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# CARBON FOOTPRINT IN KNOWLEDGE SECTOR: An Assessment from Cradle to Grave.

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# CARBON FOOTPRINT IN KNOWLEDGE SECTOR: An Assessment from Cradle to Grave.

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**Abstract**

Carbon footprint has become a widely used term and concept in the public debate on responsibility and abatement action against the threat of global climate change. It had a tremendous increase in public appearance over the last few years and is now a buzzword widely used across the media, government and in the business world. "The carbon footprint is a measure of the exclusive total amount of carbon dioxide emissions that is directly and indirectly caused by an activity or is accumulated over the life stages of a product". Until now only little research has been made trying to explore the relation between knowledge industries and their environment implications. Keeping this in view the present study highlights the carbon footprint of knowledge cycle by contemplating the existing literature so that carbon reduction strategies will be employed by the industries associated with it as a part of social responsibility.

**Keywords** – Carbon footprint, knowledge industry, CO2 emission, Green House Gases, Environmental implications, knowledge distribution systems

## Introduction

Carbon dioxide has taken a centre stage in the environmental arena. It was in the 19th century, scientists realized that gases in the atmosphere cause a "greenhouse effect" which affects the planet's temperature. At the turn of the century, various scientists like Arrhenius, Callendar and Keeling **(as cited in "The Discovery of Global Warming", 2014)** argued that the level of carbon dioxide was Climbing and raising global temperature and were of opinion it will result in global warming. With global warming dominating so many headlines today, it's no surprise that many of us are looking to reduce the amount of carbon dioxide and

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other greenhouse gases our activities produce. Researchers, academicians, and decision makers – from around the globe are working hard to generate facts and figures relating to the carbon footprint of different industries. "The carbon footprint is a measure of the exclusive total amount of carbon dioxide emissions that is directly and indirectly caused by an activity or is accumulated over the life stages of a product. Machlup argued **(as cited in "Education: The knowledge Industry", 2006)** that knowledge spreading is indeed a definable industry and breaks it down into five sub industries with 52 branches including publishing, broadcasting, research and development. Thus knowledge industries can be seen as an opportunity to reduce pollution and environmentally harmful consumption of natural resources, if carbon reduction strategies are implemented as the data gathered from the available studies, pose some real causes for concern. According to the study "Environmental Trends and Climate Impacts: Findings from the U.S. Book Industry" (2008) co-sponsored by GPI and the Book Industry Study Group, found that tree harvesting and paper production and printing accounted for a total of 65% of the industry's carbon footprint, while a publisher's office operations accounted for less than 7% . According to Tyson Miller (**as cited in "Publishing Industry", 2008**) of the non-profit Green Press Initiative, the production of one book results in 8.85 pounds of carbon emissions. With climate change high up on the political and corporate agenda, the current study intends to bring into limelight the correlation between knowledge sector and its environmental implications.

## Scope

The present study tried to sum up all the existing literature focusing on the carbon footprint of a few aspects of knowledge industry including the pulp and paper production, printing and publishing activities. The study also highlighted carbon footprint left during manufacturing of books, magazines etc. Since the ICT sector penetration in knowledge industries cannot be ignored in the present scenario. Hence the ICT sector's CO2 share has been given a little touch.

## Objectives

The major objectives are:

- Understanding the concept of carbon footprint of knowledge industry and its environmental implications.
- Highlighting the CO2 emission in knowledge distribution systems.
- To have a bird's eye view of various initiatives taken and strategies to be adopted to reduce the carbon emission from knowledge sector.

## Methodology

An extensive literature search was conducted to produce data relating to the CO2 emissions from various industries and activities associated with knowledge cycle. A detailed search on several databases – Library and Information Science technology Abstracts (LISTA), Scopus and statistical databases such as the International Energy Agency (IEA), Confederation of European Paper industries (CEPI), etc., was carried out for retrieving the literature.

## Literature Review

### Carbon footprint and knowledge sector

Human beings by nature have a craze to be at the top. They want to prosper and progress in every field. In short, by hook or crook; they want to tame the nature. But the main problem is that human beings do not know the footprint left behind by their actions and of course their consequences on the future generations. Global warming and reductions of carbon emissions are at the top of the environmental policy agenda today **(Weidema, Thrane, Christensen, Schmidt & Lokke, 2008)** and many companies, organizations are pursuing “carbon footprint” projects to estimate their own contributions to global climate change **(Matthews, Hendrickson & Weber, 2008)**.

