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Towards Greener Accreditation: Cutting Carbon Footprint through Sustainable Digital Documentation in Higher Education

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Abstract

The present study focuses on transitioning from traditional, paper-based documentation to a fully digital approach in the preparation of the Self-Study Report (SSR) for assessment and accreditation at The Cochin College. The purpose is to minimise environmental impact by reducing paper usage, thereby aligning with global sustainability goals like SDG 12 (Responsible Consumption and Production), SDG 13 (Climate Action), and SDG 4 (Quality Education). The study identifies the environmental drawbacks of traditional SSR preparation, including high paper consumption, ink/toner use, and printer energy. To address this, the Internal Quality Assurance Cell (IQAC) implemented a digital system for SSR preparation, significantly reducing the carbon footprint. The methodology involves collection, preparation, storage and management of data electronically with the aid of systems built on popular cloud-based tools. Key findings include an estimated reduction of 149.81 kg of CO_2 emissions from paper and ink usage alone. The digital process also resulted in substantial operational benefits, such as improved document security, efficient data retrieval, and reduced physical storage needs. Moreover, the study presents a comparative analysis between Paper-based SSR and Digital SSR preparation, emphasising the efficiency gains and environmental benefits of digitalization. It serves as a model for other institutions to adopt similar paperless approaches, fostering a culture of sustainability. The study concludes that digital documentation supports sustainability and institutional efficiency, offering a model adaptable to accreditation systems nationwide.

Keywords: NAAC; ECO-SSR; Paperless SSR; Carbon footprint; Sustainability

Introduction

Higher education institutions (HEIs) in India play a vital role in shaping the nation's academic and social progress. To maintain quality and accountability they undergo regular assessments and accreditations by national agencies such as the National Assessment and Accreditation Council (NAAC), the All India Council for Technical Education (AICTE) and the National Board of Accreditation (NBA).Established in 1994 under the University Grants Commission (UGC), NAAC serves as the main body responsible for evaluating higher education institutions. To date, it has accredited over 16,000 institutions across India, covering about one-third of universities and one-fifth of colleges. Among all stages of the accreditation process, preparing the Self Study Report (SSR) is the most resource-intensive. It requires collecting and verifying large volumes of data across seven criteria and fifty-six metrics over five years. Traditionally, this task depended on printed documents, involving heavy use of paper, ink, and electricity. The process led to waste generation, data-handling delays, and the need for extensive physical storage. Adopting sustainable documentation practices has therefore become essential. Reducing paper use helps institutions cut their carbon footprint while improving efficiency and transparency. In this direction, The Cochin College in Kerala introduced the electronic Self Study Report (eCO-SSR), a fully digital system for collecting and compiling data. The initiative eliminates paper use, reduces energy consumption and supports the United Nations Sustainable Development Goals (SDGs 4, 12 and 13) by promoting quality education, responsible resource use, and climate action (United Nations, 2015).

This paper presents the environmental and operational impact of the eCO-SSR model at The Cochin College. It demonstrates how digital documentation in accreditation can advance sustainability while preserving the rigor and reliability of institutional evaluation.

Rationale of this study

The Self Study Report (SSR) is a critical document in the accreditation process of higher education institutions. It presents a detailed record of institutional performance collected over five years requiring inputs from faculty, staff, and students. The SSR typically comprises data collected across seven key criteria, viz Curricular Aspects, Teaching-Learning and Evaluation, Research, Innovations and Extension, Infrastructure and Learning Resources, Student Support and Progression, Governance, Leadership and Management Institutional Values and Best Practices each containing numerous metrics that require thorough documentation and evidence (NAAC, 2024a). The preparation of such extensive documentation demands continuous data collection, verification, and compilation, which often leads to heavy use of paper and other physical resources. Recognising the environmental and operational challenges of this system, the present study explores a digital alternative for managing SSR data. The aim is to create a model that reduces resource consumption while maintaining the quality and reliability of accreditation documentation.y shifting to a paperless process, the study demonstrates how sustainability can be embedded in academic governance and adapted to similar frameworks nationwide.

