

Analysis of the paper consumption in a university context: The case of the André Salifou University in Zinder

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Abstract

This research analyzes the financial, logistical, and environmental implications of scriptural dependence at the André Salifou University (UAS) in Zinder, Niger. Adopting a quantitative approach, this study combines documentary inventories, mobile surveys via Kobo Toolbox with 5 school services and 22 departments, as well as prospective modeling.

For the reference year 2023, with 10,655 students, consumption amounted to 17,000 reams (85,000,000 XOF), 60.15% of which were absorbed by academic evaluations. The Faculty of Letters and Human Sciences (FLSH) alone accounts for 83.6% of this pedagogical demand. The results highlight a critical organizational vulnerability: 82% of departments experience stock-outs causing "operational blockades" that paralyze exams. In addition, the lack of sorting generates 25.5 tons of waste annually, exacerbating the unsanitary university environment, while the administrative premises are facing a pathogenic saturation of the physical archives. Finally, the modelling for 2050 demonstrates the unsustainability of the status quo, projecting an expenditure of 1,354,690,000 XOF and the sacrifice of 11,515 trees. These findings underline the urgency of a gradual digital transition and information governance adapted to African realities.

Keywords: Paper Consumption; Digital Transition; Operational Blockade; Ecological Footprint; UAS

1. Introduction

Historically, paper is one of the greatest vectors for the dissemination of human knowledge [1]. However, on a global scale, the paper industry is now raising important scientific debates about its ecological and economic footprint. This sector consumes immense forest and water resources, while generating significant quantities of greenhouse gases and polluting chemical compounds [2-4]. Faced with these global environmental challenges, industrialized countries have begun a transition to paperless administrative models [5-6].

Developing countries, particularly those in West Africa, are experiencing the opposite dynamic. Higher education institutions in this region are facing a rapid massification of their student population [7], which mechanically increases their material dependence on paper [8-9]. In this context, dematerialization appears to be a promising alternative for reconciling the management of information flows and sustainability. Major work carried out in comparable university spaces in West Africa, in particular at the Cheikh Anta Diop University of Dakar (UCAD), underlines the crucial but

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complex importance of the digital transition to preserve administrative memory while reducing material vulnerability [10]. Similarly, the literature puts into perspective the need for a change management dynamic, which is essential for the transition to digital to become a real vector of organizational efficiency [11].

It is precisely at the intersection of these global challenges and these ambitions for modernization that higher education in Niger is situated. Over the last two decades, the latter has undergone significant structural changes, marked by the creation of regional public universities [12]. Among these institutions, the André Salifou University (UAS) of Zinder occupies a strategic place. As a training institution, its daily operation is still based on almost exclusively physical document flows. From the drawing of the exam papers to the registration forms, including the final dissertations and the school archives, paper is omnipresent.

This material dependence raises critical issues for the Zinder UAS, whether financial, logistical or environmental. On the one hand, the supply of paper represents a heavy budgetary burden for this public institution with limited resources, exacerbated by regional logistical constraints that regularly expose it to critical stock-outs that can hinder the academic calendar. On the other hand, the accumulation and deficient management of paper residues in the university environment poses a growing health and sanitation challenge. Therefore, the general objective of this study is to analyze the financial, logistical, and environmental implications of scriptural dependence within UAS.

To meet this objective, this research is structured around four fundamental questions:

- How much paper does UAS consume annually?
- What are the different structural uses that are made of it within the academic and administrative services?
- What is the direct financial cost of this consumption on the university's budget?
- What is the local environmental and health impact generated by these physical flows and their residues?

