International Journal of Social Science and Economic Research

ISSN: 2455-8834

Volume:08, Issue:04 "April 2023"

MANAGING GREEN IT: A REVOLUTION FOR CRAFTING THE IDEA OF SMART CITY IN A DIFFERENT WAY

Reetuparna Bhattacharjee[1] and Riya Sil[2]

[1]Mahindra University, Hyderabad 500043.

[2]Adamas University, Kolkata 700126.

DOI: 10.46609/IJSSER.2023.v08i04.016 URL: https://doi.org/10.46609/IJSSER.2023.v08i04.016

Received: 6 April 2022 / Accepted: 20 April 2023 / Published: 26 April 2023

ABSTRACT

Green Information Technology (IT) denotes the policies and practices that firms should follow to manage IT operations to comply with green norms. Typically for a firm that mainly uses IT for its business, for mankind products or providing services, Green IT practices involve using IT in such a manner as to reduce carbon emissions or to use IT to monitor and manage carbon or other polluting emissions. There are mainly two aspects of Green IT practices: (i) Use IT efficiently to comply with green norms. (ii) Use IT to ensure other firm activities conform to green norms. Firms involved in making IT products or those who provide IT Services have to consider additional aspects of Green IT. The design of IT products follows Green Practices that includes designing both hardware and software. The IT artefacts produced in this manner are thus compliant with green norms, and the firms can assure their customers about the usage of environmentally sound processes. Usage of computers and networking technology requires energy both for making the device and running them. In recent years, as the usage of computer technology has grown in business, government and society, the consumption of energy has also increased. The government has recognized the threat of unrestrained and uncontrolled carbon emissions and has formed various guidelines to control emissions and pollution. Many firms have taken steps to understand their energy consumption patterns with regard to their IT usage and have implemented measures to 'Go Green'. There are economic advantages of going green, in addition to those of acting responsibly. In this paper, the authors have explained how in the realm of IT, going green means using technology in an environment-friendly manner and using IT to control carbon emissions. The aim is to conduct a detailed study on managing Green IT and how smart cities can be crafted in a different way with the help of IT. An overall comprehensive insight is provided to deliver assistance for the development of advanced smart cities in the future.

Keywords: Green infrastructure, Smart Cities, Machine learning, Green IT, Information Technology

1. Introduction

The Green IT is itself an emerging concept but the ideology has been derived since the primitive conception of global village. The ecosystem plays a significant role in the concept of smart city. The word environment is used in a broader way to denote everything that surrounds us. It therefore, includes all living and non-living things. The ecology will, therefore help us to understand our environment, and the changes that are likely to take place in it due to any kind of action that we undertake.The Kyoto Protocol established in 1997 by the United Nations recommended stringent guidelines on restraining Carbon-emissions by certain developed countries that had agreed to implement the protocol.

In this paper, authors have described about the current environmental scenario. Section 2 discusses about the concept of ecosystem with a detailed discussion of Biotic and Abiotic components. In Section 3 authors have discussed about the emergence of a new beginning of bio-diversity. In section 4 the challenges of ecological system with the focus on the research of civil society, challenging climate change etc. have been discussed. Section 5 provides a brief description about the challenges of conservation and restoration. Section 6is about the Green Technology and the laws to protect the environment. In section 7 authors have discussed about the basic principles of Green IT, tools and zero waste technology. Section 8 provides a clear concept about the contribution of smart city construction in improving the green utilization efficiency of urban land. In section 9 explains about the need of disaster management system of smart city. In section 10 the economic study of Europe and Italy in discussed in brief. Lastly, in section 11, a brief summary of the chapter has been provided.

2. Ecosystem – The concept

The basic unit of ecology is ecosystem. It is a structural and functional unit of ecology.

2.1 Biotic component

The biotic component of eco-system is called the biological environment which consists of all living organisms present in the particular ecosystem. This category of living organisms consists of various types of animals and plants. As it is known to all that the earth is a combination of different types of tiny components specially categorized as the biotic component. They are broadly divided into producers, consumers and decomposers. But still there will be so many other variations that are enriching the earth.