SSR Preparation: Paper-based vs eCO-SSR

The traditional paper-based method of SSR preparation involves heavy paperwork for data collection, verification, and storage. It requires printing large volumes of documents and coordinating many stakeholders, leading to delays and operational inefficiencies. The process consumes paper, ink, and electricity, generating a high carbon footprint. Physical files are difficult to store, retrieve, and safeguard, and frequent printing errors add to waste and cost. In contrast, the digital approach follows a fully paperless process that eliminates these drawbacks. Most institutions already have reliable computers and internet access, and faculty, staff, and students regularly use laptops or mobile devices. This makes digital participation simple, accessible, and low-cost. By using existing resources, the process becomes faster, more secure, and environmentally responsible. A comparison of paper-based and digital SSR preparation methods is provided in Table 1.

Table 1. Comparison of Traditional and Digital SSR Preparation Models

Aspect	Paper Based Method	Digital Method
Data Collection	Partly digital: manual entry of data into physical records	Fully digital with google forms with document upload
Data Compilation	Manual compilation involving significant paperwork	Automated through digital forms and cloud-based storage
Proof Verification	Printouts taken, signed digitally by Head of Institution	Proof's verified digitally:LaTex based system for signature
Signature Process	Physical signatures required on every document	Digital signatures used, LaTex based seal and signature added
Efficiency	Time-consuming due to paperwork and manual processes	Highly efficient; faster data processing and compilation
Environmental Impact	High paper consumption, printing storage requirements	Significantly reduced paper use; environmental-friendly
Document Access	Requires physical handling of documents	Digital access; easy sharing and version control
Cost	High cost of paper, printing and storage	Lower costs: savings on paper, ink and physical space
Workload	Heavy workload in handling physical documents	Reduced workload: centralised digital collection and storage
Security	Physical documents subjected to damage or loss	Digital documents with secure access and cloud backup

Significance of Carbon Footprint Assessment in SSR preparation

As of May 2024, NAAC has accredited 362 universities and 6,176 colleges across India, with many more in the process of accreditation (NAAC, 2024b; Press Information Bureau, 2024). These institutions also submit Annual Quality Assurance Reports (AQAR) and undergo re-accreditation at regular intervals. Despite this large-scale activity, the carbon emissions generated through the entire process have rarely been assessed. Measuring these emissions is important to understand the environmental cost of continuous documentation and evaluation. The need for sustainability education in digital environments has been increasingly recognized, particularly in the context of assessing digital carbon footprints (Martínez-Acosta et al., 2023). The Greenhouse Gas (GHG) Protocol provides a recognised method for estimating such emissions. It defines boundaries that determine which sources are included in the calculation and ensures consistent, comparable reporting (Greenhouse Gas Protocol, 2004). Clear boundaries help identify where reductions are possible and make results credible. When institutions move to a paperless SSR process, defining these boundaries becomes essential for assessing the environmental benefits of digital documentation. This study uses the GHG Protocol framework to quantify the emission savings achieved by shifting from paper-based methods to the eCO-SSR model. The analysis covers all three key dimensions outlined in the protocol—organisational, operational, and temporal boundaries.

Organisational Boundaries

The organisational boundary for a paperless SSR encompasses all operations controlled by the institution that contribute to the digital SSR process. This includes emissions from digital infrastructure such as servers, data centres, and hardware used for data collection, management, and storage. If third-party cloud services are used to store SSR data, emissions from these external data centres are also considered within the organisational boundary.

Operational Boundaries

The emissions associated with paperless SSR preparation can be classified into three operational scopes:

Scope 1: Direct emissions from on-site energy consumption, which are minimal in a paperless process due to the absence of physical printing and paper production. However, energy use from local servers or equipment used to manage digital data may fall within Scope

Scope 2: Indirect emissions from electricity consumption used by computers, servers, and digital platforms involved in the preparation and storage of the SSR. These include the energy required for running digital systems, storing data, and supporting electronic communication.

Scope 3: This scope represents the most substantial emissions reduction in a paperless SSR. It includes the avoided emissions from paper production, ink/toner use, and printer energy consumption, as well as the energy consumption of external cloud services for long-term digital storage. Additionally, upstream emissions from the manufacturing of hardware used in digital data management (e.g., computers and storage devices) are also included. Cloud storage relies on energy-intensive data centres. Though offsite, this energy use contributes to Scope 3 emissions under the GHG Protocol. Reducing file sizes through compression decreases the total data stored and thereby reduces the indirect energy demand and associated emissions.

