the public on proper recycling practices and to implement effective recycling programs that include sorting and cleaning processes.

Another barrier to paper recycling is the lack of infrastructure and investment in recycling facilities (Lee et al., 2022; Ramesh, 2016). Without adequate recycling facilities, it can be difficult to collect, process, and recycle paper waste. Additionally, the cost of recycling paper can be higher than producing new paper, which can make it less economically viable for businesses and governments to invest in recycling. To overcome this barrier, there needs to be increased investment in recycling infrastructure and technology, as well as incentives for businesses and individuals to recycle. By addressing these barriers, we can improve the effectiveness of paper recycling and help to create a more sustainable future. Some common barriers have been discussed under the titles in this section.

A. *Lack of infrastructure*

The lack of infrastructure is a significant barrier to paper recycling in many areas. This can include inadequate recycling facilities, insufficient collection programs, and limited transportation networks for collecting and transporting paper waste to recycling centers (Lee et al., 2022; Ramesh, 2016). In some cases, there may be recycling facilities available, but they may not be equipped to handle the volume of paper waste being generated, which can limit the amount of paper that can be recycled.

One of the main issues with infrastructure is the lack of curbside recycling programs in some areas. In the United States, for example, only about 63% of the population has access to curbside recycling programs, according to the Environmental Protection Agency (EPA) (Bohm et al., 2010; EPA, 2023). This can make it difficult for individuals to participate in recycling efforts, as they may not have convenient access to recycling facilities or collection programs. In some cases, individuals may have to travel long distances to dispose of paper waste, which can discourage participation in recycling programs.

In addition to curbside recycling programs, there may also be a lack of infrastructure for commercial or industrial recycling. This can include inadequate recycling facilities for businesses or limited transportation networks for collecting paper waste from businesses and transporting it to recycling centers. Without these resources, businesses may be less likely to participate in recycling programs, as it can be difficult and costly to transport paper waste to recycling centers.

Addressing the lack of infrastructure requires investment in recycling facilities and transportation networks, as well as the development of more comprehensive recycling programs. This can involve partnering with local governments and private companies to expand recycling infrastructure and improve accessibility to recycling facilities. In some cases, economic incentives may also be necessary to encourage investment in recycling infrastructure and to help offset the costs associated with recycling programs. By addressing the lack of infrastructure, we can increase paper recycling rates and achieve more sustainable waste management practices.

B. Confusion About What Can Be Recycled

Another common barrier to paper recycling is confusion about what materials can be recycled and how to properly prepare them for recycling. This confusion can lead to contamination of recycling streams, reducing the effectiveness of recycling efforts. In some cases, individuals may mistakenly believe that certain materials can be recycled when they cannot, while in other cases, individuals may fail to properly prepare materials for recycling, making them unsuitable for recycling.

For example, pizza boxes are a commonly misunderstood material when it comes to recycling. Many people assume that because pizza boxes are made of cardboard, they can be recycled. However, pizza boxes are often contaminated with food residue, making them unsuitable for recycling. Similarly, paper products that are coated in wax or plastic, such as paper cups or take-out containers, cannot be recycled due to the non-recyclable materials they contain.

There are also variations in recycling guidelines between different regions and recycling programs, which can contribute to confusion about what can be recycled. This can result in inconsistent messaging and confusion among the public. Additionally, some recycling programs may not accept certain types of paper, such as shredded paper or paper with adhesive labels, which can further contribute to confusion about what can be recycled.

To address this barrier, it is important to educate the public about what materials can and cannot be recycled, as well as how to properly prepare materials for recycling. This can involve developing clear and consistent recycling guidelines that are widely distributed and accessible to the public. In addition, public awareness campaigns can help raise awareness about proper recycling practices and address common misconceptions about recycling.

Improving the education and awareness around proper recycling practices can help reduce contamination in recycling streams and increase the overall effectiveness of recycling efforts (Miranda & Blanco, 2010; Muzenda, 2013). By providing clear and consistent messaging about what can be recycled and how to properly prepare materials, we can reduce confusion and encourage more individuals to participate in paper recycling programs.

C. Cultural Attitudes

Cultural attitudes can also be a significant barrier to paper recycling. In some cases, individuals may view recycling as an inconvenience or believe that it is not their responsibility to recycle. This can lead to a lack of motivation to participate in recycling efforts and a general lack of awareness about the importance of recycling for environmental sustainability.

