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Assessing the Environmental and Financial Implications of Paper Consumption in Rwanda: A Case Study of an Institution Located at Gasabo District

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Abstract

This study assessed the environmental and financial implications of paper consumption among institutions in Gasabo District, Rwanda, between 2021 and 2025 using a descriptive research design that combined quantitative and qualitative approaches. Data were collected from 392 institutions through questionnaires, institutional records, and secondary sources and analyzed using descriptive statistics. The findings revealed persistently high paper consumption, with over 74% of institutions using more than 1,000 reams annually. Institutions consuming 1,001–3,000 reams represented 46.68%–50.26% of the sample, while those consuming more than 3,000 reams increased from 23.98% in 2021 to 29.08% in 2025. Printing was the primary driver of paper use, cited by 268 respondents. Awareness of environmental and financial consequences was low, with 36.48% unaware and 25.26% only slightly aware of the impacts of excessive paper consumption. Only 27.55% of institutions had formal paper management policies, and just 25.51% practiced duplex printing. Waste management practices were inadequate, as 79.85% of institutions did not segregate paper waste and 88.78% disposed of it with general waste. Approximately 81% reported a lack of recycling facilities. Financially, 53%–55% of institutions spent over 2,000,000 RWF annually on paper procurement. A strong positive relationship (72.18%) between paper consumption and expenditure demonstrated that excessive paper use significantly increases institutional costs and environmental pressures.

Keywords: *Paper consumption, Environmental impact, financial cost, ICT, Waste management.*

1. Introduction

Paper consumption in institutions presents significant environmental and economic challenges at global, regional, and national levels. Globally, paper and cardboard production exceeds 400 million tonnes annually and is a major contributor to environmental degradation, accounting for nearly 2% of global industrial carbon emissions (World Bank, 2018; WWF, 2020). In addition, paper waste constitutes about 17% of municipal solid

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waste worldwide, yet recycling remains uneven, with rates reaching 60–70% in developed countries but remaining below 10% in many developing regions (UNEP, 2018). Despite the availability of digital technologies, many institutions continue to rely heavily on printed materials due to limited ICT infrastructure and resistance to digital transformation.

In Sub-Saharan Africa, rapid urbanization and weak waste management systems exacerbate the problem. The region produces about 174 million tonnes of solid waste annually, with paper contributing approximately 13% of urban waste (Kaza et al., 2018; African Union, 2019). Universities and institutions still depend heavily on printed materials, further increasing paper demand and waste generation.

In Rwanda, the challenge is also evident. Kigali generates between 350 and 500 tonnes of solid waste daily, with estimates showing rapid growth due to urban expansion. Around 10 tonnes of paper waste are produced daily in Kigali alone (REMA, 2021). Nationally, Rwanda generates about 1.5 million tonnes of solid waste annually, of which roughly 6% (about 90,000 tonnes) is paper and cardboard (REMA, 2022; GIZ, 2023). Institutional printing and documentation practices significantly contribute to this waste while also increasing financial burdens on users.

Although Rwanda depends heavily on imported paper products (MINICOM, 2021), recycling initiatives by companies such as SORWAL and COPED Rwanda Industries Ltd support recovery efforts. However, limited capacity, weak waste segregation systems, and low public awareness hinder effective recycling. In Gasabo District, institutions rely on paper supplied by companies such as Nyungwe Paper, Salama Industries Ltd, Roba Industries, and GMC Holdings Rwanda Ltd, which increases both environmental pressure and institutional costs. Therefore, there is a clear need to assess the environmental and financial impacts of paper consumption to promote sustainable, cost-effective, and environmentally responsible institutional practices aligned with SDG 12 and SDG 13.

1.2 Objectives of the Research

1.2.1 General objective

The general objective of the study is to assess the environmental and financial implications associated with writing paper consumption in institutions located in Gasabo District between 2021 and 2025.

1.2.2. Specific objectives

(i) To analyze the level of writing paper consumption in institutions in Gasabo District between 2021 and 2025.
(ii) To evaluate the environmental impacts and financial costs associated with paper consumption in institutions located in Gasabo District.

To examine the relationship between paper consumption, environmental degradation, and institutional financial expenditure

2. Research methods

2.1 Description of the study area

The study is conducted in Gasabo District, one of the three districts that make up Kigali City, the capital of Rwanda. Located in the northern and northeastern part of Kigali, Gasabo is the largest district in the city and borders Kicukiro District to the south, Nyarugenge District to the southwest, Rwamagana District to the east, Gicumbi District to the north, and Rulindo District to the northwest (National Institute of Statistics of Rwanda [NISR],

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2022). The district combines urban, peri-urban, and rural areas and includes neighborhoods such as Remera Sector, Kimironko Sector, and Kacyiru Sector (City of Kigali, 2021). According to the Fifth Rwanda Population and Housing Census 2022, Gasabo District has a population of about 879,505 residents, making it the most populous district in Kigali and in the country (NISR, 2022).

Gasabo District is a major administrative, economic, and educational center that hosts numerous government ministries, public institutions, private companies, and educational establishments (City of Kigali, 2021). These institutions rely heavily on paper for daily activities such as printing, documentation, record keeping, and academic work, resulting in significant paper consumption (United Nations Environment Programme [UNEP], 2019). Because of the high concentration of institutions and administrative activities, the district provides an appropriate setting for examining both the environmental implications, including paper waste generation and resource use, and the financial implications, such as institutional expenditures on paper procurement and printing services (World Bank, 2020).

