TRADE, INVESTMENT AND INNOVATION DIVISION

Assessing the environmental impact of trade procedures: A case study of the export process of Bangladesh readymade garments

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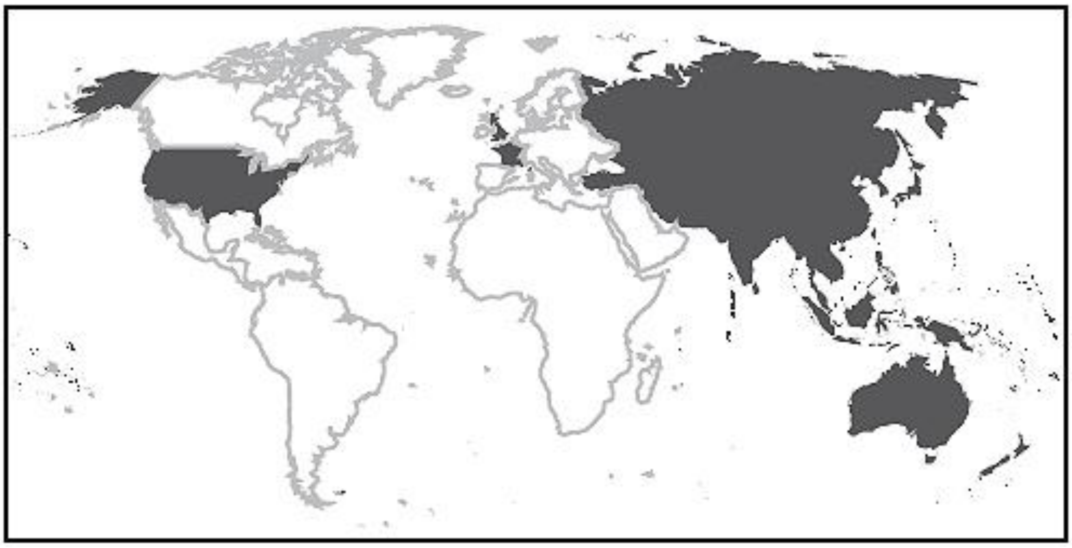

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Abstract

While digitalization increases efficiency in trade transactions and consequently facilitates more trade, it can also contribute towards minimizing the environmental impacts associated with trade processes. By going ‘paperless’, greenhouse gas emissions, waste generation and water usage associated with the production of paper documents used to support trade transactions can be saved. Moreover, the efficiency gains from digitalized processes can result in less emission from energy consumption and less waste generation and water consumption in office premises. The elimination of physical document transportation can also cut carbon emissions from fuel usage. To explore the environmental impact associated with trade transactions in more detail, a case study of the export process of garments from Bangladesh is conducted. This paper analyzes the trade processes and related environmental aspects in detail to quantify the impacts associated with the current “as-is” export process, introducing a methodology that can be integrated in future business process analysis studies. It also calculates potential savings in CO2 emissions, waste generation and water usage that may be achieved though digitalization. The study finds that there is great potential to minimize the environmental impact of trade through the implementation of paperless trade, although the savings are minor compared to the current environmental impact of transport in international trade. Further research on the environmental impacts from trade facilitation is recommended, supported by more systematic data collection of environmental impacts associated with trade processes, as done in this study.

JEL: D22, F18, F64, Q56, Q53

Keywords: trade facilitation, environmental impact, waste management, GHG emission, water, energy, trade procedures, digitalization, paperless trade, climate change, circular economy, Bangladesh, Asia Pacific.

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Acronyms

BPA	Business Process Analysis
EPA	Environmental Protection Agency
EPN	Environmental Paper Network
ESCAP	Economic and Social Commission for Asia and the Pacific
EST	Environmentally Sound Technologies
GHG	Greenhouse Gas
GDP	Gross Domestic Product
IISD	International Institute for Sustainable Development
OECD	Organization for Economic Cooperation and Development
RMG	Readymade Garments
SDG	Sustainable Development Goal
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
UN/CEFACT	United Nations Centre for Trade Facilitation and Electronic Business
WTO	World Trade Organization
WWF	World Wildlife Fund
WEEE	Waste of Electrical and Electronic Equipment

1. Introduction

Overview

During the past few decades, trade has contributed significantly to advancing the world economy. But with the growing economy, the world is facing mounting environmental challenges too, including climate change, air pollution, land degradation and other such disruptions, which in turn increase the risk of flagging wellbeing, public health, development, trade and economic growth itself. In line with the United Nations' 2030 Agenda for Sustainable Development, pro-active and progressive trade approaches can play a significant role in catalyzing the generation of a more affluent, environmentally sustainable and resilient world economy.

The importance of trade facilitation has been discussed time and again at the national, regional and international levels. It means simplification, modernization and harmonization of export and import processes and the exchange of associated information flows. According to WTO (2015), trade facilitation can significantly enhance the exports of developing countries by addressing high trade costs, delays at customs and complex procedures.

However, assessing the environmental impact of trade facilitation is a relatively new topic. While there is ample literature on international trade and environment, it is certainly not the case for trade facilitation and the environment. Trade facilitation is largely seen as "procedure"-focused rather than "production"-focused. Production – of manufactured goods, for instance – creates direct environmental impacts, and tends to attract research attention. But the procedures for trading these goods are not a common topic of research yet. This study attempts to focus on the environmental impact of trade procedures.

Digitalization is a key theme related to trade facilitation. Digitalization here broadly refers to trade-related information flows and the exchange of data in an electronic or digital form using information and communication technology, between relevant parties – whether private companies or public bodies, including suppliers, logistics providers, customs, regulatory agencies, sellers, and buyers (UN/CEFACT, 2018; Duval and Mengjing, 2017). In the context of trade facilitation, the term “paperless trade” is used to describe the digitalization of trade processes or measures. Some examples include the electronic application and issuance of preferential certificates of origin or export-import permits, electronic submission of customs declarations, electronic Single Window Systems, etc.

Implementation of paperless trade or digitalization of trade facilitation measures has great potential to generate environmental benefits. For instance, paperless trade transactions can ultimately remove the need for the huge numbers of paper documents generated and exchanged across borders. Furthermore, digitalization also increases process efficiency by reducing time spent on paperwork, and journey time for the transportation of documents and goods. Thus, digitalization will not only reduce paper usage, but also fuel or energy consumption, and waste production in offices.

But the links between trade facilitation and the environment are not always unidirectional and positive (Shepherd, 2016; ESCAP-UNEP-UNCTAD, 2021). Trade facilitation, i.e., simpler and faster trade processes, create favourable conditions for trading. This leads to more trade, which can create further stress on the environment in terms of increased greenhouse gas (GHG) emissions from production, transport, and depletion of natural resources, contributing to scarcity of water supply and loss of biodiversity. Thus, trade processes should be continuously improved – such as through digitalization – to accrue environmental gains to the extent possible.

Section 2 of this paper gives an overview of the link between the trade processes and environmental aspects that are used to analyze the environmental impacts and potential gains of paperless trade. Section 3 describes the methodology used in this study, including its equations, parameters, and assumptions. Section 4 presents a case study on the export process of the Bangladesh readymade garments (RMG) sector and analyzes probable outcomes using the proposed methodology. Limitations and further recommendations are outlined thereafter.

Objective

The objective of this study is to analyze the potential environmental benefits that may be achieved if a paperless system is fully implemented in international trade transactions. The study presents a methodology to quantify the environmental impacts of “as-is” trade processes, and demonstrates its application in a particular trade transaction.

The analysis is carried out based on the framework of the Buy-Ship-Pay model of the United Nations Centre for Trade Facilitation and Electronic Business (UN/CEFACT, 2012) and is consistent with the UNNExT Business Process Analysis Guide to Simplify Trade Procedures (ESCAP-ECE, 2012).

Importance of analyzing environmental benefits of paperless trade implementation

Studies and reports are generally available on the benefits of trade facilitation and paperless trade implementation, such as faster movement of goods, reduction in trade cost and effective cross-border regulatory cooperation. But barely any studies have quantified the environmental benefits of paperless trade implementation. In a noteworthy recent study by ESCAP (Duval and Hardy, 2021), the potential carbon savings from paperless trade were estimated.

It is all the more important to measure environmental benefits as the global trading community is pursuing a transition from a linear to a circular economy[2] for sustainable development. Trade facilitation offers great prospects for this transition. Reduced costs and increased efficiency can help reduce waste, exerting less pressure on natural resources. For example, reducing the time required for any trade transaction usually implies less energy or water usage (IISD and UNEP, 2014). Reducing trade barriers can boost trade of environmentally sound technologies (EST), goods and services, which are less polluting, and promote more sustainable use of resources (UNEP, 2018).

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[2] Although there is no internationally agreed definition of circular economy, it is generally understood as a concept aimed at minimizing pollution and waste, and at the sustainable use of natural resources (Ekins, 2019).

2. The link between trade processes and environmental impacts

Prior to describing the methodology in the next section, this section introduces the links among the different activities in trade processes, environmental aspects and environmental impacts. According to ISO 14001, an environmental aspect is the way any activity, product or service impacts the environment, such as GHG emissions from paper usage in trade processes. And an environmental impact is the change to the environment caused by the environmental aspect. For example, GHG emission is one of the aspects that contributes to air pollution – an environmental impact. To establish the links among trade processes, environmental aspects and environmental impacts, activities in trade processes that cause these impacts are mapped against their corresponding environmental aspects (table 1).

Table 1. Activities in trade processes and related environmental aspects and impacts

Activities in trade processes	Environmental aspects	Environmental impacts
Usage of paper documents • Main and supporting documents for each trade procedure.	• GHG emission from paper production • Waste production and disposal • Water usage	• Air pollution • Land degradation • Depletion of natural resources
Document transportation and goods storage • Commute for submission and receipt of documents • Storage and goods delivery	• GHG emission from fuel combustion • Energy consumption	• Air pollution
Office usage • Energy consumption • Water consumption	• GHG emission from energy consumption • Waste production and disposal • Water consumption	• Air pollution • Land degradation • Depletion of natural resources

Source: Author’s compilation based on the literature.

2.1 GHG emission

In a typical trade transaction process, there are multiple activities or interactions that can be mapped against the probable GHG emissions. Trade facilitation and digitalization of trade processes can simplify and minimize all these activities, contributing towards the reduction of GHG emissions.

Since paper is a major contributor of GHG emissions, the primary activity considered here is the use of paper documents for various regulatory and commercial procedures. This may include the submission of customs declarations, certificates of origin, sanitary and phytosanitary certificates, invoices, commercial contracts, proforma invoices, packing lists, and so on. Paperless trade implementation will eliminate the usage of all these paper documents and reduce the resulting emissions from paper, as well as the emissions from ink and electricity usage for printing. The second angle is transportation. Digitalization will lessen the need to commute for collection or submission of documents at various locations, thereby reducing probable emissions from fuel usage through different modes of transportation (e.g. motorbike, bus, etc.). Furthermore, it will also reduce the time required for transporting goods from the point of production to the border or the point of delivery. The third angle is the usage of offices or workspaces for the preparation of documents. If paperwork requirements are eliminated, human resource needs can be minimized and the corresponding energy consumption in office premises will be reduced.

