

# The Economic Cost and Environmental Effects of Paper Consumption and Computer Usage

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## ABSTRACT

The study aims at investigating the environmental and economic effects of paper consumption and computer usage in the Banking sector in Palestine. The research mainly depends on the descriptive and quantitative method. In addition, it collects the data annually and it covers the period from 2016 to 2018. The study has found out that the total cost of using paper in the banks in Palestine is about 3.24 million dollars because they consume about 658.4 tons of paper. Looking at paper production process, this amount of paper needs about 16 thousand pine trees, 25 million btus of energy, and 13.5 million gallons. Looking at the total costs of using computers in the banks in Palestine, it costs about 7.6 million dollars and about 122 tons of different minerals and materials which are required to manufacture computers in the banks in Palestine. In addition, it needs about 1.52 GW per year to operate all computers. Hence, this causes the release of greenhouse gases which is equivalent to the consumption of 2495 barrels of oil.

**Keywords:** Environmental effects, Environmental costs, Paper consumption, Paper usage, Environmental Economics

**JEL Classifications:** B41, Q51, P18

## 1. INTRODUCTION

In 2015, leaders of 193 countries worldwide met and reviewed a 17-goal plan for the next 15 years and it is called the Sustainable Development Goals (SDGs). The goal No.13 aims at taking urgent action to combat climate change and its impacts.

It has been noticed that the low percentage of vegetation is one of the things that disturb the environmental balance. But why? The answer to this is many reasons, but among them are the following: urban sprawl, soil erosion, climate change, and timber-dependent industries.

The Food and Agriculture Organization (FAO) has found out, through the Global Forest Resources Assessment, that the global forest area decreased from 31.6% to 30.6% in the period 1990-2015. Respectively, the Paper Manufacturing Industry relies primarily on tree wood. Additionally, things get worse and worse

because when one region suffers from any environmental change, other neighboring ones respectively will be affected and this may affect the global climate in general. Consequently, this highlights the need and importance of conducting studies to find out the environmental impact and financial bleeding due to the use of paper in various transactions.

As a result, this study investigates the environmental impacts and financial bleeding for paper consumption and computer usage in the banks in Palestine. This may help the decision-makers take into account the environmental and economic impacts of using paper and computers in the banking sectors in particular and open the window for further studies to take two steps; the first one is to cover different sectors and the second one is to look more with an eye on these effects. This will give a hand to come up with recommendations which will consequently make a difference in improving and developing sustainably.

## 2. LITERATURE REVIEW

In this section, some previous studies on the environmental and economic impacts of paper use on various transactions will be presented and some studies will compare between the use of paper and the use of the electronic system in conducting various transactions.

In a study (Shah, et al., 2019) in the Sultanate of Oman to estimate the environmental and economic impacts of paper consumption in higher education institutions, the financial cost of using paper in higher education institutions has been estimated at 20280 dollars in 2015 while the environmental impact of consuming 13 tons of paper is 73970 Ibs emission from carbon dioxide, 144742 kWh of energy consumption, production of 29,614 of solid waste, and 247975 gallons of wastewater.

Furthermore, looking at a study (Beckline, et al., 2016) in Cameroon, this one highlights the environmental effects of paper use, from paper making to disposal. It has been found that chemicals are used to treat the pulp fibers in the manufacturing process and these chemicals include chlorine, mercury, absorbable organic halogens, nitrates, ammonia, phosphorous and caustic soda. Concerning the disposal process, when paper is disposed by burning, the amount of methane produced due to the burned paper is 69 times the amount of methane that coal emits in producing electricity. Considering the disposal of paper by burial, the mixing of toxic inks, dyes, and polymers with groundwater and their pollution causes diseases like cancer.

As for a study (Udejah and Christian, 2013), it presents some reasons for which it is advised to replace paper in print media by technological means. The study signifies the importance of trees in producing the oxygen needed to breathe and absorb pollutants from the air. Clearly, the trees reduce the effects of the sun, wind, and rain; also, they are important to the reduction of temperatures, retaining soil water, and the support of biodiversity.

Moreover, several studies have compared between the environmental impacts of paper use and technological use in transactions and invoices. In a study (Moberg, et al., 2010), it shows that there are environmental benefits make a shift to electronic invoices concerning the cumulative demand for energy and greenhouse gas emissions. The study shows that when all invoices in Switzerland are converted into electronic invoices, about 1400 terajoules per year can be saved and the emission of about 39,000 tons of carbon dioxide can be reduced annually.

