



COMPARING PRINT AND DIGITAL MEDIA

*Research review on the sustainability,
efficiency, and perceptions of print and
digital communication tools.*

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EXECUTIVE SUMMARY.

This report summarizes the findings of Intergraf's "Print and Digital Media" project: it aims to provide an overview of the studies which compare print and digital communication tools in terms of sustainability, efficiency, and consumer preferences. More than 75 studies were analyzed for the project. This report focuses on four themes: **sustainability, reading, marketing, and the digital divide.**

1 SUSTAINABILITY – This section challenges common misperceptions on the topic of sustainability. The section first delves into the **environmental impact of the digital sector**. The impact of the ICT sector on the environment is far from negligible: it is responsible for 2-4% of all emissions. It is growingly energy consuming, and the energy decreasing effects of digitalization are dependent on energy increasing effects. Moreover, the energy increasing effects are stronger than the energy decreasing effects. It produces a substantial amount of waste, which has an unsatisfactory recycling rate compared to paper. The report also discusses **methodological nuances. Life Cycle Assessments**, the methodology used to compare the environmental impact of print and digital products, rely on **assumptions. These assumptions may create biases towards one product over the other and the results of these studies can be easily taken out of context.**

2 READING – This section of the report discusses themes related to reading comprehension and leisure reading. The academic literature on reading, while not unanimous, hints that print still holds a fundamental role in facilitating reading comprehension. They provide different benefits and possess different attributes. Therefore, it can be concluded that one should not replace the other. **Digital media expands the definition of reading but does not replace the functions of a print book.**

3 MARKETING – Digital marketing has become a de-facto component of companies' marketing mix: digital tools and communication solutions benefit from their interactive elements. However, research shows that **print marketing still holds significance** in the marketing mix of businesses and complements digital marketing tools: It creates media synergies by increasing online engagement, sustains customer retention, drives purchasing behaviour, and possesses a unique "lock-in power" which allows businesses to retain customers.

4 DIGITAL DIVIDE - The digital divide remains an important problem in the EU, despite digitalization efforts. This divide can be witnessed in terms of **access, skills, and integration** and can be witnessed across different areas of digitalization (e-health, e-government, and e-banking)

This report invites stakeholders to acknowledge the complexities of the literature on print and digital communication. Communication is a multifaceted notion, and each communication tool has its own advantages and properties. Therefore, there should be greater emphasis on **the complementarity of communication tools**, as opposed to their substitution. It is also important to be **critical of the methodologies used in studies assessing print and digital communication tools.**

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INTRODUCTION.

This report summarizes the findings of Intergraf’s “Print and Digital Media” project: it aims to provide an overview of the studies which compare print and digital communication tools in terms of sustainability, efficiency, and consumer preferences. The desk research was conducted from January to May 2024 and resulted in:

- The creation of a comprehensive database which summarizes the studies’ findings, methodologies, and limitations.
- This report, which summarizes the key themes, arguments, and trends found in the desk research.

THE STUDIES.

The studies were selected based on the following criteria:

- **Topics:** Studies which compare print and digital communication tools in the following fields:
 - **Sustainability:** comparative life cycle assessments which compare print and digital communication tools, contextual studies on the ICT sector
 - **Efficiency:** studies which compare the impact of print and digital tools (notably in the context of reading / education and marketing / general communication)
 - **Consumer preferences:** studies which compare citizens’ perceptions of print and digital tools.
- **Date of publication:** Focus on studies published between 2019 and 2024. Studies published prior to 2019 were included if they had a particularly original contribution to the literature.
- **Geographic scope:** Focus on EU-level studies and studies conducted in Member States. Global studies were included if deemed important for contextualization. Studies conducted in other geographic areas were included if no similar studies were found in the European context.

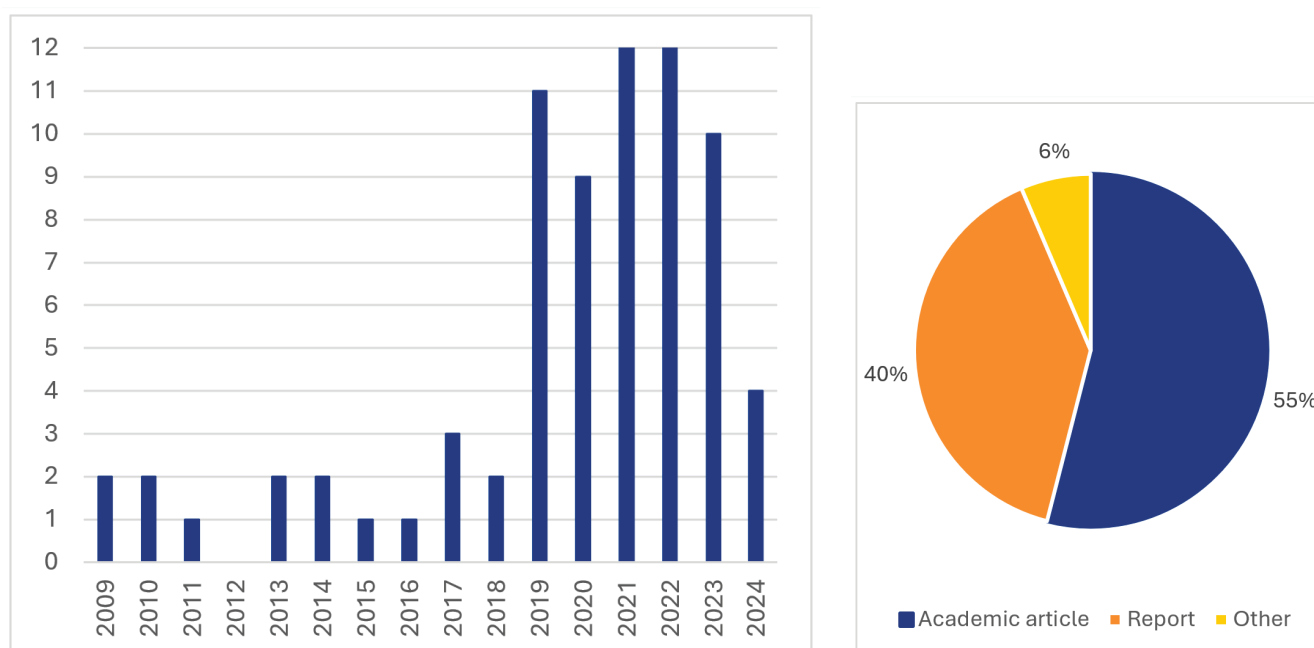


Figure 1 - Year of publication and publication type of studies included in the database

77 studies were included in the database. Most of the studies were either published in peer-reviewed academic journals (55%) or professional reports (40%). Other publication types include conference proceedings and policy reports.

REFERENCING.

Referencing was completed using the APA format: parentheticals are used for in-cite citation and indicate towards a full reference which can be found in the “studies included” annex.

For example: “Education technology products change every 36 months, on average **(UNESCO, 2023)**” refers to the following reference:

UNESCO. (2023). Technology in Education: a tool on whose terms?

To find the cited study in the database, you can search the parenthetical in the excel search bar.

THE DATABASE.

The database is encoded on an Excel document, in which each row summarizes a study. The following information are provided:

- The title
- The document type (academic article / report / ...)
- The theme (Reading, Marketing, Sustainability, or Digital Divide)
- Keywords
- Authors
- Year of publication
- Language
- Geographic scope of the study
- Aim of the study
- Methodology
- Relevant findings
- Limitations of the study (according to the authors, or Intergraf’s Research Assistant)
- Full APA reference (ex: UNESCO. (2023). Technology in Education: a tool on whose terms?)
- Parenthetical reference (ex: (UNESCO, 2023))

STRUCTURE OF THE REPORT.

This report has four main sections. Each section focuses on a theme and summarizes key studies and findings. The four themes are the following:

- 1. SUSTAINABILITY**
- 2. READING**
- 3. MARKETING**
- 4. THE DIGITAL DIVIDE**

A full bibliography of the works cited in the database is available in the annex of the report.

1 SUSTAINABILITY.

According to the European Environment Agency (EEA), **the pulp, paper, and print industries collectively generate close to 1% of CO₂ emissions in Europe.** In contrast, **digital technologies are responsible for around 2-4% of our greenhouse gas emissions** (European Commission, 2024).