ISSN: 2455-8834

Volume:08, Issue:04 "April 2023"

2.2 Abiotic component

The abiotic component of an ecosystem includes everything other than the living organisms, i.e., it consists of the three basic elements of nature, land, water and air. The climatic factors also form a part of the abiotic component as they control the entire functioning of an ecosystem. Inorganic compounds consist of waters, carbon dioxide, phosphates, carbonate, nitrates and the chemical elements includes carbon, nitrogen, sulphur, phosphorus etc. All simple and complex organic substances like amino acids, humic acid, acetates are also included in the abiotic components.

3. Emergence of a new beginning to Biodiversity

The fact that life is characterized by its diversity is a notion as old as biology itself and biologists of all persuasions are working on it. The three pillars of sustainable development: next to the economic pillar, which until recently stood alone to take us to the brink of disaster i.e., unsustainable development, the social pillar, and the environmental pillar. The actual reason is a radical change in the perspective and framework–this is what the concept of biodiversity rationally leads to. It is abandoning a vision of the world composed of parallel pipes and almost independent domains and adopting an ecological vision of it. It is therefore not the ultimate factor to bring together the three-separate rotation of economic, social and ecological acceptances and to look at where they overlap. The sphere of economy is just a subset of the sphere of humanity which is itself a subset of the biosphere.

3.1 The situation of Bio-Diversity

The collapse of biodiversity has not been halted and this is due to three reasons that depend on the very nature of biodiversity:

(i) Biodiversity is a multiple complex whole, which remains very unequally known and identified.

(ii) It has an enormous inertia–while remaining constantly in motion–and it is necessary to look closely to detect any significant changes that can be interpreted over a period of time which is in fact extremely short.

(iii) The means available for measurement and monitoring remains insufficient.

3.2 Biodiversity and its Erosion

As announced in the recently released Global Biodiversity Outlook 3,written by the CBD (Convention on Biological Diversity), the target set in 2002 to introduce a significant curtail in biodiversity losses by 2010 at all ranges (regional, national and global) has not been reached and the damage of biodiversity continues at the massive rate. It is also noted that the pressures that it

ISSN: 2455-8834

Volume:08, Issue:04 "April 2023"

is subjected to that are the cause of the erosion seem to be getting stronger rather than diminishing. The most widely used direct measurements, i.e., the species indicators, and in particular the IUCN Red List and the WWF Living Planet Index say the same things. The case of amphibians has been well scrutinized and is particularly worrisome. As for the 'habitat' and 'pressure' indicators, which are certainly essential, the assessment cleared by the Secretariat of the Convention on Biological Diversity is not highly optimistic: natural habitats (particularly coral reefs and wetlands) continue to decline in most places of the world– although some countries have shown prominent progress with the loss of tropical forest and mangroves being curtail down. As for the five main variations of pressure leading directly to losses in biodiversity (habitat transformation, overexploitation, pollution, invasive species and climate difference), they have at best stabilized but are more usually still increasing. The list of future potential victims includes migrating fishes like the Atlantic salmon, the European sturgeon and the European eel. A sharp decline has been seen in the numbers of birds, especially on farmland where a drop of 20% has been recorded over 20 years.

4. The challenges in Ecological-System

Biodiversity and ecological services remain subjected to the pressure of a human fraternity that is still under the impulsion of the continuation of thermo-industrial system that created that. The challenges to be met are of three orders: (i) Order of policy, (ii) Order of knowledge, and (iii) Order of strategies of conservation and landscape planning.

4.1 Indicators and Long-Term Monitoring

The biodiversity indicators used by the environmentalists are underdeveloped and their manpower given insufficient support. Thus, the need for long-term monitoring is imperative to really know what is happening and to be able to anticipate the future and also, to be able to assess the efficiency, of measures taken, and evaluate policies. Yet, the utility of factors is much broader: any research into biodiversity, any issue concentrating upon sustainability, needs a long-term picture. Indicators are a major priority and the decision should be taken to finally make long-awaited investments.

