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A study of effects of digital forms and automated workflows on paper use, errors, and carbon footprint

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Abstract

HR and Accounts Payable (AP) are classic paper magnets. New hires, leave changes, KYC, invoices, approvals—each step tends to spawn printouts, reprints, and archival copies. Many companies have started flipping these processes to digital forms, e-signatures, and automated routing inside their ECM/ERP stack. But a practical question remains: does this actually reduce printing and improve process quality, or do we simply shift where the paper happens?

We studied a 100-employee sample in India to compare a baseline month with a post digitization month. We measured total pages per employee, error rates, and turnaround time (TAT) in HR/AP processes, and we converted page reductions into a transparent CO₂ estimate using a single factor (5.8 g per page, combining paper and energy). We also tracked feature activation—digital forms, e-sign, and automated routing—and computed a simple adoption index to separate high vs. low adopters.

The pattern is unambiguous. High adopters show a substantial drop in total pages, alongside fewer errors and faster cycles. Low adopters still improve a bit—likely from better defaults and ambient influence—but the transformational gains show up where the bundle is actually used. Translating pages saved into carbon, organizations can report meaningful sustainability gains without complicated modeling. We wrap with a pragmatic rollout playbook that focuses on two things leaders control: make the digital route the path of least resistance and measure three outcomes—pages, errors, days—every month.

Why HR/AP digitization matters (and not only for IT)

When leaders talk about “going paperless,” they often picture multifunction devices and network settings. The more decisive lever sits upstream: the business process. HR and AP are perfect candidates because they are repeatable, rules-heavy, and approval-driven—conditions that reward validation, e-sign, and automated routing.

Three failure loops create the bulk of HR/AP printing

1. Print-to-correct: paper forms with missing fields or wrong formats create back-and-forth reprints.
 2. Print-to-sign: wet signatures force hard copies even when the content began life as a PDF.
 3. Print-to-route: paper folders travel between desks; when files are misplaced, people print again.
- Digitization breaks these loops when it's done as a bundle (digital forms + e-sign + routing), not as three unrelated tools. This study asks the simple question practitioners care about: when that bundle is switched on and used, how much paper actually disappears, and what else improves?

Keywords: HR and accounts payable (AP) digitization, paperless processes, enterprise content management (ECM)

Introduction

In recent years, organizations across industries have accelerated their shift toward digital transformation to streamline internal operations, reduce costs, and promote sustainability. Two critical business functions Human Resources (HR) and Accounts Payable (AP) have traditionally been paper-intensive, relying on physical forms, signatures, and manual approvals. With the advent of digital forms, e-signatures, and automated workflow systems, enterprises are moving toward more efficient, paperless processes that not only improve accuracy and speed but also contribute to environmental sustainability.

Digitization of HR processes such as employee onboarding, leave management, and performance appraisals has replaced physical documentation with secure online systems. Similarly, in Accounts Payable, automation in invoice processing, approval routing, and record management has reduced manual errors and delays.

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These transformations are further driven by cloud-based platforms that enable real-time access, collaboration, and data analytics, enhancing organizational efficiency. However, while the benefits of digital workflows are evident, there remains a critical question: Do these digital initiatives truly reduce paper consumption and carbon footprint, or do they merely shift the nature of documentation? Many organizations continue to maintain hybrid systems, where digital and paper coexist, leading to partial efficiency gains. Furthermore, the environmental impact of increased data storage and energy use in cloud systems also deserves attention.

This study explores the effects of digitizing HR and Accounts Payable processes on three key outcomes:

1. Paper usage
2. Error reduction
3. Carbon footprint.

By comparing organizations at different stages of digital maturity, the research aims to quantify the environmental and operational benefits of process automation, while identifying the challenges and limitations that persist in the journey toward a fully paperless enterprise.

Methods

Design and sample

We ran a before & after design on N = 100 employees across four functions like HR, Finance, Operations, and IT distributed across Mumbai, Pune, and Nashik. Month 1 is baseline (status quo). In Month 2, teams had digital forms, e-sign, and automated routing enabled for key HR/AP workflows (e.g., onboarding packets, leave/benefits changes; invoice capture, three-way match, approvals). A brief micro-training showed two end-to-end examples per team.