Temporal Boundaries

The temporal boundary for assessing the carbon footprint of the eCO-SSR spans both the preparation period and the ongoing energy consumption for data storage. By tracking emissions over an annual period, institutions can assess the long-term environmental impact of maintaining digital documentation compared to traditional paper-based methods. The shift to paperless SSR preparation results in significant carbon savings, primarily from eliminating paper, ink, and printing-related emissions. By avoiding paper production and reducing waste, institutions lower their carbon footprint while enhancing operational efficiency. However, the use of cloud services introduces recurring energy consumption, which, though lower than traditional processes, must be accounted for within the Scope 3 boundary.

In this context, Scope 3 emissions are particularly crucial, as they often represent the largest portion of an organisation's total greenhouse gas emissions. Given the minimisation of Scope 1 and Scope 2 emissions, the management and calculation of Scope 3 emissions become critical to understanding the overall environmental impact of institutional practices. This study will focus on the assessment and calculation of Scope 3 emissions to ensure a comprehensive understanding of the carbon footprint associated with the paperless approach to SSR preparation. By concentrating on Scope 3 emissions, we aim to highlight the broader environmental benefits of this transition and support effective sustainability efforts within the institution.

The transition to a paperless Self Study Report (SSR) preparation not only enhances the institution's sustainability practices but also plays a crucial role in calculating Scope 3 emissions. By focusing on the various elements of the eCO-SSR process, we can effectively assess the indirect emissions that contribute to the overall carbon footprint. The study on carbon emissions at Delft University of Technology provides a framework for quantifying direct and indirect carbon emissions in higher education institutions (Herth A and Blok K 2022). The following points illustrate this connection:

Reduction in Carbon Footprint from Paper Production: By eliminating the need for paper, the institution significantly reduces the upstream emissions associated with paper manufacturing. This aligns with Scope 3 emissions, which include those resulting from the production of goods and services consumed by the organisation. The avoided emissions from no longer purchasing paper can be calculated as part of Scope 3.

Elimination of Ink/Toner Emissions: The production and use of ink and toner also contribute to Scope 3 emissions. By moving to a paperless system, the institution can effectively eliminate these indirect emissions, showcasing the impact of digital practices on reducing its carbon footprint.
Reduction in Printer Energy Usage: While printer energy consumption is often considered a direct emission (Scope 1), the broader impact of reducing the need for printed materials contributes to Scope 3 emissions. This is particularly relevant when considering the entire value chain and the energy footprint of associated printing processes.

Impact of File Compression on Cloud Storage: Digital documents stored in the cloud resources such as Google Cloud or Amazon Web Service, continue to consume energy even after uploading, as they are hosted on remote data centres that require constant electricity to power servers, cooling systems, and network infrastructure. Although the institution does not directly operate these facilities, the energy consumed in storing, transmitting, and maintaining data contributes to Scope 3 emissions — indirect emissions arising from outsourced digital services. These emissions form part of the institution's overall carbon footprint because they occur as a consequence of its digital activities.

By optimising and compressing files before uploading, the total storage volume is reduced, thereby lowering the energy demand of cloud servers and associated cooling systems. This reduction translates into measurable carbon savings, as less data means fewer bytes stored and transmitted across networks, decreasing both energy consumption and emissions over time. Hence, file compression directly contributes to reducing the Scope 3 digital carbon footprint linked to cloud-based SSR documentation.

By linking these green impact aspects to Scope 3 emissions (Huang et al., 2009), the institution can provide a comprehensive analysis of how the transition to a paperless SSR not only enhances operational efficiency but also contributes to significant reductions in indirect emissions. This approach emphasises the importance of considering Scope 3 emissions in the context of sustainability efforts and helps institutional stakeholders understand the broader environmental benefits of the eCO-SSR initiative.

