

Sustainable Practices by Implementing a Paperless Environment in a Research Lab

Digital transformation encompasses a wide variety of activities that have the potential to play a critical role in achieving sustainability goals. Many of these activities have been implemented, and others are continuing to be implemented, in several sectors, and they are proving to be effective in improving sustainable practices. The correct and effective method to implement some digital transformation practices in an organization is via a project that is managed internally with well defined goals to be achieved within a specified time frame and budget [M. Cöster *et al.*]. Since a "well defined" goal is central to a project, such a project shall start with identifying the underlying problem and the ways to solve it. In this report, I focused on minimizing printing-paper usage in the lab. Throughout the report, I also present answers from an internal survey-questionnaire that is available here: <https://forms.gle/7uUPUAYGv1XfU3ht8> and most answers are in the Appendix. The anonymous survey was answered by 11 people from our lab. This includes 8 PhDs, 1 postdoctoral fellow, and 2 professors.

The organization:

I work in a research division (lab) at KTH. The lab includes over 100 people, including PhDs, postdoctoral researchers, professors, administrators, and post-graduate level students.

The problem and description:

We have been living in an age of technology and are surrounded by numerous digital devices, yet we are still printing lots of paper. I tried looking into the main cause and found that most paper-printing by me and fellow researchers is caused by printing research articles and journal papers (this was based on my observations, seconded by fellow colleagues in the lab). Another major source is the printing of PhD theses.

It goes without saying that reading articles is a basic necessity for a researcher. Some studies suggest that PhD students can read anywhere from 10 to 50 articles a week. However, do we really need to print all these articles?

To answer why one prints the research article, the following answers are in the survey responses: "Relevance to self-research" was selected by most participants, with other answers being "Possibility of future steps", "The method and writing style", "I liked the figures", "If I need to take notes and give comments", "Having to peer-review it", "It is something I want to read/annotate in depth. Paper makes this easier", "When I need to read it more thoroughly"

I further asked the respondents, "What is the likelihood of printing an interesting and relevant research paper?" (1-Not at all, 7 - Very likely). Only one responded with 7, while most participants scored 4 or less than 4. This shows the respondents preferred not printing as well!

At the KTH, a PhD student is required to give 30 copies of the thesis. An average thesis in our lab is 300 pages in total (considering the recent 5 theses of fellow colleagues). This implies that approx. 4500 pages (duplex, A5-sized) are printed, which are potentially staggering numbers.

An interesting discussion is presented in a web-article by Stephen Wymbs for *Elsevier*, which

discusses whether an organization transitions your society membership to online-only journal access. It is surprising that many organizations still use paper membership for journals where *huge (more than 100 papers)* journals are printed and sent to these organizations' libraries. Some organizations really need the articles printed on paper, while others, like the Chartered Society of Physiotherapy is just one example of a society that has transitioned all 60,000 of their members from print to online-only. The environmental effects of printing 60,000 hard copies of a journal and distributing them to everyone on the society's membership list throughout the world are the most crucial information in this article. Additionally, when thinking about switching from print to online, the effect on perceived member benefit is still a focus. Additionally, if the journal was only available in print format, the society might not be able to engage those who might normally be less likely to do so. Reduced commercial income may more than make up for cost savings from moving from print to online. Digital products, however, provide more creative multimedia opportunities, including podcast and video commercials, sponsored webinars for learning, and expert panel discussions. The ideal course of action may be a "print-short" approach, in which a condensed version of the journal is printed and the full text is made available online. If society charges a premium for individuals who choose paper copies, membership payments might suffer. With graphical abstractions, video and audio information, 3D modeling, high definition slides, and artificial intelligence, Elsevier's ScienceDirect and journal branded sites provide users with a richer experience. Members may view articles on the same device they use for other information thanks to mobile-optimized pages. Physicians continue to prefer print journals because they both provide a "browsing" and "multi-media/multi-resource" experience.