2. Material and methods

2.1. Scope of the study

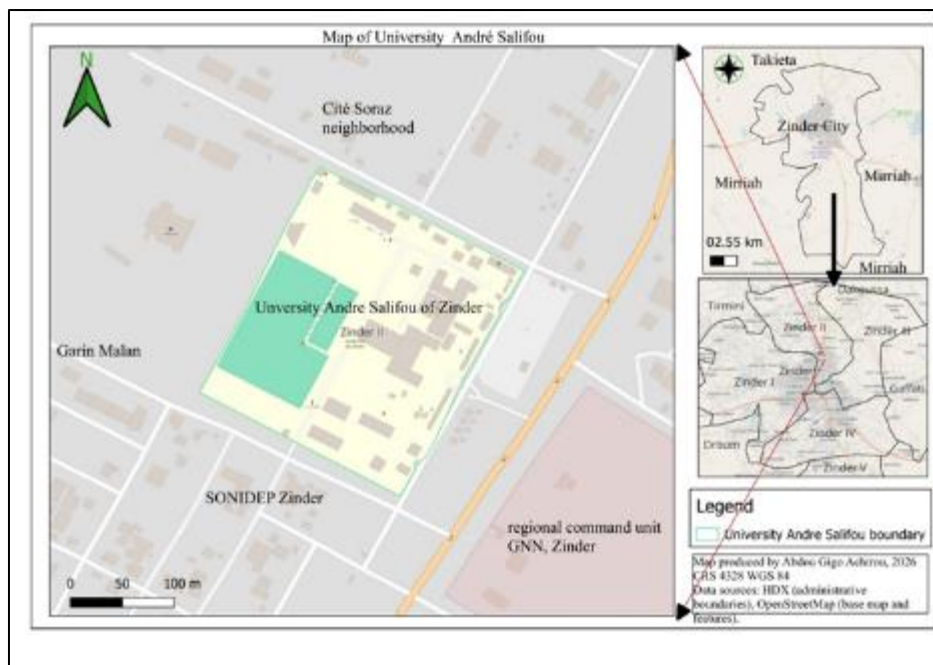


Figure 1 Presentation of the study area

The André Salifou University of Zinder (UAS) covers an area of 25 hectares in the third district of the urban commune of Zinder (Niger). Originally created in the form of a University Institute of Technology (IUT) in 2006, it was established as a full-fledged University by Ordinance No. 2010-042 of July 1, 2010 on the IUT site, which was created on August 9, 2006 by Law No. 2006-031. It is now composed of four faculties and an institute: the Faculty of Letters and Human Sciences (FLSH), the Faculty of Health Sciences (FSS), the Faculty of Science and Technology (FST), the Faculty of

Educational Sciences (FSE), as well as the IUT. During the reference academic year (2023), the UAS welcomed a total of 10,586 students regularly enrolled. The cartographic delimitation and geographical location of this study area are summarized in Figure 1.

2.2. Materials

To carry out this study, equipment was used, namely:

- Several hardware and software tools were used to carry out this study: Android smartphone: Used in the field by the investigators as mobile data entry terminals.
- Open Data Kit (ODK) / *KoboToolbox*: Mobile data collection solutions selected for the configuration, deployment and digital synchronization of questionnaires.

2.3. Methods

2.3.1. Documentary review

The examination of registration files, pedagogical models and purchase inventories made it possible to extract the number of students by level of study, by department and by faculty, as well as to estimate the volumes of purchases of writing consumables made by the institution's Central Interior General Affairs Service.

2.3.2. Field survey via questionnaire

Conducted between November and December 2023, this survey exhaustively targeted the heads of the system's key services. In total, the questionnaires were administered via the Kobo toolbox digital platform to 5 heads of academic services (IUT, FST, FSS, FSE, FLSH) and the directors or heads of the 22 academic departments of the UAS. This system made it possible to assess the frequency of supply disruptions, waste management methods, the degree of awareness of managers and their willingness to adopt digital tools.

2.3.3. Calculation of the theoretical consumption

The minimum unit (p) ratio of paper consumption per student per paper is set at 6 single A4 sheets (including 1 sheet for the exam subject, 2 sheets for the exam paper, 1 sheet for the divider and 2 sheets for the draft).

For each university component (Faculty or Institute), characterized by a number of enrolled students (E) and a total number of modules subject to evaluation (M), the theoretical overall consumption (expressed in number of sheets) is modelled by the following equation:

$$: \text{global consumption (sheets)} = E \times M \times \text{Ratiop}$$

In order to compare these results with the physical data of the establishment's stock management, this overall quantity is converted into units of standardized ream blocks of 500 sheets ($V_{\text{component}}$):

$$: \text{Consumption (reams blocks)} = \left(\frac{E \times M \times \text{Ratiop}}{500} \right)$$

2.3.4. Parameters of the prospective simulation (2023-2050)

To account for the financial challenges of long-term sustainable development, a simulation of the paper consumption trajectory has been developed from 2023 to 2050. This projection is based on the following mathematical assumptions:

