Governing Environmental Sustainability:
A Literature Review

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Abstract — **Environmental sustainability is the most important global challenge. All governments in the world are recommended to address this challenge by using digital technologies and their applications. Scientific evidence has shown that human behaviors contribute significantly to the deterioration of the natural environment. Therefore, this is crucial that governments can exploit the benefits of digital technologies to engage their citizens to handle/govern environmental sustainability. In this paper, we conduct a systematic literature review and aim to deepen our understanding of the interrelationships between e-government, citizen participation, and environmental sustainability. The results show that the research that explores this crucial interrelationship is surprisingly rare. Therefore, more future study is called for contributing more knowledge towards this research focus.**

Keywords— digital government, environmental sustainability, citizen participation, literature review

I. INTRODUCTION

Sustainable development is one of the globally accepted phenomena and its top prioritized needs of almost all the nations. The environmental sustainability cannot be achieved alone and it's always bundled with the social, economic sustainability and collective action between government and citizens[1][2].With the advancement of Information Communication technology and Digital connectivity, almost all the governments in countries focus more on providing Digital government and Digital government based services with the aim of engaging citizens in the process of decision making and governance [1][3].Engaged citizens create the opportunity to harness collective intelligence within the public sector, which could generate greater value from government initiatives[4]. The way to get citizens engaged is for governments to become more open, i.e. transparent, participative, collaborative [4] and also through e-government services, which make integrating a citizen's own resources (e.g. environmental knowledge, IT-skills, and access) with resources provided by the government, for example a website, feasible[5].E-government services within this context are thus an enabler and an arena for co-creation by allowing greater utilization of resources than traditional government would engage in [5] .

Citizens are more vigilant than ever in achieving environmental sustainability. Researcher attempts to develop theories, methods and tools aid for e-government services in addressing environmental sustainability issues [1]. Therefore, this is of great important that governments can improve/design e-government Services for citizen participation in governing Environmental Sustainability. This paper conducted a systematic literature review in order to obtain the comprehensive understanding of the state of art research regarding this research focus.

A systematic literature review was conducted based the articles found in the database Web of Science. The results from the review indicate that:

1. The research carried out to explore the interrelationship between E-government, Citizen Participation and Environmental sustainability is supervising very rare.
2. Citizens are increasing involved and engage in achieving environmental sustainability. Environmental issues can be potentially solved using collaborative approaches through E-participation.
3. Although e-government/ online platform services and ICT tools could offer to the public for citizen participation in governing environmental sustainability, governments seem not to prioritize such e-government initiatives in comparison with those for social and economic sustainability.

II. CONCEPTUAL FRAMEWORK

A. E-government

The E-government or Digital government is a multifaceted concept and it has been defined in different ways in different sources. The World Bank [6] has defined E-government as "Government-owned or operated systems of information and communications technologies (ICTs) that transform relations with citizens, the private sector and/or other government agencies so as to promote citizen empowerment, improve service delivery, strengthen accountability, increase transparency or improve government efficiency".

There are number of advantages of using Digital government services. Major advantages can be listed as 1. More efficient government, 2. Better services to citizens, and 3. Improved democratic processes [7]. A majority of the governments offer e-services for their citizens and already systems are in place to offer general services to the public. However the implementation and adoption has been a challenge in both developed and developing countries [8]. In addition to implementation and adoption challenges "Digital divide" is another fact which affect the Digital government. The term mostly refers to the gap exist in access and use of Information and Communications Technology (ICT) devices [9]. Hence, governments need to take necessary measures to improve Information Communication Technology (ICT) literacy, policy decisions and infrastructure development for accessibility of services for the general public.

B. Environmental Sustainability

Out of three major pillars of Sustainable Development, the Environmental Sustainability has become one of the main pillar of organizations and societies. Environmental Sustainability is defined as "Stakeholder behavior impacting on the natural environment that meets the needs of the present without compromising the ability of future stakeholders to meet their own needs" [10]. By the World Commission on Environment and Development defined the term as "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs" [11].