Other related questions in the questionnaire:

- 1. On an average, how many research papers/articles do you print in a week? (Including articles for reviews or self-work in progress)*
- 2. How many research papers/articles did you print in last week (Consider an average of 8 pages per paper/article, count a 16 page journal paper as 2 articles)?*
- 3. How many research papers/articles did you print in the last month (Consider an average of 8 pages per paper/article, count a 16 page journal paper as 2 articles)?*

Although the following statistics are not fully representative of the full lab (or many research labs in general), I report them for completeness. As per the answers by the respondents, there were 8 articles printed, which amounted to 64 printed pages (average 8 page articles, A4 sized) in the week. Moreover, the monthly total of 21 printed articles, i.e., 168 printed pages, was reported by only 11 people.

Project Proposal and GOAL:

I envision a future where the articles are only accessed digitally, so the project will involve slowly phasing out the printing paper facility for the articles. As a final goal, the articles available to researchers in the division will be available only digitally and not printed at all at KTH. Regarding the printing of theses, the lab should determine the minimum possible number of theses really needed for administrative purposes, as the theses are readily available online for free via the KTH library.

Project Implementation:

This transformation towards paperless research articles would be achieved in phases and implementing the following steps, with a mixed Waterfall-Agile model supervised by a SCRUM master in the lab [M. Cöster et al.]:

1. Establish a goal: Set a goal for minimizing paper usage and share it with lab members. The initial goal would be a 50% reduction in paper use and a target for the number of articles read online rather than printed. The ultimate goal should be the complete removal of printing facilities for research articles; however, this goal should be announced only after a survey to avoid a panic response.
2. Provide training: Train lab members on how to find and read research publications online. Encourage lab members to take notes and mark up digital papers using digital note-taking tools and annotation software rather than printing them out.
3. Implement technology solutions: Technological solutions, such as cloud-based document storage (KTH-onedrive) and online collaboration platforms (KTH-slack) should be encouraged. The majority of these platforms are freely available through KTH software access, and increased use of these platforms should be encouraged.
4. Monitor progress: The SCRUM master's primary responsibility is to track progress toward the paper usage reduction objective and provide comments to lab members on their progress. To retain momentum and drive, it would also be useful to celebrate milestones and recognize triumphs.
5. Evaluate and Revise: Conduct regular assessments to determine the project's impact on paper consumption, costs, and environmental sustainability. When necessary, use the outcomes of these evaluations to revise the project's goals and strategies.

Project: What do subjects think?

Since it is advised [M. Cöster et al.] to take information from the subjects for whom a project will be implemented, I decided to include the following questions in my survey:

1. *Given a choice, what is your preferred way to read/access an article/paper? (Rate 1 for only paper, while 7 for only digital)*

Answer: Ranked 7 by two subjects (18.2%), 6 by four (36.4%) subjects, 4 by four (36.4%) subjects, and 1 by one subject.

Thus, most subjects prefer to read the article digitally.

2. *What are your preferred "digital" methods to read papers?*

Laptops/Screens (5), Tablets/ipads (8) and Others (2)

3. *You find a really interesting and relevant research paper; what is the likelihood that you will print it? (Rate 1 as not likely, 7 as very likely)*

Answer: Ranked 1 by three subjects, 2 by three subjects, 3 by one subject, 4 by two subjects, 1 by one subject, and 7 by one subject.

Most subjects prefer a digital version, while some might print it while accessing it digitally as well.

4. *Do you have any arguments for printing research articles and not choosing the option to access them digitally only? Answers: See appendix*

Some have concerns about better accessibility with paper as there are no electrical components involved.

5. *Do you have any arguments for not printing research articles and accessing them digitally only?*

Most subjects realize that there are several advantages to a digital access like worldwide access, less paper, archiving etc.

6. *Consider a hypothetical case where KTH makes a decision that no paper printing is allowed for research articles. Would you be in favor or opposed to this decision? (1 Strongly Oppose, 7 Strongly Favor)*

Answer: Ranked 1 by five subjects, 2 by three subjects, 4 by one subject, 7 by one subject.

Most subjects are likely to oppose such a decision, while only 1 favors it. 4 of them are neutral.