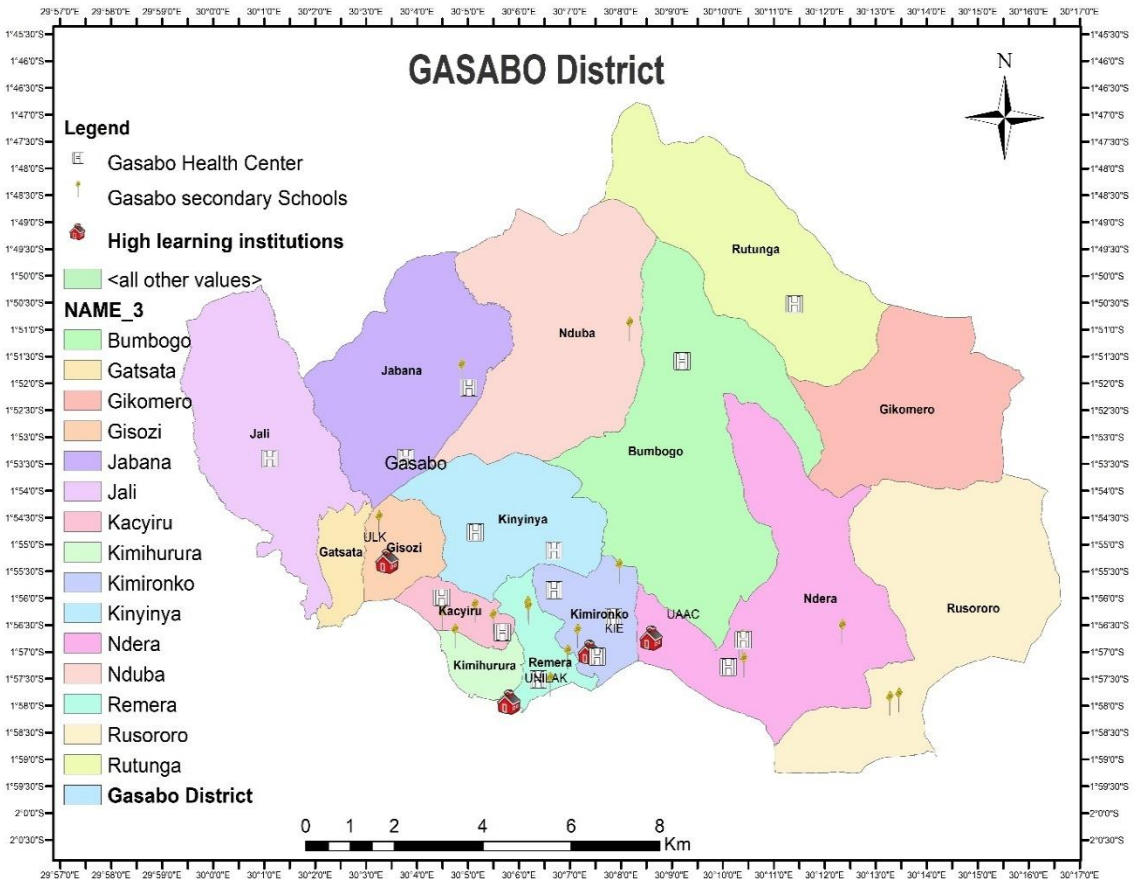

Figure 1: Map showing the study area (Gasabo district)

Source: Researcher mapping in Arc GIS 10.8, 2026

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2.2. Research design and data collection methods

This study adopted a mixed-methods research design to examine the environmental and financial implications of paper consumption in Gasabo District from 2021 to 2025. A research design is a structured plan for collecting, analyzing, and interpreting data (Grinnell, 2010). The mixed approach combined quantitative and qualitative methods to ensure comprehensive analysis. Quantitative data focused on measurable indicators such as paper volume, frequency of use, and financial costs, while qualitative data explored institutional practices, perceptions, and ICT adoption through interviews and field observations. The integration of both methods enhanced triangulation and improved validity and depth of findings.

The study population comprised 19,337 institutions in Gasabo District, including 118 public institutions, 19,067 private institutions, and 152 NGOs (NISR, 2020). From this population, a sample size of 392 institutions was determined using Taro Yamane's formula (1967) at a 5% margin of error and 95% confidence level. One respondent was selected per institution to ensure representation of institutional perspectives.

Stratified random sampling was used to ensure proportional representation of public, private, and educational institutions. Purposive sampling was applied to select key informants such as administrative staff, procurement officers, finance personnel, and ICT managers with relevant experience in paper management and institutional operations.

Data was collected using multiple techniques. Questionnaires were administered to 380 respondents to gather quantitative data on paper consumption and costs. Semi-structured interviews with 12 key informants provided qualitative insights on practices, challenges, and environmental impacts. Documentary review (Paige, 2012; Robert, 2014) and field visits were also conducted to examine institutional records, policies, and real-life paper usage, waste management, and ICT practices.

Validity and reliability were ensured through triangulation of methods, use of standardized tools, and pretesting of instruments, which improved consistency and credibility of findings. Overall, the combination of multiple data sources enabled a reliable and integrated assessment of paper consumption, environmental impacts, and financial implications in institutions within Gasabo District.

2.3 Data analysis and processing

This study employed both qualitative and quantitative data analysis methods to examine the environmental and financial implications of paper consumption in institutions in Gasabo District. Data were analyzed using Microsoft Excel and SPSS to support coding, organization, statistical analysis, and interpretation in line with the study objectives.