The paper 'Current Opinion in Environmental Sustainability' has reviewed and synthesized research on sustainability and environmental change explicitly focuses on environmental sustainability [12] based on 6 focus areas as 1.Climate systems (covering climate and climate change, climate risk management, mitigation and adaptation). 2. Human settlements and habitats (covering cities, urbanization and transport).3.Energy systems (covering energy use, energy conservation, renewable energy, energy efficiency and bioenergy). 4. Terrestrial systems (covering natural and managed ecosystems, forestry, food systems, biodiversity and ecosystem services). 5. Carbon and nitrogen cycles (covering sources and sinks, feedback processes and links to other systems). 6. Aquatic systems (covering marine and freshwater ecosystems, fisheries, currents and biodiversity)[13] .

C. Citizen Participation

The main and ultimate goal of the e-government is to be able to offer an increased array of public services to citizens in an efficient and cost effective manner to make their tasks easy and effective. Through this transparency of the government policies, procedures, future strategies will be communicated and visible among everyone. This E-participation provide number of advantages such as reduce overall administration costs, improve efficiency, make people ease of use and easy storage and retrieval of information and advantages of ease of information dissemination. This will allow government to listen for public opinion and public will get an opportunity raise their voice and be a part of decision making process. Each government can make use of citizens' trends and preferences in using internet and ICT to offer e-government services, empower them with decision making process and improve participatory management.

The Citizen Participation, Citizen Science, Citizen Engagement and Crowdsourcing are similar terms used to allow the general community to work collaboratively and solve general issues. This is a productive emerging trend that could be used and applied for, to solve many real complex tasks with least resources. For an example, in urban planning process, we could use 'Citizen Design Science' as a new strategy for cities to integrate citizens' ideas [14]. Citizen participation has applied in many form of the governance and traditional modes of decision-making has become increasingly challenged [15] . Presently a lot more researches are carried out with the concept of Citizen Science where scientists and volunteers work collaboratively to investigate various topics. During the recent past there is an increased interest on public participation in social,

scientific and other research disciplines. This growing trend of working together as scientists and citizens has mutual benefit for both parties. We could find a number of Citizen Science projects and the high visibility of Citizen Science activities in national and international including platforms such as Zooniverse, European Citizen Science Association and Australia Citizen Science Association etc.[16]

D. Enabling ICT Technologies

The emerging effective ICT tools and technologies are used to automate many of the day to day operations and provide greater services to the public and governments. Latest development of big data, Internet of Things (IoT), wired and wireless networks, sensor technologies allows to create active design tools get the opportunity involve citizens in E-government services in addressing environmental sustainability. There are many real world solutions which are provided for our lives and society through Internet of Things (IoT) is a technology by integrating smart devices in our environment and paving the way for innovative ICT applications used in smart cities, energy efficiency and home automation [16] . Smart Cities has become a widely discussed phenomena with urban development and ICT technologies. Smart city could be applied as effective and efficient solution in six domains: smart economy, smart people, smart governance, smart mobility, smart environment and smart living. It can be further broaden and within the Smart environment we could find sustainable resource management, environmental protection, pollution and attractiveness of environmental conditions[17].

III. METHODOLOGY

In this paper, we conducted a systematic literature review. A systematic review is an appraisal and synthesis of primary research papers using a rigorous and clearly documented methodology in both the search strategy and the selection of studies. This minimizes bias in the results. The clear documentation of the process and the decisions made allow the review to be reproduced and updated. In this approach, the state of the art research are systematically reviewed using inclusion, exclusion criteria and other parameters.

The literature was retrieved from international research databases Web of Science. The reason to choose this database is to ensure the review were based on relevant and high-impacted articles that published in academic journals across various disciplines.

In order to explore the interrelationship between e-government, citizen participation and environmental sustainability, the query further constructed in three categories as pair search. Categories can be summarized as follows;

- E-government and Environmental Sustainability
- Citizen Participation and Environmental Sustainability
- Citizen Participation and Environmental Sustainability and Citizen Participation

The results based on the pair search are further shortlisted through the inclusion and exclusion criteria.

