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THE USE OF PAPER IN THE ERA OF DIGITALIZATION - CASE OF JELGAVA'S EDUCATION SYSTEM

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Humanity has known and used paper for millennia, but in last decades along with technological progress and available alternatives, the discussion about the use of paper increased significantly due to its significant impact on nature and to economic development and overall efficiency. Paper provides insight about risks of continuing in same pace to use paper and gives view on some most important benefits for transition from analog to digital format. Covid-19 pandemic showed perfectly importance of digitalization and many weaknesses as well. Analysis of theoretical literature and everyday life gives evidence, that we are in long cycle of information transforming, which leads to more decrease of the use of paper in future. Paper is based on real life data from Jelgava`s education system including 25 institutions of all levels – from preschool to gymnasiums, as well as other types too. Research shows tendencies, that from 2018 – 2021 the use of paper decreased to a large extent (-67,5%), while expenditures on digital platforms grew impressively (+501,4%). However, 2022 highlighted those changes were non-persistent and showed the impact of Covid-19 containment measures on these processes, which reflected after restriction were lifted in strong rebound in the use of paper. Yet the Covid-19 pandemic gave an opportunity to see what the digitalization path looks like and what we need to do to achieve it.

Keywords: *use of paper; digitalization; education system, Covid-19 impact.*

INTRODUCTION

Although the concept of a paperless office has gained traction since the late 1960s, today paper still retains an important function in recording and storing information. (Amankwah-Amoah, Khan, Wood & Knight, 2021).

The debate on balancing paper and digital format is active, especially in the context of ecology and sustainable development. Many prefer the paper format because there are studies that indicate that reading texts on paper results in better retention of information than reading from a monitor (Clinton, 2019).

However, the arguments for the transition to a digital format (digitization) are considerable:

- Around 300 million tons of paper are produced annually in the world;
- The amount of paper used in the largest paper consuming country (30% of the world's volume) – the USA increased by 126% in the last 20 years (from 92 million t to 208 million t);
- On average, each office employee consumes around 10,000 sheets of paper per year, of which 45% is disposed of as waste;
- A typical office worker spends 30-40% of his working time on paper filing and searching for necessary information;
- More than 70% of companies may suffer severe operational and financial difficulties within three weeks if their paper documents are lost (fire accident, natural disaster);
- Storage of documents for each four-drawer filing cabinet, which contains around 10,000 – 12,000 pages and occupies an area of ~0.8 m2, costs USD 1,500 per year;
- Without changing anything, paper consumption doubles in 3.3 years (22% per year) (O`Mara, 2021).

The above real-world data demonstrates the benefits and implications of digitization for sustainable development in the context of data storage. It can be concluded that the conversion of analog (paper) material into digital format allows:

- reduce the pressure on the volumes of felled trees, which have a beneficial effect on the environment;
- significantly save the working time of human resources;
- protect organizations from significant risks in their operations;
- reduce existing and increasing future costs related to document storage and accounting.

For the purpose of rational use of resources, the largest publishers of teaching aids are switching to a digital first strategy, and thanks to the availability of free online course materials, the proportion of their users are rapidly increasing (from 3% in 2015 to 22% in 2019), as well as allows the users themselves to save financial resources (Barshay, 2019).

By going digital, organizations reduce their reliance on paper documents and provide greater opportunities for employees to access information by reducing costs associated with printing or managing physical paper flows. Also, by moving from a paper-based to a digitally-oriented approach to information storage, distribution, and processing, organizations can improve overall resource management processes by reducing administration costs. (Amankwah-Amoah et al., 2021).

In addition, the Covid-19 pandemic has highlighted the importance of digitalization in everyday life and created pressure to move more from paper to digital format in many services pointing out big changes.