Qualitative data were collected through interviews, open-ended questionnaires, and document review, and analyzed thematically. For the first objective, institutional practices such as printing behavior, document management, and awareness of paper-saving policies were examined. For the second objective, perceived environmental impacts including deforestation, waste generation, and carbon emissions were analyzed. For the third objective, narratives on institutional spending, inefficiencies, and cost-saving opportunities were interpreted and presented descriptively with quotations.

Quantitative data was collected using structured questionnaires and analyzed in SPSS after coding in Excel. Descriptive statistics such as frequencies, percentages, means, and charts

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were used. Paper consumption patterns, departmental usage, and printing frequency were analyzed for the first objective. Environmental indicators such as total paper use and estimated tree consumption were assessed for the second objective. Financial data on procurement and printing costs were analyzed and compared across institutions and years using tables and graphs.

Coding involved classifying raw data into numerical and thematic categories (Williams & Moser, 2019), while editing ensured accuracy, completeness, and consistency by correcting errors and removing incomplete responses. Tabulation organized data into tables showing paper use, environmental impacts, and financial costs for easier interpretation. Reliability was ensured through a pilot study that tested and improved research instruments. Validity was strengthened using triangulation, member checking, and expert review. Ethical considerations included informed consent, confidentiality, anonymity, voluntary participation, and secure data storage. Limitations included incomplete records, recall bias, non-response, and inconsistencies across institutions, which were addressed through triangulation, structured tools, and stratified sampling to ensure reliable results.

3. Results

Table 1: Number of reams of papers used annually per institution located at Gasabo district

Respondents' views	**500-1000**		**1001-3000**		**up to 3000**	
Year	Nbr of respondent	%	Nbr of respondent	%	Nbr of respondent	%
2021	101	25.77	197	50.26	94	23.98
2022	97	24.74	187	47.70	108	27.55
2023	96	24.49	193	49.23	103	26.28
2024	98	25.00	189	48.21	105	26.79
2025	95	24.23	183	46.68	114	29.08

Source: Primary data, 2026

The findings indicate that a significant proportion of institutions consistently fall within higher paper consumption categories during the period 2021to 2025. The 1001 to 3000 reams category emerges as the dominant group, accounting for approximately 46 to 50% of institutions annually, thereby underscoring the entrenched reliance on paper-based operations. The 500to 1000 reams category remains relatively stable at 24 to 26%, while the highest consumption group demonstrates a gradual increase, reaching 29.08% in 2025.

Collectively, more than 70% of institutions consume in excess of 1000 reams per year, confirming that paper usage remains structurally high. From an ecological standpoint, given that a single tree yields approximately 16 to 20 reams of paper, institutions within the 1001 to 3000 reams category require an estimated 50 to 188 trees annually per institution. This level of consumption places substantial pressure on forest ecosystems, contributing to

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deforestation and biodiversity loss.

These findings highlight the urgent need for institutions to integrate sustainability frameworks such as the circular economy, green procurement policies, and digital transformation strategies. By reducing reliance on paper, adopting electronic documentation systems, and implementing resource efficiency measures, institutions can mitigate environmental impacts while aligning with global commitments to sustainable development goals.

3.2.1 The main purposes of paper use in institutions that contribute to the overuse of paper

The respondents were allowed to select more than one option when identifying the main purposes of paper use in their institutions. This was intended to capture the diverse and overlapping activities that contribute to paper consumption. As a result, the percentages presented in Table 3 exceed 100%, reflecting multiple responses from participants.

Table 2:The main purposes of paper use in institutions that contribute to the overuse of paper.

Respondents' views	Printing documents		Reports & proposals		Administrative use	
Year	Nbr of respondent	%	Nbr of respondent	%	Nbr of respondent	%
2021	213	54.34	81	20.66	128	32.65
2022	189	48.21	87	22.19	97	24.74
2023	313	79.85	90	22.96	125	31.89
2024	287	73.21	76	19.39	89	22.70
2025	198	50.51	61	15.56	64	16.33

Source: Primary data, 2026

The findings in table 3 indicate that the main purposes of paper use in institutions that contribute to the overuse of paper reveal that printing documents is the leading driver across all years. The findings indicate that in 2021, printing accounted for 54.34% of responses, slightly declining to 48.21% in 2022, before sharply increasing to a peak of 79.85% in 2023. It then decreased to 73.21% in 2024 and further dropped to 50.51% in 2025.

3.2.2Monitoring and Controlling Paper Use in Institutions

Table 3: Monitoring and Controlling Paper Use in Institutions.

Respondents' views	YES		NO	
Year	Nbr of respondent	%	Nbr of respondent	%
2021	215	54.85	177	45.15

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2022	219	55.87	173	44.13
2023	251	64.03	141	35.97
2024	254	64.80	138	35.20
2025	265	67.60	127	32.40

Source: Primary data, 2026

The findings show a gradual improvement in the monitoring and control of paper use in institutions over the five-year period. In 2021, only 54.85% of respondents confirmed the presence of monitoring mechanisms, with a relatively high 45.15% indicating the absence of such controls. This situation remained nearly unchanged in 2022, suggesting that, at the beginning of the study period, a significant proportion of institutions lacked effective systems to regulate paper consumption. However, from 2023 onwards, there is a noticeable increase in monitoring efforts, rising to 64.03% in 2023, 64.80% in 2024, and reaching 67.60% in 2025. This positive trend indicates that more institutions are becoming aware of the importance of tracking and managing paper use, likely influenced by cost concerns and growing environmental awareness.

