

An Analysis of Research on the Impact of E-Commerce/ICT on the Environment

Reeti Gaur

Research Scholar,
Deptt.of Commerce,
Punjabi University,
Patiala

Nidhi Walia

Assistant Professor,
Deptt.of Commerce,
S. A. Jain (PG) College,
Ambala, Haryana

Abstract

Purpose

The paper seeks to understand the state of the art of the impact of e-commerce/ITC on the environment.

Design/Methodology/Approach

The analysis is based on the comprehensive literature survey in different forms such as journal papers, reports, conference papers and websites. The paper covers studies conducted in India and abroad for reviewing supported by relevant secondary data.

Findings

The analysis was conducted on available literature points out that the e-commerce/ICTs is of prime importance for sustainable development. Environment-friendly initiatives like green supply chain solutions, measuring carbon footprints are the frequently discussed concept in this field. The three-order effects of ICTs are the most cited concept and recognized field to be studied to understand the linkage between e-commerce activities and environment sustainability.

Implication

The study is initiated with the perspective to find out 1) How we could enhance our understanding and management of the impact of e-commerce activities on the environment, 2) What could be the best possible e-solutions for sustainability in India and abroad. The analysis suggests new innovative e-solutions for development and management of e-commerce, which could be beneficial for countries like, India.

Originality/Value

The paper addresses to the problem faced globally, what have been done so far, what could be done for sustainability and choose appropriate solutions.

Limitations

Since e-commerce is on evolving stage, especially in India, the study, therefore, suffers with the limitation of available secondary data.

Keywords: E-commerce, ICTs, Carbon Footprints, Environment, Sustainability

Introduction

With the advent of technology, economies around the globe have revolutionized. Information and communication technology have brought positive changes in the lives of the people around the world and raise their standard of living. The potential of internet/e-commerce is still unleashed. E-commerce has brought a tremendous change in the ways of doing business around the world. From procurement to selling to delivering of goods, everything is done with the help of electronic media. All industries ranging from manufacturing to services perform every functional task like advertising, selling, booking of tickets, payments of bills, etc. online. E-commerce is considered as the boon for every economy. The internet has become an integral component of the economies of all developed and developing nations (Ayre et. al., 2011). However, this is only one side of the story.

The other side of the story raised an important issue: positive/negative impact of e-commerce/ICT on the environment. Many researchers, experts, research agencies and academician around the globe have contributed in this area. Although, they all failed to provide a single consensus on this issue. The present paper seeks to understand the state of the art of the impact of e-commerce/ITC on the environment. The study was focused on finding out 1) Different ways in which we could enhance our understanding of and manage the impact of e-commerce/ICT activities on the environment, 2) The best possible e-solutions could be adopted for sustainability in India and abroad.

Objectives of the Study

1. To understand the state of the art of the impact of e-commerce/ITC on the environment.

Design/Methodology/Approach

The analysis is based on the comprehensive literature survey in different forms such as journal papers, reports, conference papers and websites. The paper aimed at reviewing studies conducted in India and abroad to know the state of the art about the environmental effects of e-commerce/ICT across the globe.

Review of Literature

The analysis is based on the following comprehensive literature survey in different forms such as journal papers, reports, conference papers and websites:

Research Papers

Tagami and Williams (2001) examined the environmental performance of B2C e-commerce in comparison to distribution and sales through traditional retail stores in Japan. The authors considered following four parameters for the study, namely, fuel used in transportation by shipping or courier services, fuel used by the consumer in travelling to and from the bookstore, packaging, sales point energy. Based on the parameters it was found that the population density and the number of books per order were the prime factors responsible for energy consumption in Japan. The study concluded that the results indicated a crossover in performance, wherein dense urban areas the retail store use less energy than in e-commerce due to avoided packaging. On the other hand, in suburban and rural areas, retail stores consume more energy due to inefficiency in private transport.

Hendrickson et al. (2001) conducted a comparison analysis of the environment and cost effects of e-commerce retailing and traditional retailing with the help of a case study on book publishing and retail logistics. The study found that e-commerce sales was more cost effective and had environmental benefits. However, if the need to return books was excluded, the environmental and cost effects would be comparable for the two logistics method.

Karbassi and Tehrani (2005) interviewed respondents from the farmaneh goods and grocery shopping center of 22 districts of Great Tehran to know the impact of the use of e-commerce in Local Home Shopping on the energy consumption and air pollution. It was found that a tremendous reduction was witnessed in energy consumption and air pollution.