2.1.1 Paper documents

Paper production is one of the world's primary sources of climate change. A single large pulp and paper mill is responsible for the consumption of over 3.5 million tons of wood in a year. Emissions from paper mainly include those generated during the production process at pulp and paper industries, e.g. the combustion of fossil fuels, carbon dioxide (CO_2) emissions from limekiln chemical reactions, or methane (CH_4) emissions from wastewater treatment facilities (EPA Victoria, 2020). These gases are directly emitted from the plant sites. Other sources of indirect emissions are the generation of offsite steam and electricity that are purchased by or transferred to the plant. The disposal of paper in landfills and the subsequent production of methane and other shortlived climate pollutants (black carbon, organic carbon) also contribute to the carbon footprint of paper products. Scientists estimate that deforestation and forest degradation are responsible for around 20 per cent of the annual GHG emissions that cause climate change (WWF, 2021). The carbon storage loss arising from deforestation and degradation is incorporated in this environmental impact.

According to the Environmental Paper Network, through the lifecycle of 1 kg of unrecycled uncoated freesheet (copy paper), 9,000 grams of CO_2 equivalent (CO_2e) are released into the environment. Production of paper receipts in the United States requires 12.4 million trees and emits 4 billion pounds of carbon dioxide a year (EPN, 2019). In addition, the usage of ink for printing purposes also adds on to the emissions.

The use of paper documents in trade is significant and has been reviewed in many reports. A recent ESCAP study analyzed 27 business process analysis (BPA) case studies and reported that on average 42 documents (including copies) are processed multiple times during trade transactions, while the average transaction involves a minimum of 63 pages of paper (Duval and Hardy, 2021). In the same report, carbon emissions due to paper and ink usage from each trade transaction were calculated at an average of 4,777 g CO_2e. A study by SITPRO reported that a typical transaction from a producer to a retailer requires up to 150 paper documents totaling up to 225 pages of paper (SITPRO, 2008). In 2006, a study on the perishable food supply chain determined that in the United Kingdom, every year one billion paper documents are generated of which over 90 per cent are subsequently destroyed (ESCAP, 2011). According to the UN Trade Facilitation Implementation Guide (UNECE, 2017), a typical cross-border trade transaction involves filling in 35 documents and contacting 25 parties.

2.1.2 Transportation of documents and goods storage

In this study, two sources of GHG emissions have been included that are related to fuel combustion in transport. First is the emissions for the delivery and receipt of various trade documents by exporters or other stakeholders. This includes fuel combustion from vehicles when exporters undertake journeys to various organizations or offices to deliver or obtain regulatory or commercial documents. The other source is the emissions from the storage of goods at any point in time during the import/export process. This includes emissions from trucks waiting at the port, or energy use in warehouses, container depots and other facilities during the journey due to the delays in paperwork and procedure.

The data for GHG emissions associated with the transportation of trade documents is scarce. Duval and Hardy (2021) present a preliminary estimate of 1 to 2 kg CO_2e emitted per trade transaction due to the transportation of documents. In general, GHG emission figures related to the overall transportation sector point to the sector's high level of impact on the environment. For example, in 2010, global CO_2 emissions from transportation were estimated at 6,700 tons, which accounted for approximately 23 per cent of global energy-related CO_2 emissions (Forslid, 2020). Combustion of one gallon of petrol produces 10.6 kg of CO_2 while diesel combustion emits 11.9 kg/gallon (Forest Research, 2021). Apart from the type of fuel used or the distance travelled, different modes of transport can also result in different levels of emissions. Hence, it is important to include the impact of transportation of documents and storage time reduction in this study.

Other than reducing the need for paper documents, trade facilitation and paperless trade ensure faster information exchange and increased security and compliance Trade facilitation can reduce the time needed for document preparation, transportation of paper documents, delay-related testing and certification, and waiting at borders, increasing the overall efficiency of supply chains.

Benefits from paperless trade are the highest for smaller shipments and for perishable goods. In Kyrgyzstan, it takes up to 25 days to obtain the certificate of conformity for exporting textile products (UNECE, 2021). The majority of this time is spent on the road or waiting due to delays in the transportation arrangement to bring the sample and related documents across the border to Kazakhstan. Bangladesh simplified its import clearance and export procedures, mainly by reducing the number of signatures and frequency of goods inspections required for clearance of consignments. This led to custom clearance time reductions of 62.5 per cent (8 days to 3 days) for exporting goods and 75 per cent (3 days to 1 day) for importing goods (Hossain and Rahman 2011). This reduction in the time needed for trade procedures could potentially reduce GHG emissions originating from the storage of goods in ambient temperatures and cargo handling. Efficiency gains due to time savings in trade processes have been discussed widely in the literature, but research on the environmental benefits from this time savings is limited.

2.1.3 Office Usage

Office usage here refers to the energy consumed in the premises of offices engaged in the paperwork of a particular trade transaction. Switching to electronic documents is expected to increase the efficiency of the whole process by reducing the volume of paperwork, hence reducing the working hours for manual preparation and processing of documents. If the amount of working hours saved in an office environment due to the digitalization of trade processes is taken into account, estimates of energy consumption in those offices will be reduced. Consequently, GHG emissions will be lower than that in the case of paper-based trade processes.

One estimate shows that full implementation of paperless trade can save between 19.68 and 50.25 man-hours per trade transaction across the different offices dealing with trade documents, and these saved productive work hours translate to reduced GHG emissions of 30-72 kg in an average trade transaction (Duval and Hardy, 2021). Research into the potential time savings of e-invoicing in SMEs shows that 18.5 minutes can be saved per invoice using a fully automated invoicing process compared to a manual process (EBA, 2010). The time required to prepare and process electronic invoices are assumed to be about one-fifth the time required for manual invoices (Tenhunen and Penttinen, 2010). In addition, electronic invoicing is expected to have a significantly lower carbon footprint than paper invoicing (ibid.).

Time savings in working hours in trade processes can be accrued not only by reducing the number of documents, but also from the digitalization of documents and the associated reduction of time needed for handling and processing these documents. Handling and processing documents includes searching, copying, managing and maintaining paper-based files and folders. Furthermore, implementing paperless systems using digital technologies like blockchain can save time spent on authenticating documents, including receiving signatures and seals, and sending them manually or through traditional mail in-out systems. Port and customs automation using electronic data exchange platforms reduces the time spent on trade logistics (World Bank, 2016). It is reported that, through the full implementation of a paperless system, exporters could save 51 working hours on average in the border compliance work of a single trade transaction (ibid.).

2.2 Waste Production

Paperless trade can minimize the generation of solid waste primarily in two ways. First, by eliminating the use of paper in trade processes that will reduce the solid waste associated with producing and discarding paper itself. Second, digitalization of the whole trade process increases trade efficiency and encourages increased productivity. This is expected to reduce working hours and result in fewer employees required at office premises, minimizing office waste production.

The potential for waste reduction from paperless trade has not been quantified or is not available in the literature. The solid waste considered here are the combinations of sludge and other waste generated at the paper and pulp production industries, and used paper waste that are disposed of in landfills or incinerators. Office waste mainly includes paper, packaging, residual waste, food waste, etc. However, the waste of electrical and electronic equipment (WEEE) such as computers and printers is not considered here, since these are fixed assets in any office. Additionally, computers are still necessary for working electronically even after the paperless process is implemented, and the same applies to printers to some extent. Nevertheless, due to the reduction in the number of personnel, the numbers of these devices are expected to reduce too. A detailed in-person survey can be carried out to estimate such waste generation.

2.2.1 Waste generated by paper production and use

The pulp and paper industry is among the world's most polluting industries with large, negative environmental impacts (Moraes et al., 2021; Shah et al., 2019; Man et al., 2020). With the increased production of paper worldwide, the amount of related waste is also increasing and contributing to deforestation, as well as air, water and land pollution (Simao et al., 2018). Producing one ton of copy paper can generate 19,075 gallons of wastewater and 2,278 lb. of solid waste (Shah et al., 2019). When paper decomposes in landfills, it also produces methane, a greenhouse gas with 25 times the heat-trapping power of carbon dioxide. Today, wastepaper accounts for more than one-fourth of landfill waste and one-third of municipal waste (The World Counts, 2021).

According to World Bank Group, paper and cardboard are the second largest waste category comprising 17 per cent of the global municipal waste (Kaza et al., 2018). On average, a typical U.S employee uses more than 10,000 sheets of paper each year, costing USD 80 to USD 100 (Forbes, 2018). More than 45 per cent of office papers are discarded by the end of the day and 30 per cent are never collected from the printer (Roadrunner, 2021). An average office generates about 350 pounds of wastepaper per employee each year (NRDC, 2017). These mixed paper products comprise an estimated 70 per cent of the total waste of offices, including print mistakes, reports, presentations, mails, packaging, etc. According to SITPRO (2008), over 90 per cent of paper documents in the perishable food supply chain in the UK are discarded. A significant quantity of these papers is not recyclable and contains chemicals potentially toxic to the environment.

2.2.2 Waste generated in the office

Office waste is a type of municipal waste that falls into the category of non-household waste or commercial waste.[3] According to Christensen and Fruergaard (2010), "Waste from office areas typically consists of paper, packaging (e.g., board, plastics, metals, etc.), waste from electrical and electronic equipment (WEEE), hazardous waste and unsorted waste associated, for example, with food consumption". Among the different types of waste products in commercial and institutional waste, paper and cardboard constitute the major share, making up over half of the waste in some cases. Other contributions come from food waste and residual waste, such as tissue paper, coffee cups, bottles, plastic packaging, cans, metals, foam plates, food wrapping paper, etc.

The World Bank estimates that globally almost 1.3 billion tonnes of municipal waste is produced every year, which is 1.2 kg/capita/day (Hoornweg and

[3] According to OECD (2021), "Municipal waste is defined as waste collected and treated by or for municipalities. It covers waste from households, including bulky waste, similar waste from commerce and trade, office buildings, institutions and small businesses, as well as yard and garden waste, street sweepings, the contents of litter containers, and market cleansing waste if managed as household waste. The definition excludes waste from municipal sewage networks and treatment, as well as waste from construction and demolition activities."

Bhada-Tata, 2012). However, the actual per capita rates vary widely because there are considerable differences in office cultures, waste generation rates and waste management processes across countries, between cities, and even within cities (Hoornweg and Bhada-Tata, 2012; Edjabou et al., 2015).

Although many studies have covered source-sorted food waste at the household level, waste data from the service sector, and specifically from office areas, is generally very limited (Edjabou et al., 2015, Christensen and Fruergaard, 2010). Edjabou et al. (2015) show that the average solid waste (only food and residual waste) generation per employee per working day in an office environment is only 0.12 kg.