Methodology

The eCO-SSR Architecture

The framework of the proposed eCO-SSR (Digital SSR preparation) is built on the process flow as represented in the flow chart (Fig. 1). The academic entities - Faculty, HOD, Students, Management, College Office are given access to a digital noticeboard (Fig.2.) implemented in Google Docs, where they can refer to the queries by the IQAC of the college. The data is collected electronically via Google Forms, whose links will be pasted alongside the queries in the Noticeboard (Fig.3.), by which the documents can be uploaded in digital formats, eliminating the need for physical paper proofs. The verification of these digital proofs is done by the IQAC team using the Google Forms' associated response sheet. If there is no further action needed, the data is accepted by the IQAC. But if there is any further requirement, the entity concerned will be informed. These events will be notified on the Noticeboard itself after verification under each query. The data compilation step involves parsing the collected data to the required format for SSR using Google Cloud Tools as it enables the IQAC team to edit the same document, resulting in congruence between the versions by utilising version history feature for tracking changes.

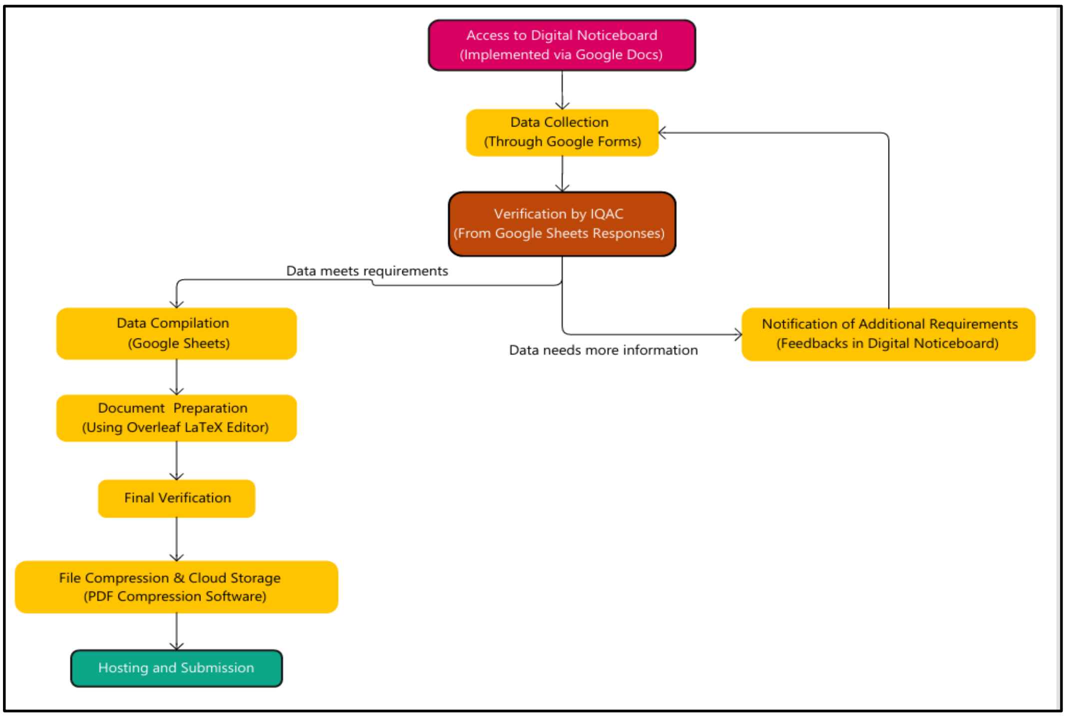

Fig. 1. *Flow chart indicating the Digital SSR preparation workflow.*

The next step is documentation wherein a technical team works online on the compiled data to make it into required documents for SSR upload using Cloud-Based LaTeX editor (Overleaf) (Fig.4. The documents are imprinted with the college seal, and necessary signatures. Subsequently after a secondary verification step, the documents are compressed and digitally signed by the Principal. The final step is hosting the proofs online so that the weblinks of the documents can be used in the SSR submission portal. The status of each file is updated and monitored at each stage in eCO-SSR portal.