7. *Please elaborate on your previous answer. Even if you are in favor, what do you think will be the arguments in opposition for this change? (optional) Answers: See appendix*

Various reasons are given, and they believe it should be an individual call and not enforced. Some agree if suitable electronic devices are given. Few also comment on the necessity of paper reading to understand better, which is an important point for habituating the subjects with digital means slowly. Overall, there seems to be resistance to change [M. Cöster et al.]:

8. *Do you think that implementing digital transformation by minimizing paper printing (for research articles) will result in more environmentally friendly practices? (1 Not at all, 7 Very likely)*

Answer: Ranked 1 by one subject, 2 by two subjects, 3 by two subjects, 5 by two subjects, and 6 by two subjects. Elaborated comments: See Appendix

Most subjects believe that this way of transformation is likely to lead to better practices for sustainability. Although a few think this is only symbolic with no real effect and there is a negative perception that it might cause a decrease in productivity.

Project Challenges:

1. The resistance to change: As we see from some responses, we see a huge opposition from some people who fear it would be hard to achieve the same productivity without paper reading. This may stem from the long standing academic practice of paper reading. Some members of the lab may be accustomed to printing research articles and may be resistant to change. They may see the project as an unnecessary burden on their work and fail to recognize the benefits of going paperless.

It can be overcome by slowly phasing out printing articles and replacing them with digital means that are user friendly. It would also be needed to provide sufficient motivation to those who find it hard to adapt. It is important to communicate the benefits of going paperless as well.

2. Questions about electronic carbon footprints: An usual objection to accessing such articles digitally is that electronic devices have their own carbon footprint. This was also mentioned by a few of the subjects in their responses.

To counter this, I added a unique question: *"When you read a paper/article you had printed out, is your laptop/desktop screen switched ON?"*. Interestingly, only 2 of the subjects answered a definite "no." This indicates our habit of having our screens switched on anyway in our modern offices while we read a printed article.

Moreover, with the rise in renewable energy sources and the Swedish aim to achieve 100% renewable energy-based electricity by 2040, the electronic carbon footprint is expected to reduce to a bare minimum in the upcoming years.

3. Technical barriers: It's possible that some lab members lack the knowledge or tools necessary to access online research articles. To use digital tools and technologies, they might need more assistance and training.

This can be overcome by providing proper training and support for digital tools and technologies. Since KTH already provides multiple online tools and their introductory tutorials, this will be easier to implement. Again, it would need proper communication of the benefits of this change to the lab members to ensure the extra effort they put in is not seen as an unnecessary burden.

In conclusion, this report presents an inspirational project to reduce paper printing in a research lab. It is possible to carry out such a project by implementing the aforementioned steps to cause an overall increase in sustainability, keeping in mind the associated challenges and reducing costs.

References:

Cöster, M., Ekenberg, L., Gullberg, C., Titlestad, G., Westelius, A., and Wettergren, G., “Digital Transformation Organizations, Processes, and Decisions”.

Stephen Wymbs , ”To print or not to print - 4 things societies should consider before moving members online only” Web-article in *Elsevier Connect*, November 11, 2020

Appendix:

Answers to some *long* questions in the survey questionnaire:

Ques: Do you have any arguments for printing research articles and not choosing the option to access them digitally only?

Answers:

“No”,

“Transportability: easier to fold and choose size on the go. No thinking required to access it later (battery, download location, wifi etc).”,

“Generally less extra things to think of that isnt written in the article.”,

“Diagram notes.”,

“Smell of paper.”

“When revisiting the paper many many times, I think having it on paper makes reviewing some parts, brainstorming new ideas, finding errors, etc. easier.”

“Way easier to read over long periods, easier to have a spatial sense of where you are in the paper, which helps organizing the knowledge

“Maybe really really long travels without the possibility to charge a device.”

Ques: Do you have any arguments for not printing research articles and accessing them digitally only?

Answers:

“Digital note taking, access worldwide”

“Paper, sustainability etc.”

“Archiving is easier.”

“If I already own all possible electronic devices and have "bought in" to the lifestyle, its not an extra cost.”

Transportability, but for large numbers.”

“More convenient. You don't lose them, can also keep notes, easier to archive. It is very easy to just print and try to read papers later but some of them are long and you might not even find the time later to read them that carefully.”