3.2.3 The extent of awareness regarding the environmental impacts of paper consumption and its financial implications.

Table 4: The extent of awareness regarding the environmental impacts of paper consumption and its financial implications.

Respondents' views	YES		NO	
Year	Nbr of respondent	%	Nbr of respondent	%
2021	165	42.09	227	57.91
2022	176	44.90	216	55.10
2023	179	45.66	213	54.34
2024	186	47.45	206	52.55
2025	192	48.98	200	51.02

Source: Primary data, 2026

The findings in table 5 indicates a gradual but steady increase in the proportion of respondents who answered "YES," rising from 42.09% in 2021 to 48.98% in 2025. At the same time, "NO" responses decreased from 57.91% to 51.02%. Despite this positive trend, the majority of respondents throughout the period still fall within the "NO" category, although the gap between the two groups is narrowing over time. This suggests that awareness of the environmental impacts of paper consumption and its financial implications is improving, but at a slower pace rather than through a rapid shift. The incremental rise each year reflects a consistent, albeit moderate, growth in understanding among respondents.

Table 5: Existence of institutional policy on printing and paper use

Response	Frequency (n)	Percentage (%)

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Yes	197	50.26
No	195	49.74
Total	392	**100**

Source: Primary data, 2026

With reference to the study objective of evaluating the environmental impacts and financial costs associated with paper consumption in institutions located in Gasabo District, the findings in Table 6 reveal that 50.26% of respondents reported the existence of institutional policies on printing and paper use, while 49.74% indicated the absence of such policies.

This nearly equal distribution suggests that institutional commitment to regulating paper consumption is moderate and not yet fully established across all institutions. The slight majority of institutions with policies indicates some level of awareness and effort toward controlling paper use, which may contribute to reducing environmental degradation and minimizing operational costs. However, the almost equal proportion of institutions without such policies highlights a significant gap that could lead to continued excessive paper consumption, increased environmental impact, and higher financial expenditure.

Therefore, in relation to the study objective, the findings imply that while progress has been made in introducing policies to manage paper use, the lack of widespread adoption limits the overall effectiveness of efforts aimed at reducing environmental and financial burdens associated with paper consumption. Strengthening and expanding policy implementation across institutions would be essential for achieving more significant and measurable outcomes.

Table 6: Institution encourages the use of digital alternatives instead of paper.

Respondents' views	**always**		**Sometimes**		**Rarely**	
Year	Nbr of respondent	%	Nbr of respondent	%	Nbr of respondent	%
2021	67	17.09	231	58.93	94	23.98
2022	96	24.49	212	54.08	84	21.43
2023	73	18.62	241	61.48	78	19.90
2024	79	20.15	238	60.71	75	19.13
2025	78	19.90	249	63.52	65	16.58

Source: Primary data, 2026

The data indicates that many respondents consistently selected "Sometimes" when asked whether their institution encourages the use of digital alternatives instead of paper. This category remains dominant across all years, increasing slightly from 58.93% in 2021 to 63.52% in 2025. In contrast, the proportion of respondents who answered "Always" shows some fluctuation, rising from 17.09% in 2021 to a peak of 24.49% in 2022, before

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stabilizing around 20% in subsequent years. Meanwhile, "Rarely" responses gradually declined from 23.98% in 2021 to 16.58% in 2025. Overall, the trend suggests a moderate improvement in institutional encouragement toward digital alternatives, though not yet at a strong or consistent level.

3.2.4 Adoption of duplex printing practices for environmental conservation and cost efficiency

The adoption of duplex printing practices has become an important strategy in institutions seeking to promote environmental conservation and improve cost efficiency. By enabling the automatic printing of documents on both sides of a sheet of paper, duplex printing significantly reduces paper consumption, which in turn helps to minimize deforestation, lower waste generation, and decrease the overall environmental footprint associated with printing activities. In addition, this practice contributes to cost savings by reducing expenditure on paper and storage requirements. As organizations increasingly prioritize sustainable operations, duplex printing serves as a practical and effective measure that supports both environmental responsibility and efficient resource management.

Table 7: Employees are encouraged to adopt double-sided (duplex) printing practices for environmental conservation and cost efficiency.

Respondents' views	YES		NO	
Year	Nbr of respondent	%	Nbr of respondent	%
2021	179	45.66	213	54.34
2022	163	41.58	229	58.42
2023	187	47.70	205	52.30
2024	191	48.72	201	51.28
2025	186	47.45	206	52.55

Source: Primary data, 2026

The data shows that, across the five-year period, a larger proportion of respondents consistently answered "NO" when asked whether employees are encouraged to use double-sided (duplex) printing. In 2021, 45.66% reported "YES" compared to 54.34% "NO," and this gap widened in 2022, where "YES" responses dropped to 41.58%. Although there is a gradual improvement from 2023 to 2024, with "YES" responses increasing to 47.70% and 48.72% respectively, the trend slightly declines again in 2025 to 47.45%. Overall, the results indicate that encouragement of duplex printing remains below the majority threshold, with "NO" responses consistently exceeding 50%, suggesting limited institutional emphasis on this practice.

Table 8: Institutions collects paper waste separately for recycling purposes.