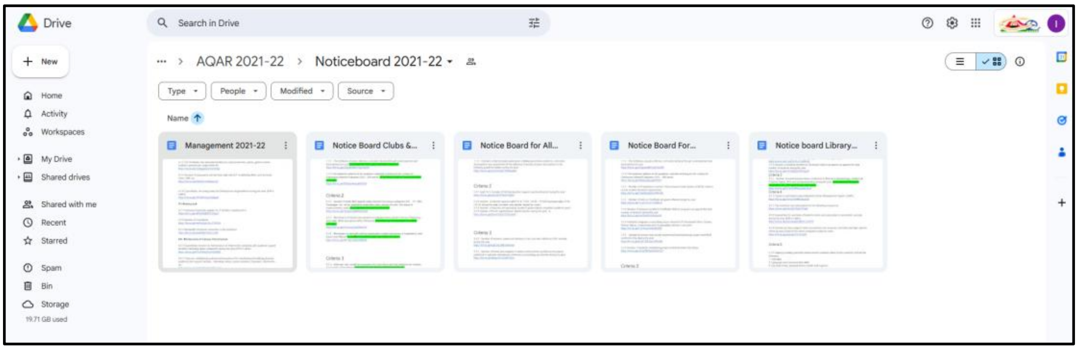

Fig. 2. Google Drive Structure for Digital Noticeboard -The screenshot displays the organised Google Drive folder structure used as the digital noticeboard. Google doc for each committee contain shared documents, links, and updates, allowing faculty to access and upload information instantly.

The carbon footprint calculation of Paper-based and eCO-SSR methods

The advantage of switching to eCO-SSR can be evaluated by the quantitative measurement and comparison of carbon footprint of Physical SSR preparation with that of the Digital SSR preparation method. The carbon footprint of Physical SSR preparation involves three aspects to be accounted for: Paper Usage (E_{PU}), Ink/Toner Usage (E_{IT}), and Printer Energy Usage (E_{PE}). Whereas for a Digital SSR preparation, the only parameter to be accounted for is the Annual Cloud Storage Energy Usage ($E_{Digital}$) (Kiehle et al., 2023). The carbon footprint emissions are expressed as the mass of CO_2 represented in kg, generated via each process, which is detailed as follows:

For conventional SSR (Paper-based)

Carbon Footprint due to Paper Usage: The emission factor (F_{PU}) of 5 grams of CO_2 per A4 sheet is widely referenced in studies of paper manufacturing emissions (Environmental Paper Network 2018). It is calculated as per the formula given below

$$E_{PU} = \textit{Number of Sheets} \times F_{PU}$$

Carbon footprint due to Ink/Toner Usage : Ink and toner manufacturing typically emit 0.5 to 1 gram of CO_2 per printed sheet, depending on toner coverage and type (Ducoulombier F 2021; Environmental Paper Network 2018). The calculation of this factor is as follows

$$E_{IT} = Number\ of\ Sheets \times F_{IT}$$

Where F_{IT} is the Emission Factor for Ink/Toner

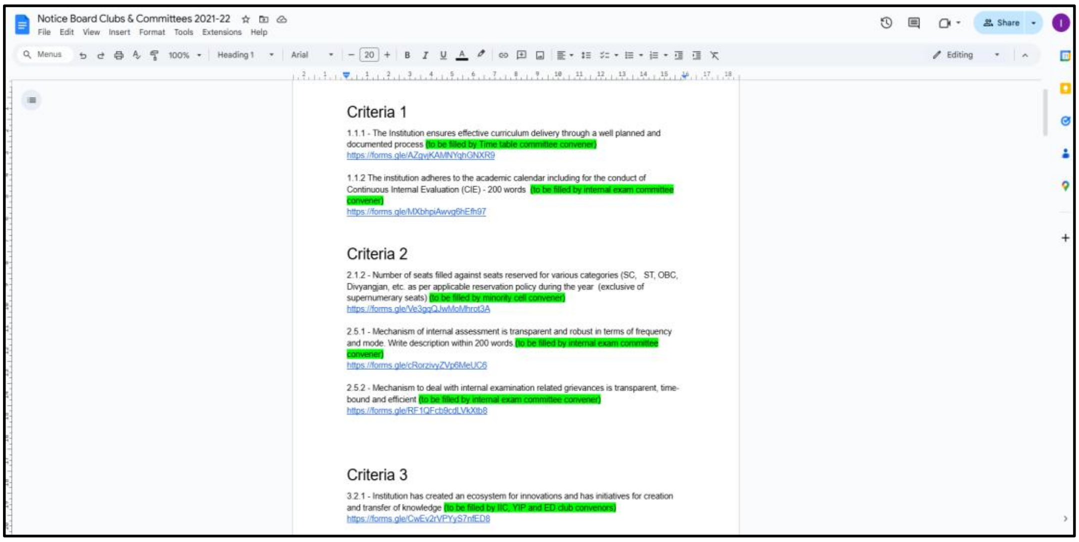

Fig. 3. Digital Noticeboard of Clubs and Committees - The screenshot shows the cloud-based digital noticeboard used for communicating NAAC-related updates to department/Club conveners. Each criterion includes hyperlinks to Google Forms.