In a similar study (Juan, 2016), this compares the environmental impacts between the use of paper flyers and the use of online publications in terms of extracting raw materials, followed by production, transportation, product use and disposal. The study has found out that the paper production process has more environmental effects than computer production. Meanwhile, the use of computers has more positive environmental effects than paper use especially when there is no difference.

Apart from the environmental impacts, according to (Jimenez, et al., 2015), the use of technological means instead of paper transactions

has great benefits: it increases efficiency, simplifies operations, lessens errors, cuts back administrative, stationery and communication costs, enhances control on information, keeps files for a long time, eliminates redundancy in documents, increases response time at work, maintains low storage space and fosters ease of query. This is shared with a study (Vesela and Radimersky, 2014) which indicates that the technological changes in the use of the electronic bill provide an opportunity for companies to improve their efficiency and develop better effective data exchange than the paper bill.

However, there are difficulties in switching from desktop use of paper to a computerized system. According to a study (Jimenez, et al., 2015), these difficulties lie in the need of investment in equipment and programs, spending on employee training, making organizational changes, having technical difficulties and application integration, getting continuous innovation that requires constant renewal and lacking of confidence in the integrity of the computerized storage system. As for the study (Vesela and Radimersky, 2014), it shows that the delay in implementing the electronic bill is due to the constant resistance to change in financial management and for the great and long time needed to move from paper to electronic substitute.

## 3. METHODOLOGY AND DATA

The study depends mainly on the descriptive and quantitative approach to achieve its goals. It collects the data from three banks in Palestine: Bank of Palestine, Palestine Islamic Bank and Arab Islamic Bank. These banks constitute 44% of the market share of the banks in Palestine in the year 2018, as stated by the Palestine Monetary Authority. Also, the research distributes questionnaires which have been answered by the banks' staff and their branches. The questionnaires ask about the quantities, prices and types of paper used in the banks annually from 2016-2018. In addition, the questionnaires have questions about the numbers of workers, the number of computers, Warehouse and archive costs at the banks.

Considering the total financial costs (direct and indirect costs) and the environmental costs of using paper, these have been found in the banks operating in Palestine during the period 2016-2018. Then work has been done to find the total financial costs (direct and indirect costs) and environmental costs for using computers in the banks in Palestine in the year 2018.

### 3.1. The Financial Costs of using Paper in Banks Operating in Palestine During the 2016-2018.

To calculate the total financial costs of using paper in Palestine, the study calculates the direct and indirect costs for the use of paper. Here, the direct costs mean the total cost for buying paper, while indirect costs refer to the archive store rents, archives' employees' salaries and the cost of printers.

The direct cost of purchasing paper has been calculated during the study period and the following formula has been used:

$$DC = \sum_{2016}^{2018} (P_{it} \times Q_{it}) \quad (1)$$

The following symbols stipulate the following:

- DC: is the direct cost of purchasing paper.
- P: is the average price of one ream in New Israeli Shekel (NIS).
- Q: is the number of reams purchased (1ream contains 500 paper).
- i: is the type of paper A3 or A4 (A3: is a paper of 297 mm width, and 297 mm height while A4: is a paper of 210 mm width, and 420 mm height).
- t: is the years from 2016- 2018.

The previous calculations represent 44% of the operating banks in Palestine. Therefore, the total costs for purchasing paper in all of the working banks are estimated by the following formula:

$$DC_{est} = (DC \times 2.273) \tag{2}$$

To find the indirect costs of using paper in the study sample banks in Palestine during the period 2016-2018, the following equation is estimated:

$$IDC = \text{Salary} + \text{Rent} + \text{Printers} \tag{3}$$

- The following symbols stipulate that:
- IDC: indirect costs of purchasing paper.
- Salary: salaries of archive employees.
- Rent: warehouse rental fee.
- Printers: the price for printers and toners.

To estimate the indirect costs of using paper in all of the banks in Palestine during the period 2016-2018, the study applies the following formula:

$$IDC_{est} = (IDC \times 2.273) \tag{4}$$

Consequently, the study finds the total financial costs (direct and indirect) for the use of paper in all of the banks in Palestine during the period 2016-2018 by the following formula:

$$TC_{est} = DC_{est} + IDC_{est} \tag{5}$$

### 3.2. The Environmental Effects of Paper Consumption in the Banks in Palestine During 2016- 2018

Finding the environmental effects of paper use by the banks in Palestine, the total weight of the paper has been calculated in the first place, then it has been converted into a number of trees, energy, gas emissions, wastewater and solid waste resulting from the production of paper.