4.2 Intersecting Research: Management and an opening to civil society

This implies exchanges between the world of research, the world of nature management and civil society. One should be able to rely on the network of protected areas to act as a vast instrument in support of research, training and education on biodiversity and what it means to us. The Man and Biosphere (MAB) culture, experiences and its failures deserve to be taken into consideration.

4.3 Territorial governance vs World governance

ISSN: 2455-8834

Volume:08, Issue:04 "April 2023"

Biodiversity needs space i.e., inserting actions in an area is a major issue whether those actions concern understanding, protection, education or development. It is in this general perspective of planning that the problems are posed and that solutions can be found. It would be useful, in this perspective, to base the work on the existing network of protected area management bodies which all work in cooperation. The Intergovernmental science-policy Platform on Biodiversity and Ecosystem Services (IPBES) doubtlessly a major issue. This is the imposition that will be the object of a decision in the coming months. This organisation of experts should help to lay the foundations of acceptable world governance.

5. Green Technology

The formation of Environmental Protection Agency (EPA) in USA emerges with the thought that the environment got extensive priority specially in the developed countries. Green technology or green chemistry as it is often called is hence, defined as the technology or the chemistry which designs and develops chemical products and processes that reduce or eliminate the use and generation of hazardous elements.

Some cases of Green Technology that have won the presidential Green Chemistry challenge awards are indicated below:

(i) Barry Trost's concepts of atom economy which looks at utilized and wasted atoms in a reaction.

(ii) A new synthesis of ibuprofen which has 77% of atom economy as against the earlier 40% to decrease the waste by products significantly.

(iii) The use of waste carbon dioxide as a blowing agent for production of polystyrene foams a common material used for packaging and food transportation.

(iv) Development of surfactants for carbon dioxide enabling CO_2 to be used as a solvent.

6. Basic principles of Green Technology

The twelve principles of Green Chemistry are :

(i) Waste Prevention: The ability of chemists to redesign chemical transformation to minimize the generation of hazardous waste is an important step in pollution prevention.

(ii) Maximization of Atom Economy: It is a concept, developed by Barry Trost of Standford University that evaluates the efficiency of a chemical transformation. Similar to a perform calculation, atom economy is a ratio of the total mass of atoms in the desired product to the total mass of atoms in the reactants.

(iii) Design Less-Hazardous Chemical Synthesis: Wherever practicable, synthetic methodologies should be designed to use and generate elements that possess little or no toxicity to human health and the environment.

(iv) Design Safer Chemical products: Chemical products should be designed to affect their desired function, while minimizing their toxicity.

(v) Use safer solvents/ reaction conditions: The use of auxiliary substances should be made unnecessary wherever possible and innocuous when used.

(vi) Increase energy efficiency: Energy requirements of chemical methods should be recognized for their environmental and economic impacts and should be minimized.

(vii) Used Renewable Feedstocks: Whenever possible, chemical transformations should be designed to utilize raw materials and feedstocks include agricultural products or the wastes of other processes.

(viii) Avoid Chemical Derivatives: Whenever possible chemical transformations should be designed to utilize.

(ix) Use catalysts: Catalytic reagents are superior to stoichiometric reagents catalysts can serve several roles during a transformation. They can upgrade the selectivity of a reaction, reduce the temperature of a transformation.

(x) Design for degradation: Chemical Products should be articulated so that at the end of their work that they break down into innocuous degradation products and do not persist in the environment.

(xi) Analyse in Real-Time to prevent Pollution: It is always important to monitor the progress of a reaction to understand when the reaction is concluded or to detect the emergence of any unwanted by-products.

(xii) Minimize the potential for accidents: One way to minimize the potential for chemical accidents is to select reagents and solvents that minimize the potential for explosions, fires and accidental releases.