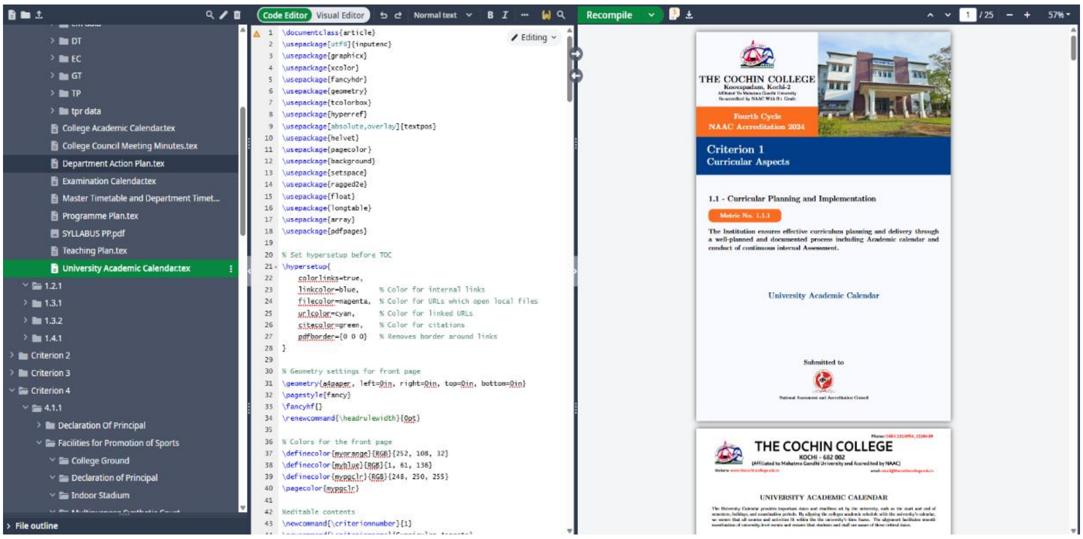

Fig. 4. Digital SSR Template Developed Using LaTeX - The screenshot shows the LaTeX-based digital Self Study Report (SSR) template created for Criterion 1. The left panel displays the source code organised into structured .tex files, while the right panel shows the compiled PDF output with institutional branding and metric-wise formatting.

Carbon footprint from Printer Energy Usage : Laser printers have an average energy consumption rate ($0.04 \times 10^{-2} kWh\ per\ page$) that aligns with typical office settings. The emission factor can vary, and sources such as the Environmental Protection Agency (EPA) or UK Carbon Trust provide standardised factors (HP Inc. 2023; Carbon Trust 2025; United States Environmental Protection Agency 2024). Thus the footprint of printer energy is calculated as follows

$$E_{PE} = Number\ of\ Sheets \times Energy\ Consumption\ per\ page \times F_{PE}$$

Where F_{PE} is the emission factor of printer energy usage.

The total carbon emission footprint from printing resources (E_{Print}) is $E_{Print} = E_{PE} + E_{IT} + E_{PU}$

For Digital SSR (Paperless)

Annual Cloud Storage Energy Usage (E_{CS})

Energy consumption for cloud storage (F_{CS}=0.0315 kWh/MB per year) can be found in studies by the Lawrence Berkeley National Laboratory and European Commission reports on data centre energy efficiency which offers solid baselines for cloud storage (Lawrence Berkeley National Laboratory 2016; European Commission 2018).

$$E_{Digital} = File\ Size \times Annual\ Energy\ Consumption\ per\ MB \times F_{CS}$$

The carbon footprint emission from Paper-based and eCO-SSR methods are then compared by calculating the $Time\ factor = \frac{E_{Print}}{E_{Digital}}$ which is expressed in years. A Time Factor of 1 implies the time required by the digital data in cloud storage to generate an equal amount of Carbon Footprint of that of a Paper-based data. To consider the eCO-SSR as a beneficial alternative to the Paper-based method in the benchmark of Carbon Footprint, the Time Factor should be greater than 1 year. The impact of file compression on the carbon footprint emission of the Digital method is also evaluated in the light of Time Factor.