However, public opinion seems to be biased against paper products on the topic of sustainability. According to the Two Sides 2023 Trend Tracker report, **18% of consumers understand the paper recycling rate exceeds 60% in Europe, and 56% believe e-communications are more environmentally friendly than paper communication.** Moreover, only 15% of consumers understand that European forests are growing. This section, which focuses on the sustainability of digital and print communication tools, challenges these beliefs.

1.1. DIGITAL IS NOT NEUTRAL: DIGITALIZATION AND THE ENVIRONMENT

Digital technologies' impact on the environment are not negligible:

- **The share of digital technologies in global greenhouse gas emissions has increased by half between 2013 and 2019 (2.5% to 3.7%)** (Shift Project, 2019)
- The CO₂ emissions of digital technologies increased by about 450 million tons since 2013 in OECD countries (Shift Project, 2019)
- The ubiquity of **online videos and streaming** further accentuates these environmental problems (Shift Project, 2019):
 - Videos are a dense communication tool: **10h of high-definition video streaming stocks as much data as all English Wikipedia text articles combined.**
 - In 2018, video streaming produced more than 300 MtCO₂ which is equivalent to greenhouse gas emissions produced by Spain (1% of worldwide emissions)
 - Greenhouse gas emissions of on-demand videos (i.e. Netflix, Amazon Prime...) are equivalent to the same levels as the country Chili (100 MtCO₂eq/year)

ENERGY.

The sector is also characterized by growing energy consumption:

- **The ICT sector is seeing a 4% annual increase in energy intensity.** This contrasts with global GDP energy intensity, which is declining by 1.8% per year (Shift Project, 2019)
- Direct energy consumption caused by \$1 invested in digital technologies has increased by 37% between 2010 and 2019 (which **goes against the Paris Accord** objective of decoupling energy consumption and climate change) (Shift Project, 2019)
- Big data further accentuates this issue: **Data centres' electricity consumption in 2021 was 220-320 TWh, around 1% of global electricity** (The Left in the European Parliament, 2022)

According to Lange et al. (2020), digitalization produces two energy-increasing effects: direct effects (Effect I) and economic growth (Effect III). Simultaneously, it also fosters energy-reducing effects: energy efficiency in the rest of the economy (Effect II) and tertiarization (Effect IV). However, the authors note that the two increasing effects (direct effects and economic growth) are stronger than the decreasing effects (energy efficiency and tertiarization).

Moreover, Lange et al. (2020) note that the four effects are interdependent:

1. Increases in energy efficiency due to ICT (Effect II) lead to rebound effects that trigger additional energy consumption and economic growth (Effect III).
2. The sectoral change towards ICT services (Effect IV) comes on top of existing agricultural production, industry, and services, and therefore fosters economic growth (Effect III).
3. Both, energy efficiency improvements throughout the economy (Effect II) and ICT services (Effect IV) are dependent on the usage of ICT devices (Effect I).
4. The growth of the ICT sector itself (Effect I) is a significant reason for economic growth (Effect III).

Therefore “**digitalization wrecks its own potentials**”. **Energy decreasing effects are dependent on energy increasing effects.** Moreover, **the energy-increasing effects are stronger than the energy-decreasing effects.**

WASTE.

Waste from electrical and electronic equipment (known as WEEE or e-waste) is often referred to as the **fastest growing solid waste stream** (STeP, UN University, 2019)

- “It is estimated that 200 to 250 million tonnes of waste from electrical and electronic equipment was generated, growing at a yearly rate of **3 to 5%**. In Europe, it is estimated that 11 million tonnes of electrical and electronic equipment were put on the market in 2019, and just 4.49 million tonnes were collected in the same year” (The Left in the European Parliament, 2022)
- “Around 50 million metric tons of e-waste is generated globally per year, with an average of more than **6 kg per person.** (...) **The amount of e-waste generated every year is equivalent to the weight of 5,000 Eiffel Towers**” (STeP, UN University, 2019)

There are discrepancies between paper and WEEE waste streams in terms of voluntary recycling.

- According to the Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012 on waste electrical and electronic equipment (WEEE), EU member states should reach a WEEE recycling rate of 65%. In 2021, **the EU-27 WEEE recycling rate (46%) stood 19 percentage points below the target rate.** The share of small consumer electronics (mobile phones, tablets, laptops, chargers) in WEEE collection is especially low. For example, the collection rate of mobile phones in the EU is under 5% (Eurostat).
- The **target paper recycling rate** for 2021-2030 set by the European Declaration on Paper Recycling is 76%. **In 2021, the rate was already only 3 points away from the target.**

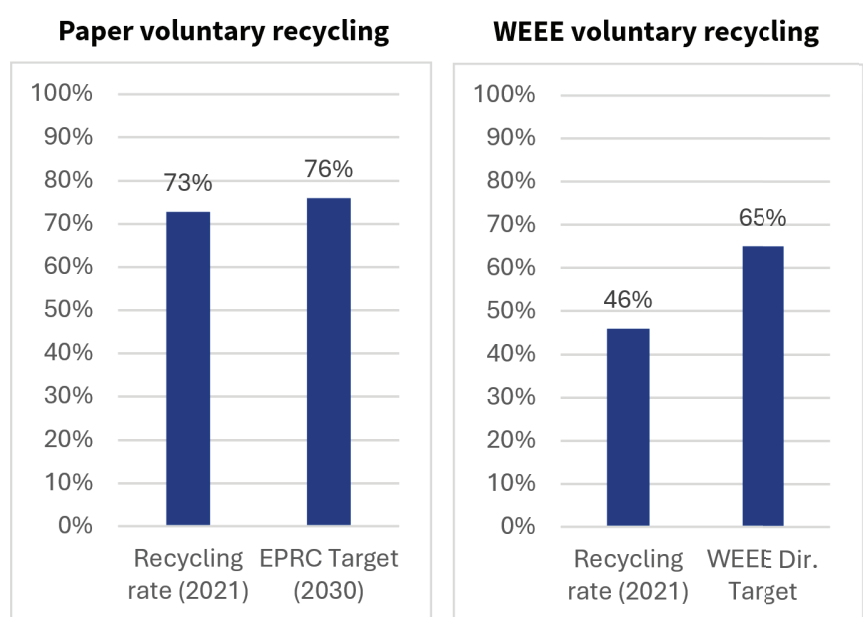


Figure 2 - Paper and WEEE voluntary recycling rates and targets, EU-27

As electronic products continue to miniaturize, **their composition become more complex**: “more than 70 stable metals (out of 83) from the periodic table can be found in a modern smartphone” (STeP, UN University, 2019). This makes WEEE recycling progressively more difficult to manage.

Moreover, although being increasingly addressed by EU legislation, **the shortening lifespans of electronic products** has an influence on the high level of e-waste. There are several factors that contribute to the shortening lifespan: rapid technological advancements (which make older products obsolete), planned obsolescence, inability to repair, and software incompatibility (STeP, UN University, 2019)

1.2. COMPARING PRINT AND DIGITAL: THE CHALLENGE OF ASSUMPTIONS

In addition to the carbon footprint, energy intensity, and waste created by digital solutions, there is a **methodological argument** to be made against the comparison of print and digital communication. The most used methodology to compare print and digital products (for example, comparing the environmental impact of a printed book versus an e-book) is **Comparative Life Cycle Assessments (LCA)**: it is a method used to evaluate the environmental impacts of products, processes, or services throughout their entire life cycle, from raw material extraction to disposal. It considers various environmental parameters such as energy consumption, resource use, emissions, and waste generation to provide a comprehensive analysis for decision-making purposes.

However, **this methodology relies on assumptions**. Their definition can have a significant impact on the study’s results.

“The literature identifies impacts ranging from **>90% reductions in life-cycle energy consumption to >2000% increases** in energy consumption. Changes to key assumptions can lead to very different estimates within a single study” (Sorrell, 2020)

Researchers may choose to make assumptions on different elements. These include (but are not limited to)¹:

1. Functional unit: this refers to the unit used by the researchers to ensure comparability of the print and digital products (For example, assessing the environmental impact of reading one page on an e-book would be equivalent to reading one page of a printed book)

2. System boundaries: this refers to the choice of stages of the life cycle to be included in the LCA (raw material extraction, production, distribution, use, disposal). If the functional unit is one page of reading, for example, the environmental impact of the disposal of ICT products (e-waste) may be considered negligible (based on the scale of the study).