Much literature has been investigated and written about carbon footprint which invades every sphere of life form cradle to the grave of a product or organization. As our main interest is about knowledge industry's footprint, the study focuses a few aspects of knowledge sector. **Lassen (2004)** studied the environmental perspectives of travel in knowledge sector and

finds it a highly flexible, networked and mobilized sector with serious environmental complications. Knowledge industries are concerned with the creation, acquisition, assimilation, utilization and dissemination of knowledge and are not confined within the four walls of a room. Thus it is important to consider every dimensional aspect of knowledge sector like paper manufacturing, pulp production; books, magazines, journal manufacturing, internet usage etc so that a reliable assessment of carbon footprint of the industrial outputs can be determined. Although the forest and paper industry is a bone to the world's economy as it has been said by **Gebler** in his interview, “Voith paper environmental solutions-a new future-oriented division” [personal communication, 2007] that Global forestry and paper industry output is worth around 750 billion Euro p.a**.** But one of the most significant, and perhaps least understood, impacts of the paper industry is climate change. The pulp and paper industry is a chemical process industry with major impact on the environment. Every phase of paper’s lifecycle contributes to global warming, from harvesting trees to production of pulp and paper to eventual disposal. The pulp and paper manufacturing industry is among the world’s largest users of energy and emitters of greenhouse gases, and a significant source of water pollution and landfill waste **(World Wide Fund, 2010). Research Information (2009)** data show that “24 trees are required to make one ton of paper", 1.5 tons of coal are required to produce the electricity for one ton of paper and this is responsible for emitting around five tons of carbon dioxide”. Paper industry is spreading its cruel hands on the environmental umbrella as this can be realized from the fact that Global production in the pulp, paper and publishing sector is expected to increase by 77% from 1995 to 2020 **(OECD Environmental Outlook, 2001).** In India, although the paper market is relatively small, continued growth of roughly 6% is expected through 2020 driven by strong demand for high quality printing **(OECD, 2010)** and currently there are about 800 paper mills operating with an annual growth of 9 **% (International Trade and Exhibitions India and ITE Group Plc, 2011)** producing an output of more than 6 million tones.

The pulp and paper industry has been regarded as "Dirty-industry “or pollution-intensive industry **(Muthukumara, Wheeler & PRDEI, 1997). Kinsella et al., 2007c and Cheeseman, 2008** suggest that the pulp and

paper industry is the fourth largest emitter of greenhouse gases among manufacturing industries, and contributes 9 percent of total manufacturing carbon dioxide emissions. However **Saibil, Attia, Landry and Markey (2011)** disagree with the above findings considering it the third largest GHG emitter after the chemical and steel industry. In this scenario **("Eco-impact", n.a)** shows that the world paper consumption for prints and copies is equal to 1.1 billion trees, 190 billion reams of paper, or 1.6 billion tons of CO2. The global publishing market grew by 1.5% in 2009 to reach a value of $235.1 billion of which Europe accounts for 41.7% of the global publishing market value **(Bharat Book Bureau, 2010).** The U.S. title output in 2007 increased slightly to 276,649 new titles and editions, up from the 274,416 that were published in 2006 **(Bowker, 2008)** and in 2009 U.K published 133,224 books with an increase of 2.3% over the last year **(Nielsen Book, 2010).** Similarly the Number of U.S. book publishers in 2007 were 74,240 and number of books produced annually in the U.S were 4.15 billion in 2006 as revealed from **Eco-Libris (2007).** Assuming the book industry, through all steps of production, retail and publishing activities, emits a net 8.85 pounds CO2 per book as shown by **Book Industry Study Group, Green Press Initiative & Borealis Centre for Environment and Trade Research, 2008**. Another study reveals that average book has a carbon footprint of 7.46 kilograms over its lifetime **(Kozak, 2003). Chowdhury (2010)** adds to the same discussion showing a variation in the results by stating that the book industry in the UK and USA alone produces about 1.8 million tones and about 11.27 million tones of CO2 respectively. Furthermore, CO2 emission for the worldwide journal publishing industry is estimated to be about 12 million tones.