“Limiting material use & environmental impact, harder to find again when you need it, you need the PDF anyway for searching through it and quickly looking something up”

“Can write long comments with a pdf viewer. Commented and highlighted pdf is easily shared across devices via cloud. No way of losing digital copies. Can have all my papers with me all the time (allows spontaneous homeoffice). After reading a paper those 8-12 printed pages become garbage. Easier to look up references (just copy title to google). Easier to copy relevant parts to knowledge management software. Reading paper on tablet is similar to having it printed.”

“Faster. Searchable. Don't need to bother with physical stuff.”

“Less paper hassle, no need to transfer annotations etc. because in the end we cannot really keep all the paper copies anyway”

“Printing uses more resources, most papers are not necessary to read in depth.”

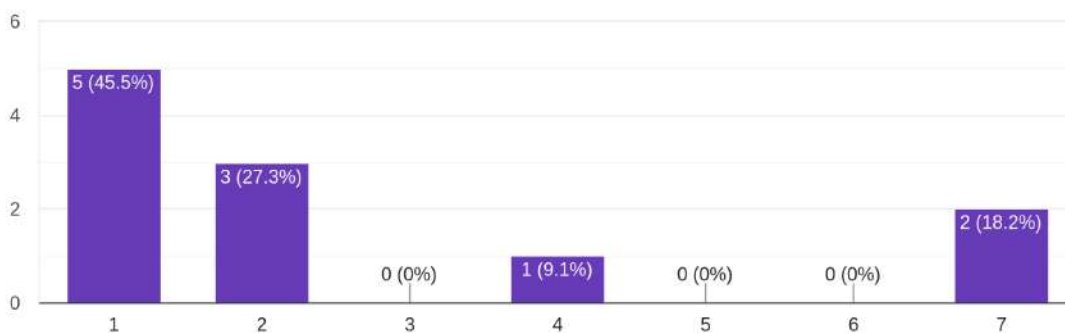
“The figures are more clear and able to zoom in/out it becomes cumbersome after some time to manage many printed articles”

QUES: Consider a hypothetical case where KTH makes a decision that no paper printing is allowed for research articles. Would you be in favor or opposed to this decision?

Answer: Ranked 1 by five subjects, 2 by three subjects, 4 by one subject, and 7 by one subject.

Consider a hypothetical case where KTH makes a decision that no paper printing is allowed for research articles. Would you be in favor or opposed to this decision?

11 responses



QUES: Please elaborate on your previous answer. Even if you are in favor, what do you think will be the arguments in opposition for this change?

Answer:

“Waste of time and effort. Un-enforcable unless printing in general is reduced which is a whole other can of worms. Leads to nothing but office drama.”

“I think 0% paper printing for research articles just does not make any sense. So I think the effort should be put towards reducing substantially the usage, but not completely cut it.”

“Sounds very much like virtue signaling. Make our flights CO2-neutral by default before you make researchers' lives harder for good PR! If this makes more people switch to alternate screens like tablets that they only buy specifically for reading, the environmental impact might even be very negative overall.”

“As long as every employee gets an tablet-like device, I am completely in favour.”

“Because it's tiring to read too much on screen, people will read less and when reading will skim more.”

“I think this kind of change should be voluntarily and not enforced. I would say it should be part of my freedom as a researcher. There are very few cases in which I print a paper but in these cases I really want to be able to print it.”

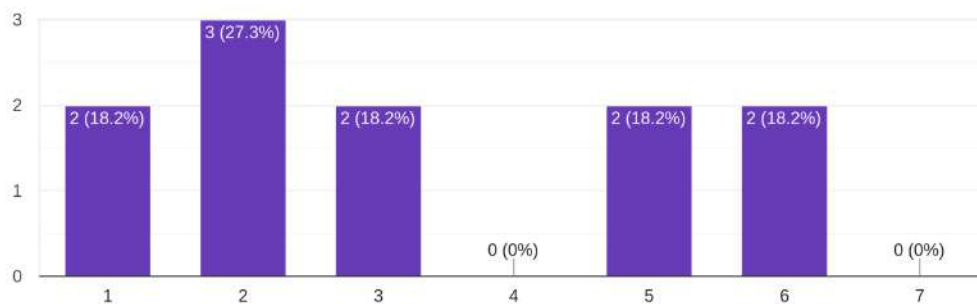
“Reading on paper is still more efficient. When doing advanced reading it is worth the extra use of resources.”