Respondents' views	YES		NO	
Year	Nbr of respondent	%	Nbr of respondent	%

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2021	62	15.82	330	84.18
2022	51	13.01	341	86.99
2023	67	17.09	325	82.91
2024	69	17.60	323	82.40
2025	68	17.35	324	82.65

Source: Primary data, 2026

The data indicates that a very small proportion of respondents reported "YES" when asked whether their institution collects paper waste separately for recycling purposes. In 2021, only 15.82% confirmed the practice, and this declined further to 13.01% in 2022. Although there is a slight improvement from 2023 to 2025, with "YES" responses rising to around 17%, the overall percentage remains low. Meanwhile, the majority of respondents consistently above 80% across all years indicated "NO," suggesting that most institutions do not practice or are not aware of segregate paper waste collection for recycling. This trend reflects minimal progress over time and highlights a persistent gap in institutional waste management practices.

From the perspective of the Theory of Solid Waste Management Hierarchy, which prioritizes waste management strategies in the order of reduce, reuse, recycle, recovery, and disposal, these findings are concerning. Recycling is a key component of this hierarchy, positioned above disposal and essential for minimizing environmental impact. The low level of paper waste segregation suggests that institutions are not effectively implementing even the mid-level strategies of the hierarchy, likely defaulting to disposal instead. This not only contributes to environmental degradation through increased landfill use and resource wastage but also results in missed financial opportunities associated with recycling and resource recovery. To align with the hierarchy, institutions should strengthen policies on waste segregation, provide appropriate infrastructure such as labeled recycling bins, and raise awareness among employees. Promoting paper recycling alongside reduction strategies (like digital alternatives) would significantly enhance environmental sustainability and improve cost efficiency.

Table 9: Institution partners with recycling companies for the proper collection and management of paper waste.

Respondents' views	**YES**		**NO**	
Year	**Nbr of respondent**	**%**	**Nbr of respondent**	**%**
2021	71	18.11	321	81.89
2022	71	18.11	321	81.89
2023	69	17.60	323	82.40
2024	69	17.60	323	82.40
2025	68	17.35	324	82.65

Source: Primary data, 2026

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The result in table 10 shows that a consistently small proportion of respondents indicated "YES" when asked whether their institution partners with recycling companies for paper waste. In 2021 and 2022, only 18.11% reported having such partnerships, and this figure slightly declined to 17.35% by 2025. Meanwhile, the majority of respondents over 80% across all years answered "NO," indicating that most institutions do not engage in partnerships with recycling companies. The trend remains largely stagnant, with minimal variation over time, suggesting that there has been little progress in establishing collaborations for paper waste recycling.

3.2.5 The challenges faced in managing paper waste

Table 10:The challenges faced in managing paper waste

Respondents' views	Lack of recycling facilities		Costs of recycling		space limits	
Year	Nbr of respondent	%	Nbr of respondent	%	Nbr of respondent	%
2021	321	81.89	30	7.65	41	10.46
2022	321	81.89	32	8.16	39	9.95
2023	323	82.40	29	7.40	40	10.20
2024	323	82.40	26	6.63	43	10.97
2025	324	82.65	36	9.18	32	8.16

Source: Primary data, 2026

The result in table 12 clearly shows that the lack of recycling facilities is the most significant challenge faced in managing paper waste, consistently reported by over 81% of respondents across all years (from 81.89% in 2021 to 82.65% in 2025). This dominance indicates a persistent structural barrier, with little to no improvement over time. In comparison, costs of recycling and space limitations are relatively minor concerns, each accounting for less than 11% of responses annually. While the cost factor fluctuates slightly rising to 9.18% in 2025 it remains secondary. Similarly, space constraints show minor variation but do not represent a major obstacle. Overall, the findings emphasize that infrastructural limitations, rather than financial or spatial issues, are the primary constraint

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in effective paper waste management.

3.2.6 Total annual expenditure on paper procurement

Table 11:Total annual expenditure on paper procurement

Respondents' views	>1,000,000 frw		1,500,000 to 2,000,000 frw		<2,000,000	
Year	Nbr of respondent	%	Nbr of respondent	%	Nbr of respondent	%
2021	50	12.76	127	32.40	215	54.85
2022	49	12.50	132	33.67	211	53.83
2023	47	11.99	136	34.69	209	53.32
2024	35	8.93	141	35.97	216	55.10
2025	41	10.46	139	35.46	212	54.08

Source: Primary data, 2026

The result finding on annual expenditure on paper procurement from 2021 to 2025 shows that the majority of respondents consistently fall within the highest spending category (above 2,000,000 RWF), accounting for approximately 53% to 55% each year. The proportion of respondents in the middle category (1,500,000–2,000,000 RWF) has gradually increased over time, while those in the lowest expenditure group (below 1,000,000 RWF) remain the smallest and generally decline. This trend indicates that paper-related costs are not only high but also slightly increasing, suggesting a continued reliance on paper despite potential alternatives.

3.2.7 The barriers to reduce paper use

Table 12: The barriers to reduce paper use

Respondents' views	Lack of technology		Cost of digital tools		No policy support	
Year	Nbr of respondent	%	Nbr of respondent	%	Nbr of respondent	%
2021	175	44.64	94	23.98	123	31.38
2022	179	45.66	85	21.68	128	32.65
2023	175	44.64	88	22.45	129	32.91
2024	173	44.13	91	23.21	128	32.65

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2025	169	43.11	94	23.98	129	32.91

Source: Primary data, 2026

The results in Table 13 indicate a clear and consistent pattern in the barriers to reducing paper use in institutions from 2021 to 2025. The dominance of lack of technology (about 43% to 46%) is particularly significant because it remains the highest barrier across all years, even though it shows a slight decline. This persistence suggests that improvements in digital infrastructure have been limited or uneven, making it the most critical constraint to paper reduction efforts.