For example, in some cultures, there may be a greater emphasis on convenience and disposability, leading to a lack of interest in recycling. Additionally, there may be cultural norms that discourage recycling, such as beliefs that recycling is a waste of time or resources. In some cases, these attitudes may be reinforced by lack of access to recycling facilities or inadequate recycling programs, which can further reduce motivation to participate in recycling.

Addressing cultural attitudes towards recycling can be challenging, as it often involves changing deeply ingrained beliefs and behaviors. One approach is to develop educational programs and public awareness campaigns that emphasize the importance of recycling and the benefits of sustainable waste management practices. This can help increase awareness about the environmental impacts of waste and encourage individuals to take action to reduce their own waste footprint (Gao et al., 2018; Towa et al., 2020).

Additionally, it is important to make recycling more convenient and accessible, particularly in areas where recycling facilities may be scarce. This can involve expanding curbside recycling programs, increasing the number of recycling bins in public spaces, and providing incentives for individuals and businesses to participate in recycling programs.

Ultimately, changing cultural attitudes towards recycling requires a multifaceted approach that involves education, awareness, and policy changes. By working together to promote the importance of recycling and sustainable waste management practices, we can overcome cultural barriers to paper recycling and create a more sustainable future for our planet.

D. Economic Factors

Economic factors can also be a significant barrier to paper recycling. The cost of collecting, processing, and transporting recycled materials can be higher than the cost of producing new materials,

particularly in regions where labor and transportation costs are high. Additionally, the market for recycled paper can be volatile, with prices fluctuating depending on supply and demand.

For example, if the demand for recycled paper is low, there may be little incentive for businesses to invest in recycling infrastructure or to pay higher prices for recycled paper products. This can make it difficult for recycling programs to remain financially sustainable, leading to a reduction in recycling efforts.

In some cases, the cost of recycling may be passed on to consumers, making recycled paper products more expensive than their non-recycled counterparts. This can reduce demand for recycled products and further exacerbate the economic barriers to recycling.

To overcome these economic barriers, it is important to develop policies and incentives that support the development of a sustainable recycling industry. This can involve providing financial support to recycling programs, such as grants or tax incentives, to offset the higher costs of collecting and processing recycled materials.

Additionally, governments can help create a stable market for recycled paper by requiring the use of recycled content in certain products or by offering procurement preferences for recycled products. This can help create a reliable demand for recycled materials and encourage businesses to invest in recycling infrastructure.

It is important to work with businesses and industries to develop innovative solutions for reducing the cost of recycling. For example, by developing more efficient recycling technologies or by implementing closed-loop systems that reduce the need for new materials, it may be possible to reduce the overall cost of recycling and create a more sustainable and economically viable recycling industry.

In summary, economic factors can be a significant barrier to paper recycling, but with the right policies, incentives, and technological innovations, it is possible to overcome these challenges and create a more sustainable future for our planet.

E. Limited Demand for Recycled Paper

Limited demand for recycled paper is another significant barrier to paper recycling. Even if there are efficient recycling programs in place, if there is no demand for the recycled paper products, the

efforts put into recycling may go to waste (Buist et al., 2020; Hervani, 2005). The limited demand for recycled paper can stem from a variety of factors. One of the main reasons is that the quality of recycled paper is often lower than that of virgin paper. Recycled paper fibers have already been processed once, and some of the fibers may have been lost during the recycling process, resulting in a lower quality product (Miao et al., 2018; Oksanen et al., 1997, 2000; Wanrosli et al., 2005). Additionally, recycled paper may contain impurities or contaminants, such as ink or adhesives, that can reduce the quality of the final product.

This lower quality can make recycled paper less desirable to manufacturers and consumers, who may be willing to pay more for higher quality virgin paper products. Furthermore, some industries may have specific requirements for the quality or appearance of their paper products, which may not be met by recycled paper. To overcome the limited demand for recycled paper, it is important to develop policies and incentives that encourage the use of recycled paper products. This can involve setting minimum standards for the quality of recycled paper, promoting the benefits of using recycled paper, and creating incentives for businesses and consumers to choose recycled paper products.

Governments can also use their purchasing power to create demand for recycled paper products by requiring the use of recycled content in their own procurement processes. By creating a stable market for recycled paper products, businesses can invest in developing better technology and processes for producing high-quality recycled paper. Furthermore, education and awareness campaigns can help increase demand for recycled paper products among consumers. By promoting the environmental benefits of using recycled paper, consumers can be encouraged to choose recycled paper products over virgin paper products, even if they are more expensive.