2.3 Water Usage

Water conservation is becoming more critical day by day. Increasing demand from the growing global population and rapidly developing economies, together with the effects of climate change, is causing lack of access to water (Water Action Decade, 2018-2028). In addition, many countries are experiencing emerging water crises as a result of unsustainable use and management of water resources (WMO, 2021). As part of encouraging a circular economy that uses natural resources sustainably, it is important to monitor and reduce water usage at various stages of trade processes. Impact on water resources can be generally defined as consumption and pollution of water resources. However, a discussion of water usage based on the type of product traded is not within the scope of this study. Mainly two channels of water usage are analyzed here. The first relates to water usage for the production of paper at paper mills and the second involves overhead water consumption, i.e., water consumed by employees responsible for trade-related paperwork in an office environment.

2.3.1 Water usage for paper production

The previous sections mentioned that a huge number of paper documents are required for documentation purposes in trade processes. Eliminating the usage of these papers can save gallons of water required in the pulp and paper mills for production. Furthermore, as mentioned earlier, the pulp and paper industry is one of the largest users of fresh water. According to Environmental Paper Network, producing one ton of paper requires about 60 litres of water even with the application of the most efficient production process techniques. Based on the location, paper mills' high dependence on process water[4] may contribute to water shortage in those regions (EPN, 2018).

Moreover, a large amount of wastewater is generated by pulp and paper mills (Lindholm-lehto et al., 2014). This wastewater is highly concentrated with toxic chemicals discharged as effluent into water bodies. Rivers, streams and waterways thus get polluted, causing significant ecological impact. However, the impact of wastewater generated from paper production is not within the scope of this study.

2.3.2 Water consumption in the office

The man-hours saved as a result of digitalization could translate to fewer employees at the office and, therefore, reduced total water consumption in the office. To understand water conservation in various trade processes, one needs to assess the "organizational water footprint", defined by Hoekstra et. al (2011) as follows – "the water footprint pertaining to the general activities for running a business and to the general goods and services consumed by the business. The term 'overhead water footprint' is used to identify water consumption that is necessary for the continued functioning of the business but that does not directly relate to the production of one particular product."

Therefore, in the context of an export or import process, measuring water usage can consist of (i) identification of paper documents used in each trade procedure and measuring their corresponding water usage in the paper mill; (ii) identification of organizations involved in completing each trade procedure, calculating the number of employees or individuals working in the premises responsible for completing these processes, and measuring the corresponding water usage in those premises.

[4] Process water is broadly defined as water used in industry, manufacturing processes, power generation and similar applications.

3. Methodology

This study focuses on a typical trade transaction process, i.e., export or import of a product originating from a particular country with a specific international destination. Building on traditional BPA methods, it introduces a sequential way to quantify the environmental impacts of each export/import process caused by paper-based activities in a single transaction. This provides the basis for estimating potential savings (reductions) of these environmental impacts when paperless trade is implemented. The impacts or the potential savings are then scaled up to the total export value of the product considered at the national, regional (Asia-Pacific) and global levels. Potential savings are calculated based on partial or full implementation of paperless trade and will vary depending on country context.

First, a particular use case, which defines the scope of the study, is identified. A BPA is then carried out based on the UNNExT methodology to identify the core trade processes. Through the BPA, detailed information about the activities within each core trade process and the actors involved in those activities are identified. Based on this information, a survey is carried out with traders (exporters or importers), with the survey results verified through other actors.

For the survey, a mix of large, medium or small-sized traders are randomly selected. A detailed questionnaire is developed to collect data on the various activities in each trade process. This data includes the main paper documents and supporting documents used, number of pages in each document, electricity and water usage at the exporter's office, total number of employees in the traders' head or main offices, total number of personnel involved in the paperwork, number of journeys, modes of journeys and times to and from other stakeholder's offices for submission and collection of documents, number of trade transactions, etc. (see Annex 2). Based on the survey data, environmental impacts are calculated, using the equations in the next subsection, in terms of GHG emissions, waste generation and water usage for each trade process (e.g., buy, preparing export documents, arrange transport, etc.) identified in the BPA study. The total values for all the processes are then summed up to obtain the impact for a single trade transaction (see Annex 1).

Next, using the value of total exports/imports and the average value of a single export/import transaction for a specific product, an approximate number of transactions are calculated for the country, as well as for the region and the world. The number of transactions is then multiplied with the impact values for a single transaction to estimate the GHG emissions, waste generation and water usage of a typical export/import process at the country, regional and global levels.

3.1 Calculations

3.1.1 Calculation of GHG emission

The GHG emission related to a single trade transaction can be calculated as:

$$E = \sum(Q_i \times EF_i)$$

*Where, E = Emissions Estimate, Q_i = Activity data related to source **i**, i.e. amount used or distance travelled (kg, kWh, km, etc.), EF_i = Relevant Emission factor (kg of emissions per unit of activity), **i** = source of emission (paper usage, electricity, travel, etc.)*

Activity data is a major input into the calculation of GHG emissions. It refers to quantitative data associated with the activity generating the GHG emissions (EPA Victoria, 2020; UNFCCC, 2009). Activity data provides a measure for the magnitude or emission intensity of the activity. For example, in this study, the kWh of electricity consumed by the personnel responsible for paperwork in a particular exporter’s office premises, is activity data of the emissions from purchased electricity.

An emission factor is a representative value that attempts to relate the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant (EPA, 2007). Emission factors are usually expressed as the weight of pollutant divided by the unit weight, volume, distance, or duration of the activity that emits the pollutant. The emission factor depends on different parameters including geographical location, type of fuel or product usage, etc. For the calculations in this study, the emission factors considered are mostly applicable for Bangladesh.

3.1.2 Calculation of waste generation

To investigate the potential waste generation from paper-based trade processes, two channels are considered in this study. One is from the amount of paper used for the end-to-end transaction process, and the other is the waste generated by personnel working on these paper documents in their offices. The waste from electrical and electronic equipment (WEEE) is not included.

The paper waste related to a single trade transaction is calculated as:

*Total solid waste from paper, W_P (grams) = (**Np * Ws**)* waste per kg of paper/1000*

*Where, **Np** = Total no. of pages, **Ws** = Weight of a single page in grams*

It is taken into account that 1 metric ton or 1,000 kg of paper generates 2,283 pounds or 1,035 kg of solid waste (Jawad et al., 2020; Shah et al., 2019; Standard Chartered, 2010). Also, it is assumed that in terms of the paper grade, the papers used for the transaction are general A4 copy papers, i.e. uncoated freesheets, with zero per cent recycling rate, and each page weighing 5 grams.

Considering these data, the solid waste generation from paper usage can be estimated as:

*W_P = (**Np** * 5 * 1.04) gram of waste = (**Np** * 5.2) gram of waste*

*Where, **Np** = Total no. of pages*

Office waste includes mainly food waste and residual waste (i.e., waste from paper packaging, plastic, cardboard, metal, glass, etc.). The data used here is based on the scarce literature on office waste, and may not be fully representative of the sector for the purpose of quantifying the environmental impacts of office-related waste. Detailed surveys can be conducted on the waste collection systems at the exporter's or stakeholder's workplaces for future, more in-depth estimations of waste generation.

The amount of per capita waste generation in the office is calculated as:

$$\boldsymbol{W_c} = \frac{\sum_{i=1}^{n} \boldsymbol{W_i}}{\sum_{i=1}^{n} \boldsymbol{P_i}} \times \frac{\mathbf{1}}{\boldsymbol{T_i}}$$

*Where, W_c = Per capita waste generation in an office environment (kg/person/day), **n** is the total number of offices of the exporter involved with any trade transaction for which data are recorded, **Wi** = The annual* *waste generated in office i (kg/year), **Pi** = Number of employees in office i, T_i = Number of working days in a year*

Data for the annual waste generated in an office can be obtained at the waste collection point. Then, by estimating the amount of per capita waste generation using the above formula and taking into account the number of personnel involved in the paperwork or documentation process in the office environment and the duration of a single transaction, one can calculate the office waste generation at any stakeholder's office as:

$$\boldsymbol{W_t} = \boldsymbol{W_c} \times \boldsymbol{P_t} \times \boldsymbol{T_t}$$

Where, $\boldsymbol{W_t}$ = Total waste generated by the employees involved in the trade-related paperwork processes in an office environment (kg), $\boldsymbol{W_c}$= Per capita waste generation in the office (kg/person/day), $\boldsymbol{P_t}$ = Number of employees involved in the trade-related paperwork processes in the office, $\boldsymbol{T_t}$ = Duration of a single transaction process (day)

Even if paperless trade is implemented, it should be noted that some employees will still be needed for processing the data electronically. However, each employee can be more productive during their working hours due to the reduction in the volume of paperwork. Therefore, assuming a fixed amount of transactions to be processed, the number of employees in a particular office will be reduced, and the resulting waste generation will be less.

According to EPA, office waste can be assumed to be one-third of total municipal waste, as people sleep for eight hours on average, and are awake and generating waste/recyclables for 16 hours a day (8 hours at the office, 8 hours at home/elsewhere) (EPA, 2016). From a report of the Washington Statewide Waste Characterization Study, it was found that the average office waste generation rate is 1.5 lb/employee/day, while council offices or public offices generate 214.45 kg/day (EPA, 2004).

3.1.3 Calculation of water usage

To estimate the amount of water usage, just as with the waste calculation method outlined above, this study considers two channels related to the activities of trade transactions that involve water usage. One is the water usage during paper production in the paper industry, and another is the water consumption by the personnel working on trade-related paperwork in an office environment.

According to EPN (2021), producing one kg of paper requires 23.6 gallons or 89 litres of water. Assuming that most of the paper used in trade transactions is uncoated freesheet of A4 size, it is estimated that a single sheet of paper accounts for the use of 0.48 litres of water. Knowing the number of papers used in a single transaction, one can estimate the water usage using the following simple equation:

$$\boldsymbol{D_p} = \boldsymbol{Np} * 0.48$$

Where, ***Dp*** *= Total usage of water for paper production (L),* ***Np*** *= Total number of pages used in a single trade transaction*

The calculation of water consumption at the exporter's office is relatively straightforward. One needs to know the monthly usage of water (e.g. from water bills). Then, the per capita water consumption can be estimated using the following formula:

$$D_c = \frac{\sum_{i=1}^{n} D_i}{\sum_{i=1}^{n} P_i} \times \frac{1}{T_i}$$

Where, ***Dc*** *= Per capita water consumption in the office (litre/person/day),* ***n*** *is the total number of offices of the exporter involved with any trade transaction for which data are recorded,* ***Di*** *= The annual water consumption in office i (litre/year),* ***Pi*** *= Number of employees in office i,* $\boldsymbol{T_i}$ *= Number of working days in a year*

Multiplying the amount of per capita water consumption with the number of personnel involved in the paperwork or documentation process in the office environment and the duration of a single transaction, one can calculate the water consumption by the employees involved in the trade-related paperwork processes at any stakeholder's office as:

$$\boldsymbol{D_t} = \boldsymbol{D_c} \times \boldsymbol{P_t} \times \boldsymbol{T_t}$$

Where, $\boldsymbol{D_t}$ *= Total water consumption by the employees involved in the trade-related paperwork processes in an office environment (L),* $\boldsymbol{D_c}$*= per capita water consumption in the office (litre/person/day),* $\boldsymbol{P_t}$ *= Number of* *employees involved in the trade-related paperwork processes in the office,* $\boldsymbol{T_t}$ *= Duration of a single transaction process (day)*

3.2 Emission Factors and Assumptions

An emission factor is a coefficient used to convert any process or activity data into GHG emissions. A single activity may emit different kinds of greenhouse gases. So, the emission factor is generally reported as the sum of emissions of CO_2 equivalent of the human activity (Clim'Foot, 2016). Each GHG emission is converted to a CO_2 equivalent by multiplying its gas quantity (kg GHG) with its Global Warming Potential, which is a physical characteristic of GHG, in order to represent its impacts in CO_2 equivalent (kg CO_2eq / kg GHG). Next, all the emissions are summed up and the emission factor is expressed as the mass unit of CO_2 equivalent/unit activity data. Emissions of different gases can also be compared.