- An Average Annual Growth Rate of Student Enrolment (CAGR) of **10.80%**, calculated from the actual evolution of enrolments at the André Salifou University of Zinder between the academic years 2017/2018 and 2022/2023. This rate was obtained using the formula:

$$: TCAM : \left(\frac{Vf}{Vi} \right)^{\frac{1}{n}} - 1 = \left(\frac{10655}{6382} \right)^{\frac{1}{5}} - 1 = 0,1080$$

Or 0,108= 10,80%

where V_f represents the final number, V_i the initial number and n the number of years of evolution. Applying this formula to the number of students at the André Salifou University of Zinder, which increased from 6,382 students in 2017/2018 to 10,655 students in 2022/2023, the rate obtained is: **10.80%**

- An average unit purchase cost is estimated at **5000 XOF** per block of standard reams of paper.
- The consistency of the ratio of individual paper consumption per student measured in the reference year 2023.

The geometric projection formula used to estimate the number of students in year (n) is:

$$: E_n = E_{2023} \times (1 + r)^{n-2023}$$

Where E_{2023} represents the initial enrolment of 10,655 students regularly enrolled in the reference year. On the basis of this demographic projection, the annual volume of reams of paper required V_n is determined by multiplying the projected number of reams by the utilization factor per student C_u , which amounts to 1.59 reams per student per year, according to the following formula:

$$: V_n = E_n \times C_u$$

The financial translation of this physical volume is reflected in the calculation of the projected annual financial cost F_n , expressed in CFA francs, obtained by the following equation:

$$: F_n = V_n \times 5000$$

Finally, to highlight the challenges of environmental protection and sustainable development, the model includes an ecological impact indicator corresponding to the cumulative number of trees destroyed to support the institution's scriptural consumption. In accordance with the international environmental standards of the American government [13], which estimate that one ton of conventional paper requires the felling of 17 adult trees... and since a standard 500-sheet A4 ream block of paper weighs exactly 2.5 kilograms (or 400 reams per ton), the ecological conversion coefficient has been set at 0.0425 trees per ream block of paper. The equation for the cumulative life cycle balance since the reference year is as follows:

$$: A_{cumul} = 0,0425 \sum_{i=2023}^n V_i$$

3. Results

3.1. Physical balance of paper consumption at UAS in 2023

During the reference academic year 2023, for a total actual enrolment of 10,655 students enrolled in the institution, the total volume of paper made available by the Central Internal Service of General Affairs (SCIAG) amounted to 17,000 blocks of standardised A4 reams.

3.2. Distribution of paper consumption by type of use

The SCIAG delivers the equivalent of 17,000 blocks of reams to the faculties and IUTs. The analysis of document flows highlights two main types of uses of paper resources within the André Salifou University of Zinder: academic use (evaluations) and administrative use. Figure 2 illustrates the distribution of consumption by type of use.

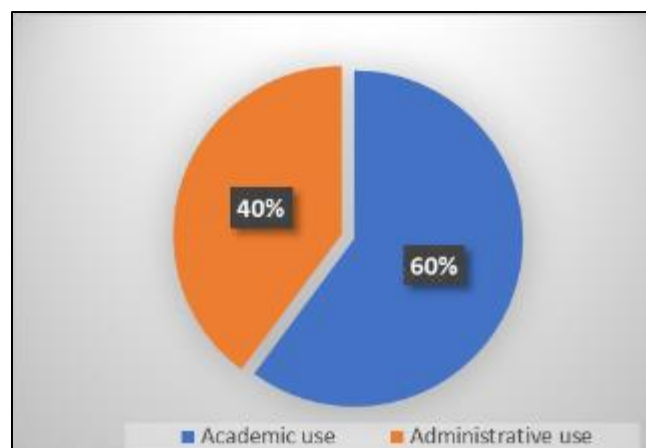


Figure 2 Distribution by type of use

The examination reveals that the actual academic need amounts to 10,225.5 blocks of reams, which represents 60% of the overall volume allocated to pedagogical activities (printing of exam subjects, duplicate, divider and draft composition papers). The remaining 40% (i.e. 6,774.5 reams) are absorbed by the day-to-day running of the administrative services (official letters, activity reports, physical registration registers, minutes of deliberations, transcripts and school records).