Results and Discussion

The table below provides a detailed breakdown of the number of pages and the file sizes before and after compression across various criteria. Each criterion represents a different aspect of institutional evaluation, such as curricular aspects, teaching-learning, research, student support, governance, and best practices. The table outlines the digital data related to 26,373 pages, categorised across various institutional evaluation criteria. These pages, though not printed, underwent significant file compression without information loss, reducing the total file size from 5880 MB to 736.67 MB.

Table 2. Breakdown of the number of pages and the file sizes before and after compression

Criterion	Pages	Size before compression (MB)	Size after compression (MB)
Curricular Aspects	11,710	1589.80	257.52
Teaching- Learning and Evaluation	2,293	396.23	89.04
Research Innovations and Extension	1,455	567.05	94.17
Infrastructure and Learning Resources	996	659.7	60.97
Student Support and Progression	3,948	1508.50	126.92
Governance, Leadership and Management	3,707	735.9	108.1
Institutional Values and Best Practices	1,463	444.7	72.7
Total	26,373	5904.88	809.42

Carbon footprint from Paper-based SSR method

From Table 3, total carbon emission footprint from printing resources can be calculated and is found to be, E_{Print} =149.76 kg. This calculation is based on the ideal condition wherein the appreciable paper wastages that are common in Paper-based SSR preparation are not factored in.

Table 3. Estimated carbon footprint emission in Paper-based SSR

Category	Estimated emission of CO_2 per printing resource and energy for an A4 sheet (g)	Carbon footprint emission for 26,373 sheets (kg)
Paper production	5	131.87
Ink/Toner production	0.5	13.19
Laser printer energy	0.18	4.7

Carbon footprint from eCO-SSR method

In the case study, it was found that the eCO-SSR method generated an annual carbon footprint of 83.61 kg/year without file compression. The Time Factor for this is around 1.8 years. Hence it is evident that the eCO-SSR method is a more suitable alternative to Paper-based method. It is worth noting that when the same files are compressed prior to upload (resulting in a reduced carbon footprint of 11.45 kg/year), the Time Factor is significantly enhanced to around 13 years. In a typical scenario, these data are required to be online for one year for SSR evaluation purposes. Afterwards it can be downloaded and stored in local storage space thereby reducing further annual carbon footprint to near zero. Hence the Time Factor obtained after file compression is a very lucrative number in the context of carbon footprint. Factoring in the total number of Higher Education Institutions in India (46641), the Paper-based SSR method results in approximately 6985 tons of CO_2 emission. Whereas our methodology of eCO-SSR, if adopted nationwide, will substantially reduce it to 534 tons of CO_2 emission.

Table 4. Estimated reduction in carbon footprint from file compression

	Before file compression	After file compression
Initial file size (MB)	5904.88	809.42
Carbon Footprint per MB per year(kg/year)	0.418	0.418
Total Carbon Footprint per year (kg/year)	83.61	11.45
Percentage Reduction in Carbon Footprint	86.32	

Conclusion

The transition to paperless data management for accreditation at The Cochin College has yielded substantial environmental benefits, including the reduction of paper usage, lower carbon emissions, and significant energy savings. By adopting digital solutions, the institution has saved over 149.76 kg of CO_2 emissions and reduced waste production, making a positive contribution toward global sustainability goals. The findings demonstrate that going paperless not only enhances operational efficiency but also supports a more sustainable institutional framework. As more educational institutions adopt similar practices, the potential for a significant cumulative environmental impact grows, making the shift to digital systems a crucial component of modern, eco-friendly administrative functions. Though developed in an Indian higher education setting, the eCO-SSR represents a scalable framework for sustainable accreditation and documentation applicable to institutions nationwide.

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Author Contributions
SK conceived the study, guided the research framework, and supervised the preparation of the manuscript. TP designed the eCO-SSR model, performed the carbon footprint analysis, and prepared the initial draft. VKTV and MVS contributed to data collection, validation, and interpretation related to environmental and operational outcomes. US assisted in methodological design, technical review, and preparation of figures and tables. All authors discussed the findings, revised the manuscript critically, and approved the final version for publication.

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