For this study, a number of assumptions are made for calculation purposes (see table 2 for a list of the emission factors and assumptions used). It is important that the appropriate emission factors and assumptions are used in the calculation, based on geographical location, type of fuel or product usage, mode of transportation, etc.

Table 2. Emission factors

	Emission factor	Assumptions	Sources	Geographic relevance
Paper	9.1 gCO_2e/g of unrecycled paper	Uncoated freesheet A4 paper, 80gsm, 0% recycling rate. Weight: 5g/page.	Environmental Paper Network (2021); www.papersizes.org (2021)	North America/ World
Ink	2.5 gCO_2e/g ink	One gram of ink covers 12.6 pages with 10% coverage rate.	Duval and Hardy (2021)	World
Transportation	40 gCO_2e/km	Means of document transportation: Motorbike. Fuel type: petrol. Distance travelled per round trip journey is 20 km.	Fattah and Morshed (2021)	Bangladesh
Electricity	670 gCO_2e/KWh	9 working hours per day and 22 working days per month.	Bangladesh Department of Environment (2017)	Bangladesh
Waste from paper	1.04 gram/g of paper	Uncoated freesheet A4 paper, 80gsm, Weight: 5g/page. Solid waste includes the waste generated during production and the waste for disposal after usage.	Environmental Paper Network (2021)	North America/ World
Waste from office usage	290g/capita/day	MSW (Municipal Solid Waste) generation/capita/day in Bangladesh is 0.58kg and office waste is assumed to be ½ of the per capita daily MSW generation since people sleep on average 8 hours per day, so they are awake and generating waste/recyclables for 16 hours a day (8 hours at the office, 8 hours at home/elsewhere).	Waste Concern (2014); Environmental Protection Agency (2016)	Bangladesh
Water usage for paper production	0.454 L/sheet of A4 paper	Uncoated freesheet A4 paper, 80gsm.	Environmental Paper Network (2021)	North America/ World

Source: Author's compilation.

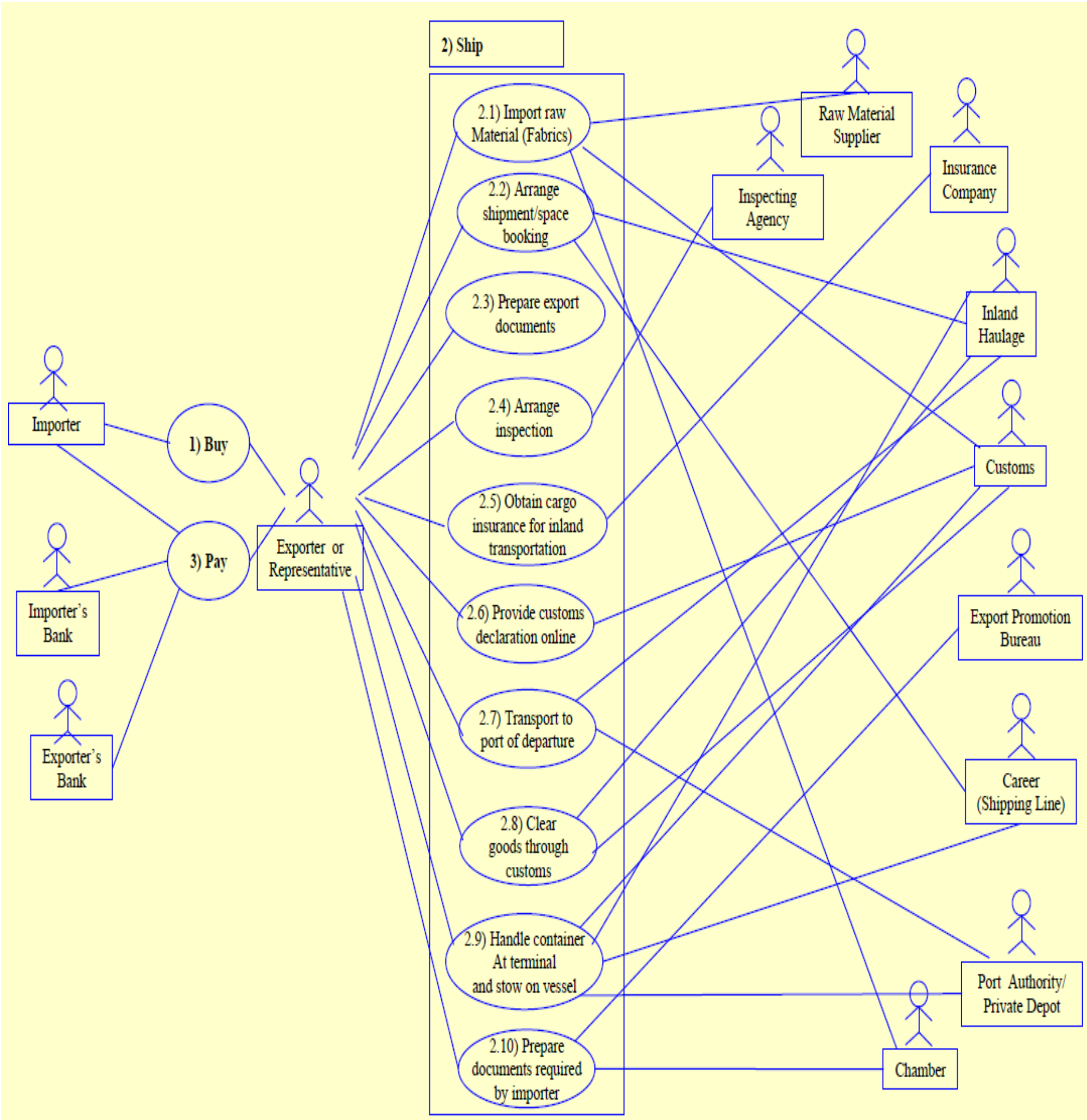
4. A Case Study

4.1 Scope

This case study calculates the environmental impact of the current paper-based activities of the trade processes in a single trade transaction using the methodology described in section 3. The use case identified for this case study is the export transaction of ready-made garments (RMG) from Bangladesh to India (Hossain and Rahman, 2011). There are 12 trade processes for RMG export from Bangladesh to India by sea. These trade processes are similar for other destinations like the European Union or the United States of America. Hence, the findings here can be applied for other destination countries too. The RMG sector has been selected for this case study as it is the largest export earner in Bangladesh. According to the latest figures, Bangladesh is the third-largest exporter of RMG products in the world, marginally behind Viet Nam (WTO, 2021). The sector employs about 4.4 million people and constitutes 11 per cent of the Gross Domestic Product of Bangladesh (IFC, 2020). The findings of this case study can work as a catalyst for carrying out other national- or regional-level studies in the RMG or textile sectors.

The use case diagram is shown in figure 1. It shows the core trade processes that are typically carried out in a single RMG export transaction from Bangladesh to India, and the stakeholders that an exporter is directly or indirectly linked with throughout the whole transaction. The main trade processes are also listed in table 3 below.

Figure 1. Use case diagram of trade processes in RMG export from Bangladesh to India by sea



Source: Hossain, S. and Rahman, M (2011), Facilitating Trade through Simplification of Trade Processes and Procedures in Bangladesh.

Table 3. List of trade processes in RMG export from Bangladesh to India by sea

Trade Processes: Export of RMG from Bangladesh to India
1. Buy
2.1 Import raw material
2.2 Arrange shipment
2.3 Prepare export documents
2.4 Arrange inspection
2.5 Obtain cargo insurance for inland transportation
2.6 Provide customs declaration online
2.7 Transport to port of departure
2.8 Clear goods through customs
2.9 Handle container at terminal
2.10 Prepare documents required by importer
3. Pay

Source: Hossain, S. and Rahman, M (2011), Facilitating Trade through Simplification of Trade Processes and Procedures in Bangladesh.

4.1.1 Application of the methodology

This case study includes investigation and verification of trade processes, and collection of new activity data using surveys and online interviews with key informants. The trade processes in this particular export transaction were investigated to crosscheck and update the activities and steps, documentation requirements, actors, and time required within processes. A questionnaire was developed to collect detailed activity data under each trade process (see Annex 2). Using this questionnaire, a survey was carried out with ten RMG exporters (large and medium-sized) in Dhaka and its surrounding area. For each trade process, the number of main documents and supporting documents and their number of pages, total number of people in the exporter's offices, total number of people involved in preparation and handling of paper documents, total journey time for the collection or submission of documents, and the electricity and water usage from the monthly bills of the exporter's offices were recorded. The total number of employees in these head offices ranges from 11 to 200. Employees in the commercial departments or units who are responsible for export-related paperwork range from 8 to 39. Several online interviews were conducted with exporters and Export Promotion Bureau and customs officials to verify and validate the key information obtained through the questionnaires.

Some corrections were made to the data after the verification. Publications, reports, articles, scientific journals and research studies were thoroughly consulted to obtain acceptable parameters and to derive practical assumptions. It is worth bearing in mind that the environmental impact in this study is calculated using data from the exporters only.

4.1.2 Calculation of impacts for each trade process

(See Annex 1 for step-by-step calculation)

For the calculation of GHG emissions, the equation discussed in section 3 is utilized. For each trade process, the paper usage (number of pages), ink usage (g), electricity consumption (kWh), and distance travelled for document transportation (km) are multiplied by the relevant emission factor (table 2) to obtain the corresponding GHG emissions.

For the calculation of waste generation from paper production and from office premises, the number of pages of paper utilized, the number of people involved in each trade process and the duration of a single export transaction was recorded. Due to the lack of data of total waste generation at exporters' offices, data for per capita Municipal Solid Waste (MSW) generation in Bangladesh (0.58 kg per day) is used (Waste Concern, 2014). The waste at exporters' offices, assumed to be half of the per capita daily MSW generation (with personnel spending 8 hours at the office, 8 non-sleeping hours at home/elsewhere), is 0.29 kg per day (EPA, 2016). This figure is also in line with the data found by other researchers (Edjabou et al., 2015). Finally, the amount of waste generation is calculated using the formula discussed in section 3.

