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Internet of Things (IOT) and Sustainable Development Focusing on Its Environmental Effects (Case Study: Denmark)

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Abstract: *Internet of things (IOT) technology is being quickly expanded, advanced, and implemented in developed countries. In this situation, Denmark is considered an instance of successful implementation and application of IOT in terms of the connected equipment. The present study investigates the issue of IOT and sustainable development focusing on its environmental effects in Denmark. The research has been done by analytical citation referring to the papers and reports published in Denmark. Study of the resources shows that IOT has realized the goals of sustainable development in the area of environment. Several components including waste management, reduction of pollution and wastes, supplying renewable energies, reduction of carbon production and greenhouse gas emission, energy efficiency, saving energy, and reduction of pollutants have been extracted from the reviewed literature. The results suggest that regarding the use of fuel consumption planning and traffic information, IOT can decrease fossil fuel consumption and pollutants in transportation area. In general, achieving the mentioned goals makes it possible to create environmentally-friendly cities that are favourable places for living.*

Keywords: *Internet of things (IOT), environmental effects, sustainable development, Denmark.*

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Introduction

Technology is rapidly advancing. After the expanded use of the internet and its popularity among the user, emergence of IoT has led to creation of smart devices and communication of humans and things via the internet. Developed countries are pioneering in this path and developing countries are also moving in this path but with a distance from developed countries due to the obstacles in communication tools and economic and political infrastructures (Fazeli, 2012). IoT is a new communication platform that is rapidly providing wireless telecommunication solutions. It is expected that exchanging the information about every individual thing facilitates the creation of chain networks of global resources, increases clarity, and promotes efficiency. IoT can be widely used as the main foundation of inclusive systems and activation of smart environments for simple detection of the things and retrieving the information from the internet at any time and place. In fact, urban IoT has been designed for supporting smart city tendencies that aim to benefit from the most advanced communication technologies for

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creating added value of services for citizens (Dadipour and Sani, 2018; quoted by Miranvandi et al., 2012).

In 2011, Gartner published the hype cycle for emerging technologies and included the concept of IoT in technology-based companies. It attracted the attention of consumers, industries, and different governments in the world to investigate the true potential of this concept. IoT is currently known as a dominant area of activity. In 2012, the widest European web-based conference i.e., LeWeb discussed IoT as its main issue. Furthermore, in the same year, popular technology journals such as Forbes, Wired, and Fast Company started to implement IOT in their vocabulary and describe this concept. In 2013, in International Data Corporation (IDC) published a report, suggesting that the value of IoT would reach from 1.9 trillion dollars in 2013 to 8.9 trillion dollars in 2020. It means that in terms of large-scale studies, there is a great potential for promotion of the technological growth and increasing the budget allocated to different actors of IoT (Larsen and Annan, 2020; quoted by Loet, 2014). On the other hand, sustainability is a concept that has been divided into three dimensions over time: Social, economic, and environmental dimensions. The environmental dimension refers to creation of ecological balance for future generations by minimizing the discharge of non-renewable natural resources. The economic dimension of sustainability refers to supplying the people's demands and trying to fairly distribute the limited financial resources and other resources. Finally, the social dimension of sustainability refers to covering all social groups for creating equality and eliminating poverty (Kuhlman and Farrington, 2010). Regarding the importance of sustainable development and its environmental goals and the growing popularity of IoT and its functions, the present study is a documentary analysis of environmental effects of IoT in Denmark. In fact, the authors try to review the papers and documents published in Denmark and answer to the question "What are the environmental effects of IoT in Denmark?"

Background

In the research "The effect of smart transportation and IoT on the improvement of national indicators of sustainable development", Niloofar Mirsepasi (2020) has claimed that IoT aims to empower the things to be connected to any thing or person that uses a pathway or network at any time and place. Such things cooperate to achieve a joint goal and they create new applications or services in smart areas of energy, transportation, health, security, business, home, cities, etc. The research is an applied study performed by descriptive-correlation approach. Data collection has been done by library studies. The population includes all the people who are familiar with IoT in ICT area. Structural equation modeling (LISREL 8.54) was used to study the proportionality of the variables and test the hypotheses. The findings suggest that the IoT-based conducted vehicle industry and its indicators are effective in the improvement of national indicators of sustainable development.