Cullinane et. al. (2008) tried to assess the carbon footprint of the online grocery shopping in comparison to conventional shopping and its relationship with freight movement nationally by analysing the consumer shopping habits. For this purpose, the authors conducted a survey of 1300 on-campus students and 4700 off-campus students for two consecutive days. The study showed that a small percentage of respondents shopped online for food. Moreover, a negative relationship was found between online grocery shopping and car ownership, which

concluded that online shopping had little impact on the monthly car mileage of the respondents.

Cullinane et. al. (2009) made a comparative analysis of the carbon footprints of conventional and online retailing for the purchase of small, non-food items. The study found that neither home delivery nor conventional shopping carried an absolute CO₂ advantage. However, the study justified that the on an average, home delivery operations generate less CO₂ as compared to conventional shopping. Further, the factors responsible for this were, drop densities, distance and nature of delivery rounds, types of vehicle used and the treatment of failed deliveries and returns. The study suggested that the consumers and suppliers need to be aware of the environmental implication and should take effective steps for CO₂ savings.

Ayre (2011) presented an overview of a network based model of power consumption in Internet infrastructure and explains the different factors influencing the contribution to network power consumption. The author opined that the widely accepted model of power consumption has been based on equipment inventory and/or sales figures. Further, the method to estimate power consumption of the internet was an access bit rate, i.e., in bits per second. The author showed with the help of the model that the internet power consumption is dominated by internet access and with the increase in speed of internet access, the core network routers will increase the power consumption. It was found that the infrequent download of material and the transportation of frequently downloaded material also had a great influence on power consumption. The author suggested that the problem of an increase in power consumption can be reduced by improving energy efficiency. Various strategies were also provided in this regard.

Singh and Tiwari (2011) made an attempt to find out the answer to whether e-commerce had a positive or negative impact on the environment. The study focused on spreading awareness regarding the possible impact of e-commerce on society. Based on the respondent's response and past studies, it was found that there is no clear definition that e-commerce was a prospect or a threat. The authors clarified that it is the attitude of people that decide whether e-commerce would be a prospect or threat in future. The study suggested that the e-commerce sales had a cost advantage and environmental benefits if people become attentive towards internet usage and select only those e-commerce organization that aim to reduce carbon emissions.

Nadia (2011) explored the current state of thinking of the impact of the digital economy, on the environment and also introduced the concept of green economy in relation to the digital economy. The author emphasized on the need for synergies between green economy and digital economy for the long-term effects. Further, the author brought the concept of Knowledge Green Economy as a solution the challenge of climate change and global warming which will also promote social and economic development.

Abukhader and Jonson (2003) made a critical review of the research studies on the environmental implications of e-commerce till date. The authors observed that it is difficult to generalize the results due to scarcity of evidences. However, the author stated that instead of looking e-commerce as “a vehicle driving towards freely satisfying the market needs”, it should be looked as “a cart attached to our vehicle towards sustainable development”.

Abukhader and Jonson (2004) proposed an assessment model for green supply chain management based on extensive survey on different areas such as logistics, environmental science, manufacturing, production and operational management and resolve the problem of conflicting results. The research showed that green supply chains requires a new outlook and direction in research. There is a need to build new constructs for decision making by performing assessment on a larger scale and consider the impact of the environment.

Reports

Bio-Intelligence Service (2008) examined the impact of information and communication technologies (ICT) on the energy efficiency in Europe during 2005-2020.

Task	Objective	Results	Recommendations
Task 1	Impact of ICT sector on environment	Overall electricity consumption would be doubled from 2005 till 2020 due to increase in the stock of ICT applications and network infrastructure.	<ul style="list-style-type: none"> • Awareness among consumer to promote value efficiency and life cycle cost over purchase costs. • Adoption of European Green Procurement Scheme • Development of financial incentives to adopt green products.
Task 2	Impact of ICT applications on environment	Implementation of ICT applications in various areas like business, industries, residential, service sector and energy grid had led to energy savings.	<ul style="list-style-type: none"> • Supporting multi-disciplinary research and innovation • Regulatory watch • Public and Private Partnership
Task 3	Impact of use of ICT applications in support of dematerialized practices	Implementation of ICT led to energy savings through energy efficiency and reduction in consumption of resources like paper, pendrive, etc.	<ul style="list-style-type: none"> • Improvement and monitoring statistical data • Regulatory watch • Public and Private Partnership • Technology Development