3.3. Distribution of Paper Consumption by Component

The detailed assessment of the theoretical pedagogical needs (10,225.5 reams) highlights a strong asymmetry between the different components of the UAS (Figure N°3)

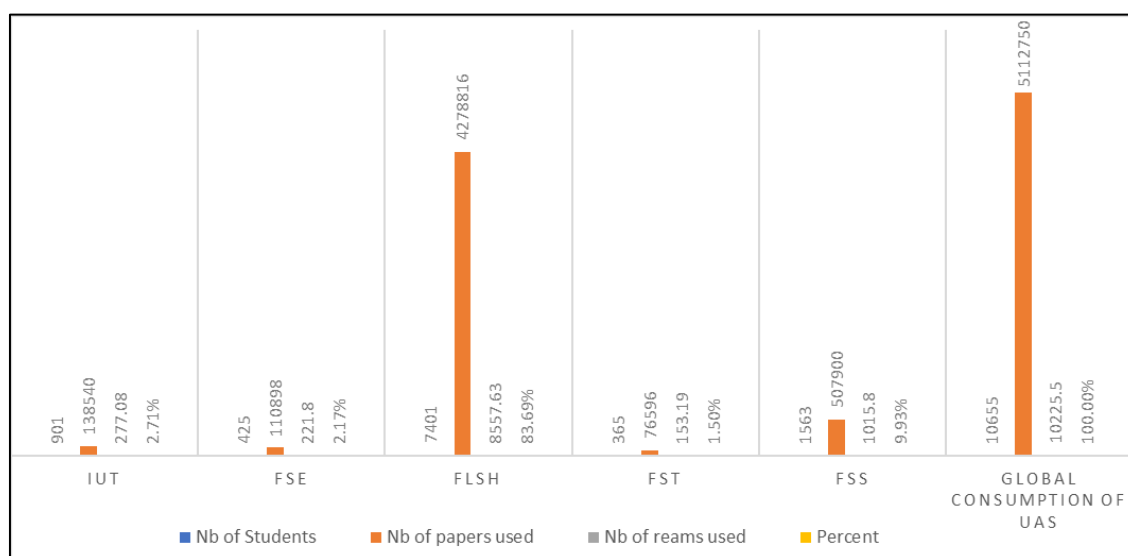


Figure 3 Distribution of paper consumption by component at UAS in 2023

The consumption of paper is logically proportional to the number of students in the faculties. Thus, the FLSH, with 70% of the workforce, consumes 83.6% of the papers. While the FSE consumes 2.1% with 5% of the workforce.

3.4. Immediate financial stakes and the phenomenon of "operational blockades"

The acquisition on the local market of the physical volume of 17,000 blocks of A4 reams of paper for the year 2023 generated a direct financial burden estimated at 85,000,000 XOF, based on an average cost of 5,000 XOF per unit. This amount highlights the high economic cost of using paper within the institution.

Beyond the financial costs, the material dependence on paper media induces a systemic fragility in the continuity of the public education service. Field surveys reveal that 82% of UAS's academic departments experienced at least two major episodes of total paper stock-outs during the 2023 academic year.

These supply disruptions, dictated by budget constraints or delivery delays, instantly paralyze the school and departmental secretariats. This phenomenon of "operational blockade" regularly forces the decanal authorities to postpone exam sessions, to postpone the posting of deliberation minutes or to suspend the delivery of critical academic acts (registration certificates, transcripts), directly penalizing the university career and the professional integration of students.

3.5. Paper waste, archival challenges and unsanitary conditions on campus

The post-utility analysis of the 42.5 tons of paper consumed annually (corresponding to 17,000 reams with a unit weight of 2.5 kg) highlights a two-dimensional environmental management crisis, torn between the pollution of outdoor spaces and the pathogenic saturation of administrative premises.

3.5.1. Paper waste and unsanitary conditions on campus

Field measurements indicate that approximately 15% of printing paper is initially wasted in the form of "bad prints", technical defects in reprography or leftover blank copies. Adding obsolete drafts and proofs, the total mass of paper waste generated amounts to 25.5 tons per year (or 2.13 tons per month).

The lack of selective sorting systems, combined with the fact that 80% of users do not use the available bins, causes the uncontrolled dumping of about 1.70 tons of paper per month in the university space. Dispersed by the winds, these residues accumulate in courtyards, at the foot of trees and along physical fences, generating chronic insalubrity and a profound degradation of the landscape quality of the university environment.