Here we can remember two prominent economists – Nikolai Kondratiev and Joseph Schumpeter with long economic cycle theories. The last coined the term „Kondratiev Waves" in respect for Nikolai Kondratiev, because he saw in Nikolai Kondratiev's ideas about the long wave cycle that they were driven by technological innovation (McCraw, 2006). Other researchers also writhe about Kondratiev waves that "after the steam, steel, electricity, and petrochemical revolutions, network-based digitalisation is the driving force today on the stage of business and private life" (Vogelsang, 2010). Their theories are backed up by statistics - today services are accounting for 80% of economic output in almost every developed economy across the world. For instance in UK share of services have grown by 30% over the past 20 years, but by comparison, gross domestic product (GDP) generated from selling products has contracted. (Baines, Bigdeli, 2020). This can also be applied to paper and digitalization – as paper can be seen as part of GDP of tangible goods and digitalization as service share of GDP.

According to (Hilbert, 2022) we can distinguish three different long-term metaparadigms, each with different long waves. The first focused on the transformation of material, including stone, bronze, and iron. The second, often referred to as industrial revolutions, was dedicated to the transformation of energy, including water, steam, electric, and combustion power. Finally, the most recent metaparadigm aims at transforming information.

Paper is based on believe that this long cycle of information transforming is happening (we could call it era of digitalization), and it should impact also use of paper. Basis of the work is the real life data and the aim is to find out impacts and volumes of use of paper in period from 2018 to 2022 (including Covid-19 pandemic period) in case of Jelgava`s education system. Research object - Jelgava education system. The subject of the research - the impact of the use of paper on the educational system of Jelgava.

RESEARCH METHODS

In the first phase aim was to obtain data and study real statistics of the use of paper in 25 Jelgava educational system institutions for the period from 2018 to 2022 (Table 1).

Table 1. Type and number of educational institutions

Type of educational institution	Number of institutions
Preschool	11
Elementary school (incl. primary school)	3 (1)
Secondary school (incl. gymnasium)	5 (2)
Special	2
Interest	1
Professional orientation	1
Professional	1
Administration (Board of Education)	1

In second phase - to analyse various indicators - frequency of orders, number of papers, price, investments in digital technologies, number of employees and pupils, as well as other relative indicators per 1 employee or pupil, a total of 13 indicators were selected and analysed.

Massive data (about 950 entries) about paper and equipment orders in educational institutions was obtained through Latvian Electronic Procurement System (LV: *Elektroniskā Iepirkumu sistēma - EIS*), a platform where municipal institutions can order means of maintenance of the institution in compliance with the procurement law. Data about digital platforms is from each institutions budget annual actual reports. But information about number of employees (pedagogical and technical staff) and pupils comes from State Education Information System (LV: *Valsts Izglītības informācijas sistēma – VIIS*) and institution staff list. The collected and summarized information is shown in Table 2.

All information includes last full 5 years. The number of pupils and employees is on September 1 of each year.

Printing equipment includes – printers and copiers, but digital equipment - demonstration equipment, computers, monitors, TV`s.

Official standard A4 paper sheet size (0,297 m x 0,210 m) has been used, converted in square meters (m^2) – 0,06237 m^2 (Proflags, 2023).

To calculate weight of 1 A4 sheet, we used technical information from manufacturer of the paper (80 g/m^2), so 1 A4 size paper weights 0,00499 kg.

Table 2. Summary of indicators for 2018 – 2022.

Indicator / year	2018	2019	2020	2021	2022
paper sheets, number	3 111 500	2 857 500	2 456 000	1 010 000	2 911 250
price of 1 box [1], EUR	14,08	14,18	13,88	14,15	20,96
total paper, EUR	17 247,35	16 011,38	13 433,67	5 689,65	24 187,78
printing equipment, EUR	18 476	8 960	8 660	7 162	10 195
digital equipment, EUR	179 186	150 315	118 270	202 345	127 027
digital platforms, EUR	12 694	13 126	37 862	76 337	190 178
number of pupils	10 463	11 297	11 555	11 444	11 810
paper, EUR per pupil	1,65	1,42	1,16	0,50	2,05
paper, sheets per pupil	297	253	213	88	247
digital platforms, EUR per pupil	1,21	1,16	3,28	6,67	16,10
number of employees	1 671	1 704	1 773	1 795	1 745
paper, EUR per employee	10,32	9,40	7,58	3,17	13,86
paper, sheets per employee	1 862	1 677	1 385	563	1 668