The Climate Group (2008) on behalf of the Global eSustainability Initiative (GeSI) presented a report determining the impact of ICT on climate change and carbon development. The report depicted that ICT played a critical role in bringing climate change and reducing carbon development through initiatives like smart motor system, smart logistics, smart buildings, smart grids. The report outline the key actions needed:

SMART	Actions	Description
S	Standardize	How information related to energy consumption and emissions can be traced across different processes excluding the ICT’s products and Services
M	Monitor	Real time monitoring of energy consumption and emissions and producing data needed to optimize for energy efficiency
A	Accountability	Making energy consumption and emissions accountable with the help of network tools
R	Rethink	How to live, learn, play and work in the low carbon economy by optimizing efficiency and providing cost effective alternatives to high carbon emitting activities
T	Transformation	Transforming the economy through standardization, monitoring, accounting, optimization and developing low carbon emitting alternatives for business models

International Telecommunication Union (2008) reviewed the recent ICT trends and examined the impact of ICTs on the environment and climate change. Based on the reviews, the report presented

Berkhout and Hertin (2001) submitted a report to OCED explaining the impact of Information and Communication Technology (ICTs) on environmental sustainability based on the speculations and past evidences. The report opined that ICTs had significant impact on environmental sustainability, but it is difficult to determine the sign and magnitude of effects due to sparse evidences available. However, the report summarized three types of effects, namely first order impacts (effects due to the production and use of ICTs), second order impacts (effects on structure of economy, production processes, products and distribution systems) and third order impacts (indirect effects due to level of consumption, life styles changes or change in value system. Further, the report suggested that better monitoring and evaluation of relations between ICTs and environment performance of industrialized economies was needed and OCED could play a major role in this regard.

guidelines for the developing countries, helping the mankind to mitigate and adapt to changes. The results of the research showed that the ICTs could help in reducing the greenhouse effect. The report

summarized the various ways in which ICTs can benefit the environment and mankind such as, green data centres, Shared services, free and low-cost web based applications like Google apps, video conferencing and tele-education. The report recommended to spread awareness and strengthen the capacity of the developing countries to use ICT for the environment. Further, there is the need for financial assistance for environmental research and modernization and computerization of ministries and departments of the environment.

Edwards and McKinnon (2009) undertaken a study to analyze the level of carbon footprint by online retailing and compare it with the traditional shopping. The report focus on the purchase of small, non-food items for the study. The analysis depicted that online retailing had a significant influence on the development of low carbon emission in the future. The report suggested that since the maximum contribution to emission is made by personal travels of consumers, i.e. either for shopping and returning unwanted goods or to collect the missed deliveries, the overall emission could be reduced by minimizing the consumer related emissions.

Koomey et. al. (2009) submitted a report to Microsoft Corporation and Intel Corporation, examining the energy and CO₂ emission related to the different alternatives available for delivering music albums to customers. The different alternative covered under study included, traditional sales, e-commerce sales via CDs or digital download services. The study found that purchasing music digitally produce less energy and CO₂ emission than the traditional sale of music as the task of preparing CDs, CD packaging and physical delivery of CDs to households are eliminated. However, the difference fund was not enough, i.e., the difference could be eliminated if the customer walks rather than drives for shopping or the file transfer size might increase. The study suggested to focus on other alternatives such as subscription and steaming services for further study.

Ahlqvist et. al. (2010) presented roadmap report on ICT for the environmental sustainability. The roadmap presented cover three themes:

Themes	Description
Empowering People	Using ICT to enhance people's awareness of the impact of their behavior on the environment and guiding them to adopt ways to become environment-friendly
Extending natural resources	Using ICT solutions instead of environmental unsustainable resources
Optimizing Systems	Reducing the environmental load of diverse systems by optimizing them and their operations.

The basic idea of the report was to bring together the society, ICTs, business enterprises and other parties on a common platform in order to improve environmental sustainability. The report summarized following topics for future consideration, such as environmentally sustainable consumption,

smart energy and buildings, lifecycle efficient production and optimized and adaptive networks.