**Bengtsson and Heimersson (2009)** calculated the carbon footprint of various printed products and showed that for master thesis the carbon footprint is 0.5 kg CO2- equivalents per booklet and 43 g CO2-equivalents per square meter printed product (with 40 copies), of which paper production accounts nearly 37g and transportation accounts 6g of CO2emission. Similarly for a bound book, the carbon footprint is calculated to be 0.3 kg CO2-equivalents per booklet and 42g CO2-equivalents per square meter printed product (printed in 54 copies) of which paper production accounts nearly 34g, ink production 2g and transportation

accounts 6g of $CO_2$ emission while a booklet, printed in four color with 8000 copies, emits 0.2 kg $CO_2$-equivalents per booklet and 109g $CO_2$-equivalents per square meter printed product of that paper production contributes nearly 83g,transportation 5g $CO_2$ emission and the rest others. **INFRAS and Zurich (1998)** carried out a lifecycle assessment of two products, a newspaper and a magazine. The study suggests that the impact of a rotogravure-printed magazine (1.8 kg of $CO_2$per kg of product) was more than double to the newspaper (0.7kg). In the life cycle of the newspaper, 31 % of the environmental load came from printing, 26 % from papermaking and 29 % from pulping. For the magazine, printed on a SC paper, papermaking had the largest share of impacts (44 %) while pulping and printing corresponded to 25 % and 28 %, respectively. The National Geographic life cycle study showed that each copy of the magazine is responsible for the release of about 0.82 kg of carbon dioxide equivalents into the atmosphere, approximately equivalent to the quantity emitted by driving a car for 3 kilometers (based on a gas consumption rate of 8.5 km/liter) with greatest opportunities for reducing the magazine's carbon footprint in manufacturing and printing **(National Geographic Magazine Life Cycle Assessment, 2014)**. **Transcontinental printing (2009)** connotes that U.S. magazine production generates 648,000 tons of carbon or 2.39 million tons of $CO_2$-eq emissions.

The findings show that the printing and publishing industries are less conscious about their product's impact on the environment and seem to play a less responsible role in using eco-friendly tools. **Viluksela (2008)** opined that only 5 % of publishing companies apply environmental management tools, e.g. environmental management systems or eco-labels. It is noteworthy in reviewing much of the literature that there is a strong drive to improve the impact of the pulp and paper industry upon the environment. This includes moves to sustainable forest management with Forestry Stewardship Certification and removal of harmful bleaching technologies **("The Environmental Impact of Paper Production", 2012).** Technology can also play an important role in increasing energy efficiency and reducing $CO_2$ emissions in the pulp and paper industry. The most

promising energy savings technologies in the industry are black-liquor gasification and advanced drying technologies **(Gielen & Tam, 2006).**

**Carbon footprint and digital knowledge distribution systems**

With the introduction of the internet and the increasing amount of services are being provided electronically, e-books and e-readers are gaining momentum and will significantly change the book industry **(PWC, 2010). Chowdhury (2010)** opines that that the production and distribution costs of digital knowledge products are negligible compared to the environmental costs of production and distribution of printed knowledge products. **Fat Knowledge (2008)** agrees with the above statement saying that the e-books are better for the environment than their paper brethren and presumes that reading the physical version of the NY Times for a year uses 7,300 MJ of energy and emits 700 kg of CO2 and reading it on a Kindle (digital version) uses 100 MJ of energy and emits 10 kg of CO2 thereby reducing about 70% of CO2 emission. These figures clearly show that electronic media can be a safe and better alternative but the dark face of technology also needs to be understood as indicated by below mentioned studies.