The study has applied the following equation to calculate the paperweight used in the banks in Palestine:

$$TW = \sum_{2016}^{2018} (W_{it} \times Q_{it}) \tag{6}$$

- The following symbols signify:
- TW: is the total weight of the paper used.
- W: is the weight of one ream.

Therefore, estimating the paperweight used in all of the banks in Palestine, the study has applied the following formula:

$$TW_{est} = (TW \times 2.273) \tag{7}$$

After finding the paperweight used in the banks in Palestine and using what is in the study (Standard Chartered Bank, 2010), the paperweight has been converted into environmental indicators as follows:

As banks depend on computers for their work, the financial and environmental costs of using computers in the study sample banks in Palestine in the year 2018 are calculated.

### 3.3. Financial Costs of using Computers in Banks Operating in Palestine During 2016-2018

The direct financial costs for purchasing computers in the study sample banks in Palestine in the year 2018 have been calculated by applying the following formula:

$$TC_{comp} = Q_{comp} \times P_{comp} \tag{8}$$

- The following symbols stipulate that:
- $TC_{comp}$ : total cost of purchasing computers.
- $Q_{comp}$ : number of computers.
- $P_{comp}$ : average price of a computer.

To estimate the direct financial cost of all computers in all of the banks in Palestine in the year 2018, the research applies the following equation:

$$TC_{est\_comp} = TC_{comp} \times 2.273 \tag{9}$$

### 3.4. Environmental Effects of using Computers in Banks Operating in Palestine During 2018

Each computer consists of several materials and metal and non-metal elements, including iron, aluminum, copper, plastic, and many other elements. To find the environmental impact of the use of computers, the number of computers in all of the banks in Palestine has been estimated. Besides, to calculate the weight of elements used in the manufacture of all computers in all of the banks in Palestine, a study (Eygen, et al., 2016) has been taken. Furthermore, to estimate the amount of energy used to operate all computers, the Greenhouse Gas Equivalencies Calculator from the United States Protection Agency (EPA) website has been used.

## 4. RESULTS AND ANALYSIS

### 4.1. The Direct Financial Cost of Paper used in the Banks Operating in Palestine

The quantity of paper, A4 type, used in the banks: Bank of Palestine, Arab Islamic Bank and Palestine Islamic Bank during the period 2016-2018 reached about 115707 reams, whereas the average price per ream during this period was approximately 11.12 Nis. The quantity of A3 paper used during the same period was only 80 reams and an average price of 23.82 New Israeli Shekels per ream. Figure 1 shows the quantities of paper used in the banks operating in Palestine (for the study sample only).

The direct financial cost of paper used in the banks operating in Palestine: Bank of Palestine, Arab Islamic Bank and Palestine

Islamic Bank, which constitutes 44% of the market value of banks operating in Palestine in the period 2016-2018, can be calculated by substituting the values into formula (1). The result would be 129,081,9 New Israeli Shekels.

The values have been substituted into formula (2) to estimate the direct cost of paper used in all of the banks in Palestine during the period 2016-2018. The result has been 2934031 Israeli shekels or about 380 thousand dollars. This forms about 0.14% of the production value of the financial activity of all commercial and Islamic banks operating in Palestine in the year 2018.

### 4.2. The Indirect Financial Cost of Paper used in the Banks Operating in Palestine

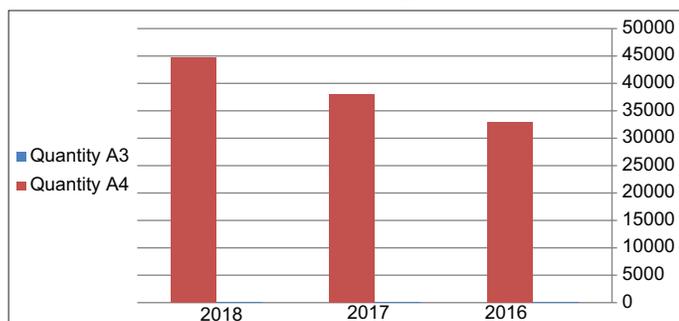
Tons of paper have been used annually in the banks in Palestine, which cost millions of dollars. However, there are indirect financial costs for using paper in banks, which include the costs of the archives for paper stores, and the salaries of employees of the archives and supplies department, as well as printers and toners for paper.

Considering the costs of archive store rents for the study sample banks during the period 2016-2018, they have been approximately 165,000 Israeli shekels, or about \$ 46,000. That is, the cost of archive store fees for all the banks in Palestine during the period 2016-2018 is about \$104,000.