Findings

The present paper showed the results of existing studies on the impact of e-commerce/ICT on the environment. The results are summarized as follows:

1. The utilization of ICT had a significant impact on environmental sustainability over the years, but it is still difficult to define the sign and magnitude of environmental effects it had. This was due to sparse evidences available.
2. The attitude of users would decide that whether e-commerce/ICT would be considered as a prospect or a threat.
3. Online retailing has a significant influence on the development of low carbon emission in the future.
4. ICTs can benefit the environment and mankind in different ways, such as, reducing the greenhouse effect, creating green data centres, Sharing services, providing free and low-cost web-based applications like Google apps, video conferencing and tele-education.
5. ICT played a significant role in reducing carbon emission through initiatives like smart motor system, smart logistics, smart buildings, smart grids.
6. The results stated three types of effects, namely first order impacts (effects due to the production and use of ICTs), second order impacts (effects on structure of economy, production processes, products and distribution systems) and third order impacts (indirect effects due to level of consumption, life styles changes or change in value system).
7. There is a continuous need for better monitoring and evaluation of relations between ICTs and environment performance of industrialized economies.
8. There is a need to spread awareness and strengthen the capacity of the developing countries to use ICT for the environment.

It was found from the analysis that application of e-commerce in different stages of logistics proved to be beneficial for the economies in terms of cost advantage and environmental benefits. Although the benefit provided was comparatively more than the conventional retail shopping, the difference was only minimal. The e-commerce companies are suggested to initiate their activities with the aim to provide energy efficiency.

Conclusion

The analysis conducted on available literature points out that the e-commerce/ICTs are of prime importance for sustainable development. Environment-friendly initiatives like green supply chain solutions, measuring carbon footprints are the frequently discussed concept in this field. The three-order effects of ICTs are the most cited concept and recognized field to be studied to understand the linkage between e-commerce activities and environment sustainability. The papers, however, failed to provide a consensus on whether e-commerce/ICTs served as a prospect or a threat for

the environment and mankind. There is a minimal difference between the energy emission by conventional retail shopping and e-commerce. It is difficult to have consensus on the sign and magnitude of effects mainly due to sparse evidences available. It is the attitude of people that decide whether e-commerce would be a prospect or threat in future. There is a need to spread awareness among people and businesses and strengthen the capacity of the developing **countries** to use ICT for the benefit of the environment with great focus on getting energy efficiency.