3.5.2. Saturation and health risks associated with physical archiving

At the same time, an annual flow of 17 tons of official documents (exam papers, registers, administrative reports) is directed to the university's archive spaces. Although the mandatory legal retention period is set at 5 years for evaluation copies (and not specified for other documents), academic structures keep them indefinitely due to the lack of regulatory de-archiving procedures, causing a critical saturation of the built areas.

This anarchic and non-hermetic piling exposes the documents to bad weather (rain, dust) and accelerates the degradation of the cellulosic fibers, altering the quality of the indoor air. In addition, these piles of paper constitute biotopes favourable to the proliferation of rodents (rats) and venomous reptiles (snakes), posing an immediate risk of insecurity and public health for administrative staff.

3.6. Perception of the digital transition by department managers

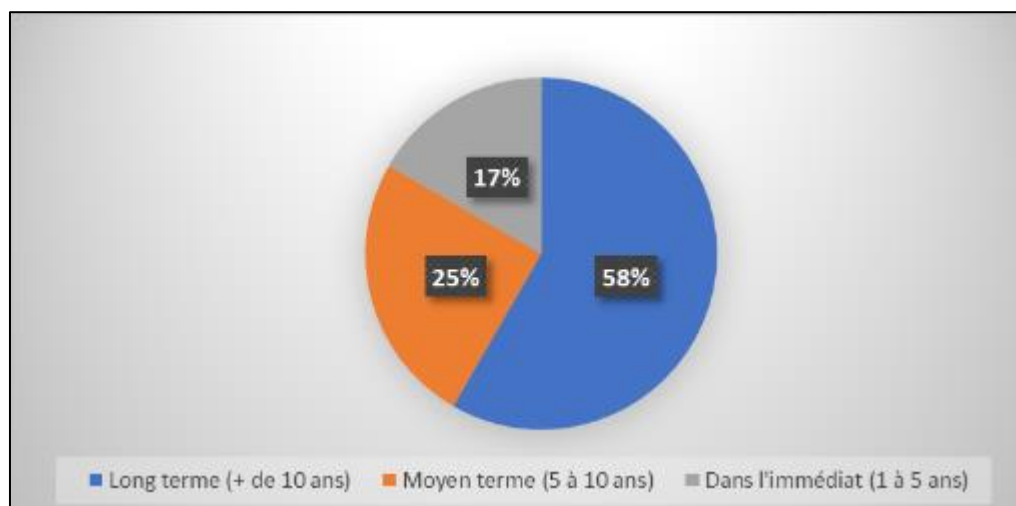


Figure 4 Transition time to zero paper at UAS

The survey conducted among the heads of services and departments on paper management at UAS made it possible to assess the time perception necessary to make a complete switch to dematerialized processes. (See Figure 4)

The data in Figure 4 shows that a majority of the managers surveyed (more than 50%) say they are in favor of and ready to move to a "paperless" policy. However, they stress the need for a reasonable and planned transition over time, broken down into the short term (1 to 5 years for pre-computerised processes such as registration), the medium term (5 to 10 years for administrative engineering) and the long term (more than 10 years) for the most dependent structures.

3.7. Prospective simulation of consumption trends (2023-2050)

In order to quantify the level of sustainability of the current physical management model, a prospective simulation was implemented over the period 2023-2050. The model is based on a geometric projection of the student demography of Zinder's UAS, characterized by a historical Average Annual Growth Rate (CAGR) of 10.80% (Equation₃). The financial projections are based on a constant cost of the ream of paper at 5,000 XOF, while the ecological projections apply the standard impact coefficient of 0.0425 trees destroyed per ream of A4 paper consumed.

According to the calculations, by 2050, the student population of the UAS will reach the critical enrolment of 170,401 students. Under the assumption of a constancy of traditional pedagogical practices (maintenance of the individual historical consumption ratio), the volume of paper required will amount to 270938 blocks of reams per year, inducing an annual budget expenditure of 1,354,690,000 XOF for the acquisition of this resource alone.

On the environmental front, the analysis of the ecological balance sheet shows that the trajectory of the "all-paper" will require the total and irreversible destruction of 11,515 mature trees to cover the institution's scriptural needs, contradicting the commitments of sustainable development and deforestation mitigation. Table 1 provides information on the prospective trajectory of demographic, financial and ecological indicators.