Note: [1] 12 500 sheets per box

Two different open methodology used to calculate how many trees are needed to produce consumed paper. According to the first one (a) from one tree we can produce 8616,42 A4 size paper sheets (Conservatree, 2023). In turn according to the second (b) to produce 1 ton of printing paper approximately 24 trees are required (Reunion Technology Inc., 2023).

To calculate, how many paper sheets are needed to cover footbal field, we used Zemgale Olympic Center football field size, which is located in Jelgava, Latvia and which meets the requirements of the UEFA (Zemgales Olimpiskais centrs, 2023).

RESEARCH RESULTS AND DISCUSSION

Analysis of summarized information from Table 1 shows valuable insight about changes between indicators by years, which is shown in Table 3.

Table 3. Changes of indicators in 2018 – 2022.

Indicator / changes, %	2019/2018	2020/2019	2021/2020	2022/2021	2021/2018	2022/2018
paper sheets, number	-8,2%	-14,1%	-58,9%	188,2%	-67,5%	-6,4%
price of 1 box [1], EUR	0,7%	-2,1%	2,0%	48,1%	0,5%	48,9%
total paper, EUR	-7,2%	-16,1%	-57,6%	325,1%	-67,0%	40,2%
printing equipment, EUR	-51,5%	-3,4%	-17,3%	42,3%	-61,2%	-44,8%
digital equipment, EUR	-16,1%	-21,3%	71,1%	-37,2%	12,9%	-29,1%
digital platforms, EUR	3,4%	188,4%	101,6%	149,1%	501,4%	1398,2%
number of pupils	8,0%	2,3%	-1,0%	3,2%	9,4%	12,9%
paper, EUR per pupil	-14,0%	-18,0%	-57,2%	311,9%	-69,8%	24,2%
paper, sheets per pupil	-14,9%	-16,0%	-58,5%	179,3%	-70,3%	-17,1%
digital platforms, EUR per pupil	-4,2%	182,0%	103,6%	141,4%	449,8%	1227,3%
number of employees	2,0%	4,0%	1,2%	-2,8%	7,4%	4,4%
paper, EUR per employee	-9,0%	-19,4%	-58,2%	337,3%	-69,3%	34,3%
paper, sheets per employee	-9,9%	-17,4%	-59,4%	196,5%	-69,8%	-10,4%

Note: [1] 12 500 sheets per box

Analysis shows, that according to tendencies, we can divide 5-year period in two parts: from 2018 till 2021 and from 2022. In the first period from 2018 till 2021 overall tendency shows, that paper usage was decreasing each year, and it dropped 67,5% in 2021 comparing to 2018. While the price of paper was relatively stable varying within 2% and it also resulted in massive drop of total expenditures on paper in this period (67%).

Expenditures on printing equipment also in first period decreased each year (-61,2% in 2021 comparing to 2018). Similar trend was in expenditures in digital equipment such as computers, monitors, but huge investments in 2021 (+71,1% to 2020), levelled decrease of previous years resulting in total increase from 2018 till 2021 (+12,9%).

Number of pupils (+9,4%) and employees (+7,4%) in first period (and overall) are increasing, thereby similar trendline are in indicators, which show changes per pupil/employee. For instance, expenditures paper per pupil drops by 69,8% in 2018-2021, but paper sheets per pupil decreased even more – by 70,3% in the same time. Similar changes happened with indicators per employee – 69,3% and 69,8% respectively.