**Global Action Plan (2007)** report reveals that there are more than 1 Billion computers on the planet and the worldwide ICT sector is responsible for around 2.3% of manmade CO2 each year going neck to neck with global airline industry and is projected to double by 2020. Production of a PC took around 1.8 tons of chemicals, fossil fuels and water, and its operation generates 0.1 tons of CO2 in a typical year **(Pandikumar, 2012)**. Computers generate an estimated 35 million tons of carbon dioxide into the atmosphere each year **(United Nations University, 2004 & Ecofriend, 2014)** and view of GHG's of internet searches and web page browsing which go unnoticed to us can give astonishing figures as it has been found that Internet releases about 300 million tons of carbon dioxide annually **("How big is the Internet's carbon footprint?", n.a). Leake and Woods (2009)** in an article published in The Sunday Times while quoting Harvard physicist Wissner-Gross concluded that viewing a simple web page generates about 0.02g of CO2 per second and it rises tenfold to about 0.2g of CO2 a second a when viewing a website with complex images,

animations or videos and moreover they also show that performing single Google search releases about 7 g of CO2 - the same amount of carbon dioxide as boiling a kettle for a cup of tea. It is here noteworthy to say that assuming a Google search creates one gram of CO2 emissions, it is possible to calculate the total impact of Google searching on the earth's atmosphere. **Gombiner (2011)** calculated the CO2 emission of Google search engine and You Tube on the basis of his assumption and believed that when 1 billion Google searches are occurring every day, it means there are 1 billion grams of CO2 emitted into the atmosphere due to Google searches alone. Moreover, if YouTube users are watching about 2 billion videos every day and If the average time a user watches a video is ten seconds (a random guess), then watching of videos on YouTube accounts for another four billion grams of CO2 emissions, or an additional 320,000 car commuters. So one can imagine that Google and YouTube represents only a portion of internet content, it is easy to see how the Internet as a whole is a major contributor to global CO2 emissions, as **Roslin (2011)** in her article “Could the Net be killing the planet one web search at a time?” states that If the Internet was a country, it would be the planet's fifth-biggest consumer of power, ahead of India and Germany.

ICT deployment can have both a positive and negative impacts on GHG emissions. It may enable GHG emission reduction in a variety of sectors and through many different channels by playing a significant role in reducing the remaining 98% in particular by enabling smart energy efficiency and providing a substitute for the physical transport of goods and people. But we must also face the challenge of using ICTs to help other industries to realize greener objectives, whether self-imposed or externally regulated. Further, the sustainability of our environment lies with proper management of our industrial processes. Various initiatives addressing the carbon footprint reduction strategies can be followed in order to achieve the carbon neutrality seeing that **Viluksela (2008)** stressed the need of introducing and developing Environmental awareness and training both in the educational institutions as well as in the printing and publishing industry and it is worthy to note that we cannot opt for economic development through our industrial activities at the sake of environment.

**Carbon footprint initiatives and Eco publishing**

Environmental issues have not faded, but really have become an integral part of all our business and manufacturing discussions. The knowledge industry cannot isolate itself from the consequences of the resource consumption, and hope that somebody else will make the tough decisions for it and make climate change go away. It has to change the ways, by realizing its harmful effects on the environment, now knowledge industry is in the midst of a positive environmental transformation. one of the unparallel Initiative at global level is Green Press Initiative (GPI) by Tyson miller in 2001 which takes a collaborative approach towards working with publishers, printers, paper manufacturers and others in the book and newspaper industries to minimize social and environmental impacts, including impacts on endangered forests, impacts on climate change, and impacts on communities where paper fiber is sourced. Its efforts have led to the development of environmental paper policies from over 180 book publishers – approximately 42% of market-share in the U.S. book sector and has resulted in a six fold increase in recycled fiber use i.e. reduction of over approximately 1.4 million tons of greenhouse gas emissions (equivalent to over 250,000 cars/yr) and nearly 3 million trees per year **(GPI, 2011).** The Book Industry Treatise on Responsible Publishing initiated by GPI is an industry-developed agreement that defines shared goals for improving the environmental impacts associated with the book industry's average consumption of over one million tons of paper each year. A Leadership Council involving Baker Publishing Group, Chronicle Books, Continuum Publishing, Harvard University Press, Lantern Books, Square One Publishers, Thomson-Shore Book Manufacturing and others is guiding its implementation process and oversees future content revisions **(GPI, 2007).**

Canopy (formerly Markets Initiative) is an independent, non-profit organization dedicated to making the conservation of wild places a reality and helps to reduce the biodiversity and carbon footprint of the North American publishing, printing and paper industries. It has kick-started a new market for paper made from wheat waste, which has the potential to save at least 200 million trees a year in North America alone and 650 book publishers, magazines, newspapers, printers and 11 countries, including