A. Inclusion criteria

- Journal articles from all the disciplines related research with a primary focus on above three search categories.
- Studies published in the English Language.

B. Exclusion criteria

- The research is focused on environmental sustainability and research articles with a focus on general sustainability or social and economic sustainability are excluded.
- Papers are not 'Full Paper'.

The final results were stored in a Microsoft excel sheet for final analysis (Table I).162 results were generated by the three categories of search query pairs. It was reduced to 10 after a refined search with the inclusion and exclusion criteria. The filtered articles were re-examined using the abstract of the articles. The exact focus area is considered when we review through abstract of the articles. The articles which do not focus both of the terms specified in the pair search were excluded. In the end, ten papers were included in this review. The full text of the papers was carefully read to gain comprehensive understanding of the research question.

TABLE I. NUMBER OF SELECTED ARTICLES

Category	No. of articles
Citizen Participation and Environmental Sustainability	6
E-government and Environmental Sustainability	3
E-government and Environmental Sustainability and Citizen Participation	1

IV. RESULTS AND ANALYSIS

The results indicate at the research that explore the interrelationships between e-government, citizen participation and environmental sustainability is extremely rare. Digital technologies do support citizens to participate more and more in solving environmental issues. The state of the art e-governments services have the potential to engage citizens in achieving environmental sustainability. However, not many governments are prioritizing and pursuing e-government projects for achieving environmental sustainability in comparison to social and economic sustainability.

A. Citizen Participation AND Environmental Sustainability

Out of 6 papers reviewed under Citizen Participation in Environmental sustainability (Table II), 3 of the papers discussed the general Environment issues. Another 2 of them on Water issues and other research is based on Air/Water. The research was mostly conducted in developed countries (Europe, New Zealand, USA, Australia, and China) and all are based on qualitative studies, for instances, 3 of the researches used Case studies and other 3 is based on qualitative Survey. Observation, Interviews and questionnaire are the data collection methods applied in the research. One research has applied the Ladder of Citizen participation and commons theory [18].The "Ladder of citizen participation" that showed participation ranging from high to low. The ladder is a guide to seeing who has power when important decisions are being made.

TABLE II. ENVIRONMENTAL SUSTAINABILITY ASPECT VS. APPROACH OF CITIZEN PARTICIPATION.

Citation	Environmental Sustainability Aspect	Approach of Citizen Participation
Johannes,E. ;Sonja. H. (2017)[18]	Water	Active inclusion of the public in the governance of waterbodies to enhance the effectiveness and legitimacy of water management schemes across the EU.
Valentina,D.(2017) [19]	General	Provide public sufficient opportunities to safeguard environment.
Bernard, M. K. et.al.(2016) [20]	Air, Water and some other	Through concerned private citizens and visionaries change and enhance the Environmental conditions.
Wilhelmina, V.R.(2017)[21]	General	Involve public in Environmental Protection activities.
Thomas, J. et.al. (2018) [22]	General	Through Networks (Urban-Rural) people can make strong voice against Environmental Degradation.
Angela,J. D. et.al (2018) [23]	General	By providing citizens better/meaningful experiences and make them feel engaged more in Environmental Protection activities.

The government cannot make all the necessary arrangements or necessary steps to make sure environmental protection of a country. But through Citizen or public participation many of the environmental issues can be solved in less cost and in an effective manner. By empowering and involving citizens', effectivity and legitimacy of decision making process could be increased. Further , creating general awareness and establishing conflict resolution mechanisms also helps as remedy on environmental issues [18]. The Citizens can be together and concerned citizens and visionaries could build collectivist culture which leads to Community-building and community participation that would pave the way for the environmental protection[20]. Australian government has involved citizens in country's largest community-based environmental annual event to remove rubbish from their environment. Through this event the citizens knowledge about the environment and understanding about environmental issues has increased [21] . With the rapid development of economies sustainable development has become a challenge. For development activities environmental degradation is unavoidable. But at the same time citizen opposition activities and informal networks between citizens in the villages and urban activists formed a strong voice against environmental issues[22]. Another form of citizen engagement is providing citizens' a better and meaningful experiences and make them feel engaged more in environmental protection activities [23].