Table 1 Prospective trajectory of demographic, financial and ecological indicators at UAS (2023-2050)

Year (n)	Student Enrolment	Paper volume (Vn in block of reams/year)	Annual financial cost (Fn in XOF)	Ecological impact (No. of trees)
2023	10655	17000	85000000	723
2030	21713	34524	172620000	1467
2040	60446	96109	480545000	4085
2050	170401	270938	1354690000	11515

4. Discussions

The analysis of scriptural management at the André Salifou University highlights the contradictory dynamics that characterize higher education institutions in the digital age, torn between a rapid massification of their staff and the inertia of traditional documentary practices [8-9]. In this respect, an examination of the macro-functional distribution of flows revealing that academic use alone absorbs 60.15% (10,225.5 reams) of the overall allocation compared to 39.85% (6,774.5 reams) for the central and decanal administration shows a strong structural dependence of evaluation engineering on the physical medium. Moving down the component level, the absolute predominance of the Faculty of Letters and Human Sciences (FLSH) which concentrates 70% of the student population and captures 83.6% of the volume of theoretical academic paper reflects the direct impact of this demographic massification on traditional evaluation methods. This phenomenon is mainly explained by the prevalence of tests of a writing nature (essays, commentaries on documents, textual analyses) requiring long scriptural developments and a multiplication of dividers. Conversely, the marginal share of the Faculty of Education Sciences (FSE), which requires only 2.1% of the resource for a demographic weight representing 5% of the total number of students at the university, or that of the IUT, illustrates the existence of a marked disciplinary asymmetry. This disparity confirms the observations of the Latin American literature, which emphasize that humanities departments maintain a strong culture of material support compared to technological and scientific courses, the latter being more prone to adopt more concise or partially computerized methods of evaluation [14].

Beyond these sectoral disparities, this exclusive material dependence on paper exposes the UAS to a deep systemic fragility that the concept of "operational blockade" makes it possible to theorize. Indeed, the fact that 82% of academic

departments experienced at least two episodes of total paper stock shortages during the reference year demonstrates that traditional supply channels, constrained by centralized ordering procedures and local market fluctuations, are unsuited to the real pace of academic flows. In line with the theoretical framework set by similar West African studies, notably at the Cheikh Anta Diop University (UCAD) in Dakar, these results illustrate how the precariousness of a physical infrastructure can instantly paralyze academic activities [10]. Paper shortages are not just a logistical hazard; It leads to a break in the continuity of the public service by forcing the postponement of exam sessions and blocking the delivery of academic acts (certificates of achievement, transcripts). This detrimental situation artificially lengthens students' careers and delays their integration into the job market, transforming a material constraint into a social and professional problem.

In parallel with these operational disruptions, the macroeconomic impact of this model is particularly heavy, since the direct financial burden of 85,000,000 XOF borne in 2023 for the purchase of 17,000 reams reveals a high opportunity cost for an African public university. The allocation of such budgetary resources to disposable consumables necessarily comes at the expense of long-term structural investments in information technology. In addition, the comparison of this initial assessment with the results of the prospective modelling for 2050, which projects a critical annual budget of 1,354,690,000 XOF under the effect of an average annual growth rate of 10.80 XOF, highlights the absolute financial unsustainability of the status quo. This linear consumption model leads to a budgetary impasse which, in the long term, could force the institution either to drastically ration educational evaluation tools, or to cut other essential budget items, such as the renewal of laboratory equipment or the development of network infrastructures.

In addition to these economic constraints, the analysis of the ecological externality of the paper resource highlights a two-dimensional environmental crisis, which goes far beyond the sole issue of deforestation to be anchored in the daily health and aesthetics of the campus. On the one hand, the uncontrolled monthly discharge of about 1.70 tons of paper residues (bad impressions, abandoned drafts) on the university grounds testifies to the absence of a culture of office waste management. Dispersed by the combined action of the winds and the lack of civic-mindedness of users (80% not using the bins), this waste permanently degrades the landscape quality of the university ecosystem. While some authors rightly point out that dematerialization does not eliminate the ecological footprint but moves it to data centers [6,15], the local environmental emergency in Zinder remains of a plastic and health nature. Empirical data here suggest the theoretical relevance of concepts from the circular economy: the valorization of this local cellulosic biomass (by grinding and mechanical compression into alternative heating briquettes) would transform a visible vector of insalubrity into a substitute energy opportunity, indirectly mitigating the local pressure on traditional firewood.