6.1 Concept of Atom Economy

This concept evaluates the efficiency of a chemical process so as to get the idea of the wastes produced in that process. In other words, the atom economy estimates the percentage of atoms which get converted into final end product. The greater is this percentage of atom economy, the lesser will be the produced wastes, because lesser atoms will be left out from the final end product

ISSN: 2455-8834

Volume:08, Issue:04 "April 2023"

for conversion to waste by-products. The atom economy may, hence, be calculated by totalling the formula mass (FM) of all the atoms in the final end product, and dividing the same by the total formula mass (FM) of the atoms in all the reactants.

6.1.1 Tools Used for Developing Green Technology

In order to achieve the goal of developing the green technology, one needs to find areas where improvements can be made. These areas serve as the tools for green technology. Any improvement made in these areas will help in fulfilling the basic objective of making the manufacturing processes green and clean. The areas which have been identified for development of green technology are:

(i) Alternative feed stocks

(ii) Alternative benign reagents

(iii) Clean synthetic transformation reactions

(iv) Alternative solvents/reaction conditions

(v) Production of safer chemicals/ substances

(vi) Minimization of energy consumption.

6.1.2 Zero Waste Technology in Chemical Synthetization

Zero wastes technology in chemical synthetization is the fundamental principal of green technology, as it is the basic concept of atom cost-effective. 100% atom utilization of atom economy eventually means that there will be no waste products [46].As zero waste technology may also be developed when a by-product or waste product of any unit is utilized as a raw material for another unit in integrated manufacturing system. There is a great need to replace the old conventional environmentally polluting and waste generating manufacturing techniques with the new modern technologies, which ensure the use of green materials, green reagents, green solvents, and green synthetization reactions to produce green products, without the generation of any wastes. These are the goals of green chemistry and green technology researchers.

7. Contribution of Smart City Construction in Improving the Green Utilization Efficiency of Urban Land

Green development is key to the changes of China's economic development model, and it is also an vital part of enhancing high-quality economic development to realize the 'Beautiful China' strategy, which is to achieve good ecology, economy, improved health, and people's happiness.

ISSN: 2455-8834

Volume:08, Issue:04 "April 2023"

The aim of green development is to combine economic, social, and ecological development to make a society that is ‘resource-conserving’ and environment friendly. The land is an important vehicle for human productivity, life, and socio-economic activities. Regarding land usage, the green development concept, featuring the harmonious existing side by side of humans and nature with sustainable development, must be imposed throughout the process to unify the economic, social, and ecological utilization of land usage. Since the reform and opening-up, China’s urbanization level has uplifted significantly. In 2019, the rate of urbanization was greater than 60%. The upgradation in urbanization is an important driving force for pulling economic growth, but serious issues have arisen in the process. Upgrading the urban land green utilization efficiency is one of the primary tasks of developing countries. In this context, the key to grabbing the goal of the harmonious development of urban development, land use and environmental preservation are to follow the concept of green development and promote urban land green use. The green utilization of urban land not only introduces the concept of green development into the land use method, but also maximizes the economic output and social wellbeing, while reducing environmental pollution as much as needed. Reasonable parameters of urban land green utilization efficiency has important theoretical and practical significance for the understanding of urban land green utilization and the formulation of related policies. The 19th National People’s Congress of the Communist Party of China report discussed that supporting and encouraging green development and adjusting the urban development model is the key to reconstructing the momentum of urban growth and enhancing the core competitiveness of cities. The declaration of the smart city pilot policy in December 2012 provided a new-type model for urban development that integrates innovation and green development. In China, a smart city is officially described as an urban development model that evolves technological innovation, product innovation, market innovation, resource allocation innovation, and organizational innovation. Innovation creates the green urban development model, optimizing economic development through innovative advantages and an eco-conscious foundation. As the medium of a wide variations of economic activities, urban land presents a concentrated dissemination space for both secondary and tertiary industries, which can bring both “desirable” economic and “undesirable” outputs. Accumulating undesirable outputs into the measurement framework of urban land utilization efficiency can improve the science of land utilization efficiency measurement, while also conforming to the current state of urban land utilization cause a steep upliftment in regional ecological and environmental risks. According to this paper uses the panel data of 152 municipalities in China in 2004–2017, based on the 2012 China Smart City Pilot as the Quasi-Natural Experiment, use difference-in-differences (DID) format to investigate the impact of smart urban construction on the urban land green utilization efficiency and its transmission mechanism. The contributions of this article are:

ISSN: 2455-8834

Volume:08, Issue:04 "April 2023"

(i) Different from existing research that explores the impacts of the urban development level and urban specifications on land utilization efficiency, they ignore the effect of new urban construction on the green utilization efficiency of urban land with undesirable output. This study evaluates the importance of new-type urban development on the green utilization efficiency of urban land in a scientific manner.