- Court & Sorrell (2020) note that **rebound effects** are often neglected in LCAs comparing print and digital communication tools. Rebound effects refers to situations in which anticipated improvements in energy efficiency or environmental benefits from new technologies are reduced or negated due to changes in behaviour. For example, the environmental benefits theoretically gained from switching from receiving bills in the mail to electronic billing could be negated: the user may decide to use a home printer to print the bill they received in their e-mails, which may be more environmentally taxing than receiving print in the mail.

3. Data quality: this assumption refers to the reliability of the data used by researchers on properties of the industry (such as energy and materials used in the production process).

¹ This list is inspired by the findings of the following meta-analyses (which focus on LCAs which compare print and digital communication): Schmidt & Pizzol (2014), Sorrell (2020), Bull & Kozak (2014), Kang & Xu (2021)

Assumptions may be made if industry data is not readily available to the researchers, which may be problematic.

- For energy data, researchers may assume a national average or a coal-based energy mix to assess the energy contribution of the production process for print products or the energy use of data centres.
- This approach may ignore how different energy mixes may influence the environmental footprint of the production process and does not take into consideration the best environmental practices for the industry.

4. Allocation: In this context, the allocation assumption refers to what percentage of an e-reader's total environmental impact is attributed to its use as a reading device.

5. Technology and process assumptions: the types of technologies and processes used in manufacture, use, and disposal of the studied products. This could be, for instance:

- For print products: the researchers assume the use of a specific printing technology.
- For ICT products: the researchers chose a specific brand and model. As the components of ICT products change as new models enter the market, and therefore their environmental implications change, this methodological choice could make the results difficult to interpret.

6. Market and consumer behaviour: These assumptions concern how the studied products are consumed by individuals. If a study compares printed books to e-readers, for example, these assumptions could include (but are not limited to) the reading speed, if user prints the text they are reading on the ICT device, if the consumer only reads the printed book once, if the printed book is read by multiple people...

While researchers may communicate the assumptions they make in their studies, there is a risk that these nuances get lost when the results are used in a non-academic setting.

CASE STUDY 1: MEDICAL LEAFLETS.

In their paper *Carbon footprint of package leaflets: A comparative study on greenhouse gas emissions of paper-based and digital package leaflets for pharmaceuticals*, Dobers et al. (2024) carry out an LCA to compare the greenhouse gas emissions of printed and digital medical leaflets. Data on the printed leaflets were collected by a questionnaire which circulated via 3 associations of the pharmaceutical industry (representing 29 companies), and the data on the digital leaflet was generated via a literature search. The study concludes that the potential reduction of greenhouse gas emissions from replacing a paper-based medical leaflet by a digital leaflet exceeds 90 %. These results rest on several assumptions and limitations including, but not limited to:

- **Functional unit:** The study makes the implicit assumption that the ePLs will include the same content as printed leaflets (whereas other sources, which are in favour of a digitalization of leaflets, used the argument that it can include longer texts, various translations, videos...)
- **System boundaries and consumer behaviour:** there are limitations to the comparability of the systems defined by the authors, especially when it comes to transport emissions (18% of the carbon footprint)
 - For paper leaflets, the carbon emission calculation includes the paper production, the printing, the further processing at the pharmaceutical company as well as the **transportation of the medication boxes including the paper leaflet to the pharmacies/hospitals and ultimately to the patient.**
 - For digital leaflets, **only the emissions caused by the digital provision and the access**

of information through the search of the medicine identification code in an online database have been considered. Comparability is questionable, as it is likely that patients would access digital leaflets via QR codes printed on the medication box. This was not taken into consideration in the research design. If it were to do so, the transport emissions of paper leaflets could have been computed by assessing the emissions caused by the additional weight of the leaflet in the box (and not the weight of the entire box).

o The study does not consider the fact that patients have a right to **‘print on demand’**: Patients can ask their pharmacy or hospital to print the electronic patient information leaflet or print it themselves using a private printer. This environmental impact of printing on demand is omitted from the analysis.

• **Data collection and gaps** (concerning print): The authors admit that, due to the limited time frame of the research process, they were not able to receive an adequate number of details responses to the survey. This meant that some of the data relevant to printed medical leaflets was not available or could not be collected, and assumptions were made instead.

• **Energy mix**: According to the study, electricity accounts for approximately 15% of the total carbon footprint calculated for the paper leaflets. The authors use the German electricity mix, which is a national average. It therefore does not evaluate best environmental practices for print in terms of energy efficiency.

This example showcases how assumption modelling influences results in an LCA. Due to these methodological specifications, the study concludes that printed leaflets perform worse than digital ones. **These results, therefore, may overestimate the environmental impact of printed leaflets.** Alternative research designs are necessary to gain a clearer picture of the environmental footprint of both products.

Moreover, it is important to remember that LCAs follow a micro approach to the debate on the sustainability of print and digital products: they limit their analysis to the environmental impact that can be attributed to the product (in this case, print and digital medical leaflets).. However, on a macro level, the **promotion of digital leaflets is embedded in policies and discourses on digitalization and the environment - the double transition**: transitioning into a greener and more digital society. In this context, it is important to consider **the environmental implications of the digital sector as whole** (as presented in the first subsection).

CASE STUDY 2: BOOKS.

In their study *Role of e-reader adoption in life cycle greenhouse gas emissions of book reading activities*, Amasawa et al. (2017) aimed to identify to what extent e-book reading reduces global warming potential (GWP) of book reading activities relative to that of reading only paper books. Only novels were taken into consideration for this study. The results are mixed and contingent on the number of books read:

- The GWP of e-books breaks even at nine books, provided the e-book reading hour is less than 1.66 h per day.
- The GWP results differ based on the digital device used. The study analyses both e-readers (such as Kindles) and tablets (such as iPads). Consumers of e-readers purchase more than seven e-books annually on average, which resulted in a smaller GWP per book relative to the GWP per paper book. On the other hand, tablet users purchase less than nine e-books per year; thus, tablet users' GWP per book outweighed that of the GWP per book of those who only read paper books.

This example illustrates the importance of **consumer behaviour in analysing the environmental impact of printed and digital products**, notably in this case the number of books purchased and read. The reading time is also an important variable: the longer the reading time, the larger environmental footprint for digital media. Print communication, on the other hand, has a “fixed” footprint: for longer reads, it may be more environmentally friendly to consume printed material.

1.3. CONCLUSION - SUSTAINABILITY

This section explored two main arguments:

1. Digital is not neutral:
 - a. The impact of the ICT sector on the environment is far from negligible: it is responsible for 2-4% of all emissions.
 - b. It is growingly energy consuming, and the energy decreasing effects of digitalization are dependent on energy increasing effects. Moreover, the energy increasing effects are stronger than the energy decreasing effects.
 - c. It produces a substantial amount of waste, which has an unsatisfactory recycling rate compared to paper.
2. The environmental argument for the digitalization of print products can be **methodologically questionable** at times: LCAs rely on assumptions, which can create biases towards one product over the other. **The results of these studies can be easily taken out of context.**

These arguments aim to provide a certain nuance to the trend of digital solutionism (the supremacy of digitalization and digital solutions in addressing environmental issues). In addressing this debate, it is important to

- Distinguish **micro and macro** impacts of the print and digital sector on the environment; to take into consideration how digitalization, as a phenomenon, has negative environmental consequences.
- **Contextualize and critically assess** data which compare print and digital solutions.

2 READING.

From e-books to online textbooks, the digital sphere has made its way into our homes and classrooms. However, it is crucial to examine the enduring role and relevance of printed materials. This section provides an overview of arguments which make a case for the role of print in a progressively digitalized reading landscape, whether in the context of education or leisure.

2.1. EDUCATION

In 2019, more than 200 European scholars and scientists of reading, publishing, and literacy co-signed the **Stavanger Declaration Concerning the Future of Reading**. The declaration follows 4 years of research on digitalization and reading practices, and concludes that print is here to stay:

“In today’s hybrid reading environment of paper and screens, we will need to find the best ways to utilize the **advantages of both paper and digital technologies** across age groups and purposes.” (Stavanger Declaration, 2019)

The following subsections present arguments against a fully digitalized classroom environment.

CASE STUDY: SWEDEN.

In 2017, the Swedish national strategy for digitalization of schools was launched: it advocated for a strong emphasis on developing digital skills and on the inclusion of digital tools in the classroom. Throughout the years, tablets have become the norm and replaced textbooks.