Similarly, the water usage during paper production is calculated based on the number of pages used in each process, and using the formula in section 3. For the calculation of water consumption in the office, data on monthly water bills and the total number of employees in the exporters' offices were collected through the survey questionnaire, and the per capita water consumption is deduced. Finally, the per capita data is multiplied by the number of people involved in each trade process and the duration of a single export transaction to estimate the water consumption in the office.

4.2. Results and discussion

For the purpose of this study, data from a mix of large, medium and small-sized exporters is used. With wide-ranging employee headcounts among the different-sized exporters, a large variation is also observed in the impacts calculated. Therefore, in the estimation and analysis, the maximum and minimum values of the impacts are considered, rather than the average values.

4.2.1 Impact analysis for individual trade processes

Among all the processes in a single export transaction in the RMG sector in Bangladesh, importing raw materials accounts for the highest amount of GHG emission, waste generation and water usage (see table 4). The GHG emission ranges from 5-20 kg CO_2e, waste generation is between 23-81 kg and the water usage is calculated at 8-19 thousand litres per transaction for this single process. These figures are associated with the highest number of printed pages (12-61), highest number of employees (2-7 persons) involved in paperwork in an exporter's office, and longest time spent by the employees behind the paperwork among all the processes.

In addition, to comply with all the regulatory requirements, 6 to 14 journeys are required on the exporter's side to and from banks and other offices in this process, resulting in it accounting for the highest emissions from fuel usage among all the processes. An important step of this process, utilization declaration (UD), is requested online now. So, the paper usage or journeys for the main document of UD are excluded in the calculation. But the paper usage and journeys that are required for the retrieving of the supporting documents are still counted, including bill of lading, bill of entry, commercial invoice, insurance certificate, etc. These are some of the key paper documents required for the entire export process that are issued in this step, which are scanned and submitted online for issuing a UD. The copies of these documents are re-used multiple times in other trade processes in this transaction.

Table 4. Estimated environmental impact in each trade process per transaction in the RMG sector in Bangladesh

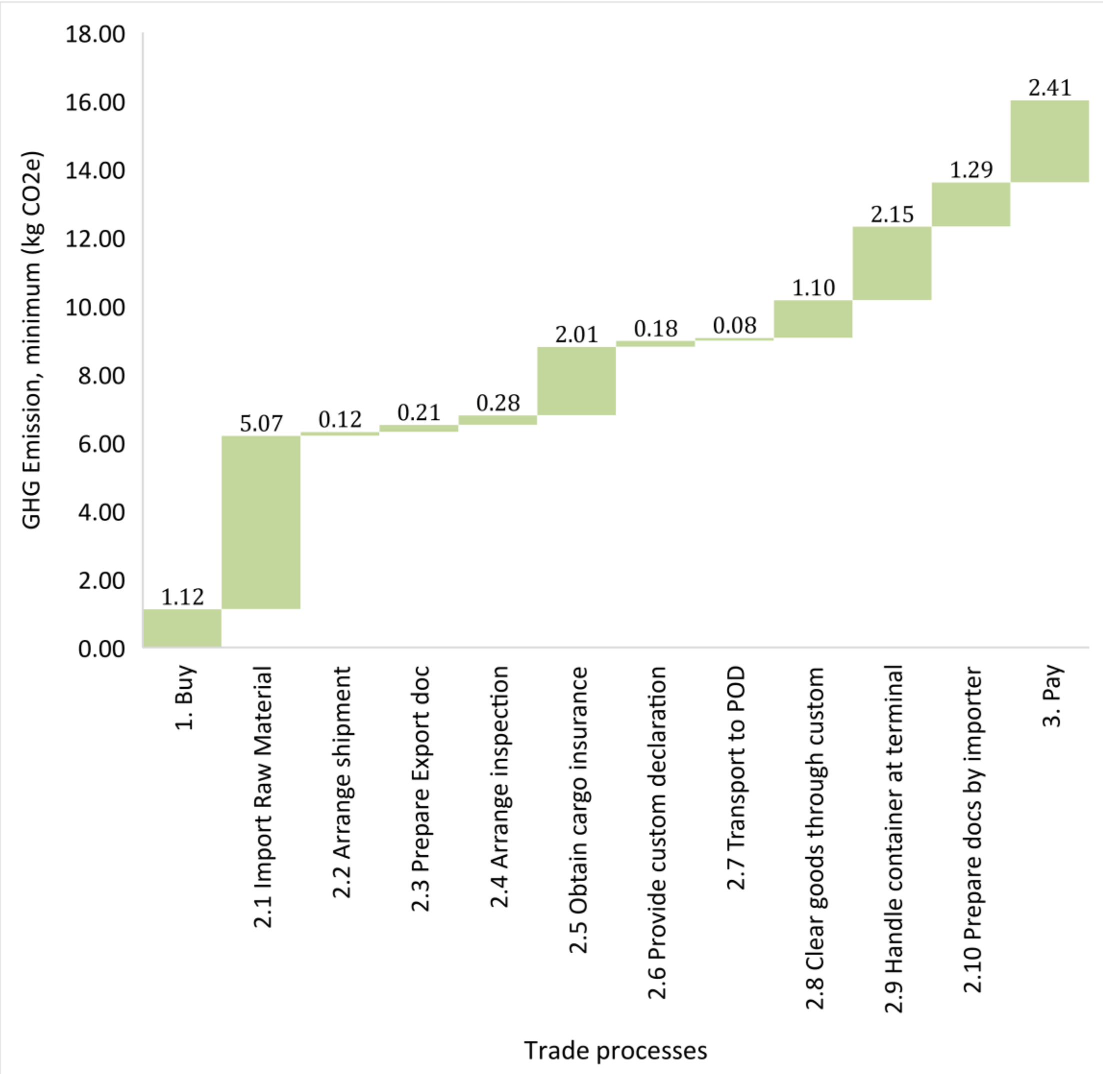
Trade Processes	Estimated environmental impact (per process per transaction)					
	GHG Emission (kg CO_2e)		Waste Generation (kg)		Water Usage (L)	
	Min	**Max**	**Min**	**Max**	**Min**	**Max**
1. Buy	1.11	5.11	11.62	34.89	2 996	11 027
2.1 Import raw material	5.07	20.24	23.28	81.56	8 665	19 425
2.2 Arrange shipment	0.116	1.13	11.60	34.80	4 329	11 905
2.3 Prepare export documents	0.208	2.25	11.61	46.48	2 165	11 983
2.4 Arrange inspection	0.276	6.10	11.62	34.99	2 995	14 562
2.5 Obtain cargo insurance for inland transportation	2	5.04	11.63	34.91	4 332	8 991
2.6 Provide customs declaration online	0.17	0.47	11.60	11.60	2 165	5 953
2.7 Transport to port of departure	0.08	0.95	11.60	11.66	2 165	5 957
2.8 Clear goods through customs	1.10	2.29	11.64	34.85	2 167	8 986
2.9 Handle container at terminal	2.15	4.84	11.64	34.92	4 332	9 707
2.10 Prepare documents required by importer	1.29	2.35	11.64	23.29	4 332	11 913
3. Pay	2.41	3.39	11.66	23.32	4 334	5 998
TOTAL	16.01	54.16	151.14	407.27	44 978	126 408

Source: Author's calculation based on survey results.

Other processes that are major contributors to the environmental impacts are "2.5 obtain cargo insurance", "2.9 handle container at terminal" and "3 payment". The minimum amount of GHG emissions in each of these processes is 2 kg, whereas the minimum amounts of waste generated and water usage are 11 kg and 4,000 litres respectively.

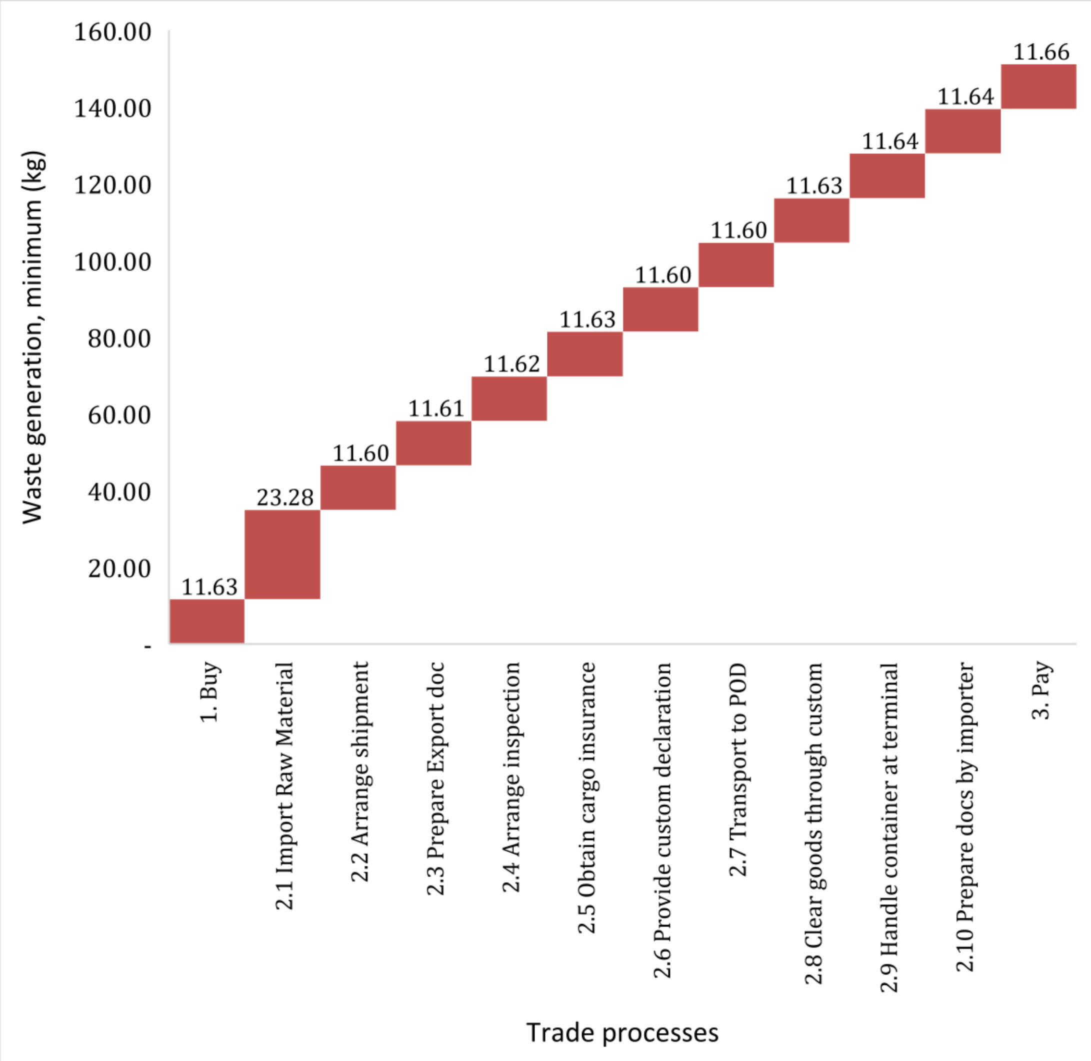
Figure 2 shows the incremental change as well as cumulative GHG emissions for individual trade processes in this particular export transaction. Figures 3 and 4 show the same for waste generation and water usage respectively.