(ii) The green utilization efficiency of urban land may be affected by non-policy factors that vary over time and may present endogenous problems. Smart city construction provides a quasi-natural experiment for this study, deriving other factors from policy factors to avoid endogenous problems.

(iii) Different from the traditional urban development model, this article is the first one based on the perspective of the new urban development model, and uses it to proper chronological examine the impact of smart city construction on the efficiency of green land use and its transmission format, and to test the impact of smart city construction under different city scales and different city characteristics.

8. Conclusion

Green IT (Information Technology) has recently emerged into an active research area in the Information Systems (IS) discipline. A major difference that exists in the Green IT research literature today is the absence of a theoretical framework that can be used to assist organizations in assessing their potential for undertaking Green IT initiatives and implementing them via upgraded technological means such as virtualization. This study aims to covere this gap by developing and proposing an integrative framework which focuses on identifying and examining the ideas that contribute to the assessment of a firm's readiness to go green via IT-enabled virtualization. The smart homes, smart cities, disaster management by using the network system of IT everything are contributing a lot to form the gen-next livelihood. Though, it is in a research level still it is an emerging and the most promising concept to form the advanced format of livelihood.

References

[1] Jenkin, T. A., Webster, J., & McShane, L. (2011). An agenda for 'green' information technology and systems research. *Information and Organization*, *21*(1), 17–40. https://doi.org/10.1016/j.infoandorg.2010.09.003

[2] Bai, C., & Sarkis, J. (2013). Green Information Technology Strategic Justification and evaluation. *Information Systems Frontiers*, *15*(5), 831–847. https://doi.org/10.1007/s10796-013-9425-x

ISSN: 2455-8834

Volume:08, Issue:04 "April 2023"

[3] Mishra, D., Akman, I., & Mishra, A. (2014). Theory of reasoned action application for green information technology acceptance. *Computers in human behavior*, *36*, 29-40.

[4] Mithas, S., Khuntia, J., & Roy, P. K. (2010). Green information technology, energy efficiency, and profits: Evidence from an emerging economy.

[5] Akman, I., & Mishra, A. (2015). Sector diversity in green information technology practices: technology acceptance model perspective. *Computers in human behavior*, *49*, 477-486.

[6] Molla, A., Cooper, V., Corbitt, B., Deng, H., Peszynski, K., Pittayachawan, S., & Teoh, S. Y. (2008). E-readiness to G-readiness: Developing a green information technology readiness framework.

[7] Chuang, S. P., & Huang, S. J. (2018). The effect of environmental corporate social responsibility on environmental performance and business competitiveness: The mediation of green information technology capital. *Journal of business ethics*, *150*(4), 991-1009.

[8] Zheng, D. (2014). The adoption of green information technology and information systems: An evidence from corporate social responsibility.

[9] Dezdar, S. (2017). Green information technology adoption: Influencing factors and extension of theory of planned behavior. *Social Responsibility Journal*.

[10] Sarkis, J., Koo, C., & Watson, R. T. (2013). Green information systems & technologies–this generation and beyond: Introduction to the special issue. *Information Systems Frontiers*, *15*(5), 695-704.

[11] Molla, A., &Abareshi, A. (2012). Organizational green motivations for information technology: empirical study. *Journal of Computer Information Systems*, *52*(3), 92-102.

[12] Molla, A., &Abareshi, A. (2012). Organizational green motivations for information technology: empirical study. *Journal of Computer Information Systems*, *52*(3), 92-102.