B. E-government and Environmental Sustainability

Under the category of e-government and environmental sustainability (Table III), three papers are carried out in general environmental issues. Out of them two of the research used Surveys as the research strategy [24] [25] and the other was based on a Case study [26] . As data collection methodology semi structured interviews, field observations,

web content analysis and analyzing secondary data sets have been applied in the research. The research was carried out in Japan, Southern European, Nordic countries and Small Island Developing States (SIDS) in Pacific , Africa , Indian Ocean , Mediterranean and South China. Citizen centric social governance Framework Analytical model to estimate the direct and indirect effects of e-government development on Environmental Sustainability.

TABLE III. ENVIRONMENTAL SUSTAINABILITY ASPECT VS. INVOLVEMENT OF E-GOVERNMENT

Citation	Environmental Sustainability Aspect	Involvement of E-government
Akemi T.C.;Christopher G. R. (2016)[26]	General	Citizen Engagement for Smart City implementation
Andrés N.; Mercedes R.; Pilar T.;Araceli D.L.R.(2017)[24]	General	E-government services
Young B. L.(2017)[25]	General	E-government services/ICT based solutions(weather warnings, correct use of fertilizer

Many of the governments consider Environmental sustainability as critical global issue and they develop required policies to cater for the requirement of the citizens. Smart City is an emerging solutions for many of the environmental issues and to reduce city-wide carbon emissions it includes solutions such as smart micro-grids, smart meters, and home/building energy management systems[27] .The governments offer e-government services and ICT based solutions such as weather forecasts for precautions, warnings and alerts for disasters, correct use of fertilizer in agriculture etc.[25].

C. E-government, Environmental Sustainability and Citizen Participation

Author found only one research paper carried out in this category (Table IV). This paper has been applied in the Survey as a research strategy with a combination of data collection methods including online questionnaire, media data analysis and an online survey. It was carried out in Beijing, China.

TABKLE IV. ENVIRONMENTAL SUSTAINABILITY, E-GOVERNMENT AND CITIZEN PARTICIPATION

Citation	Environmental Sustainability	E-government	Citizen Participation
Guizhen ,H.et.al (2016) [3]	General	Provide platform for e-participation	Collaborative approaches through e-participation

This paper was carried out with the objective of understanding the interrelationship between e-government in promoting public participation for the purpose of environmental sustainability issues in urban China. Researcher's objectives are to analyze what public motivations, perception/attitudes and actions drive

environmental e-participation, identify barriers to e-participation and assess the different applications and functions of ICT for citizen participation in environmental sustainability. The government can offer more online services to the public. It is proved that general public is more interested to disclose their views through the use of ICT and E-platforms. This E-participation allows Citizens to work collaboratively and solve Environmental issues. [3]

V. DISCUSSION

This paper is aimed to obtain the comprehensive understanding towards the interrelationship between e-government, citizen participation and environmental sustainability by conducting a systematic literature review. The results surprisingly show the research in this focus is extremely rare. From the Web of science search we found that only one research has been carried out in E-governmental services for Citizen Participation in governing Environmental sustainability. Therefore, the research gap is identified.

Firstly, in addition to produce knowledge to understand social and economic sustainability, e-government research should pay more attention to explore e-government services for the purposes of environmental sustainability by engaging citizens.

All the nations and humans cannot deny the importance of environmental sustainability. The Human actions caused many of the environmental degradations. As citizens we all can agree and work together on our responsibilities to protect the environment for the sake of the future generations. Achieving this Environmental sustainability is a collective work and different stakeholders including government, technology providers and citizens' should work together with common objectives.

In the process, citizen participation plays a major role and there is no blueprint for best practice participation involving them in environmental sustainability endeavors. When a community work together with proper leaders, environmentally concerned citizens and visionaries it can make a revolution in the society. Involving citizens in community based events of environmental protection is considered as valuable part of their learning about the environment that contributed to their understanding about sustainability and improves the power of positive community participation as a force for good. Through careful design of citizen science programs on environmental issues, community could be educated on environmental impacts while providing meaningful experiences and building environmental skills.