Figure 2. Minimum GHG emission in individual trade processes (g CO_2e)



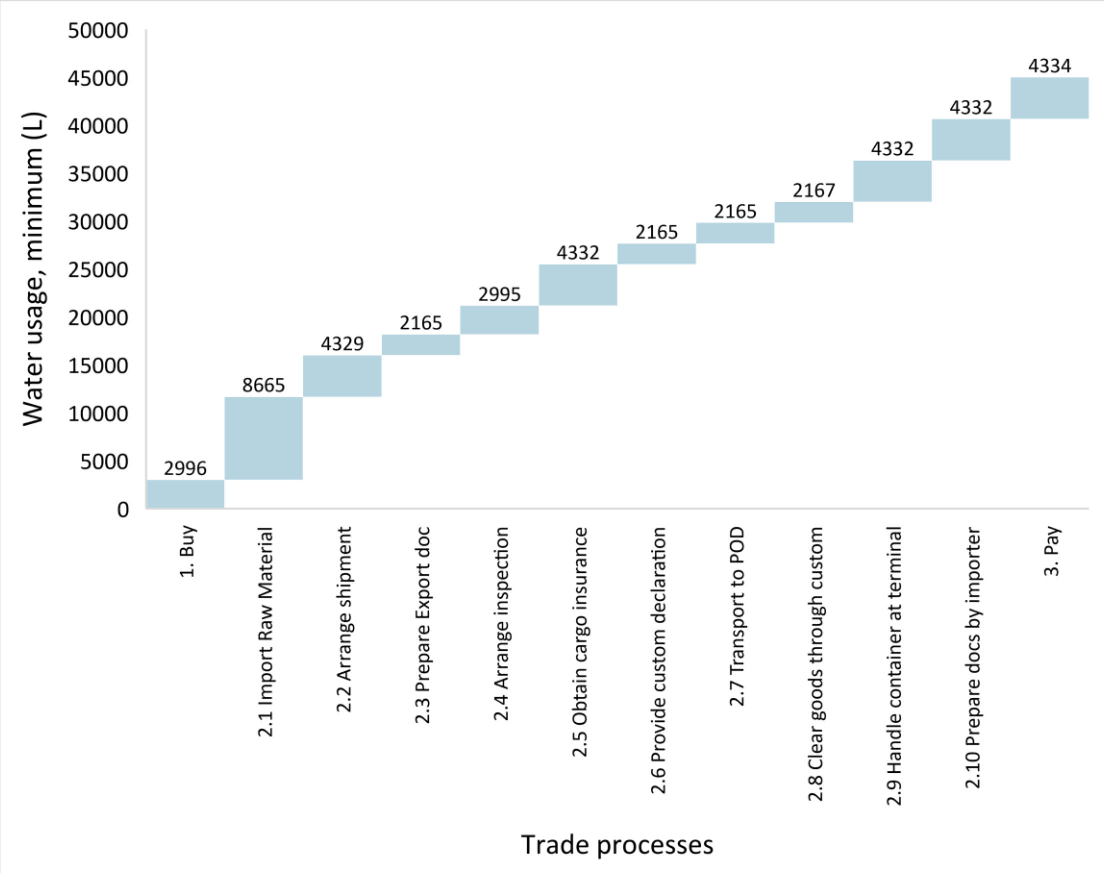
Source: Author's calculation based on survey results.

Figure 3. Minimum waste generation in individual trade processes (kg)



Source: Author’s calculation based on survey results.

Figure 4. Minimum water usage in individual trade processes (L)



Source: Author's calculation based on survey results.

According to the current practices and the information received from the exporters, there are some processes for which the paperwork is fully conducted online, e.g., the process of transporting goods to the port of departure, customs declaration, etc. Although these processes are almost paperless (only a one-page acknowledgement receipt is printed) and there is no journey involved, the reason for the environmental impacts calculated is the electricity consumed and waste produced by the employees working online on such processes. Nevertheless, being almost paperless, these processes account for some of the lowest GHG emissions or water usages in the whole transaction. With the adoption of a paperless system, efficiency will increase and less human resources will be required to do the same work. Therefore, savings can be expected in all environmental aspects.

4.2.2 Impact analysis and potential savings for a single export transaction

Table 5 shows the cumulative impact of the activities in a single export transaction towards GHG emission, waste generation and water usage, and the potential savings of these impacts from the full implementation of paperless trade.

Table 5. Estimated environmental impact and potential savings per export transaction in the RMG sector in Bangladesh

Environ-mental aspects	Activities in trade processes	Estimated environmental impact (per export transaction)			Potential savings in environmental impact from implementing trade facilitation and paperless trade (per export transaction)		
		Min	Max	Avg	Min	Max	Avg
GHG emission (kg CO_2e)	Paper usage	3	11.43	6	**16.01**	**54.16**	**28.02**
	Ink usage	0.01	0.04	0.02			
	Document transportation	9.60	20	12			
	Energy consumption	3.40	22.69	10			
	Total	**16.01**	**54.16**	**28.02**			
Waste generation (kg)	Paper usage	0.34	1.30	0.75	**66.69**	**179.94**	**108.92**
	Office usage	150.80	406	245.85			
	Total	**151.14**	**407.30**	**246.60**			
Water usage (L)	Paper usage	29	111	64	**19 806**	**55 682**	**36 229**
	Office usage	44 949	126 297	82 193			
	Total	**44 978**	**116 408**	**82 257**			

Source: Author's calculation based on data received from respondents of the survey and UNCOMTRADE data for trade.

The aggregate amount of GHG emissions in the "as-is" trade processes is calculated at 16-54 kg CO_2e per transaction in the RMG sector in Bangladesh. On average, for each transaction one tree is required to offset this GHG emission. The GHG emission only from papers in a single transaction is estimated at 3-11 kg CO_2e. Verifying each of the processes revealed that for each document submitted or obtained, a number of supporting documents are required, which were not always included in the activity descriptions in the BPA report. While a total of 26 documents are required to complete a single transaction, an average of 50 supporting documents are also issued or submitted with the main documents. These are mostly copies of the same documents, repeatedly submitted at various locations. In addition, the total number of pages may change as some documents, such as packing lists and lab reports, can have varying numbers of pages for different transactions. On average, 135 pages (A4 size) of main and supporting documents are used for a single transaction.

Paper documents are transported by employees of the exporters to and from various offices for the submission or collection of regulatory or commercial documents. For a single transaction, on average, employees make 18 journeys. Journey times are subject to distance, mode of transportation and traffic density. Hence, even in the same city, it is very difficult to ascertain exact journey times. However, anecdotal evidence from the exporters indicates an estimate of 1 hour for a one-way, 10-kilometre journey in Dhaka city by motorbike during office hours. In Bangladesh, app-based motorbike-taxies are a popular mode of transportation, and are used in the calculation of this study. However, small or medium exporters usually use the services of clearing and forwarding agents, especially for customs clearance, towards the end of the transaction. So, the number of journeys mentioned above does not include the journeys made by the agents.

No emission is considered here for the purpose of storage of goods. Several exporters confirmed that for RMG exports, usually the cargo-carrying vehicles do not need to queue or wait at the ports except during the religious holiday period in Bangladesh. Since this holiday period happens only once or twice a year and cargoes are usually not delayed in storage, this factor is excluded from the calculation to avoid any overestimation of the total emission. Nevertheless, document transportation alone causes emissions of 10-20 kg CO_2e per transaction. However, for other export products, e.g., perishable goods, storage in refrigeration units would add to the total emission.

On average, 62 hours are required by the exporters, engaging 14 to 30 employees, to handle the paperwork. Taking these figures into account and assuming 9 working hours per day for 22 working days a month, the emission from energy consumption is estimated at 3-23 kg CO_2e per transaction. This figure is notable, despite the application of conservative assumptions in some cases due to the lack of data. For example, there are other stakeholders involved in the same export process, including employees from customs, banks, the Export Promotion Bureau, etc., and the electricity usage by them is not considered in the calculation. But these organizations are quite large and extensive surveys would be required to estimate the electricity usage, waste generation or water usage from these offices for the employees handling the trade-related paperwork.

The electricity used covers the energy usage for all the electrical appliances in the office including computers, printers and air-conditioners. However, the fugitive emission from air conditioners is not considered here due to the lack of detailed data on the refrigerants used. The operating emission for a commercial air conditioner is reported to be only 5-10kg/year and therefore it is assumed to have a negligible effect in this estimation (EPA, 2014).

The total amount of estimated GHG emitted can be potentially saved if a paperless system is fully implemented. This is due to the fact that all the data considered for emission calculation, including the data for paper, ink, document transportation and energy consumption, are attributed to the exact activities conducted and time spent for the purpose of paperwork. This time does not include the time utilized for other office tasks and activities, including idle time, and waiting or queuing time.

The waste generation and water usage from paper production are estimated at 0.35-1 kg and 29-111 litres, respectively, for a single transaction. These figures relate to the production of the specified quantity of paper used in a single transaction in the “as-is” trade processes. Therefore, if all paper documents are eliminated, this total amount of waste and water can be potentially saved.

On the other hand, in the case of office usage, the amount of waste generation or water consumption varies from office to office based on the number of employees, size of the office, office amenities, office work culture, etc. The findings in this study show that, for a single transaction, the waste generated by office employees doing the paperwork ranges from 151 to 407 kg, while the total water usage attributed to them ranges from 45 to 126 thousand litres. The daily hours spent only on paperwork do not really affect the calculation for waste generation or water consumption, because these people are assumed to be at the office premises during the full working hours, regardless of the exact task they are doing. Therefore, it is impractical to attribute waste generation or water consumption only to the specific working hours spent on paperwork.

As such, if paperless measures are implemented, the total amount of waste reduced or water saved will result from efficiency gains due to a shorter total transaction time. As put forward by Shepherd (2014), full implementation of paperless trade measures would reduce export times by a maximum of 44 per cent (Shepherd, 2014). According to the BPA report, the time required for completing a single export transaction is 40 days on average. Applying Shepherd's approximation to this study, the total duration of the export process would be reduced to 22.4 days. Correspondingly, the potential reductions, per transaction, in waste generation and water usage are estimated at 67-180 kg and 20-56 thousand litres respectively.

In addition, errors made during the processes can add a further 10 per cent to the work hours spent, number of pages used, or distance travelled to complete the trade transaction (Duval and Hardy, 2021). However, the accounting for such possible mistakes is not considered in the calculation to keep the possible range of the results at its minimum.

The "per export transaction" results in table 5 can be further scaled up to the national, regional (Asia-Pacific) and global levels, using export data of the textile and clothing sector from United Nations COMTRADE[5] and World Trade Statistical Review (2021). The estimates at country, regional and global levels for the year 2020 are presented in table 6.