[13] vomBrocke, J., Watson, R. T., Dwyer, C., Elliot, S., & Melville, N. (2013). Green information systems: Directives for the IS discipline. *Communications of the association for information systems*, *33*(1), 30.

[14] Dao, V., Langella, I., & Carbo, J. (2011). From green to sustainability: Information Technology and an integrated sustainability framework. *The Journal of Strategic Information Systems*, *20*(1), 63-79.

ISSN: 2455-8834

Volume:08, Issue:04 "April 2023"

[15] Paul, P. K. (2013). Green information science: information science and its interaction with green computing and technology for eco friendly information infrastructure. *International Journal of Information Dissemination and Technology*, *3*(4), 292-296.

[16] Benitez-Amado, J., Perez-Arostegui, M. N., & Tamayo-Torres, J. (2010). Information technology-enabled innovativeness and green capabilities. *Journal of Computer Information Systems*, *51*(2), 87-96.

[17] Taghva, M. R., Zohrabi, M., &DehdashtiShahrokh, Z. (2019). A Structural Model for Green Information Technology and Organizational Sustainability. *BI Management Studies*, *7*(27), 5-28.

[18] Chowdhury, G. (2012). An agenda for green information retrieval research. *Information Processing & Management*, *48*(6), 1067-1077.

[19] Lei, C. F., & Ngai, W. T. (2013, January). Green IT adoption: An academic review of literature. In *17th Pacific Asia Conference on Information Systems, PACIS 2013*. Pacific Asia Conference on Information Systems.

[20] Przychodzen, W., Gómez-Bezares, F., &Przychodzen, J. (2018). Green information technologies practices and financial performance–the empirical evidence from German publicly traded companies. *Journal of Cleaner Production*, *201*, 570-579.

[21] Ali, S., & Green, P. (2012). Effective information technology (IT) governance mechanisms: An IT outsourcing perspective. *Information Systems Frontiers*, *14*(2), 179-193.

[22] Green, K. C., & Gilbert, S. W. (1995). Great expectations: Content, communications, productivity, and the role of information technology in higher education. *Change: The magazine of higher learning*, *27*(2), 8-18.

[23] Fang, C., Yu, F. R., Huang, T., Liu, J., & Liu, Y. (2015). A survey of green information-centric networking: Research issues and challenges. *IEEE Communications Surveys & Tutorials*, *17*(3), 1455-1472.

[24] Ferguson, C., Green, P., Vaswani, R., & Wu, G. (2013). Determinants of effective information technology governance. *International Journal of Auditing*, *17*(1), 75-99.

[25] Khan, S. A. R., Golpîra, H., & Zhang, Y. U. (2018). The importance of advanced information technology and green vehicles in supply chain management. *DEStech Transactions on Computer Science and Engineering*, (ccme).

[26] Molla, A., & Cooper, V. (2010). Green IT readiness: A framework and preliminary proof of concept. *Australasian journal of information systems*, *16*(2).

[27] Molla, A. (2008). GITAM: A Model for the Adoption of Green IT. *ACIS 2008 proceedings*, 64.

[28] Molla, A., Cooper, V. A., &Pittayachawan, S. (2009). IT and eco-sustainability: Developing and validating a green IT readiness model. *ICIS 2009 proceedings*, 141.

[29] Chou, D. C., & Chou, A. Y. (2012). Awareness of Green IT and its value model. *Computer Standards & Interfaces*, *34*(5), 447-451.

[30] Hedman, J., & Henningsson, S. (2010). Three strategies for green IT. *IT professional*, *13*(1), 54-57.

[31] Viitanen, J., & Kingston, R. (2014). Smart cities and green growth: outsourcing democratic and environmental resilience to the global technology sector. *Environment and Planning A*, *46*(4), 803-819.

[32] Casini, M. (2017, August). Green technology for smart cities. In *IOP Conference series: earth and environmental science* (Vol. 83, No. 1, p. 012014). IOP Publishing.