However, in the past five years, Swedish children’s reading comprehension skills fell from “high” to “intermediate” according to the Progress in International Reading Literacy ranking (PIRL).

In response, the Swedish government decided to not proceed with the digitalization strategy. The Swedish government took note of criticisms from neuroscientists and paediatricians and decided **to bring books back to the classroom**. In 2023, the government released the equivalent of €58 million this year so schools can buy new books. In 2024, €44 million will be added. Each student is supposed to have one book per subject.

Sources:

- Government Offices of Sweden. (2024, February 8). Government investing in more reading time and less screen time. Retrieved May 2, 2024, from <https://www.government.se/articles/2024/02/government-investing-in-more-reading-time-and-less-screen-time/#:~:text=The%20Government%20considers%20that%20pupils,access%20to%20staffed%20school%20libraries.>
- Gustafsson, U. (2021). Taking a step back for a leap forward: Policy formation for the digitalisation of schools from the views of Swedish national policymakers. *Education Inquiry*, 12(4), 329-346.

DIGITALIZATION OF THE CLASSROOM: CHALLENGES.

Education is becoming increasingly digitalized, which entails several challenges:

- 1. Evaluation of education technology** - Education technology products **change every 36 months**, on average (UNESCO, 2023). This makes them difficult to evaluate in a peer-reviewed framework.
- 2. The digital divide** - Children are also impacted by the digital divide: “In 2019, **5.3% of children in Europe are digitally deprived**: that is, they lived in a household that could not afford to have a computer and/or lived with adults who claimed they could not afford to have an internet connection for personal use at home” (Ayllón et al., 2021). This digital divide is even more significant in Eastern European countries, such as Romania (23.1%) and Bulgaria (20.8%). More details can be found in the section on the digital divide.
- 3. Privacy concerns** – According to the UNESCO (2023) report on technology in education, **89% of education technology products recommended for children during the COVID-19 pandemic could follow users outside of school hours**. On the European level, this could imply a violation of the General Data Protection Regulation (GDPR): some states in Germany have banned Microsoft products that do not comply with the regulation (UNESCO, 2023).
- 4. Impact on learning outcomes and reading comprehension** – Digital textbooks and teaching material are becoming increasingly present in the classroom. This may have an impact on learning outcomes, which will be discussed in the following paragraphs.

READING OUTCOMES: EVIDENCE FOR A PRINT ADVANTAGE.

Several studies find that print yields greater results compared to digital media in a classroom context. The literature references two main hypotheses:

- **The Shallowing Hypothesis:** According to this hypothesis, reading on screens is synonymous with superficial reading behaviours (quick reading, skimming). This type of behaviour can be transferred to other reading contexts, including in-depth reading materials. Therefore, digitalization has a negative impact on educational outcomes.
- **The Metacognitive Deficit Hypothesis:** Digital texts are often nonlinear and accompanied by multimedia elements, creating distractions. Some readers may find it difficult to monitor their understanding, plan their reading path, and employ effective strategies suited to digital reading. In that sense, readers may be less “in touch” with a text when presented digitally.

Delgado et al’s (2018) meta-analysis on the topic illustrate this claim:

- The authors found that paper-based reading yields larger advantage in terms of reading comprehension **in situations demanding increased mental effort**.
- This is specifically applicable to context of **time-constrained reading** (as opposed to self-paced reading) and **informational** texts (as opposed to narrative texts).

Zivan et al. (2023) provide **neuroscientific** evidence. The study was conducted in Israel, with 15 participants aged 6-8 years old.

- “Results indicated that while reading from a printed paper was accompanied by higher energy in high-frequency bands (beta, gamma), reading from the screen was manifested by a higher power in the lower frequency bands (alpha, theta)”
- In simpler terms, the results indicate that **reading on screen yields more “daydreaming” and less focused attention**. When reading from a paper, their brain activity pattern is more concentrated, **indicating higher-order comprehension and speed, and lower fatigue than when reading on screens**.

Froud et al. (2023) explores similar themes by observing differences in N400 signals (semantic processing) through an experimental study conducted in New York City with a sample of 59 middle-school children.

- The results show “differences in how the brain processes expository text when presented in digital and print medium”, with **digital mediums prompting more shallow engagement**.

Similar results can be found when evaluating test results.

- According to Støle et al. (2020)’s experimental study in Norway (10-year-old students, 1139 participants), children at all skill levels perform better on paper-based tests. However, this difference in results becomes **statistically more significant in a sample of higher-skilled students**.

The studies cited above present print and digital in a dichotomy, which may neglect the complementarity of the two reading technologies. The results of the Academic Reading Format International Study (ARFIS), the world’s largest study of tertiary students’ format preferences and behaviours (n=21,265 students in 33 countries), show that:

- **78% of university-level students prefer print for reading.**
- **82% said they focus best with print.**
- **72% said they remember best with print.**

However, in all countries except Germany and the United States, **responses were balanced between print and electronic**, implying that they are comfortable with either format or use both depending on specific circumstances (Mizrachi et al., 2021).

A DIGITAL GRIP.

“The most likely explanation for the negative correlation between extensive digital reading and reading skills is actually the invisible elephant in the room: **the grip of the digital infrastructure on our existence**.” (van der Weel & Mangen, 2022)

Digitalization has also impacted the way we conceptualize and research reading comprehension. Van der Weel & Mangen (2022) critique the digital delivery of the 2018 PISA test (the OECD’s Programme for International Student Assessment): they argue that digitalization has skewed its definition of reading comprehension by:

- Emphasizing on multiple-source texts
- Increasing multimodal materials (which reflects reading on the internet)
- Focusing on “reading as information processing for the purpose of efficient navigation and access”

This entails that the research design is modelled after digital reading, which decreases the focus on single texts and disregards narrative texts. More importantly, according to the authors, it disregards **higher levels of reading**: “testing different interpretations, finding patterns and unusual language in the text, detecting and differentiating different meanings, subtexts, contradictions, biases and ideologies, or connecting the text with other texts or cultural backgrounds.”

RESEARCHING READING COMPREHENSION: NUANCES TO TAKE NOTE OF.

It must be noted that there is no scientific consensus on the notion of print supremacy in reading comprehension, with results varying from positive to negative. These differences may be influenced by the methodologies and samples used in the research.

Peras et al. (2023) identify several factors which may influence differences in reading comprehension on print and digital mediums:

- **Individual-level:** students' prior comprehension skills, reading strategies, motivational constructs.
- **Family-level:** the number of (physical) books at home and parental enjoyment of reading
- **School-level:** usage of ICT resources in schools
- **Socioeconomic status:** the higher the socioeconomic status, the higher the level of reading comprehension

In Furenes et al. (2021)' meta-analysis, the researchers argue that results also depend on the design of the digital books: When paper and digital books are practically the same, the authors argue that print yields higher results in terms of story comprehension and vocabulary learning. **The inclusion of enhancements** in e-books can counter this screen inferiority effect.

2.2. LEISURE

A growing body of literature is focusing on **experienced readers' perceptions of printed and digital books**. Experienced readers swap between books, e-books, and audiobooks **based on their perceived benefits and the reading context**. Kosch et al. (2022) argue that the growth of e-books has expanded experienced readers' reading (in terms of purchase decision, quantity, location...). **This entails that they do not replace physical books: they complement them**. The following characteristics may influence the decision to read a text physically or digitally:

- **The complexity of the text:** audiobooks and e-books allow for "light and ambient literature consumption" (Spjeldnæs & Karlsen, 2022), and printed books may be more practical for heavier reads (which require going back and forth in the text) (Kosch et al., 2022)
- **Daily reading:** Digital literature allows readers to benefit from features that printed books do not necessarily have – the availability, weight, and personal customisation of e-books are attractive features for daily reading (Spjeldnæs & Karlsen, 2022).
- **Physicality:** Printed books can act as "visible reminders of their personal intellectual history and of past reading experience" (Kosch et al., 2022).
- **Memory and retention:** "A printed book as an object is perceived as a reminder of the specific content of a book, the reading place, and the particular situation in which it once was read." (Kosch et al., 2022).

OECD data also note a certain **association between the choice of reading medium and leisure reading time amongst students**: "Compared to students who rarely or never read books, digital-book readers across OECD countries read for enjoyment about 3 hours more a week, print-book readers about 4, and **those who balance both formats about 5 hours or more a week**" (OECD, 2021).