Table 6. Estimated environmental impact from RMG-export transactions at country, regional, and global levels

Environmental aspects	Coverage	Environmental impact		Potential savings	
		Min	Max	Min	Max
GHG emission (metric tons CO_2e)	Bangladesh	8 969	30 333	8 969	30 333
	Asia-Pacific	145 795	493 084	145 795	493 084
	World	224 360	758 793	224 360	758 793
Waste generation (metric tons)	Bangladesh	84 641	228 092	37 350	100 771
	Asia-Pacific	1 375 894	3 707 772	607 156	1 638 091
	World	2 117 324	5 705 780	934 335	2 520 811
Water usage (million gallons)	Bangladesh	6 649	18 688	2 928	8 232
	Asia-Pacific	108 091	303 786	47 598	133 815
	World	166 338	467 487	73 248	205 924

Source: Author's calculation based on survey results.

When scaled up for the Asia-Pacific region, the potential impact from implementing paperless measures amounts to 146 to 493 thousand metric tons

[5] Product group -50-63_textile and clothing, HS 2012. Data year: 2020. Accessed August 2021. Available from https://wits.worldbank.org.

of GHG savings, 0.6 to 1.6 million metric tons of waste reduction and 48 to 134 billion gallons of water saved. At the global level, the estimated GHG savings stand at 224 to 758 thousand metric tons, which is equivalent to planting 7 to 23 million trees[6]. In addition, the amount of waste projected to be reduced worldwide is 0.9 to 2.5 million metric tons, which is equivalent to 133 to 360 thousand garbage trucks of waste. The results also indicate great prospects for conserving water resources. The estimated amount of water saved is comparable to the water required to operate 52 to 148 million residential clothes washers for a year.

[6] To compensate for 1 metric ton of CO_2, a minimum of 31 trees are required. Calculation available from https://www.encon.be/en/calculation-co2-offsetting-trees.

5. Limitations of the study

Although this study quantifies different environmental impacts for a typical trade transaction, there will be large variations in the results calculated when this methodology is applied to different sectors of trade in different countries, simply because the activity data would vary greatly depending on the sector or product, such as perishable goods, auto parts, leather goods, etc. For example, for the export or import of perishable goods, a large volume of waste may be generated during storage which should be added to the calculation of total waste generation, whereas this type of waste does not fall into the scope of this study.

Moreover, even for similar products, the environmental impact can be very different in different countries. This is due to the fact that countries have different organizational cultures, waste collection systems, climatic conditions, etc. Apart from the nature of the product, the environmental impact will also depend on how the paperwork is being conducted and the type of infrastructure or facilities used. The parameters used to estimate the environmental impact in different dimensions can vary greatly. For example, in the case of transportation of documents, GHG emissions from cars will significantly differ from those from motorbikes. Furthermore, an exporter's office that has an extensive heating/cooling system or many electrical appliances will certainly account for more energy consumption than one with limited facilities. Hence, the proposed framework in this paper needs to be customized significantly, in terms of the level of parameters, to integrate specific contexts in question.

In this study, the trader (exporter or importer) is the only actor from whom activity data are collected. They are involved in all trade processes and are a key stakeholder. But certainly, much more detailed primary research could be undertaken to obtain activity data from other actors. In some cases, data collection may not be straightforward, and there may be a lack of accurate data. For example, people responsible for paperwork may be involved in other official tasks. Hence, it is difficult to gather and calculate accurate activity data, specifically for calculating the electricity usage during the time taken to do the paperwork. As for document transportation, in reality, various types of transport may be used but only the most commonly used ones have been considered for calculating emissions from fuel usage.

Another challenge is the limited applicability of the emission factors and assumptions used in this study, which will be different in various contexts. For example, the emission factor for electricity used in this study to calculate energy consumption is applicable specifically to Bangladesh, and different figures will have to be used in the calculations for other countries. To estimate the emission from paper, this study used the emission factor derived by the Environmental Paper Network, which is based particularly on the North American paper industry. Therefore, the accuracy of the emission estimation on paper usage in this study is uncertain when applied to Asia-Pacific countries. Similarly, due to the lack of data on waste generation at offices, data for municipal waste have been extrapolated to account for such waste.

Finally, due to COVID-19 restrictions and lockdowns in Bangladesh, offices were closed for a few months, limiting the small sample size of companies and offices that could be visited and reached as part of the study.

6. Conclusion and future research

This paper presented a case study on the RMG export sector in Bangladesh, quantifying the total environmental impacts arising from paper-based trade processes – impacts which might be saved (reduced or eliminated) if a paperless system is implemented. Savings in terms of GHG emissions, waste production and water usage were estimated. Savings in these three areas will contribute towards the transition to a circular economy, and to the sustainable development goals, especially those on climate action (SDG 13), responsible consumption and production (SDG 12), clean water and sanitation (SDG 6), life on land (SDG 15), and partnerships for the goals (SDG 17).

Despite applying conservative estimates in the calculation, the results from the primary research on the RMG sector in Bangladesh suggest that the potential environmental gains for the global RMG sector (from implementing a paperless system) is equivalent to saving 7 to 23 million trees a year. Globally, each year 133 to 360 thousand garbage trucks' worth of waste could be eliminated and an amount of water equivalent to operating 52 to 148 million residential clothes washers could be saved. Even the lower bands of these estimates translate to a significant amount of environmental impact that could be avoided. However, it is worth noting that the potential emission savings from implementing paperless trade is very low compared to the emissions from the international transportation of goods in the global supply chain (Duval and Hardy, 2021). Moreover, increased trade induced by greater trade facilitation means that the total emissions generated from transportation and related infrastructure will be much more. Hence it is extremely important that, alongside the implementation of paperless trade, energy-saving or decarbonizing features be introduced or applied to related emission sources.

This paper has highlighted certain aspects important to environmental impacts/savings which are relatively less visible compared to others. For example, the focus on paper documents and the reduction of their use is quite notable in trade facilitation, but through waste reduction and water conservation – as discussed in this study – significant environmental gains can also be potentially achieved. Finally, the exploratory character of this research and the data analysis performed contribute to the emerging global discourse on mainstreaming circular-economy approaches in trade facilitation and paperless trade. The links between these topics warrant further emphasis by policy makers, researchers and the global trading community in general.

This paper provides a baseline methodology to quantify the environmental impacts of trade processes for future analysis. Based on the methodology developed in this study, environmental impact assessments may be integrated into the scope of future BPA studies. However, estimating the environmental impact of trade transactions is expected to remain a difficult undertaking due to current data limitations. It is hoped that this first case study can encourage relevant stakeholders to collect data and develop emission factors applicable to a wider variety of situations, locations, and activities.

As pointed out at the beginning of this paper, since there is very limited research in this area, there are significant opportunities for embarking on further in-depth research. First, a survey on a larger scale of all actors involved in fulfilling trade – and transport – procedures could be conducted. This will increase the scope and accuracy of the measurement of the environmental impact. Second, notwithstanding the difficulty of obtaining activity data, primary data in areas such as waste collection and recycling, WEEE waste count, emission from heating and cooling systems, fugitive emission, etc., could be added into the calculation of environmental impacts. Third, research in trade transactions in other sectors may be conducted. For example, targeted primary research in perishable goods or agricultural products would be helpful to find out their environmental impacts and potential benefits from paperless trade, including potential savings in food loss and waste.

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Annex 1

Example for calculating the environmental impacts of an individual trade process in a single transaction

Note: The calculation method is the same for other processes in the transaction.

Process 1 (Buy)

The data used in the calculation have been collected from ten export companies. Maximum and minimum figures are based on responses from all of them.

The documents used in this process are:
i) Proforma invoice, ii) Letter of credit (LC) and other supporting documents.

Maximum number of pages including supporting documents = 15
Minimum number of pages including supporting documents = 4
Maximum number of journeys to/from other offices = 3
Minimum number of journeys to/from other offices = 1
Maximum number of envelopes = 3
Minimum number of envelopes = 1

Emission factors and assumptions considered in the calculation are listed in the following table:

	Emission factor	Assumptions	Sources	Geographic relevance
Paper	9.1 g CO_2e/g of unrecycled paper	Uncoated freesheet A4 paper, 80gsm, 0% recycling rate. Weight: 5g/page.	Environmental Paper Network (2021) www.papersizes.org (202	North America/ World
Ink	2.5 g CO_2e/ g ink	One gram of ink covers 12.6 pages with 10% coverage rate.	Duval and Hardy (2021)	World
Transportation	40 g CO_2e/km	Means of document transportation: Motorbike. Fuel type: petrol. Distance travelled per round trip journey is 20 km.	Fattah and Morshed (2021)	Bangladesh
Electricity	670 g CO_2e/KWh	9 working hours per day and 22 working days per month.	Bangladesh Department of Environment (2017)	Bangladesh
Waste from paper	1.04 gram/g of paper	Uncoated freesheet A4 paper, 80gsm, Weight: 5g/page. Solid waste includes the waste generated during production and the waste for disposal after usage.	Environmental Paper Network (2021)	North America/ World
Waste from office usage	290g/capita /day	MSW generation/capita/day in Bangladesh is 0.58kg and office waste is assumed to be ½ of the per capita daily MSW generation since people sleep on average 8 hours per day, so they are awake and generating waste/recyclables for 16 hours a day (8 hours at the office, 8 hours at home/elsewhere).	Waste Concern (2014) Environmental Protection Agency (2016)	Bangladesh

Water usage for paper	0.454 L/sheet of A4 paper	Uncoated freesheet A4 paper, 80gsm.	Environmental Paper Network (2021)	North America/ World

1. Calculation of GHG Emission in Process 1 (Buy)

1.1. Emission from paper

Step 1. Multiply the weight of a single page/envelope by the number of pages/envelopes used, to obtain the total weight of paper.

Weight of paper and envelope, g (max) = ((5*15)+(6.75*3)) = 95.25g
Weight of paper and envelope, g (min) = ((5*4)+(6.75*1)) = 26.75g

Step 2. Multiply the total weight of paper by the paper emission factor to obtain the amount of CO2e emission from paper used.

Thus, from paper,
Maximum GHG emission, gCO2e = 95.25*9.1 = 866.78
Minimum GHG emission, gCO2e = 26.75*9.1 = 243.43

1.2. Emission from ink

Step 1. Calculate the amount of ink used by dividing the total number of pages by the ink coverage rate.

Assuming ink coverage rate of 12.6%,
Total ink used, g (max) = 15/12.6 = 1.19
Total ink used, g (min) = 4/12.6 = 0.32

Step 2. Multiply the total amount of ink used by the ink emission factor to obtain the amount of CO_2e emission.

From ink,
Maximum GHG emission, gCO2e = 1.19*2.5 = 2.98
Minimum GHG emission, gCO2e = 0.32*2.5 = 0.80

1.3. Emission from document transportation

Step 1. Multiply the number of round-trip journeys to and from other offices by the distance per round-trip journey, to obtain the distance travelled.