References

1. Abukhader, S. M. and Gunilla, J. (2003). *The Environmental Implications of Electronic Commerce- A critical Review and Framework for Future Investigations, The Environmental Implications of Electronic Commerce – The Assessment Approach Problem*, pp.25-44.
2. Abukhader, S. M. and Gunilla, J. (2003). *Ecommerce and the Environment: A Gateway to the Renewal of Greening Supply Chains, The Environmental Implications of Electronic Commerce – The Assessment Approach Problem*, pp.45-60.
3. Ahlqvist, T. et al (2010). *ICT for Environmental Sustainability: Green ICT roadmap*. VTT Tiedotteita, Research Notes 2532, pp-1-57.
4. Ahmad, A. R. et al (2009). *State-of-the-art in E-Commerce Carbon Footprinting*. *Journal of Internet Banking and Commerce*, Vol. 14(3). http://doi.org/10.1007/978-3-531-92534-9_12
5. Ayre, R. et al. (2011). *Power consumption and energy efficiency in the internet*. *IEEE Network*, pp. 6–12. <http://doi.org/10.1109/MNET.2011.5730522>
6. Berkhout, F., & Hertin, J. (2001). *Impacts of Information and Communication Technologies on Environmental Sustainability: speculations and evidence, Organisation for economic Co-operation and Development*, pp. 1–24.
7. Ciocoiu, C. N. (2011). *INTEGRATING DIGITAL ECONOMY AND GREEN ECONOMY: OPPORTUNITIES FOR SUSTAINABLE DEVELOPMENT* Theoretical and Empirical Researches in Urban Management. *Theoretical and Empirical Researches in Urban Management*, Vol. 6(1), 33–43.
8. Cullinane, S. et al (2008). *Clicks Versus Bricks on Campus: Assessing the Environmental Impact of Online Food Shopping*, pp. 1–6. Retrieved from [http://www.greenlogistics.org/SiteResources/58b76433-8e63-45b7-879c-6f4b23555e24_Clicks_vs_Bricks_on_Campus_LRN_paper_\(Sharon\).pdf](http://www.greenlogistics.org/SiteResources/58b76433-8e63-45b7-879c-6f4b23555e24_Clicks_vs_Bricks_on_Campus_LRN_paper_(Sharon).pdf)
9. Edwards, J. B., & McKinnon, A. C. (2009). *Shopping trip or home delivery: Which has the smaller carbon footprint?* *Focus*, July, pp.20–24. <http://doi.org/10.1007/s12146-007-0019-8>
10. Cullinane, S. L. et al (2010). *Comparative analysis of the carbon footprints of conventional and online retailing: A “last mile” perspective*. *International Journal of Physical Distribution & Logistics Management*, Vol. 40(1/2), pp. 103–123. <http://doi.org/10.1108/09600031011018055>
11. European Commission DG INFSO. (2008). *Impacts of Information and Communication Technologies on Energy Efficiency - Final report, Bio Intelligence Service*, pp.1-432.
12. Fichter, K. (2003). *Sorting Out the Environmental Consequences*. *Journal of Industrial Ecology*, Vol. 6(2), pp. 25–41. Retrieved from <http://mitpress.mit.edu/jie>
13. Gary Cook, J. V. H. (2011). *How dirty is your data?* *Greenpeace International*, 1–36.
14. IISD Commentary (2010). *The Digital Economy and the Green Economy: Opportunities for strategic synergies*. *IISD Commentary*, (July), pp. 1-20.
15. ITU. (2009). *ICT and Climate Change: Conclusions of ITU-T Focus Group*. Retrieved from www.itu.int/ITU-T/focusgroups/climate
16. Hendrickson, C. et al (2001). *Environmental and Economic Effects of E-Commerce: A Case Study of Book Publishing and Retail Logistics*. *Transportation Research Record*, 1763(1), pp. 6–12. <http://doi.org/10.3141/1763-02>
17. Hendrickson, C. T. et al (2002). *Energy implications of online book retailing in the United States and Japan*. *Environmental Impact Assessment Review*, Vol. 22(5), pp. 493–507. [http://doi.org/10.1016/S0195-9255\(02\)00024-0](http://doi.org/10.1016/S0195-9255(02)00024-0)
18. Hendrickson, C. T. et al. (2009). *Life cycle comparison of traditional retail and e-commerce logistics for electronic products: A case study of buy.com*. *Sustainable Systems and Technology*, 2009. ISSST '09. *IEEE International Symposium on*, 2011, Vol. 1–6. <http://doi.org/10.1109/ISSST.2009.5156681>
19. Koomey, J. G. et al. (2009). *The Energy and Climate Impacts of Different Music Delivery Methods*. Retrieved from http://download.intel.com/pressroom/pdf/CDsvsd_owloadsrelease.pdf
20. Karbassi, A.R. and Tehrani, S.M. (2005). *Application of E-commerce in Local Home Shopping and its Consequences on Energy Consumption and Air Pollution Reduction*. *Iran J. Environ. Health Sci. Eng.* Vol. 2(5), pp. 247-250.
21. Labelle, R. (2008). *ICTs for e-Environment Guidelines for Developing Countries, with a Focus on Climate Change*. *International Telecommunitaion Union*, 149–176. Retrieved from <http://www.itu.int/ITU-D/cyb/app/docs/itu-icts-for-e-environment.pdf>
22. Mickoleit, A. et al (2009). *The Impact of the Crisis on ICTs and their Role in the Recovery, Organisation for economic Co-operation and Development* (August). <http://doi.org/10.1787/221641027714>
23. Sui, D. Z., & Rejeski, D. W. (2002). *Environmental impacts of the emerging digital economy: The e-for-environment e-commerce?* *Environmental Management*, Vol. 29(2), pp. 155–163. <http://doi.org/10.1007/s00267-001-0027-X>
24. The Climate Group. (2008). *SMART 2020: Enabling the low carbon economy in the information age*. *Group*, Vol. 30(2), pp. 1–87. <http://doi.org/10.1111/j.2006.0906-7590.04873.x>

25. Tiwari, S., & Singh, P. (2011). *E-Commerce: Prospect or Threat for Environment*. *International Journal of environmental Science and Development*, 2(3). <http://doi.org/10.7763/IJESD.2011.V2.126>
26. Tagami, T. and Williams, E. (2001). *Energy analysis of e-commerce and conventional retail distribution of books in Japan*. *EnviroInfo 2001: Sustainability in the Information Society*, pp. 37-80.
27. Thomas, H. R. and Yi, L. (2007). *A review of research on the environmental impact of e-business and ICT*. *Environment International*, Vol. 33(6), pp. 841–849. <http://doi.org/10.1016/j.envint.2007.03.015>