The new merging trends in ICT such as IoT , Big Data ,Sensor technologies , Artificial Intelligence etc. have taken citizen engagement in to a new direction. Through this emerging technologies citizens will get enough channels for public voice on environmental governance and sustainability issues which was not well looked after by the relevant authorities under the government. While these technologies will enhance the public voice, it allows citizens to contribute on different collaborative approaches to solve problems. It is well proved that compared to offline, citizens prefer to use online platforms, ICT tools and Internet to engage in expressing their views and to be involved in environmental public participation.

So far, not many governments are pursuing many e-government projects to maintain environmental sustainability. Though politicians and decision makers believes development of e-government as major requirement for environmental sustainability[25].

Secondly, the evidences (see section 4) have shown that citizen's participation to environmental issues are increasing and have resulted in valuable and positive consequences both for citizen's daily life and for protecting environments. However, a broad range of issues needs to be considered in order to enable citizen participation, such as access to information, equality, enabling participation of representative groups, the specifications of participation in different contexts, and a legal framework enabling meaningful participation, especially for environmental issues. Furthermore, participation is essentially unequal, as participants basically always represent specific groups, contexts, experiences and opinions. In a research [28] it points out that the main focus of, e.g., e-government is usually merely on enhanced public services and improved government operations, while how to support the transformation of governments into more open and interactive operating modalities is given considerably less attention; this fundamentally obstructs a rapid and efficient transition to an inclusion of systematic open and participatory mechanisms in the general governance. Ambitions with a more participatory and responsive government are therefore often not fulfilled, as pointed out. [29] [30].

Thirdly, Citizens are more vigilant than ever in achieving environmental sustainability. More research is needed to explore how e-government services can be improved/designed for coping with different environmental issues through collective action with the citizens[2]. Future research can be conducted to provide better understanding of how to make value co-creation successful in the public sector, i.e. how to co-create public value especially for environmental sustainability. "Governments have to learn to promote innovation and create public value not through direct intervention, but by leveraging and enabling the best capacities of citizens to be deployed and fully realized." In particular, research can pay attention to a growing area of research on "citizen observatories" as a socio-technical innovation that brings together both digital technologies and political decision making processes to contribute to sustainable and resilient social ecologies[2].

Finally, research is called for understanding how developing countries improve their e-government services for citizen participation in governing environmental sustainability. The literature shows that most of the studies were conducted in developed countries which may indicate that these countries have strong intentions and endeavors to achieve environmental sustainability. However, developing countries face more challenges in sustaining environment. Digital technologies offer significant support for the governments to make faster progress in changing circumstances for improving public policy-making capacity and engaging citizens in improving environment. During recent past, Sri Lanka as a nation challenged by nature and end up with environmental disasters including losses of people's life. Deforestation (Deforestation has increased soil erosion, landslides, floods, fauna and flora degradation, and damage to human lives and properties), Garbage and Pollution, Wildlife Poaching, Coastal Degradation, Mismanagement of Land use Changes due to Tsunami Resettlement, Freshwater Pollution, Urban and Industrial Wastes, Destruction of Mangroves, Air Pollution are some of the major environmental issues in Sri Lanka [13]. We aim to conduct empirical research in Sri Lanka to understand environmental issues, design solutions, and contribute knowledge towards this research focus.

VI. CONCLUSION

The existing literature proves that research carried out in digital government services for citizen participation in governing environmental sustainability is extremely rare. More research is required in this research focus. We argued the three important areas that we can continue to conduct research and bring better understanding of improving/designing e-government services for citizen participation and addressing environmental sustainability.

Although the Web of Science database collects important research our research focus across disciplines, we may unfortunately miss many articles which may not include in this database. In our future research, we will enlarge the search scope to other databases, for example, Scope, Springer, as well other conferences proceedings.

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