China, Germany, the UK and the United States, have developed environmental publishing campaigns under Canopy's mentorship **Canopy (n.a)**. Book Industry Environmental Council **(Book Industry Environmental Council, n.a)** is another initiative in this direction, coordinated by green press initiative and book industry study group. It is a group of more than 30 publishers, printers, paper suppliers and non-profit organizations that are collaborating to set environmental goals minimize the industry's impact on the environment by developing eco-labels for publishers. The publishing industry is ready for 20-20 vision, as Book Industry Environmental Council has set a goal to reduce the U.S. book industry's greenhouse gas (GHG) emissions 20 percent by 2020 (from a 2006 baseline) and 80 percent by 2050.

By realizing the support to above mentioned initiatives it can be said that several publishers like Pearson (including Penguin) and McGraw-Hill have begun to attack the issue of paper use and have formal environmental policies in place with specific targets for eliminating the use of endangered forest fiber and increasing the use of recycled and FSC certified papers, as also revealed by **Book Industry Getting Greener (2009)** that more than 200 publishers have commitments in place to increase recycled and FSC-certified fiber, and to lessen impacts on endangered forests. McGraw-Hill has chain-of-custody forest certification achieved for over 95 percent of paper purchased in USA, 42 percent reduction in waste to landfill and 5 percent reduction in total GHG emissions from 2010 thus moving in the direction of environmental sustainability **(McGraw-Hill, 2010)**. One of the publishing giants, Emerald identifies environmental issues as a big concern to clients, employees and the community as a whole and works in partnership with suppliers and regulatory authorities to address the environmental impacts of its activities, products and services and aims to run a sustainable business, makes use of FSC/Programme for Endorsement of Forest Certification (PEFC) logos where applicable, committed to prevention of pollution and continual improvement of its environmental impacts **(Emerald, 2011)**. **Cambridge University Press (2011)** in its yearly report for 2011 affirms that good environmental practice is at the heart of the press's commitment to being a responsible member of the community thereby retaining its registration to ISO14001 and dropping

GHG emissions by 13 percent below the level of the previous reporting year.

**Conclusion:**

A walk along the shore leaves footprint in the sand that disappear with the next high tide or big wave. Footprint in the sand is renewable, though; someone else will walk along the beach in the near future. Humanity's consumption of resources, however, leaves voids that are not so easily erased. Every act of consumption of non-renewable resources like oil, coal and gas leaves a void that helps define a carbon footprint. CO2 and other greenhouse gases are subjects that people are looking to now since global warming is more and more in the public eye.

Since carbon dioxide (CO2) is considered as the sole responsible gas for Greenhouse effect, it has taken a centre stage in the environmental arena. Knowledge is spreading fast and the activities associated with knowledge acquisition, storage, production and dissemination etc. all come under the domain of knowledge cycle in a knowledge industry. Knowledge industries are considered as the bone to economic development. Global forestry and paper industry output has been measured to be around 750 billion Euro p.a. Research has been done for understanding the negative aspects of knowledge industries on the environment but there is a need of more precise and accurate figures covering all the aspects of knowledge cycle. Researchers have identified a number of sectors contributing to emissions of CO2-the power sector being the most prominent one. It has been found that paper industry is the fourth largest emitter of GHG's-after chemical, steel and cements industry. Within the paper industry, paper manufacturing has been found to be the prominent source for GHG's where as publishing operations accounted for less than 7% of emissions. The production of one book results in 8.85 pounds of carbon emissions and a newspaper is found to have less carbon footprint than a magazine.

The production and distribution costs of digital knowledge products are found negligible as compared to the environmental costs of printed products. This significant difference has been stated due the traditional modes of distribution of printed products and the underlying technologies. Information and communication technology's footprint is also a matter of

worry while discussing their implementation in the knowledge industry. At the global level ICT is responsible for 2.3% of manmade CO2 each year, thus going neck to neck with the airline industry. The computers are estimated to release about 35 million tons of CO2 each year. The overall picture of internets carbon footprint shows that about 300 million tons of CO2 is released annually from internet usage. At the microscopic level, viewing a web page generates about 0.02 grams of CO2per second and performing a Google search releases about 7 grams of CO2. However the positive impact of ICT results in substantial reduction of CO2. In 2010 ICT implementation resulted in about 107 million tons of CO2 reduction.