2.2. CONCLUSION - READING

The academic literature on reading, while not unanimous, hints that print still holds a fundamental role in facilitating reading comprehension.

- In the context of education, physical books remain an important learning tool for students, especially when dealing with complex topics and long reads.
- Digital mediums may prompt more shallow reading and daydreaming. However, digital tools can improve student engagement if designed efficiently.

They provide different benefits and possess different attributes. Therefore, it can be concluded that one should not replace the other. **Digital media expands the definition of reading but does not replace the functions of a print book.**

It must be noted that comparative studies in the leisure reading context have their limitations. They are exploratory in nature, meaning that they tend to follow qualitative methods (focus groups, interviews) with a small sample size, in contrast to the large-scale surveys that can be found in the literature on education. Moreover, there is a focus on experienced readers: the data presented in this subsection may not apply to casual readers or students.

3 MARKETING.

What is print's role in a digitalized marketing landscape? Amidst a sea of emails, social media ads, and digital banners, print marketing cuts through the digital noise to make a lasting impression. More than 58% of consumers don't pay attention to online adverts (Two Sides, 2023). In this context, research shows that **print marketing still holds significance** in the marketing mix of businesses and **complements digital marketing tools**: It creates media synergies by increasing online engagement, sustains customer retention, drives purchasing behaviour, and possesses a unique "lock-in power" which allows businesses to retain customers.

3.1. INTERACTIVITY AND INVOLVEMENT

Digital media (including digital and social media advertising and marketing) has the advantage of being **interactive**, which leads to **customer involvement**.

- "Mobile advertising can extensively involve consumers with contextual messages that can engage and stimulate. Thus, mobile advertising can **involve consumers, develop interactions, provide seamless and pleasing experience, which eventually develops positive attitude towards the brand and develop purchase decisions.**" (Dwivedi et al., 2021)
- In a digital and social media context, **consumers play a greater role in shaping their experiences with brands**. This involvement gives them the possibility to "create (or destroy) value for an organisation through purchase-related behaviours as well as through influencing others, generating knowledge exchanges and co-creation/developing behaviours with brands." (Dwivedi et al., 2021)
- Customers also **interact with one another** to make purchasing decisions (through online reviews and ratings, for example).

Digital media can also provide a **tailor-made experience** for customers, as demonstrated by the example of **location-based advertising (LBA)**.

- "LBA facilitates comparison among stores, location, entertainment, or shopping and helps the marketers as well as consumers by **connecting the "when" and "where" elements**. Further, the weather associated with a location also have significant role in determining effectiveness of mobile advertising on consumers." (Dwivedi et al., 2021)
- While LBA has existed for a long time (i.e. through billboards), digital media provides an interactive experience which can answer customers' immediate desires and needs.

However, there are several ethical considerations to take note of when discussing the advantages of interactive digital advertisement media:

- **Intrusive advertising**: digital and mobile advertisements, in the form of pop-ups and banner notifications for example, can interrupt the activities of the customer, which can lead to negative associations and irritation. (Dwivedi et al., 2021)
- **User misbehavior**: this may include harassment, spreading fake news, writing fake reviews...
- **Microtargeting and data privacy**: brands may "weaponize" user data (demographics, interests, likes, fears..) to precisely target the marketing messages. There have been several scandals involving microtargeting and user data, notably the Cambridge Analytica scandal (during which personal data belonging to millions of Facebook users were collected to be used for political advertising purposes, without their consent).
- **Targeting vulnerable groups**: Children and teenagers are vulnerable groups which consume

digital media on a daily basis. From an advertisement perspective, this can make them exposed to unhealthy products (unhealthy foods, tobacco, alcohol...)

- o In their meta-analysis on advertising and critical reasoning abilities, Packer et al. (2022) assessed that “that children’s understanding of advertising intent was limited and not nuanced”: they can recognize that adverts are trying to sell them products, but not that they were intended their attitudes or behaviors.

- o The authors argued that this problem remains present amongst teenagers, as media (including social media) plays an important role in their social identity development: “Digital marketing, especially on social media, is designed to target these unique developmental vulnerabilities.” (Packer et al., 2022)

- o While this issue is present in all forms of advertisements, it is particularly present in digital marketing: “Understanding was **lower for digital compared with nondigital formats, and lower when children were more involved with the medium** (eg, advergames or online advertising). This is unsurprising since digital advertising is more integrated and, therefore, may be **less explicit and more difficult to identify and understand, in addition to greater personalization and targeting**”.

3.2. BRAND RECALL, CUSTOMER BEHAVIOR, AND RETENTION

Despite the advantages of interactivity in digital marketing (which favours customer engagement), print media still has an interesting impact on brand recall, as well as customer behavior and retention.

CUSTOMER RETENTION.

With digitalization comes the risk of alienating customers who prefer printed products. While digital marketing provides benefits in terms of customer acquisition, fully digitalization a brand’s marketing operations may come at a cost:

“By shifting to online communication, however, retailers may reduce the reach previously granted by print. Retailers that wish to sustain reach could opt for a mix of print and online communication.” (Ieva et al., 2017)

CUSTOMER BEHAVIOUR AND BRAND RECALL: A NEUROSCIENTIFIC PERSPECTIVE.

Direct mail marketing’s benefits can be demonstrated using neuroscience data:

“The brain’s “default network” appeared to remain more active when viewing direct mail. Activity in this brain network has been associated with a greater focus on a person’s internal emotional response to outside stimuli. This suggests that the individuals were relating information to their own thoughts and feelings.” (Millward Brown, 2009)

A report commissioned by Canada Post (2015) also argues that direct mail has a strong response-driving power compared to digital mails:

- Physical media requires **21% less cognitive effort** to process and elicits a much higher **brand recall** (75% for physical, 44% for digital)
- Physical media’s **motivation response** is 20% higher than digital (according to the report, a 2-5% positive difference is usually considered to be a predictive indicator of future behavioural change.)

- “Direct mail is **visually processed quicker** than digital media”: Digital media elicited more time on Average Attention on Areas of Interest (price, product, logo, social context), with an average of 3.119 ms compared to 2.261 for physical media.
- “Physical mail is more likely to **drive behaviour**¹ than digital media: Direct mail surpasses the important motivation-to-cognitive load ratio threshold of 1”, with direct mail achieving a motivation-to-cognitive load ratio of 1.31, and digital media scoring 0.87.”

This data, while imperfect due to the date of publication and lack of peer review framework, provide interesting insights into how the medium of a marketing message influence its impact.

3.3. “LOCK-IN” POWER AND ATTENTION

Print marketing can captivate attention without the distractions of digital screens: It has “**lock-in**” power.

- Unlike fleeting online advertisements, printed materials often linger in households or workplaces, providing **repeated exposure** to the brand message and enhancing brand recall over time.
- They also **do not have to compete for screen time**, an increasingly scarce resource.

According to a report by JICMail (2023), this translates into increased attention: The average Direct Mail item generates 108 seconds of attention across 28 days; Business Mail 150 seconds; Partially Addressed 64 seconds; and Door Drop 46 seconds.

Mark et al. (2019) explain this feature in their discussion on the role of printed catalogues in a digital marketing landscape:

“A catalogue, well-designed and rich in content, is likely to be kept around for a long enough time that consumers can take their time looking through it.” (Mark et al., 2019)

This ability to “lock-in” the customers’ attention highlights the economic efficiency of print marketing media, as highlighted by the data provided by JICMail (2023) summarized in the chart below