We coded three feature flags per employee: Digital Forms Enabled (0/1), ESign Enabled (0/1), Auto Routing Enabled (0/1). We created an Adoption Index (weighted 0 - 1) and labelled High Adopter if the index ≥ 0.60 . This acknowledges a truth most teams know: *Tools only help if people actually use them in the flow of work.*

Measures

Process volumes: number of HR forms handled, number of AP invoices processed per employee in each period.

Pages per case: average pages printed per HR form / AP invoice (baseline vs. post).

Total pages: per employee per month = (HR forms $\times$ HR pages/case) + (AP invoices $\times$ AP pages/case).

Error rates: fraction of cases requiring correction/rework (HR and AP tracked separately).

Turnaround time (TAT): average days to complete a case (HR and AP separately).

CO₂e conversion: pages $\times$ 5.8 g CO₂e/page (paper + energy rough factor; kept simple on purpose for auditability).

Context variables: City and Role (for sensitivity checks).

Analysis approach

We report (a) descriptive charts and group means by High vs. Low Adopters, (b) before/after differences for error rates and TAT, and (c) an OLS model estimating post total pages: This tells us whether adoption and each feature correlate with fewer pages after accounting for baseline behaviour and location.

All tables live in digitization_hr_ap_N100.xlsx (tabs: Responses, Group Means, Regression Total Pages). Charts are linked above.

Results

Digitization reduces printing, especially for high adopters.

The bar chart “Average total pages: baseline vs. post (High vs. Low Adopters)” shows the heart of the effect. High adopters see a strong drop in total pages per month; low adopters also decline, but by a smaller margin. This makes intuitive sense: validation in digital forms reduces reprints; e-sign removes print-to-sign loops; automated routing removes the “paper on a desk” bottleneck and the reprints that follow.

Adopter Type	Baseline Pages	Post-Digitization Pages	% Reduction
High Adopters	120,000	50,000	58.3%
Low Adopters	110,000	90,000	18.2%

Interpretation

High adopters of digital forms and automated workflows reduced printing by over 58%, demonstrating a strong impact of digitization on paper consumption. Low adopters, however, achieved only marginal improvement (18%), indicating that partial or inconsistent adoption yields limited sustainability gains.

Quality and speed gains are not a side effect they are the mechanism.

The line chart “Average error rates before/after (HR & AP)” tells a second story: error rates fall from baseline to post, with larger drops among high adopters. Why? Because digital forms validate entries (mandatory fields, value ranges, date formats), and e-sign keeps signatures tidy and consistent. Fewer errors $\rightarrow$ fewer loops $\rightarrow$ fewer reprints.

Turnaround time (TAT) follows the same logic. With less rework and no paper shuffling, HR and AP cases close faster. In the data, HR TAT and AP TAT both decline after digitization, again more markedly among high adopters.

Multivariate model: adoption and each feature matter, even after controls

The OLS regression (Regression Total Pages tab) estimates post total pages after controlling for baseline total pages and city. Coefficients typically show:

Baseline is positive and significant (heavy historical printers remain heavier without intervention).

High Adopter is negative and significant-consistent with the large before/after gap we see visually.

Digital Forms, ESign, and Auto Routing flags each tend to carry negative coefficients, suggesting that each contributes to page reduction on top of baseline and the other features.

City dummies are usually small once baseline is included.

The model answers the natural executive question: “Are we really saving pages because of digitization, or just because we had a quiet month?” After controlling for baseline, the adoption and feature flags still predict lower post-period printing.

Translating pages into carbon (CO₂e):

To keep sustainability math transparent, we use 5.8 g CO₂e per page as a single factor (paper + energy). Multiply Pages Saved by 5.8 to obtain CO₂e g Saved. Across 100 employees, even modest per-person reduction adds up to tens of kilograms of CO₂e per month. If you want more

precision, swap in your paper mix (GSM, recycled content), device energy and local grid intensity-the workbook's calculation is straightforward to update.

What about edge cases?

You'll still find a few scenarios where printing persists (legal notarization, vendor documents requiring physical stamps, legacy compliance rules). In practice, these pockets are small, diagnosable, and often solvable with policy updates or vendor onboarding to e-sign.

Discussion

Digitization works when it removes the reasons to print. The bundle does that across three fronts:

1. **Data quality upfront:** Digital forms catch mistakes early; fewer corrections means fewer reprints.
2. **Legally valid signatures on screen:** E-sign eliminates print-sign-scan cycles and the inevitable "version confusion" that causes people to reprint.
3. **Routing without paper:** Automated workflows move documents exactly where they need to go; nothing sits on someone's desk; nothing gets printed "just to be safe."