However, simultaneously with trends mentioned above, opposite happened with expenditures in digital platforms. Each year more than double increase since 2020 – a whopping 501,4% in 2018-2021 period (and 449,8% per pupil in the same time).

But great U-turn happened in 2022, when almost every indicator rose significantly against 2021. Combination of post Covid demand surge, what reflected in significant price jump (+48,1%) and huge rise in use of paper (+188,2%) resulted in whopping increase of expenditure on paper (+325,1%) and respectively +311,9% in expenditure of paper per pupil, +179,3% paper usage per pupil. Similarly, use of paper per employee rose by +196,5% and expenditure on paper per employee increased by +337,3% in 2022. Only expenditures on digital platforms continued to increase as before (by +149,1% in 2022) and respectively expenditures on digital platforms per pupil (+141,4%).

If before 2022 we could see clear trendline, which showed us continual decrease in the use of paper, then after almost all gains in this course they levelled as we can see in Figure 1. In whole period from 2018 – 2022 the use of paper however decreased by relatively small amount -6,4%, but because of rapid price surge (+48,1%), total expenditures on paper were 40,2% larger, than in 2018. Since pupil and employee number increased as well (+12,9% and +4,4% respectively), the use of paper in overall period dropped (-17,1% and -10,4% respectively), but total expenditures per person on the contrary – increased (+24,2% and +34,3% respectively).

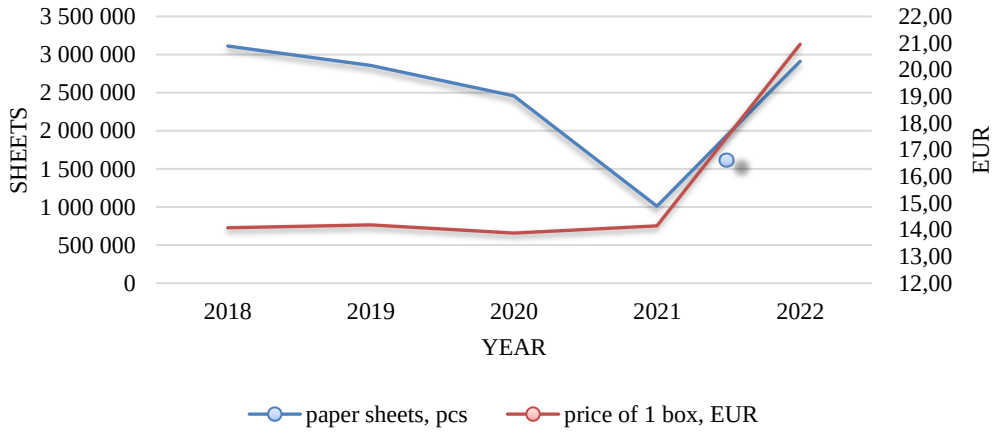

Figure 1. Amount and price of paper use in 2018-2022

We come to the need to understand what is happening with the indicators of the atypical year 2022 in this research. As we mentioned before – many indicators changed their trendline quite sharply. In this context we need to add background fact about Covid 19 and its containment measures in Latvia in 2020-2021. These measures impacted directly educational institutions in country and in Jelgava as well, such as school closures due to high infection numbers, quarantine requirements and distance learning. This reflected in even more needs in digital equipment (+71,1% in 2021 against 2020) and digital platforms (stunning +1398,2% in 2022 against 2018). It contributed to use less paper, because of less physical institution attendance (-58,9% in 2021 against 2020) and to use more digital platforms (see Figure 2).