Looking at the archive department, it is supervised by many employees, as the number of archive and warehouse employees of the study sample banks during the period from 2016-2018 has been about 30 employees and their monthly salary is 700 dollars. Therefore, the total wages of the archive and warehouse staff of the study sample banks during the period of 2016- 2018 has been amounted to about 756 thousand dollars. This means that the total wages of all of the employees of the archive and warehouse department in all of the banks in Palestine during the period 2016-2018 is about 1.72 million dollars..

Furthermore, the number of printers in the study sample banks in Palestine has reached about 3110, with an average price of 150 dollar per printer. This means that the cost of buying printers in the study sample banks in Palestine is about 466 thousand dollars, or about 1060000 dollars during the year 2018. To be notified, this cost does not include the costs of inkjet printers.

**Figure 1:** Quantity of paper (number of reams) used in the operating banks in Palestine during 2016-2018



Getting the total indirect financial costs for the use of paper in the banks in Palestine during the period 2016-2018, the study substitutes in equation (4). Therefore, the total indirect financial costs for the use of paper in banks in Palestine during the period 2016-2018 are approximately 2880000 dollars.

On the other hand, the total financial costs for using paper in the banks in Palestine during the period 2016-2018, the study substitutes in equation (5). Hence, it turns out that the total costs are approximately 324,000,000 dollars. Table 1 summarizes the financial costs of using paper in the banks in Palestine

### 4.3. The Environmental Effects of Paper Consumption in the Banks Operating in Palestine

The used paperweight has been calculated by substituting in formula (6) to measure the environmental effects of using paper in the banks in Palestine. Taking into consideration that the weight of an A4-ream is 2.5 kg, and the weight of an A3-ream is 5 kg. As a result, the paperweight used in the study sample banks is 289,668 kilograms. Consequently, the used paperweight has been estimated in all of the banks in Palestine by substituting in formula (7). Subsequently, the result would be 658,414 kilograms or about 658.4 tons of paper.

Going back to Table 2, which is extracted from the Standard Chartered Bank, 2010 study, the used paperweight by the banks in Palestine has been converted into environmental indicators. It takes up to 15,992 trees (i.e. three-meter high and 45.72 centimeters wide pine tree) to make 658.4 tons of paper. According to a study (Melmenstine, 2019), two trees supply oxygen to a four-member family annually. Thus, 15,992 trees produce enough oxygen for 31,984 people every year.

Considering the process of producing paper, 25,480 million btus of energy are needed to produce 658.4 tons of paper and

**Table 1: Environmental impact of paper consumption**

Production	Description	Amount	Equals to
Paper per 1 ton	Wood requirement	3.47 ton	24.29 trees
	Energy requirement	38.7 million btus	0.5 year of the energy of a US household
	Solid waste produced	2283 lbs	0.08 fully loaded garbage trucks
	Emissions	5868.8 lbs	0.5 year emission for a car
	Water requirement	20520 gallons	0.03 Olympic sized swimming pool
	Waterborne wastage	109.69 lbs	-

Source: Standard Chartered Bank 2010

**Table 2: Financial costs of paper used in banks operation in Palestine during 2016-2018**

Direct costs	The cost of paper used	380,000
Indirect costs	Salaries of archive employees	1,700,000
	warehouse rental fee	104,000
	Cost for printers and toners	1,060,000
<b>Total costs</b>		<b>3,244,000</b>

The currency used is the US dollar

this amount of energy is equal to the electricity that ten US families sufficiently need to use in 33 years. On the other hand, 13.5 million gallons of water is required to produce the same amount of paper which is the amount of water needed to fill 20 Olympic swimming pools.

The production of 658.4 tons of paper will result in approximately 1.5 million lbs of solid waste or about 53 truckloads of waste emitting 3.86 million lbs of carbon dioxide and this what ten cars emits for 33 years. As for liquid waste, the paper production process will produce about 72 thousand lbs of waterborne wastage in order to produce the same amount of paper. Looking at Table 3, it summarizes the environmental effects of paper use in the study sample banks in Palestine in the period 2016-2018.

#### 4.4. The Financial Cost of using Computers in Banks Operating in Palestine

The number of computers in the study sample banks in Palestine is 3992 computers, or about 9072 computers in all of the banks in Palestine in the year of 2018. According to Statista website, the average price ceiling for computers is 736 dollars per device. Applying equation (9), the direct costs of purchasing computers in all of the banks operating in Palestine in the year 2018 are approximately 6.7 million dollars.