At the end it can be concluded that the sustainability of our environment lies with proper management of our industrial processes. More research needs to be carried out for bringing into light the exact carbon emission of knowledge distribution systems like magazines, journals etc as the carbon emission figures are not readily available for these systems. Various carbon reduction initiatives like GPI by Carbon Trust (U.K), Canopy and Book Industry Environmental Council etc. should be supported and adhered to by the industries to achieve carbon neutrality. Environmental awareness and training both in the educational institutions as well as in the printing and publishing industries should be introduced and developed to be in line with the targets set by Kyoto protocols. Moreover, the least but not last, ICT implementation in knowledge industries under specific licenses, adoption of energy saving technologies, recycling more waste paper and using more recycled paper can be the only solution to this alarming threat of increasing CO2 emission of knowledge cycle.

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Carbon Capture and Utilization (CCU) is an emerging field proposed for emissions mitigation and even negative emissions. These potential benefits need to be assessed by the holistic method of Life Cycle Assessment (LCA) that accounts for multiple environmental impact categories over the entire life cycle of products or services. However, even though LCA is a standardized method, current LCA practice differs widely in methodological choices.Â  4. What are the environmental footprints of products or services used as basis for customer decisions (product declaration)?Â  In general, the system boundary should cover the entire life cycle from cradle-to-grave (European Committee for Standardisation, 2009). Carbon footprint (cradle to gate) of input materials For Accoya and Meranti the figures from the Verco report were adopted as these are based on the most recent production runs for Accoya. Note that the Idemat 2012 data on Accoya are 16% lower, and for Meranti 22% higher, which would result in more favourable results for Accoya. For PVC, Steel and Aluminium the Idemat 2012 figures were taken. These figures have a lower carbon footprint compared to the figures provided in the Verco report (derived from Bath University, 2011).Â  at plant/m3/RERâ€ 30.8 kWh/m3 * 3.6 = 110.9 MJ/m3, in case of a processing efficiency for planing. Cradle to Grave Carbon Footprint Assessment for AccoyaÂ® Wood and its applications â€“ Dr. Ir. J.G. VogtlÃ¤nder. 8. Cradle-to-Grave Assessment. Related terms: Energy Engineering.Â  Interest in life cycle, â€˜cradle to graveâ€™ assessments of the environmental impacts of products grew in the mid- to late 1990s. In the view of some experts and environmental advocates, these life cycle costs could be used to set an advance disposal fee that would internalize all the environmental costs associated with products.Â  One of the solutions to reduce GHG emission from transportation sector is to deploy electric vehicles (EVs), as EVs require several materials that should be rare and can be depleted, is it possible for us to move towards 100% EVs for ground transportation? Please provide your reasons. 3. Carbon footprints are measured by undertaking a greenhouse gas assessment. Once the size of a carbon footprint is known, a strategy can be devised to reduce it. Why Carbon Footprint? Growing public awareness about climate change and global warming has resulted in an increasing interest in â€˜carbon footprintingâ€™.Â  Carbon footprint is the foremost indicator of environmental responsibility and helps to identify climate impacts and lower them cost-effectively by strategic and operative planning, constructing a climate policy, environmental reporting etc. In addition, carbon footprint promotes positive, environmentally conscious company image and can boost the marketing of an organization and its products. Types of Carbon Footprint. "The carbon footprint is the amount of carbon dioxide emitted due to your daily activities â€“ from washing a load of laundry to driving a carload of kids to school." The carbon footprint was calculated by "measuring the CO2 equivalent emissions from its premises, company-owned vehicles, business travel and waste to landfill." (Patel 2006).Â  Process analysis (PA) is a bottom-up method, which has been developed to understand the environmental impacts of individual products from cradle to grave. The bottom-up nature of PA-LCAs (process-based LCAs) means that they suffer from a system boundary problem - only on-site, most first-order, and some second-order impacts are considered (Lenzen 2001).