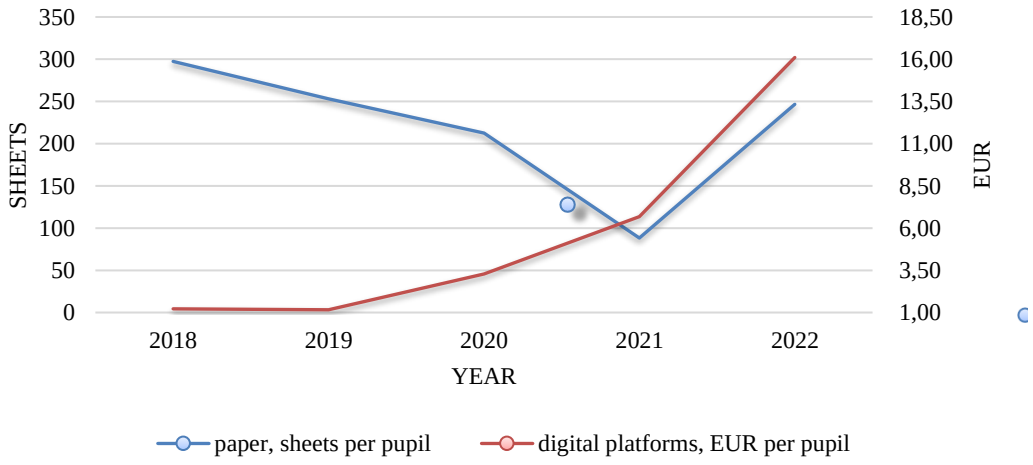

Figure 2. Amount of paper and digital platforms per 1 student in 2018-2022

However, despite the fact that the use of paper bounced massively in 2022, sheets per pupil against 2018 were less (-17,1%), but investments in digital platforms continued to grow (+1227,3% EUR per pupil) giving hope that the transition to digital will be strengthened.

Our interest in the use of paper doesn't stop with situation analysis, but there is a need also for some demonstrative visualization of the impact on nature from this lifestyle (Table 4).

Table 4. Natural visualization of indicators in 2018 – 2022.

Indicator / year	2018	2019	2020	2021	2022	2022/2018
use of paper, m2	194 064	178 222	153 181	62 994	181 575	**-12 490**
weight of paper, kg	15 525	14 258	12 254	5 039	14 526	**-999**
(a) trees cut down, number	361	332	285	117	338	**-23**
(b) trees cut down, number	373	342	294	121	349	**-24**
football fields, number	27	25	21	9	25	**-2**

Only in Jelgava`s education system there are used almost 200 thousand square meters and around 14 – 15 tons of paper annually. To produce such volume, more than 300 trees are needed to be cut down each year. And if we would put together all consumed paper, it would cover more than 25 football fields. Ofcourse, in 5-year period there is overall decrease of the use of paper (-6,4%), which means less trees cut down, but period from 2018 – 2021 shows us that there is much greater potential to be achieved.

CONCLUSIONS

As a long cycle of information transformation is happening (era of digitalization), issue about the use of paper is very topical. The example of Jelgava's education system shows us the importance and potential impact of these processes.

There was visible tendency between the use of paper per pupil and expenditures on digital platforms per pupil – from 2018 – 2021 there was inverse relationship, the less use of paper, the more expenditures on digital platforms, but 2022 highlighted the impact of Covid 19 containment measures on these processes, which reflected after restriction were lifted in strong rebound in the use of paper.

If price pressure in 2022 (+48,1%) wouldn't be so high, there was possibility, that paper usage could be as it was in start of the research period in 2018 or even more. But price surge slowed already rapid increase in the use of paper, because institutions were forced to balance their budget.

And as 2022 show, we must admit, that the use of paper is still in high level, but also, it shows that it is possible to reduce the use of paper, focusing more on digital capabilities.

And one of the positive conclusions is fact, that in Covid-19 pandemic period we saw that the use of paper can be radically reduced thus saving more than 200 trees each year, and if we apply this to broader areas or even worldwide – impact can be shockingly huge, almost incomprehensible to the mind, but most importantly – particularly beneficial to nature and people.

One of the great roles to accelerate transition from paper to digital is more about to review our attitude and everyday habits regarding the use of paper, as well as targeted investments in digital infrastructure. This is a field for further research.

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