The cost of purchasing computers is accompanied by unavoidable costs, such as maintenance costs, protection programs, updates and technical support. Taking into consideration that the annual depreciation rate for computers is 20% according to the Palestinian Cabinet’s Resolution No. (16) in the year 2005 in the consumption regulations for income tax, i.e. That every five years, computers have been consumed.

**Table 3: Environmental impacts of paper consumption in banks operation in Palestine during 2016-2018**

Production	Description	Amount
658.4	Wood requirement	2285 ton
	Energy requirement	25480 million btus
Ton of paper	Solid waste produced	1.5 million lbs
	Emissions	3.86 million lbs of carbon
	Water required	13.5 million gallons
	Waterborne wastage	72 thousand lbs

**Table 4: The weight of materials used in computer equipment in banks operating in Palestine for the year 2018**

Computer hardware	Inputs for one device (kg)	Inputs for all devices in banks (kg)	% Recycled
Ferrous	5.02	45,541	89
Aluminum	0.62	5624	83
Copper	0.58	5261	78
Precious metals	$1.5 \times 10^{-3}$	14	49
Other non-ferrous metals	$8.6 \times 10^{-2}$	780	29
Plastics	2.54	23,043	43
Other organics	$1.2 \times 10^{-2}$	109	0
Minerals	4.05	36,741	0
Others	0.58	5262	0
Total	13	122,472	49

Author’s calculations depend on the study (Eygen et al., 2016).

#### 4.5. Environmental Effects of using Computers in the Banks Operating in Palestine

The number of computers in all of the banks operating in Palestine in the year 2018 has reached about 9072 computers. Looking at the consumption of electricity, the average consumption of one device of electricity is 0.1 kWh; meanwhile, all of the banks in Palestine have consumed 1.52 GW of electricity in 2018. This is not surprising as the banks work for five days in a week and the daily working hours is 7 hours.

According to the United States Environmental Protection Agency (EPA) and by using the Greenhouse Gas Equivalencies Calculator, 1.52 GW will cause the emission of greenhouse gases by 1188 tons. This is equivalent to consuming 2495 barrels of oil, which needs 1407 Acres of forests to get rid of emissions for one full year.

A single computer consists of many different materials and metallic and non-metallic elements, including iron, aluminum, copper, plastic, and other elements. Table 4 shows the amount of materials used in the manufacture of all the computers in all of the banks in Palestine during 2018 and the percentages that can be recycled. In general, the percentage of materials that can be recycled in a single computer is 49%.

### 5. CONCLUSION AND RECOMMENDATIONS

The study aims at finding out the environmental impacts and the financial cost of paper consumption and computers used in the banks in Palestine. The study has covered the period from 2016 to 2018. The research conducts the study on only three banks, which constitute 44% of the market value of banks operating in Palestine, because the other banks refused to cooperate with the researchers. Hence, the environmental impacts and economic cost of all the banks in Palestine have been estimated.

This research sheds light on a subject that is rarely discussed. Specifically, during a period which suffers from a serious economic dilemma such as unemployment, which has reached 31% in the year 2018. Additionally, the deficit in the public budget has been amounted to one billion dollars in the same year, according to the Palestinian Central Bureau of Statistics.

Moreover, the banks in Palestine consume 658.4 tons of paper in the last three years and the computers in the banks in Palestine need about 122 tons of different minerals and materials to manufacture them. However, this sounds a little bit astonishing as it is a large amount consumed only by one sector in a Palestine, which is not considered as a large country with a large number of people. Therefore, this paves the way for further studies to be conducted discussing the environmental and financial implications of paper used in various sectors in different countries and regions.

What is the solution? Working on reducing the environmental and economic impacts resulting from the use of paper, a computerized system can be adopted in the banks. This can be considered as an effective system because according to the employees in the banks,

this system reduces the use of paper by 95%. In addition, it offers less storage space, better control of information and management, makes the inquiry easy, cost less and rise the productivity of the banks. Another solution is the adoption of paper recycling strategy. This will ease the burden on the environment as recycling does not need much of energy and many resources. Also, this strategy reduces air pollution and minimizes the problem of solid waste disposal.

Moreover, the study proposes one more solution which is adopting solar panels in every bank. This will generate clean energy so as to reduce the use of fuel-dependent electricity. Also, banks can work hand in hand with companies to recycle the materials from which the computers are made in order to get benefit from these materials when the banks get rid of the computers.

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