Samira Dadipour and Tayebeh Sani (2018) performed a research titled "A review on IoT technology for creating smart cities. They claim that IoT is not only important in controlling the equipment, but it can also play a major role creation of smart cities or countries. This paper has tried to investigate the application of IoT-based smart cities. Cooperation in climatic energy programs, integration of systems and especially transportation systems, and promotion of the capacities of ICT for empowering the consumers have a major role in development of cities and industries. IoT should cover a large number of different ultimate systems in an integrated manner, while free access to the selected data subsets is provided for development of digital services.

Mariya Ghahramani and Fatemeh Karami (2017) performed a study titled "IoT in the environment". They have claimed that IoT lets physical things to hear, imagine, and perform their tasks, share information, and coordinate the decisions. These things are changed from traditional frameworks into smart ones by using relevant technologies such as inclusive calculations, the set tools, communication technologies, sensory networks, and internet protocols and programs. IoT is expected to play a major role in commercial, environmental, and home programs to promote the quality of life and economic growth while improving the environmental functions. Due to its applications, IoT has attracted the attention of many universities, industries, and citizens. Meanwhile, it is effective in measures taken to preserve the environment and prevent its threatening factors. IoT can connect smart devices at any time

and place. Also, it provides significant market opportunities for manufacturers of equipment, internet service providers, and application developers who work in the area of environment.

Fatemeh Ilkhani and Ali Akbar Naji (2017) performed a research titled "The effect of environmental quality on Legatum prosperity index in the selected OECD countries". They investigated the effect of environmental quality on Legatum prosperity index in the selected OECD countries in 2009-2012. Legatum prosperity index is one of the indexes that can be effective in this area and it has been proposed by Legatum Institution. This index includes the factors related to economic growth an accumulation of national wealth and also the factors that are more correlated with welfare and quality of life. The results show that there is a significant positive relationship between the environmental function index and Legatum prosperity index in the selected countries.

Zeynab Saaddati and Batul Mehrshad (2017) performed a research titled "IoT and big data applications in sustainable smart cities". They claim that sustainable smart city is a new technological urban phenomenon that has been created as a result of the development of three global flows i.e. sustainability, expansion of ICT, and urbanization. A sustainable smart city is an innovative city that used ICT technologies and other tools for improving the quality of life, promoting the efficiency of urban operations, and increasing the service level and competition to ensure that the current and future generations' needs are matched in terms of economic, social, and environmental aspects. IoT is one of the main components of ICT infrastructures in sustainable smart cities and due to its significant potential in realization of environmental sustainability, it is considered an urban development approach. IoT is one of the main resources of creating macro data and macro data analysis is obviously penetrating into most of the urban areas for optimization of energy efficiency and reduction of environmental impacts. Manuchehr Ansari et al. (2017) performed a study titled "Identifying the functions of IoT in smart homes by meta-synthesis". In terms of purpose, their research is an applied one and in terms of data collection, it is a qualitative study. For this purpose, first 371 papers were studied and out of them, 85 papers were used for final analysis. Finally, 122 codes were obtained that were classified into seven functions including electricity consumption management (27 references), heating system, ventilation and air flow (15 references), reduction of water consumption (4 references), building safety (12 references), health control (24 references), incident management in the building (10 references), and home appliance automation (29 references).