Maximum distance travelled, km = 20*3 = 60 km
Minimum distance traveled, km = 20*1 = 20 km

Step 2. Multiply the distance travelled by the transport emission factor (using appropriate emission factor for the geographic location, vehicle and fuel used)

From transportation,
Maximum GHG emission, gCO2e = 60*40 = 2,400
Minimum GHG emission, gCO2e = 20*40 = 800

1.4. Emission from electricity usage

Step 1. Using the electricity usage data (kwh) per month, total number of employees, number of employees responsible for documentation in a particular process, number of hours spent on documentation in a particular process, and total working hours; the electricity usage for documentation purposes is derived as:

Electricity usage (kwh) =

$$\frac{Electricity\ usage\ per\ month\ (kwh)}{Total\ working\ hour\ per\ month\ (h)} \times \frac{Number\ of\ people\ doing\ documentation}{Number\ of\ people\ in\ the\ office} \times Total\ hours\ for\ documentation\ (h)$$

For example, the export company accounting for maximum -
electricity usage for documentation purposes (kwh) = $\frac{816}{22*9} \times \frac{2}{30} \times 10 = 2.75$

The export company accounting for minimum-
electricity usage for documentation purposes (kwh) = $\frac{2041}{22*9} \times \frac{1}{95} \times 1 = 0.11$

Step 2. Multiply the kilowatt-hour used by the appropriate emission factor (using appropriate geographic location and grid factor) to obtain the emission caused by the electricity

From electricity,
Maximum emission, gCO2e = 2.75 × 670 = 1,841.54
Minimum emission, gCO2e = 0.11 × 670 = 73.7

1.5. Total GHG emission

Add all maximum and minimum emissions respectively, derived from 1.1 to 1.4.

Maximum GHG emission, gCO2e =
Emission from paper + Emission from ink + Emission from document transportation + Emission from electricity usage = 866.78 + 2.98 + 2,400 + 1,841.54 = **5,111.30**

Minimum GHG emission, gCO2e =
Emission from paper + Emission from ink + Emission from document transportation + Emission from electricity usage
= 243.43 + 0.80 + 800 + 73.7 = **1,117.93**

2. Calculation of waste generation in Process 1 (Buy):

2.1. Waste from paper (generated at paper mills during production)

Multiply the total weight of paper (grams) used in this process with the weight of solid waste (grams) generated by producing one gram of paper.

One gram of paper produces 1.04 grams of solid waste (refer to section 3.2.1 for sources and details).

Thus,
Solid waste from paper = Total weight of paper x 1.04

And,
Maximum waste generated from paper, g = 95.25 X 1.04 = 99.06
Minimum waste generated from paper, g = 26.75 X 1.04 = 27.82

2.2. Waste from office usage (accounting for people involved in paperwork only)

Multiply the total number of people involved in paperwork by the per capita waste per day and the total number of days required for a single export transaction.

Thus,
Maximum waste generated from office, g = 3 * 290 *40 = 34,800
Minimum waste generated from paper, g = 1 * 290 * 40 = 11,600

2.3. Total waste

Maximum total waste generated, g = waste from paper + waste from office = 99.06 + 34,800 = 34,899.06 g = **34.89 kg**

Minimum total waste generated, g = waste from paper + waste from office = 27.82 + 11,600 = 11,627.82 g = **11.62 kg**

3. Calculation of water usage in Process 1 (Buy):

3.1. Water usage for paper production

Water usage for paper production = Total number of pages and envelopes used in the trade process X water required to produce one A4 sheet of paper

Producing one A4 sheet of paper requires 0.454 g of water.

Thus,
Maximum water usage for paper production, L = 18 * 0.454 = 8.17
Minimum water usage for paper production, L = 5 * 0.454 = 2.27

3.2. Water consumption in the office (accounting for people involved in paperwork only)

Using the water usage data (L) per month from the water bill, total number of employees, and number of employees responsible for documentation in a particular process, the per capita water consumption per month for documentation purpose is derived as:

$$Water\ usage\ (L) =\ Water\ usage\ per\ month\ (L) \times \frac{Number\ of\ people\ doing\ documentation}{Number\ of\ people\ in\ the\ office}$$

For example,

The export company accounting for maximum usage:
From water bill, Water consumption per month (L) = 33,333
Number of people doing paperwork in this process (buy) = 2
Total number of people in the office = 11
Maximum water consumption per month by the employees involved in paperwork in the office (L) = 33,333 × 2 / 11 = 6060.61

The export company accounting for minimum usage:
From water bill, Water consumption per month (L) = 247,000
Number of people doing paperwork in this process (buy) = 1
Total number of people in the office = 150
Minimum water consumption per month by the employees involved in paperwork in the office (L) = 247,000 × 1 / 150 = 1646.67

Now multiply the per capita water consumption per day with the total number of days required for a single export transaction, to derive the total water consumption in the office for documentation purpose of the particular process.

Working days in a month = 22 days
Total duration of a single export transaction = 40 days

Thus,

Maximum water consumption in the office by the employees involved in paperwork, L = (6,060.61 / 22) * 40 = 11,019.28
Minimum water consumption in the office by the employees involved in paperwork, L = (1,646.67 / 22) * 40 = 2,993.93

3.3. Total water usage

Maximum total water usage, L = water usage for paper production + water usage in the office = 8.17 + 11,019. 28 = **11,027.45 L**

Minimum total water usage, L = water usage for paper production + water usage in the office = 2.27 + 2,993.93 = **2,996.21 L**

Potential Savings:

In the case of GHG emission and water usage during paper production, the potential savings are the same as the estimated impact. Figures for paper usage, ink usage, journey time for document transportation and energy consumption in the office are calculated for the specific time spent on paperwork in a single export transaction. This paperwork will be eliminated with the full implementation of cross-border paperless trade.

In the case of waste generation in the office, the total time needed for a single export transaction is assumed to be 40 days (as per the BPA study). Full implementation of paperless trade can reduce this export time by a maximum of 44% (Shepherd, 2014). Applying this approximation to waste generation in the office, the potential savings is calculated as:

Potential savings in waste generation in the office = Total impact in waste generation in the office X 44%

Scaling up at the country, regional and global levels:

Coverage	**Export value (USD 1,000) in textile and clothing sector***	**Year**	**Number of transactions per year****
Bangladesh	28,000,000	2020	560,000
Asia-Pacific Region (ESCAP member countries excluding North American and European members)	455,154,889.6	2020	9,103,098
World	700,424,366.3	2020	14,008,487

Source:
https://wits.worldbank.org/CountryProfile/en/Country/WLD/Year/2019/TradeFlow/EXPIMP/Partner/EAS/Product/All-Groups.
*HS 1988/92. Product code 50-63

**Assumption: USD 50,000 per transaction, as used in the World Bank Doing Business Report's Trading Across Borders database.

The numbers of export transactions per year – for Bangladesh, the Asia-Pacific region and the world – are derived by dividing their total export value per year in the textile and clothing sector by the average transaction value of USD 50,000.

Next, the environmental impact (and the potential savings) of each environmental aspect can be calculated by multiplying the respective value of impact per export transaction with the total number of transactions as derived above.

Thus,

For GHG emission:

Estimated minimum emission in Bangladesh, metric tons of CO_2e (in RMG export, year 2020)
= **Number of export transactions per year in Bangladesh X minimum GHG emission per transaction**
= (560,000 X 16,016) / 1,000,000
= 8,968.96

Estimated maximum emission in Bangladesh, metric tons of CO_2e (in RMG export, year 2020)
= **Number of export transactions per year in Bangladesh X maximum GHG emission per transaction**
= (560,000 X 54,167) / 1,000,000
= **30,333**

Estimated minimum emission in the Asia-Pacific region, metric tons of CO_2e (in RMG export, year 2020)
= **Number of export transactions per year in Asia-Pacific X minimum GHG emission per transaction**
= (9,103,098 X 16,016) / 1,000,000
= 14,580

Estimated maximum emission in the Asia-Pacific region, metric tons of CO_2e (in RMG export, year 2020)
= **Number of export transactions per year in Asia-Pacific X maximum GHG emission per transaction**
= (9,103,098 X 54,167) / 1,000,000
= 493,084

Estimated minimum emission in the world, metric tons of CO_2e (in RMG export, year 2020)
= **Number of export transactions per year in the world X minimum GHG emission per transaction**
= (14,008,487 X 16,016) / 1,000,000
= 224,360

Estimated minimum emission in the world, metric tons of CO_2e (in RMG export, year 2020)
= **Number of export transactions per year in the world X maximum GHG emission per transaction**
= (14,008,487 X 54,167) / 1,000,000
= 758,793

The same scaling method is applied for estimating waste generation and water usage at the country, regional and global levels.

Annex 2

Sample questionnaire

Dear Respondent,

I am conducting a research on 'The environmental impact of trade facilitation and paperless trade' for The United Nations Economic and Social Commission for Asia and The Pacific (UNESCAP). In this regard, I am surveying on the export process of woven garments in Bangladesh to quantify the environmental impact of the whole processes. These questions are related to the paper works, transportation and office details (human resources, working hours etc.) that are required to complete the export process. Please note that this is not related to any factory or production level information.

Please find attached the questionnaire below.

Thank you for your kind participation in the Survey.

Mahezabin Natasha
UNESCAP, Bangkok

Documents	QUESTIONS							
	PAPER-USAGE			**OFFICE USAGE**	**TRANSPORTATION**			
	How many pages are in this document?	*How many additional supporting documents are needed to obtain or submit this document?*	*How many pages are in the additional supporting documents?*	*How many hours/days are needed to prepare the document?*	*How is it submitted or collected? (Email/Pa-per?)*	*How many times do you need to travel to submit or collect the document?*	*What is the medium of travel e.g. motorcycle, car, bus etc. (Others – please specify)*	*What is the average travel time to go and come back?*
1. Proforma Invoice								
2. Letter of credit (L/C)								
3. Back to back Letter of Credit (L/C)								
4. Export form								
5. Commercial invoice								
6. Utilization declaration								
7. Packing List								

8. Customs declaration								
9. Insurance Certificate								
10. Inspection Certificate								
11. Lab test report								
12. Transport Contract								
13. Bill of Lading								
14. GSP Certificate								
15. Certificate of Origin								
16. Bill of Entry								
17. Port Entry Receipt								
18. SAPTA Combined Declaration and Certificate								
19. Shipping Bill								

20. Manifest								
21. Career Booking Request								
22. Career Booking Confirmation								
23. Inland Haulage Booking Request								
24. Inland Haulage Booking Confirmation								
25. Container Loading List								
26. Cargo insurance application form								
Any other document (please specify)								

Minimum Number of Export Transaction per year (over 5 years)	
Maximum Number of Export Transaction per year (over 5 years)	
Average Number of Export Transaction per year (over 5 years)	
Electricity usage per month in office (excluding factory), KWh	
Water usage per month in office (excluding factory), Litre	
Total number of employees in the office	
Total number of employees responsible for paper work	