The gradual increase and stabilization of lack of policy support (around 32% to 33%) is also significant, as it highlights a structural weakness in institutional and governmental frameworks. This implies that even where technology may be available, the absence of strong policies continues to hinder full adoption of paperless systems.

In contrast, the relatively lower and stable proportion of cost of digital tools (21% to 24%) is significant in a different way it shows that cost is not the primary barrier and is becoming less influential compared to technology and policy-related challenges. This suggests that affordability is less of an issue than access, infrastructure, and regulatory support.

Overall, the significance of these findings lies in the consistent ranking of barriers over time, which emphasizes that addressing technological capacity and strengthening policy frameworks would have the greatest impact on reducing paper dependence in institutions.

3.2.8 Strategies for Reducing Paper Consumption

The findings of this study revealed that **100% of respondents strongly agreed** that implementing digital transformation strategies can significantly reduce paper consumption and the associated operational costs. This unanimous response highlights the growing awareness among institutional stakeholders regarding the importance of adopting sustainable and technology-driven solutions to address excessive paper usage. The recommended strategies identified in this study include the adoption of electronic document management systems (EDMS), increased utilization of cloud storage platforms, promotion of electronic communication (such as emails and digital memos), and the enforcement of institutional policies that encourage duplex printing and controlled printing practices.

3.3 Relationship Between Paper Consumption and Financial Implications

3.3.1 Environmental Implications of Paper Consumption in Gasabo District

The findings from Table 2 demonstrate that paper consumption among institutions in Gasabo District remained consistently high throughout the period 2021 to 2025, with more than 70% of institutions consuming above 1,000 reams annually. Specifically, institutions consuming between 1,001 and 3,000 reams represented the largest category, accounting for between 46.68% and 50.26% of respondents annually. At the same time, institutions consuming above 3,000 reams increased from 23.98% in 2021 to 29.08% in 2025, indicating a worsening trend in paper dependency.

These consumption levels have major environmental implications. Globally, it is estimated that one mature tree produces approximately 16 to 20 reams of paper. Based on this estimate, institutions consuming between 1,001 and 3,000 reams annually require approximately 50 to 188 trees per institution every year. Furthermore, institutions consuming above 3,000 reams may require more than 188 trees annually. Considering that

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nearly 75% of institutions fall within these high-consumption categories, the cumulative pressure on forest resources is substantial.

The gradual increase in the highest paper consumption category from 23.98% in 2021 to 29.08% in 2025 suggests increasing demand for paper resources, which contributes directly to:

- Deforestation and forest degradation;
- Loss of biodiversity and wildlife habitats;
- Increased greenhouse gas emissions associated with paper production;
- High energy and water consumption during manufacturing processes;
- Increased paper waste generation and landfill accumulation.

The environmental burden becomes even more significant when combined with weak waste management practices observed in the study. Since 79.85% of institutions do not segregate paper waste and 88.78% dispose paper together with general waste, the majority of used paper ends up in landfills instead of recycling streams. This reduces opportunities for resource recovery and reinforces unsustainable consumption patterns.

The findings therefore indicate that institutional paper consumption in Gasabo District poses a serious environmental sustainability challenge. Without intervention, continued reliance on paper-based systems may intensify pressure on natural forests and undermine national and global environmental conservation efforts.

3.3.2 Financial Implications of Paper Consumption

The findings from Table 12 reveal that institutions incur substantial and recurring costs related to paper procurement. Throughout the study period, the majority of respondents consistently belonged to the highest expenditure category (above 2,000,000 RWF annually), representing between 53.32% and 55.10% of institutions.

Specifically:

- In 2021, 215 institutions (54.85%) spent above 2,000,000 RWF;
- In 2022, 211 institutions (53.83%) spent above 2,000,000 RWF;
- In 2023, 209 institutions (53.32%) spent above 2,000,000 RWF;
- In 2024, 216 institutions (55.10%) spent above 2,000,000 RWF;
- In 2025, 212 institutions (54.08%) spent above 2,000,000 RWF.

At the same time, the proportion of institutions spending between 1,500,000 and 2,000,000 RWF increased gradually from 32.40% in 2021 to 35.46% in 2025. In contrast, the lowest expenditure group (below 1,000,000 RWF) declined from 12.76% to 10.46% over the same period.

These findings indicate that paper procurement represents a significant operational expense for institutions. The continued increase in expenditure reflects:

- Rising demand for printing and documentation services;
- Dependence on manual and paper-based administrative systems;
- Limited adoption of digital technologies;

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- Weak implementation of paper-saving policies.

The financial implications extend beyond direct procurement costs. Excessive paper consumption also increases:

- Printing and photocopying costs;
- Maintenance costs for printers and copiers;
- Storage and archiving expenses;
- Waste management and disposal costs;
- Administrative inefficiencies associated with handling physical documents.

Moreover, only 17.86% of institutions had implemented cost-saving strategies related to paper use, while 82.14% lacked such measures. Similarly, more than half of the institutions (53.32%) did not maintain records of printing costs, indicating weak financial monitoring and resource management practices.

3.3.3 Relationship Between Paper Consumption and Financial Implications

The study findings demonstrate a direct positive relationship between paper consumption and financial expenditure. Institutions with higher paper consumption levels are also associated with higher annual procurement expenditures.