On the other hand, this dynamic of unsanitary exterior is compounded, indoors, by an annual accumulation of 17 tons of administrative documents and evaluation copies, which highlights a clear failure in the management of the life cycle of documents (*records management*). The indefinite storage of these documents, fueled by the lack of knowledge of the Administrative Useful Periods (DUA) even though the legal period for the mandatory retention of exam papers is set at 5 years, can be analyzed as a passive strategy of overcrowding rather than as a rational archiving policy [16]. As the literature on repository saturation demonstrates, the absence of a regulatory retention schedule condemns workspaces to critical saturation [17]. At the UAS, this situation creates real safety and public health risks: non-hermetic piles, exposed to rainwater infiltration and abrasive dust, alter the quality of the indoor air through the proliferation of mould. In addition, they are ideal biotopes for the development of pests and venomous reptiles, directly threatening the safety of administrative staff within their offices.

Faced with the extent of these material, logistical and health constraints, the survey conducted via KoboToolbox fortunately reveals a favorable social acceptability factor, since more than 50% of department managers say they are ready to engage in a digital transition. This positive receptivity is a major strategic asset for the institution. It will be fully in line with the total quality management approaches developed in archival science, where the success of an organizational restructuring depends on the direct involvement and co-construction of tools by their end users [16]. However, the stakeholders interviewed lucidly underline the need for a gradual and segmented approach over time, articulated around three strategic horizons: the short term (1 to 5 years) for the dematerialization of pre-computerized flows (such as online registration), the medium term (5 to 10 years) for more complex administrative engineering (career management, minutes of deliberations), and finally the long term (more than 10 years) for the most dependent terminal educational structures (physical examinations of the large numbers of FLSH students).

This progressive empirical planning is in line with recent warnings, which demonstrate that hasty digitization without rigorous application of archival principles is limited to transferring physical disorder to virtual digital chaos [18]. To preserve the probative value, integrity and long-term accessibility of data in the face of the challenge of software and hardware obsolescence [20], UAS cannot do without true information governance [20]. Ultimately, the implementation of this transition requires the methodical application of the change management model [11]. In the absence of a

comprehensive support programmed (continuous training in collaborative tools, reinforcement of the network infrastructure and securing of backup servers) and a strong internal legal framework conferring enforceable legal value on electronic documents, dematerialization would risk leading to an under-efficient hybrid system where digital entry would be systematically coupled with a security paper printout, neutralizing the financial, logistical and ecological gains sought by the institution.

5. Conclusion

This study analyzed the systemic implications of the dependence on paper at the André Salifou University (UAS) of Zinder, in the face of the challenges of the massification of student numbers and budgetary constraints. The overall objective is to analyze the financial, logistical, and environmental implications of scriptural dependency within UAS. To do this, the methodology combined documentary inventories, field surveys digitized via Kobo Toolbox with 5 school services and 22 academic departments, as well as prospective modeling by 2050.

The main results reveal that for the reference year 2023 (10,655 students), the overall consumption amounted to 17,000 reams (85,000,000 XOF), of which 60.15% (10,225.5 reams) were absorbed by academic needs. The Faculty of Letters and Human Sciences (FLSH) alone accounts for 83.6% of this teaching load. The analysis highlights a critical operational vulnerability, characterized by "operational blockades" during stock-outs (suffered by 82% of departments), as well as a paper waste management crisis generating 25.5 tons of annual residues and pathogenic saturation of physical archive spaces.

Prospects

Finally, prospective modelling demonstrates the unsustainability of the current model by 2050, providing for an expenditure of 1,354,690,000 XOF and the ecological sacrifice of 11,515 trees.

With this in mind, the research perspectives are based on three immediate operational axes:

- The evaluation of the managerial and behavioral impact of a pilot project for the total dematerialization of assessments within the FLSH, structurally the most budget-intensive component.
- The modelling of a university Business Continuity Plan (BCP) backed by long-term electronic archiving, capitalizing on feedback from crises disrupting physical flows.
- The technical and economic analysis of a circular economy sector on campus, aiming at the transformation of unavoidable paper waste into ecological fuel briquettes.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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