“There are people who don't like digital readings”

“I feel like my understanding of the papers and my ability to recall the content of what I read would be severely affected”

“The individual should decide what is the best course of action given the context.”

Do you think that implementing digital transformati... result in more environmentally friendly practices?
11 responses



QUES: Do you think that implementing digital transformation by minimizing paper printing (for research articles) will result in more environmentally friendly practices?

Answer: Ranked 1 by one subject, 2 by two subjects, 3 by two subjects, 5 by two subjects, 6 by two subjects.

QUES: Please elaborate on your previous answer

Answer:

“The entire premise of reducing the paper used by a couple hundred people when TRILLIONS of it is being wasted en masse by corporations is funny. Stop micro-optimizing for showing off and start making BIGGER waves against corporations.”

“I don't really think it will make people more conscious, just get more used to using digital resources more.”

“This seems like a very low impact decision that mostly sounds great, while other decisions would be a lot more impactful. Make flights CO2-neutral. Make all fika, buffets etc. vegan by default and have all other options under "food preferences/allergies".”

“Tablet need a lot of electronic components which is bad for environment.”

“There are much more efficient ways to lower environmental impact. Fewer flights would be the obvious”.

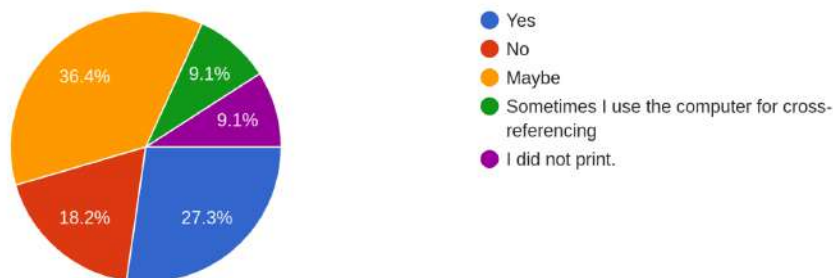
“Research articles are only a small portion of what I print. It would be much better to limit the papers printed for administrative/education reasons. Admin type papers do not add value, here it is much better to go fully digital. This includes written exams.”

“I don't think the paper used to print out academic papers in the various research department account for a sensible share of our society waste but it might decrease the research output overall”

“Printing papers is not a meaningful source of environmental pollution. It is a lot like banning plastic straws: annoying to everyone, and at best symbolically meaningful.”

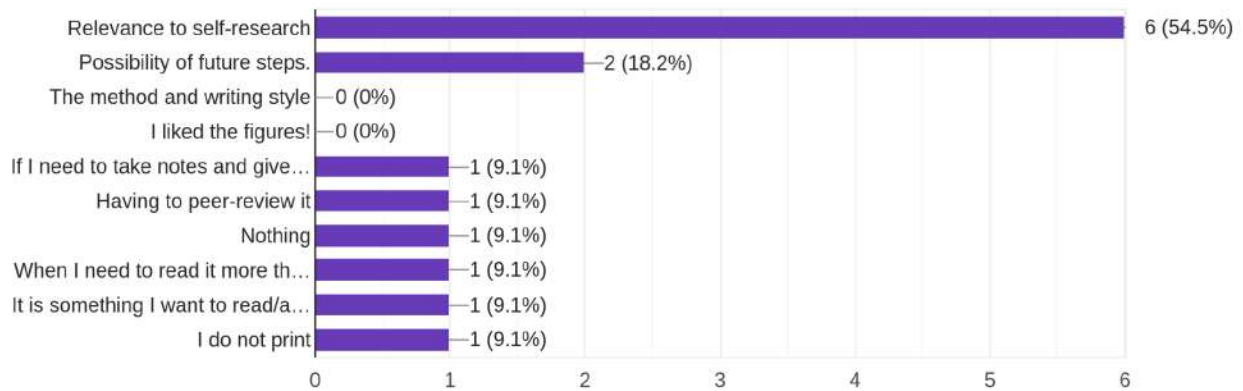
When you read a paper/article you had printed out, is your laptop/desktop screen switched ON?