Limited demand for recycled paper is a significant barrier to paper recycling. To overcome this challenge, it is important to develop policies and incentives that create a stable market for recycled paper products, set minimum standards for the quality of recycled paper, and promote the environmental benefits of using recycled paper.

Addressing these barriers is crucial to increasing paper recycling rates and achieving sustainable

waste management practices. By improving recycling infrastructure, educating the public about the benefits of recycling, and providing economic incentives, we can overcome these challenges and create a more sustainable future.

III. THE IMPACT OF BARRIERS TO PAPER RECYCLING

The impact of barriers to paper recycling can be significant both environmentally and economically. When paper is not recycled, it ends up in landfills, where it can take hundreds of years to decompose. As paper decomposes, it releases methane gas, a potent greenhouse gas that contributes to climate change. Additionally, the production of virgin paper involves cutting down trees, which results in deforestation and habitat destruction for wildlife.

Economically, the impact of barriers to paper recycling can be felt at both the individual and societal level. When paper is not recycled, it can result in higher costs for waste disposal and landfill management, which can ultimately be passed on to taxpayers. The production of virgin paper also requires significant amounts of energy and resources, which can drive up the cost of paper products.

Furthermore, limited recycling infrastructure can result in missed opportunities for job creation and economic growth. According to the U.S. Environmental Protection Agency, the recycling industry in the United States employs over 757,000 people and generates over \$6.7 billion in wages and benefits annually (Rajendran et al., 2019). By investing in recycling infrastructure, communities can create jobs and support economic development.

Cultural attitudes can also have a significant impact on the success of paper recycling programs. When recycling is not seen as a priority or is viewed as inconvenient or unimportant, it can result in lower participation rates and reduced success of recycling programs. Education and awareness campaigns can help shift cultural attitudes towards recycling and promote the importance of reducing waste and conserving resources.

For several reasons, removing barriers to paper recycling is critical to increasing recycling rates and reducing waste. Paper is one of the most widely used materials on the planet, and demand for paper products is expected to rise further. If we do not increase our efforts to recycle paper, we will face an increasing problem of environmentally hazardous waste.

By removing the barriers to paper recycling, we can reduce the demand for virgin paper, which is a major cause of deforestation and habitat destruction. We can save resources and reduce the environmental impact of paper production by recycling paper.

Removing barriers to paper recycling can result in significant economic benefits. Recycling supports economic development and helps to reduce the cost of waste disposal and landfill management. Communities can support economic growth and create a more sustainable future by investing in recycling infrastructure and promoting recycling programs.

Getting rid of the barriers to paper recycling is critical for lowering our carbon footprint and mitigating the effects of climate change. Paper that is not recycled ends up in landfills, where it decomposes and emits methane, a powerful greenhouse gas. We can reduce the amount of paper waste that ends up in landfills and help mitigate the effects of climate change by increasing paper recycling rates.

Increasing recycling rates, reducing waste, conserving resources, promoting economic growth, and mitigating the effects of climate change are all dependent on removing barriers to paper recycling. We can create a more sustainable future for ourselves and future generations by investing in recycling infrastructure, promoting education and awareness campaigns, and addressing economic and cultural factors that affect recycling.

A. *Environmental Costs*

Deforestation is one of the most significant environmental impacts of low paper recycling rates. As more and more trees are cut down to produce new paper, natural habitats are destroyed, and biodiversity is lost. Deforestation also contributes to climate change by reducing the amount of carbon dioxide absorbed by forests. This, in turn, leads to higher levels of greenhouse gases in the atmosphere, exacerbating global warming. By increasing paper recycling rates, we can reduce the demand for new paper and help to preserve the world's forests.

In addition to deforestation, the paper manufacturing process also contributes to climate change through its energy use and greenhouse gas emissions. Producing paper from virgin pulp requires significant amounts of energy and emits greenhouse gases, including carbon dioxide, into the

atmosphere. By recycling paper, we can reduce the amount of energy and greenhouse gases required to produce new paper, mitigating the impact of climate change.

Water pollution is another significant environmental concern associated with paper manufacturing. The process requires large amounts of water, which can lead to water scarcity and pollution. Additionally, the disposal of paper waste can lead to water pollution, as chemicals and other contaminants can leach into the water supply. By recycling paper, we can reduce the amount of waste that ends up in landfills and reduce the risk of water pollution. This, in turn, can help to protect aquatic ecosystems and promote water conservation. Overall, increasing paper recycling rates can have significant environmental benefits, reducing deforestation, mitigating climate change, and reducing water pollution.