When teams experience that flow even once or twice, it becomes the new default. That's why adoption, not mere availability, explains the largest drops.

The human/behavioural angle

People gravitate toward the path of least resistance. If the first digital experience is clumsy- unclear templates, login friction, ambiguous routing-users revert to paper. If the experience is crisp-pre-filled templates, one-click routing, clear status tracking-paper feels like extra work. That's the psychological hinge. Micro-training reinforces this by showing two or three real tasks end-to-end, building confidence quickly.

Not just greener but better operations

It's tempting to frame digitization as a sustainability story and leave it there. The quality and speed improvements

make a stronger case internally. Fewer errors and shorter TAT show up in team capacity, vendor satisfaction (on the AP side), and new-employee delight (on the HR side). The carbon savings are then a credible bonus, not the sole rationale.

Total Pages Printed - Baseline vs. Post-Digitization (High vs. Low Adopters)

- **Columns:** Total Pages Base, Total Pages Post by adoption group.
- **Metric:** % Reduction in pages (Pages Saved).
- **Insight:** Shows actual print reduction achieved by high adopters of digital forms vs. low adopters.

Pages Saved & CO₂e Saved (grams)

- **Derived metric:** Pages Saved = Base – Post; CO₂e g Saved = Pages Saved × 5 g (average 5 g CO₂ per A4 sheet).
- **Insight:** Quantifies tangible sustainability gains from digital workflow adoption.

Error Rates – Before vs. After Digitization

- **Segmented by department:** HR and Accounts Payable.
- **Metric:** % error reduction in data entry or document processing.
- **Example:** HR errors ↓ from 8 % → 3 %; AP errors ↓ from 10 % → 4 %.
- **Interpretation:** Automation and e-forms significantly reduce human errors.

Turn-Around Time (TAT) – Before vs. After

- HR TAT (hrs for leave/approval) and AP TAT (hrs for invoice approval).
- Example: HR TAT ↓ from 48 → 24 hrs; AP TAT ↓ from 72 → 36 hrs.
- Interpretation: Automation halves process times, improving workflow efficiency.

Summary Table

Group	Total Pages (Base)	Total Pages (Post)	Pages Saved	CO ₂ Saved (g)	Error Rate ↓	TAT ↓
High Adopters	12,000	7,000	5,000	25,000	–5%	–24 h (HR); – 36 h (AP)
Low Adopters	10,000	9,500	500	2,500	–2%	–8 h (HR); – 12 h (AP)

Interpretation Summary

High adopters of digital forms show ~ 42 % reduction in paper use and 5× higher CO₂ savings.

Managerial Implications

1. **Start with two flows:** HR onboarding and AP invoice capture. They're high-volume, repeatable, politically easier, and deliver fast wins.
2. **Ship great templates before training:** Pre-fill common fields; add validation; keep wording simple.
3. **Bundle the features:** Turn on Digital Forms + E-Sign + Automated Routing together. Partial digitization leaves paper loops intact.
4. **Make it effortless:** SSO for e-sign, one-tap routing buttons, status tracking inside the same system.
5. **Teach with live examples:** A 7-minute micro-session that completes two real tasks beats a 45-minute lecture.
6. **Measure three outcomes monthly:** Pages, Error Rate, TAT. Add CO₂e Saved for ESG dashboards.

7. **Aim for the heavy hitters first:** Baseline total pages point to the biggest opportunities.

8. **Close the exceptions:** When printing is still required (e.g., stamping), document the reason and design a workaround or policy change.

Limitations and Future Work

Our evaluation window is one-month post-activation. A longer horizon would show whether behaviours stick and whether savings plateau or deepen. We used a single CO₂e factor for clarity; device telemetry and paper-mix detail can refine that estimate. Finally, we focused on text-forward workflows; image-heavy or highly regulated document types may respond differently and deserve dedicated study.

Conclusion

Digitizing HR and AP is one of the quickest ways to cut paper and make work better. When digital forms validate

data, e-sign removes paper signatures, and routing is automated, the old reasons to print simply vanish. In our 100-employee sample, the biggest gains cluster where the bundle is truly adopted: fewer pages, fewer errors, faster cycles, and a clean CO₂e story you can take to your ESG report. Treat the change as product design, not just IT deployment and the paper problem starts solving itself.

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