11 responses



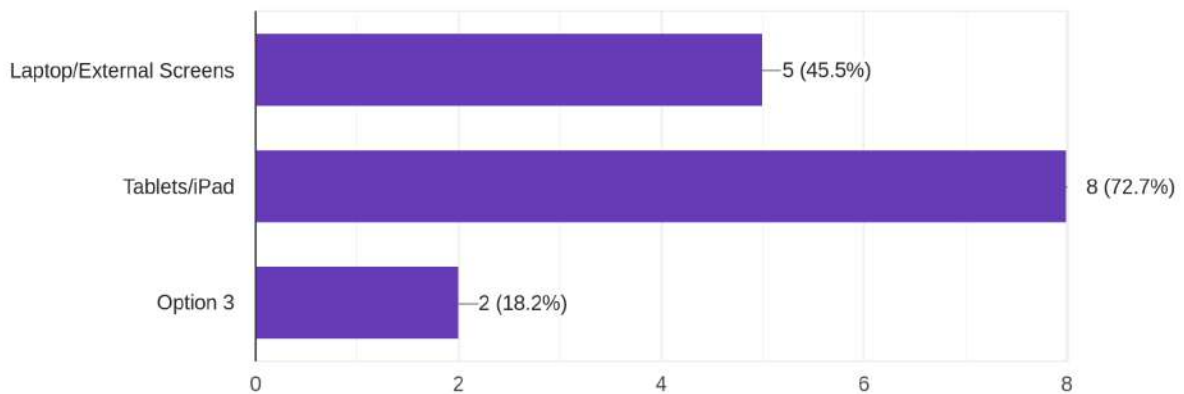
Given a research paper/article, what are the factors that potentially lead you to print it?

11 responses



What are your preferred "digital" methods to read papers?

11 responses



Appendix 2

The peer-review I wrote on the report "Reimagining Education for a Sustainable Digital Age: A Speculative Fiction Journey for Swedish Higher Education" by Iosif Gidiotis.

This work investigates how technology and sustainability may be able to change Swedish higher education in the future. It suggests a project named "The Digital Campus" to develop a more sustainable and open learning environment. By integrating cutting-edge technologies, picturing a future with non-sustainable university practices, and developing a national or international network of students and educators, the Digital Campus project seeks to establish a more sustainable and equitable learning environment.

In the project details, it was interesting to ask for non-sustainable practices in the future envisioned? What is the particular reason for this? This choice can be made more clear.

> I applaud the author for including the main emphasis of the report of the Swedish Digitalization

Commission that focuses on national and global solutions, contextualizing teaching and learning, and using neoliberal master narratives to support its arguments.

The proposed project intends to include faculty members and students in sustainability and digital transformation in higher education, motivating them to become knowledge creators and innovators.

Although it is implicit, I suggest the author to directly link the proposed project with the report of the Digitalization Commission (how It would realize some of the objectives and what this project adds on top of that)

> It is mentioned that despite the fact that Swedish universities are actively working to alter higher education in a sustainable manner, a project that would involve students and staff members in this process might revolutionize education, give them more power, encourage inclusion, diversity, and representation, and open their eyes to new ideas.

I like the optimism behind the project and how well it has been presented. It can be helpful to add how some Swedish universities (or KTH) are currently engaging students and faculties in this regard.

> Risks exist, but participants will engage in a world-building and story-writing process to become change agents. Through stories of hope and difficulty, the project seeks to aid participants in understanding the current state and potential futures of university teaching, learning, and belonging. Projects that attempt to imagine a sustainable digital future frequently run the danger of encountering resistance to change. Stakeholder participation and effective communication can help overcome opposition and accelerate the adoption of sustainable digital solutions. Resistance is a sign of engagement and can be utilized as feedback.

I agree to potential risks due to resistance to change. I would suggest adding a short example of what a sample story would look like from a student perspective (or even a faculty perspective).

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