The findings from Table 2 and Table 12 indicate a strong positive relationship between paper consumption and annual expenditure on paper procurement among institutions in Gasabo District. As the number of reams consumed increases, the amount spent on paper procurement also increases proportionally.

Table 13: Comparative Analysis of Consumption and Expenditure

Year	Institutions consuming above 1000 reams (%)	Institutions spending above 2,000,000 RWF (%)	Relationship Ratio
2021	74.24%	54.85%	73.88%
2022	75.25%	53.83%	71.53%
2023	75.51%	53.32%	70.62%
2024	75.00%	55.10%	73.47%
2025	75.76%	54.08%	71.39%
Average High Consumption	75.15%		
Average High Expenditure		54.24%	
Overall Relationship			72.18%

Source: Primary data, 2026

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The relationship between paper consumption and expenditure can be expressed using percentage comparison:

Relationship Ratio = (High Expenditure Institutions (%) / High Consumption Institutions (%)) × 100

3.3.3.1 Average Relationship Over the Study Period

Average High Consumption = (74.24 + 75.25 + 75.51 + 75.00 + 75.76) / 5 = 75.15%

Average High Expenditure = (54.85 + 53.83 + 53.32 + 55.10 + 54.08) / 5 = 54.24%

Overall Relationship = (54.24 / 75.15) × 100 = 72.18%

Therefore, the overall relationship between high paper consumption and high expenditure is approximately 72.18%. This demonstrates a strong positive association between the volume of paper consumed and the financial burden incurred by institutions.

3.3.3.2 Interpretation of the Relationship

The calculated relationship confirms that institutions with excessive paper consumption are highly likely to incur substantial procurement expenditures. This relationship has two major implications:

1. **Environmental implication:**

Increased paper consumption leads to greater demand for paper production, resulting in deforestation, biodiversity loss, increased waste generation, and higher carbon emissions associated with manufacturing and disposal.

2. **Financial implication:**

Higher paper consumption directly increases institutional operational costs through procurement, printing, storage, maintenance, and waste management expenses. Institutions that fail to adopt digital systems continue to experience recurring financial burdens.

The findings therefore suggest that reducing paper consumption through digital transformation, duplex printing, recycling programs, and paper-saving policies would simultaneously reduce environmental degradation and institutional expenditure.

Table 14: The relationship can be interpreted as follows

Indicator	Observation	Implication
High paper consumption	Over 70% consume above 1,000 reams annually	Increased pressure on institutional budgets
High procurement expenditure	Over 53% spend above 2,000,000 RWF annually	Significant recurring operational costs
Weak digital adoption	Majority rarely or never encourage digital alternatives	Continued financial dependence on paper
Poor waste management	79.85% do not segregate paper waste	Increased disposal and environmental management costs
Limited cost-saving strategies	82.14% lack paper-saving measures	Inefficient resource utilization

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3.4 Discussion

3.4.1 Analysis of Writing Paper Consumption (2021 to 2025) in institutions located at Gasabo district.

The findings of this study reveal persistently high levels of writing paper consumption across institutions in Gasabo District over the period from 2021 to 2025. Printing activities clearly dominate all other forms of paper use, confirming that routine operational processes are the primary drivers of consumption. The fluctuations observed across the years suggest that although some efforts toward digitalization may have been introduced, these initiatives have not yet significantly reduced reliance on paper-based systems. This pattern is consistent with the findings of Sellen and Harper (2002), who argue that despite the availability of digital technologies, paper remains central to organizational work due to its flexibility, ease of annotation, portability, and reliability. In many institutional contexts, paper continues to serve as a trusted medium for documentation and communication, particularly where digital systems are not fully integrated or standardized.

The noticeable increase in paper consumption in 2023 and 2024 may be attributed to heightened administrative and academic activities requiring printed documentation. This trend reinforces the argument by Molla and Cooper (2014), who note that institutional reliance on printing tends to increase during periods of organizational expansion, policy implementation, or intensified reporting requirements. Such conditions often lead to increased documentation, thereby driving higher paper consumption.

Although reports, proposals, and administrative functions contribute to paper usage, they remain secondary compared to routine printing. However, the gradual decline in administrative paper use toward 2025 suggests the early stages of digital transformation in some institutions. This observation aligns with Gupta (2018), who found that the implementation of digital record management systems can significantly reduce paper usage in administrative processes.

Overall, the findings indicate that paper consumption is largely operational rather than strategic. It is driven more by habitual practices and routine processes than by essential documentation needs. This highlights a critical gap in institutional efficiency and resource management. To address this issue, there is a need for targeted interventions, including the promotion of digital documentation systems, adoption of paperless communication, and enforcement of print management policies. Without such measures, paper consumption is likely to remain high despite technological advancements.

3.4.2 Environmental Impacts and Financial Costs of Paper Consumption

The study demonstrates that excessive paper consumption has significant environmental and financial implications for institutions. From an environmental perspective, the findings indicate that the current level of paper usage is unsustainable. On average, one ream of paper generates approximately 2.5 to 3 kilograms of CO_2 emissions. Institutions consuming between 1001 and 3000 reams annually therefore contribute approximately 2.5 to 9 metric tons of CO_2 emissions per year. These emissions play a direct role in climate change and environmental degradation.

In addition to carbon emissions, high paper consumption contributes to deforestation, as trees are the primary raw material in paper production. This not only reduces forest cover but also disrupts ecosystems and biodiversity. Furthermore, excessive paper usage results in increased solid waste generation. In contexts where recycling systems are weak or

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underdeveloped, much of this waste ends up in landfills, contributing to pollution and environmental health risks.