[33] Kaur, G., Tomar, P., & Singh, P. (2018). Design of cloud-based green IoT architecture for smart cities. In *Internet of Things and Big Data Analytics Toward Next-Generation Intelligence* (pp. 315-333). Springer, Cham.

[34] Yigitcanlar, T., Mehmood, R., &Corchado, J. M. (2021). Green artificial intelligence: Towards an efficient, sustainable and equitable technology for smart cities and futures. *Sustainability*, *13*(16), 8952.

[35] Chithaluru, P., Al-Turjman, F., Kumar, M., & Stephan, T. (2020). I-AREOR: An energy-balanced clustering protocol for implementing green IoT in smart cities. *Sustainable cities and society*, *61*, 102254.

[36] Lu, W., Gong, Y., Liu, X., Wu, J., & Peng, H. (2017). Collaborative energy and information transfer in green wireless sensor networks for smart cities. *IEEE Transactions on Industrial Informatics*, *14*(4), 1585-1593.

[37] Sodhro, A. H., Pirbhulal, S., Luo, Z., & De Albuquerque, V. H. C. (2019). Towards an optimal resource management for IoT based Green and sustainable smart cities. *Journal of Cleaner Production*, *220*, 1167-1179.

ISSN: 2455-8834

Volume:08, Issue:04 "April 2023"

[38] Ercoskun, O. Y. (Ed.). (2011). *Green and Ecological Technologies for Urban Planning: Creating Smart Cities: Creating Smart Cities*. IGI Global.

[39] Tomar, P., & Kaur, G. (Eds.). (2019). *Green and smart technologies for smart cities*. CRC Press.

[40] Yang, Z., Jianjun, L., Faqiri, H., Shafik, W., Talal Abdulrahman, A., Yusuf, M., &Sharawy, A. M. (2021). Green internet of things and big data application in smart cities development. *Complexity*, *2021*.

[41] Zong, J., Li, Y., Lin, L., & Bao, W. (2019, May). Evaluation guide for green and smart cities. In *IOP Conference Series: Earth and Environmental Science* (Vol. 267, No. 5, p. 052009). IOP Publishing.

[42] Singh, P., Dixit, V., & Kaur, J. (2019). Green Healthcare for Smart Cities. *Green and Smart Technologies for Smart Cities*, 91-130.

[43] Harrison, C., & Donnelly, I. A. (2011, September). A theory of smart cities. In *Proceedings of the 55th Annual Meeting of the ISSS-2011, Hull, UK*.

[44] Chen, L., Anandhan, P., & Balamurugan, S. (2020). Analysis of performance-based issues in green transportation management systems in smart cities. *The Electronic Library*.

[45] Zhang, X., Manogaran, G., & Muthu, B. (2021). IoT enabled integrated system for green energy into smart cities. *Sustainable Energy Technologies and Assessments*, *46*, 101208.

[46] Li, B., Kisacikoglu, M. C., Liu, C., Singh, N., & Erol-Kantarci, M. (2017). Big data analytics for electric vehicle integration in green smart cities. *IEEE Communications Magazine*, *55*(11), 19-25.

[47] Mingaleva, Z., Vukovic, N., Volkova, I., &Salimova, T. (2019). Waste management in green and smart cities: A case study of Russia. *Sustainability*, *12*(1), 94.

[48] Dogan, O., &Gurcan, O. F. (2022). Applications of big data and green IoT-enabling technologies for smart cities. In *Research Anthology on Big Data Analytics, Architectures, and Applications* (pp. 1090-1109). IGI Global.

[49] Abdullah, M. A., Al-Hadhrami, T., Tan, C. W., & Yatim, A. H. (2018). Towards green energy for smart cities: Particle swarm optimization based MPPT approach. *IEEE Access*, *6*, 58427-58438.

ISSN: 2455-8834

Volume:08, Issue:04 "April 2023"

[50] Srivastava, A., Gupta, M. S., Kaur, G., &Tomar, P. (2019). Green smart cities. In *Green and Smart Technologies for Smart Cities* (pp. 1-18). CRC Press.