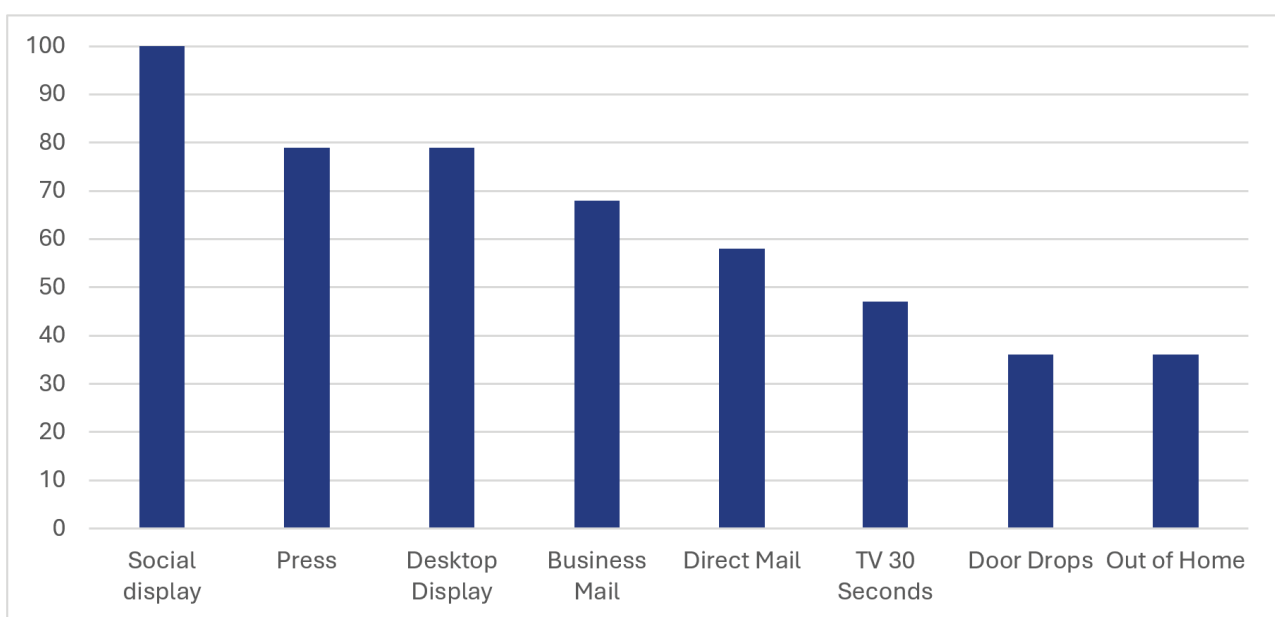


Figure 3 - Indexed cost per time unit of attention per marketing media type, Index: Social display = 100, JICMail (2023)

¹ “noticing an item among its competitors, seeking out more information, showing a stronger emotional response towards a stimulus, or ultimately making a purchase.”

3.4. MEDIA SYNERGIES

The integration of print and digital marketing strategies fosters powerful media synergies, maximizing reach and engagement across both traditional and online platforms.

- Lesscher et al. (2021) argue that printed direct mail has “**direct and indirect** impact on consumers’ **purchase behavior** and **synergy with display advertising.**”
 - Print and digital channels can fulfill different functions within a marketing mix. For example, door drops could contribute to customer brand awareness and acquisition, while email marketing could contribute to customer retention (i.e. renewing a subscription) (JICMail, 2023)
- From a Business to Business (B2B) perspective, companies in the financial services industry, but also in the digital sector, still use direct mailing as a client acquisition tactic. Google uses direct mailing to contact prospects (Lesscher et al., 2021)
- The example of QR codes highlight the interplay between print and digital advertisements: “QR codes steer purchase intention in a low-involvement product category if used alongside an emotional appeal. Advertisements for high-involvement products benefit if QR codes are combined with an overall informational appeal.” (Triverdi et al., 2019)

3.5. CONCLUSION - MARKETING

Despite the increasing trend towards digital marketing, print media (such as brochures, printed catalogues, door drops, and others) still holds an important role in companies’ marketing mix. It synergizes with digital efforts, retains customers, and possesses unique “lock-in” power. Research suggests it elicits stronger emotional responses and drives behaviour change compared to digital media. Therefore, adopting a balanced approach that incorporates both print and digital marketing tools is vital for maximizing marketing effectiveness.

Moving forward, further research in this domain could give greater insight. Firstly, using more recent data could better reflect the current (post-pandemic) marketing landscape. Secondly, further peer-reviewed neuroscience research on the topic could greatly contribute to the legitimacy of the claims presented. Thirdly, a more comprehensive study on customers’ current perceptions and attitudes towards print and digital marketing could be beneficial for marketers and industry professionals alike.

THE DIGITAL DIVIDE.

Print communication is necessary to reach out to those who are left behind by digitalization. The digital divide remains an important problem in the EU, despite digitalization efforts. This divide can be witnessed in terms of access, skills, and integration.

4.1. ACCESS

“Internet access is accessible to the majority of the European countries’ populations (ranging from 75 to 98%).” (Van Kessel et al., 2022) However, there are discrepancies in terms of **internet access rates**:

- **Inequalities between regions:** The rate is higher in North and North-West than other European regions (94-98% compared to 89-91% in Central and South-West and 75-87% in South and East) (Van Kessel et al., 2022)
- **Inequalities between Member States:** In 19 Member States, less than 3% of households lacked fixed broadband coverage, whereas in Lithuania, Poland, and Romania, over 10% of households lacked access to fixed broadband services (EPRS, 2022)
- **Inequalities between rural and urban areas:** There is a 7.7 percentage points difference between the availability of fixed broadband services in rural areas (89.7 %) and in all areas combined (97.4 %) (EPRS, 2022)

4.2. SKILLS

“It may be ill-advised to interpret the EU as a homogenous region in terms of digital skills” (van Kessel et al., 2022).

The Commission’s definition of digital skills rests on 5 pillars Individuals are considered possessing “at least basic level of digital skills” if they have basic or above skills in the following:

- 1. Information and data literacy:** browsing, searching, and filtering data and content, evaluating data and content.
- 2. Communication and collaboration:** interacting, sharing, engaging in citizenship through digital technologies.
- 3. Digital content creation:** developing, integrating, and programming digital content.
- 4. Safety:** protecting devices, personal data, and privacy
- 5. Problem solving:** solving technical problems, identifying needs and technological responses

According to Eurostat (2023) data, **more than 44% of Europeans do not have basic digital skills.** However, there are notable **regional differences** within the EU. In Northern and Northern-Western Europe, more than 50% of individuals possess above basic digital skills. **In contrast, less than 20% of individuals in South-Eastern Europe have above basic digital skills.** (van Kessel et al., 2022). There are also national differences: For example, only 17% of individuals in the Netherlands lack basic digital skills. In Romania, however, more than 72% of the population lacks those skills.

“The groups that could potentially benefit most from the uptake of digital technologies tend to be the groups that are faced with the biggest barriers to access” (van Kessel et al., 2022)

This gap can be seen across different individual-level factors. Vulnerable groups (individuals living in rural areas, with lower levels of formal education, older citizens...) are more likely to have limited digital skills, and therefore neglected by digitalization:

- **Education:** Amongst 25–54-year-olds, 84% of those with a high level of formal education have at least basic digital skills, whereas only 35% of those with a low level of formal education possess those skills (Figure 5).
- **Age:** More than half of European individuals aged 55-64 don't have basic digital skills. 72% of European individuals aged 65-74 have no basic digital skills. Internet engagement was reported by only 20% of respondents aged 75 and above in the EU, in contrast to 98% among individuals aged 16 to 29 (EPRS, 2022)