B. Economic Costs

Low paper recycling rates can have significant economic impacts, including increased costs of raw materials, increased waste disposal costs, and lost economic opportunities. As demand for virgin wood pulp increases due to low recycling rates, the cost of raw materials for paper production can rise, making paper production more expensive for businesses and consumers. This can lead to reduced profitability for paper manufacturers and higher costs for consumers.

In addition, low paper recycling rates can increase waste disposal costs for businesses and municipalities. As landfill space becomes scarce and expensive, disposing of paper waste in landfills can become increasingly costly. By increasing paper recycling rates, we can reduce the amount of paper waste that goes to landfills, helping to reduce waste disposal costs and preserve valuable landfill space.

Low paper recycling rates also mean missed economic opportunities in the recycling industry. Recycling creates jobs and supports local economies, but low recycling rates mean fewer opportunities for job creation and economic growth in the recycling sector. By increasing paper recycling rates, we can help to support local economies and create new job opportunities in recycling industries.

In conclusion, low paper recycling rates have significant economic costs that affect businesses, consumers, and local economies. By increasing

paper recycling rates, we can reduce the environmental impact of paper production, as well as reduce costs and create economic opportunities. Increasing paper recycling rates is a win-win solution that benefits both the environment and the economy.

IV. SOLUTIONS TO BARRIERS TO PAPER RECYCLING

A. Expanding Recycling Infrastructure

Expanding recycling infrastructure is a critical step towards increasing recycling rates. Lack of access to recycling facilities can be a significant barrier to recycling, especially in areas with limited infrastructure. Governments and private companies can invest in building new recycling collection centers, recycling bins, and processing facilities. They can also develop partnerships with existing facilities to provide recycling services to communities that do not have access to them. By expanding recycling infrastructure, more people will be able to recycle, which can increase recycling rates and reduce the amount of waste that ends up in landfills.

B. Improving Education and Outreach

Education and outreach are essential to increasing recycling rates. Many people do not recycle because they are not aware of the benefits of recycling or how to recycle properly. Governments and organizations can launch campaigns that raise awareness about the importance of recycling and how to recycle properly. These campaigns can use a variety of media, such as television, radio, social media, and billboards, to reach a wide audience. Governments and organizations can also partner with schools, community centers, and other local groups to provide education on recycling. By improving education and outreach, more people will understand the importance of recycling and be more likely to recycle.

C. Addressing Cultural Attitudes Through Targeted Messaging

Cultural attitudes can be a significant barrier to recycling in some communities. For example, some communities may have beliefs that recycling is not necessary, or that it is too much trouble. Targeted messaging can be used to address these attitudes and encourage people to recycle. Messages can be tailored to specific communities to address cultural beliefs and highlight the importance of recycling for

the environment and the community. Governments and organizations can also partner with community leaders and influencers to promote recycling. By addressing cultural attitudes through targeted messaging, more people will be receptive to recycling and be more likely to participate.

D. Providing Economic Incentives

Economic incentives can be a powerful motivator for increasing recycling rates. Governments can offer tax credits or subsidies to businesses that recycle or use recycled materials. They can also offer cash incentives to households that recycle. These incentives can make recycling more attractive to people who may not have otherwise participated. Governments can also impose penalties for businesses and individuals who do not recycle, such as fines or increased fees for waste disposal. By providing economic incentives, more people will be motivated to recycle, which can increase recycling rates and reduce the amount of waste that ends up in landfills.

Expanding recycling infrastructure, improving education and outreach, addressing cultural attitudes through targeted messaging, and providing economic incentives are all critical solutions to barriers that hinder recycling. By implementing these solutions, governments and organizations can help increase recycling rates and reduce the environmental and economic costs of low recycling rates. By working together, we can create a more sustainable future for ourselves and future generations.

V. CONCLUSION

This study discusses the environmental and economic costs of low paper recycling rates and the importance of addressing the barriers that hinder paper recycling. These barriers include a lack of recycling infrastructure, inadequate education and outreach, cultural attitudes towards waste, and a lack of economic incentives. To address these barriers, governments and organizations can implement solutions such as expanding recycling infrastructure, improving education and outreach, addressing cultural attitudes through targeted messaging, and providing economic incentives. Examples of successful implementation of these solutions in other locations or industries are provided. The study emphasizes that addressing these barriers is crucial for increasing paper

recycling rates and reducing the environmental and economic costs of low recycling rates.

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