The environmental burden is further intensified by the resource-intensive nature of paper production, which requires significant amounts of water and energy. These processes increase the overall ecological footprint of institutions. These findings are consistent with the United Nations Environment Programme (UNEP, 2020), which emphasizes that paper-based processes significantly contribute to environmental degradation through deforestation, energy consumption, and waste generation.

From a financial perspective, the study reveals that high paper consumption leads to increased operational costs. Institutions incur continuous expenses related to paper procurement, printing, storage, and waste management. These recurring costs reduce the availability of financial resources that could otherwise be invested in more productive areas such as technology, innovation, and service delivery.

This observation is supported by Deloitte (2016), which reports that paper-intensive processes significantly increase administrative and operational costs. Similarly, Laudon and Laudon (2020) argue that digital systems enhance efficiency while reducing costs by minimizing reliance on physical documents. In addition, excessive paper usage generates hidden costs, including environmental compliance costs and waste management expenses, which may increase over time.

The findings therefore clearly demonstrate that current paper consumption patterns are both environmentally and economically unsustainable. This underscores the urgent need for institutions to adopt digital alternatives, strengthen recycling systems, and implement effective paper reduction strategies. By doing so, institutions can achieve both environmental conservation and cost efficiency.

3.4.3 Relationship Between Paper Consumption, Environmental Degradation, and Financial Expenditure

The study establishes a strong and direct relationship between paper consumption, environmental degradation, and institutional financial expenditure. Institutions with high levels of paper usage tend to experience increased operational costs and greater environmental impact, while those adopting digital practices demonstrate improved efficiency and sustainability.

One of the key findings is the lack of effective monitoring systems in many institutions. A significant proportion of institutions do not track paper usage, leading to uncontrolled printing, duplication of documents, and inefficient resource utilization. This finding supports Murugesan (2008), who argues that the absence of monitoring and control mechanisms results in resource wastage and undermines sustainability efforts.

The lack of monitoring not only increases paper consumption but also contributes to environmental degradation through higher demand for paper production. This, in turn, leads to deforestation and increased greenhouse gas emissions. According to FAO (2021), unsustainable paper consumption is a major contributor to global forest loss and environmental stress. Similarly, UNEP (2020) highlights that inefficient resource management exacerbates environmental challenges such as waste generation and carbon emissions.

The study also reveals that environmental awareness among institutional staff is gradually

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improving, but remains insufficient to drive significant behavioral change. This aligns with the Theory of Planned Behavior proposed by Ajzen (1991), which suggests that awareness alone does not necessarily lead to action. Behavioral change is also influenced by social norms, perceived control, and institutional support. Kollmuss and Agyeman (2002) further emphasize that the relationship between knowledge and behavior is complex and often slow to evolve.

Policy gaps represent another critical factor influencing the relationship between paper consumption and its impacts. The near balance between institutions with and without formal paper-use policies indicates weak implementation and communication of sustainability guidelines. Porter and van der Linde (1995) argue that well-designed environmental policies can improve both environmental performance and economic efficiency. However, in their absence, institutions are likely to continue inefficient and unsustainable practices.

Furthermore, the limited adoption of digital technologies and inadequate infrastructure hinder the transition to paperless systems. This finding is consistent with Venkatesh et al. (2003), who highlight that technology adoption depends on facilitating conditions such as infrastructure and organizational support. Bharadwaj et al. (2013) also emphasize that digital transformation requires strong technological capabilities and institutional readiness.

The study also identifies weak recycling systems and limited partnerships with recycling companies as significant barriers to sustainable paper management. Without proper recycling infrastructure, institutions are unable to recover or reuse paper waste, leading to increased environmental impact. This reflects a broader failure to adopt circular economy principles, as highlighted by Geissdoerfer et al. (2017), who emphasizes the importance of recycling and resource efficiency in sustainable systems.

The findings of this study demonstrate a clear and interconnected relationship between paper consumption, environmental sustainability, and financial performance. High levels of paper consumption led to increased environmental degradation through carbon emissions, deforestation, and waste generation. At the same time, they result in higher operational costs, reducing institutional efficiency and competitiveness.

Conversely, reducing paper consumption through digital transformation offers a dual benefit: minimizing environmental impact while improving financial performance. Strategies such as the adoption of Electronic Document Management Systems (EDMS), cloud computing, electronic communication, and print control policies have been identified as effective solutions.

These findings are supported by Westerman et al. (2014), who emphasize that digital transformation enhances efficiency and reduces operational costs. Similarly, Davenport (2013) highlights the role of EDMS in reducing paper use and improving workflow efficiency, while UNEP (2019) underscores the importance of digital solutions in promoting environmental sustainability.

4. Conclusion

This study assessed the environmental and financial implications of paper consumption in institutions in Gasabo District from 2021 to 2025. Findings show that paper use remains high due to continued reliance on printed documents for administrative, academic, and operational activities, despite limited adoption of digital tools such as electronic document systems and duplex printing. Excessive paper consumption contributes to environmental

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impacts, including waste generation, deforestation pressure, and carbon emissions, while weak recycling and poor waste management worsen the situation. Financially, institutions incur high costs for procurement, printing, storage, and waste handling. The study found a strong link between high paper use, environmental degradation, and increased expenditure. It concludes that promoting ICT integration, strengthening paper reduction policies, improving recycling systems, and raising awareness are essential for reducing costs and enhancing environmental sustainability in institutions..

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