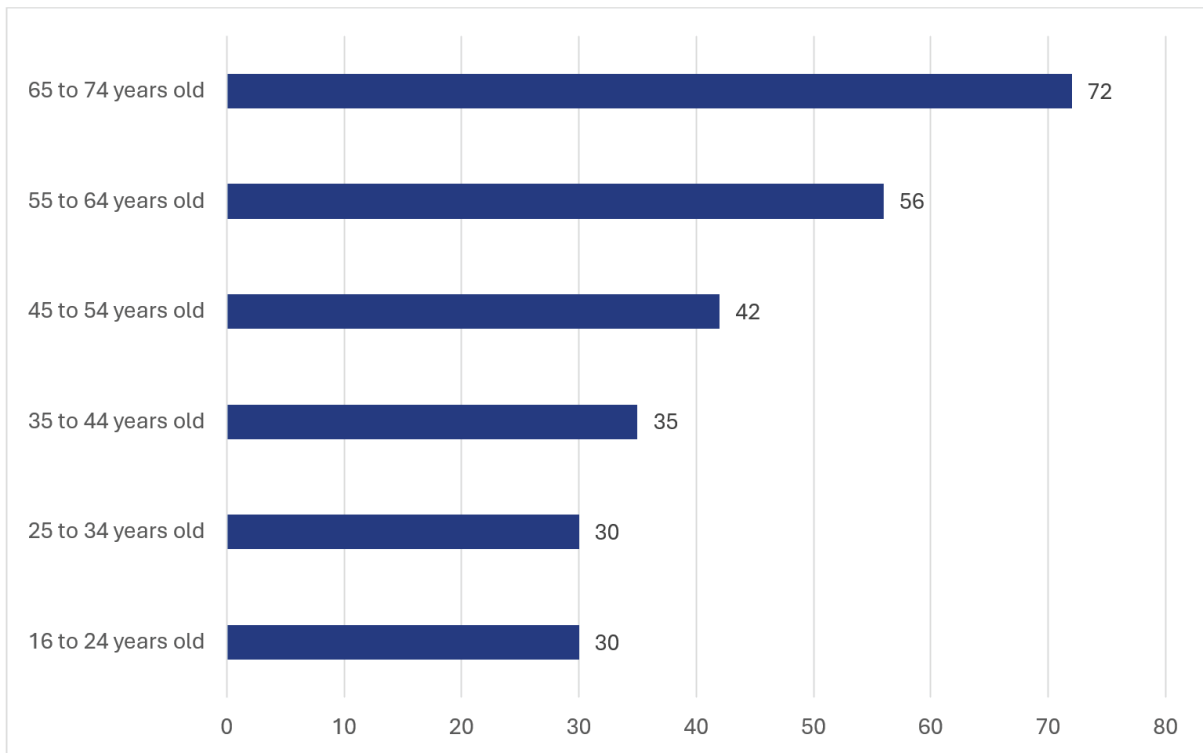


Figure 4 - Share of individuals without basic digital skills, by age group, EU-27, in % (Eurostat, 2023)

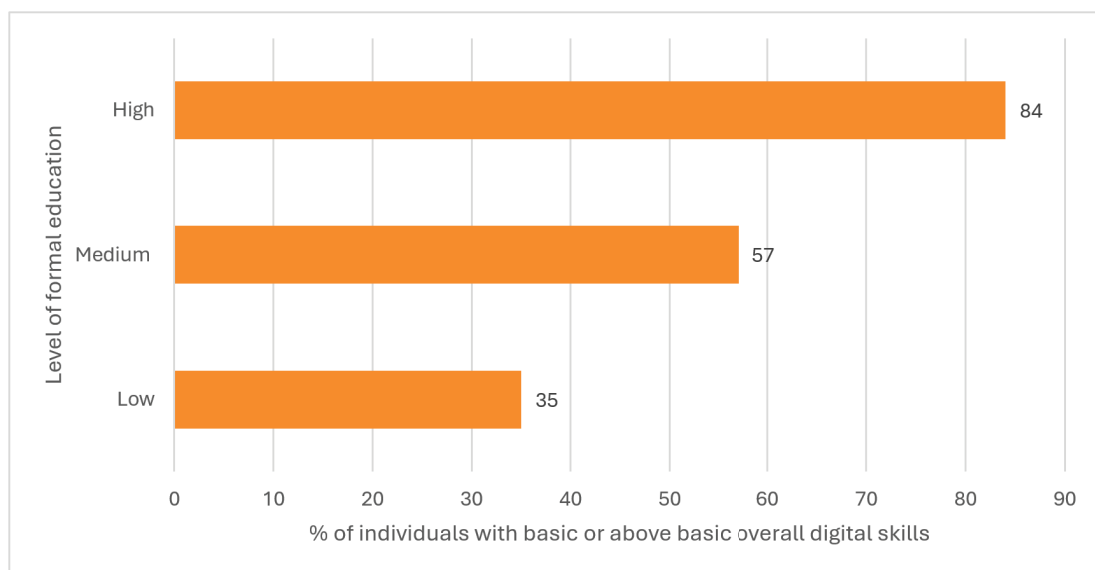


Figure 5 - Share of individuals with basic or above basic overall digital skills, 25-54 year olds, by level of education, EU-27, in % (Eurostat, 2023)

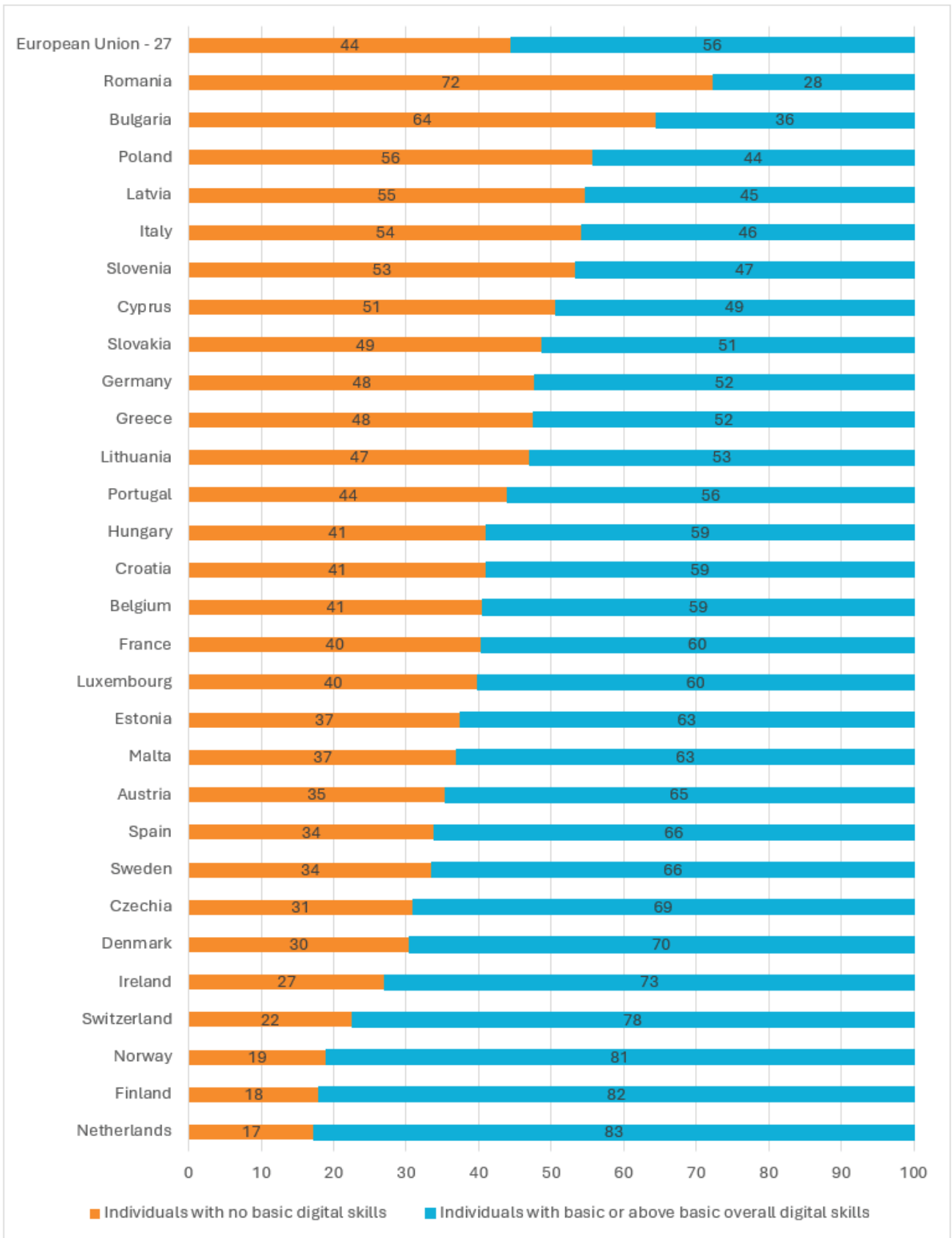


Figure 6 - Digital skills in the EU, in % (Eurostat, 2023)

4.3. INTEGRATION

The digital divide is also present in the digital integration of companies and organizations. In 2020, 60% of small and medium-sized enterprises (SMEs) registered in EU-27 countries had integrated digital technologies in their operations (Eurostat, 2020). Disparities persist among countries: Denmark and Finland are nearing the EU target at 88%, whereas Bulgaria and Romania lag at 33% (EPRS, 2022).

The problem of access remains problematic at the rural level, where it is more difficult to secure a functioning internet connection than in urban economic centres (Esteban-Navarro et al., 2020). However, providing access to high-speed internet is not sufficient to encourage economic growth in rural areas. For example, The French plan Auvergne très haut débit, which aims to expand access to fibre optic internet to the Auvergne region of France did not significantly contribute to rural development except in specific sectors (hostelry; public administration, education, health, and social work) (Esteban-Navarro et al., 2020).

4.4. DIGITALIZATION AND THE DIGITAL DIVIDE

The impact of this digital divide is keenly felt amidst the burgeoning landscape of digitalization. For instance, e-health, e-government, and e-banking stand as pivotal arenas in which these disparities manifest themselves.

E-HEALTH.

“The pandemic has caused a situation in which the access to the internet seems to have become necessary even for survival, especially if it is related to health issues.” (Esteban-Navarro et al., 2020)

According to DG-Connect’s (2022) report on e-Health indicators, there are four “gaps” that can be identified in the digital transformation of the European health sector:

- **Data gaps:** Electronic medical records, including medical imaging reports, hospital discharge reports, and to some extent laboratory test results, remain the most challenging category of data to access for citizens across most EU27 member states.
- **Data supply gap:** The proportion of private healthcare providers connected to data infrastructures and offering relevant health data for EU27 citizens, particularly beyond primary and secondary care, is low, necessitating collaboration between Member States and private providers.
- **Digital equity gap:** Half of the surveyed Member States fail to ensure fair access opportunities in accordance with Directive (EU) 2016/2102 (Web Accessibility Directive), resulting in a “digital equity gap” for vulnerable groups across the EU27.
- **Harmonization gaps:** Half of the member states have yet to align their authentication systems at the European level, creating a “harmonization gap” for secure and mutually recognized access to electronic health records.

E-GOVERNMENT.

Through e-government initiatives, governments aim to streamline administrative procedures, improve citizen engagement, and foster innovation in public service delivery. However, disparities persist across the EU. According to Eurostat, 58% of internet users interacted with public administration online in 2021, compared to 46 % in 2015. This is still far from the target of getting 80 % of citizens using them by 2030 (EPRS, 2022).

The data provided in Figure 7 illustrates that:

- **“The higher the activity required by the citizens, the lower the adoption”** (Botrić & Božić, 2021): the adoption rate for interaction with public authorities is 58%, while the adoption rate for obtaining information from public authorities’ websites (47%) and downloading official forms (38%) is lower.
- The difference in adoption rate between age groups is particularly noticeable amongst **older citizens**. For example, only 22% of citizens reported downloading official forms in the past year.

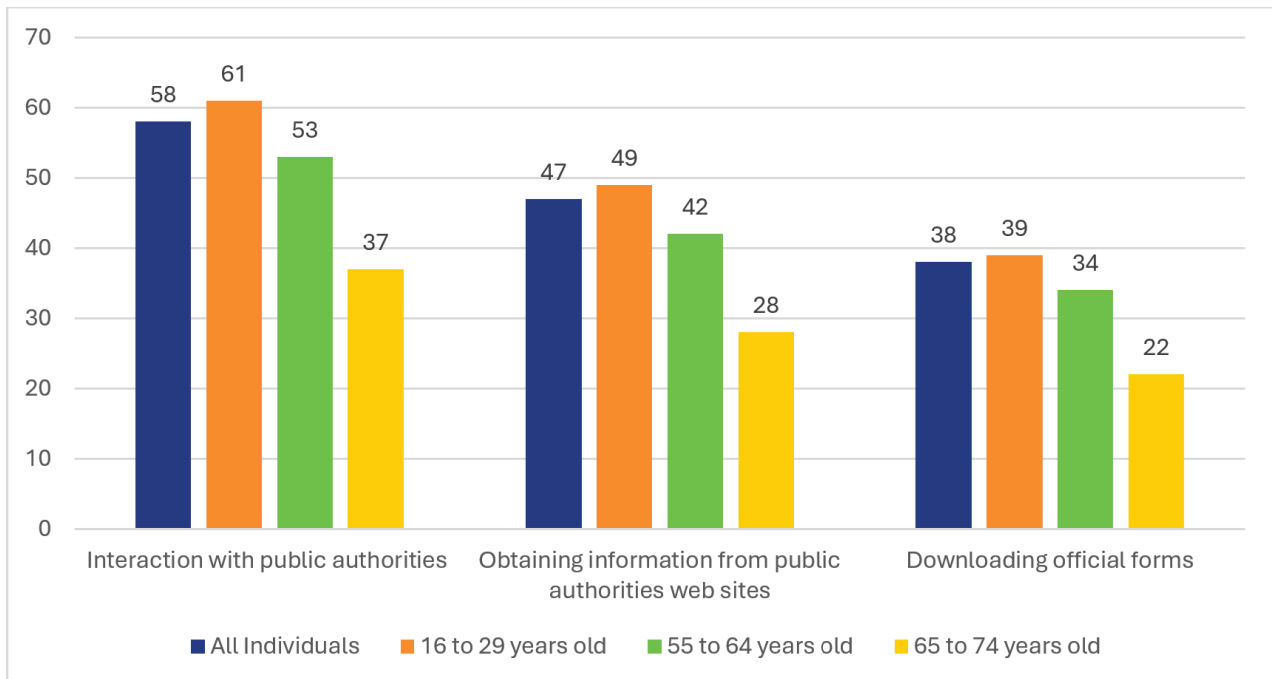


Figure 7 - E-government activities of individuals via websites, last 12 months, by age group EU-27, % of individuals (Eurostat, 2021)

E-BANKING / FINTECH.

The use of financial technology (fintech) declines with age. Data from World Bank Findex for 136 countries show that on average, over 40% of those younger than 40 use digital payments, but less than 25% of those of age 60 and above do (Doerr et al., 2022):

“They are also less willing to use a fintech entrant or share their personal data for cheaper offers; or use a fintech even if it offers better products or products that are better suited to the respondent’s lifestyle. Thus, **the perceptions of the benefits of using fintech services may be lower and the costs of getting used to new technology higher.**” (Doerr et al., 2022)

CHOICE AND SECURITY.

According to Two Side's 2023 Trend Tracker, 76% of European respondents expressed their desire to be able to choose how they receive bills and statements (electronically or in print) (Two Sides, 2023). **Print, therefore, is not just a tool to reach out to those who are on the margins of digitalization (in terms of access or skills). Consumer preferences, and the right to choose, are also important variables to take into consideration.**

This desire to choose modes of communication is often informed by **security concerns**. More than half (56 %) of the EU citizens surveyed expressed their concern about **cyber-attacks and cybercrimes in society**. (EPRS, 2022). **71% of European consumers have privacy concerns regarding personal information being held electronically, with 73% believing that keeping hard copies at home is a safe and more secure way of storing information** (Two Sides, 2018).

4.5. CONCLUSION - THE DIGITAL DIVIDE

“Europe is currently unable to host a sustainable digital society without exacerbating cross-country inequalities due to substantial differences in internet access and digital literacy.” (van Kessel et al., 2022)

Despite a growing trend towards digitalization, inequalities persist in terms of use, skills, and integration. Vulnerable groups, such as older individuals or individuals living in rural areas, are the most affected. There are also regional inequalities: North-Western Europe is more equipped to digitalize its economy than other regions of the continent. In this context, print holds an important role: it can reach citizens who are in the margins of digitalization. Such inequalities need to be taken into consideration in policy design and analysis to make sure no one is left behind.

CONCLUSION.

This report invites stakeholders to acknowledge the complexities of the literature on print and digital communication.

Communication is a multifaceted notion, and each communication tool has its own advantages and properties. The literature shows that print communication remains an important tool in our digital environment:

- Digital media expands the definition of **reading** (how, what, where, and when we read) but does not replace **the functions of a print book**: they are an important learning tool, specifically in situations which require a high level of concentration. In a learning context, printed books are also more efficient in terms of reading comprehension for longer, more complex reads.
- Brochures, printed catalogues, door drops, and other print marketing tools still hold an important role in companies' **marketing mix**: they foster synergies with digital marketing, drive purchasing behaviour, and possess a unique “lock-in” power.
- **The digital divide** remains a pressing issue across the Union, especially amongst vulnerable groups. In this context, print communication remains an important tool to reach citizens who are on the margins of digitalization.

Therefore, there should be greater emphasis on **the complementarity of communication tools**, as opposed to their substitution.

It is also important to **be critical of the methodologies used in studies assessing print and digital communication tools**. This is particularly relevant to the topic of **sustainability**. LCAs depend on assumptions: they highly influence the studies' results, which may be easily taken out of context and create biases towards one mode of communication over the other.

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