Internet of Things

IoT is being formed as one of the main strategies of technological development in ICT area. Changing the application of internet for connecting the final users and moving toward the connection of physical things requires the revision in some of the traditional approaches on network management in cloud computing (Vahdat and Gheysari, 2018). The term "IoT" was first introduced by Kevin Ashton (1999) to describe a system in which, things can be connected by a sensor in the physical world. Ashton's idea was to count and check the supply chain of large companies by the internet. Nowadays, IoT is one of the contemporary phenomena that is being changed into a global favorable reality. Daily items and sensors and devices are necessary for describing our connection to the internet and performing the calculations. In fact, it aims to reduce the distance between the things in the physical world and information systems. In IoT, smart things are expected to be changed into active members of businesses and social information processes, so that they can interact with the external environment by exchanging the sensed information and data (Azimi, 2018). IoT mainly aims to control the things in any part of the world. The first set of questions raised for an engineer includes: How can we control the things in any part of the world? Why are we seeking for this remote control? Who is responsible for this control and monitoring? How is the security of this technology guaranteed? (Gheysari and Taher, 2018). IoT can be used in air transportation, automobile industry, telecommunication, media, recreation and shopping, smart buildings, medicine, health, social control, smart cities, the environment, agriculture, etc. (Gheysari and Taher, 2018). All over the world, IoT is used for solving some of the main problems in global development issues. It is used for improving the results of service development in different areas including reduction of poverty, sustainable improvement of water and health management, and connected technologies (Gheysari and Saadat Fakhim, 2017). It should be noted that IoT is highly

adopted. We are changing our mobile phones and tablets far more quickly than the past. Experts believe that in the period of 2009-2010, an explosion occurred in which, the number of connected devices increased more than the population growth. This explosion is not only limited to laptops, mobile phones, and tablets. Rather, it also includes sensors and daily devices that have not been connected so far. According to the analyses, the adoption rate of this technology is five times more than the electricity and telephone worth rate. Since technology adoption has been always proportional to population growth, it is expended that the gap in the adoption of IoT over the future years will be filled with the large number of sensors and objects (Gheysari and Taher, 2018). IoT is a promising phenomenon providing the opportunity of transportation in quality of life and efficiency of companies. IoT can create a new ecosystem for development of programs and fundamental services in transportation, facility, security, urban services, education, healthcare, etc. by a distributed smart network of smart devices.

IoT in Denmark

Denmark is the second country to receive the global coverage of IoT. Copenhagen, the capital of Denmark, is moving toward integrated smart development with environmental policies. Smart systems of this city control the traffic, air quality, waste management, energy, etc. In the global connectivity index (2017) proposed by Huawei, Denmark has shown a better performance than most countries in terms of all the five technology activators i.e., bandwidth, data centers, cloud space, big data, and IoT. Denmark is a frontrunner. Front runners are developed countries (with the average per capita GDP of 50 thousand dollars) that promote the digital user experience for developing smart societies by using big data and IoT. Regarding the increased investment, establishment, integration of cloud services, big data, and IoT, frontrunners are allowed to move further and quicker to reach the technology edge in 5G, artificial intelligence, smart cities, e-government, and smart production. These advanced technologies also play a major role in innovation, industrial transformation, establishment of companies, and job creation. According to the classification of the European Union, Denmark is one of the most powerful European countries especially in digital and environmental industries. The growth of green technology can be attributed to the 1950s program that has planned the achievement of a fossil fuel-free future in Denmark by 2050. Nowadays, the new companies working in the area of clean energy and sustainable construction constitute 8.5% of employment in Denmark companies. This rate is equal to 1.5% of employment in Britain. The government of Denmark is trying to use the opportunities resulting from digital transformation for creating more welfare for people. Brian Mickelson, the Industry Trade and Finance Minister of Denmark claims that the government wants Denmark to become a digital frontrunner where all the people have a share of the advantages of digitalization. The new technologies can make us a wealthy country and improve our environment, healthcare, and life in many aspects. We should use this opportunity to reach Denmark to a digital future.

Environmental Effects of IoT

Since the early 1960s, a new experts and environmental and socioeconomic activists of western communities revealed the negative effects of industrial development. Rachel Carson published the book "Off Spring" to emphasize the upcoming environmental disaster. Dudley Seers proposed the paper "The concept of development" to emphasize the reductionism in the economic approach of 1969. Donella Meadows and Dennis Meadows published the report of clubroom development constraints. Barbara Ward and Rene Dubos published the report "Only an earth" and consequently, the global conference on human environment in Stockholm (1972) showed the acceptance of threatening outcomes of the common development model assumed in the public opinion. Then, adoption of environmental policies got an increasing importance and changed into a necessity in political opposition in western countries. Meanwhile, non-governmental movements such as green peace were formed for public resistance against the environment destructing measures all over the world (Etaat et al, 2013). One of the most important cultural and social issues in the present era is the environment and its effect on people's life. The interaction between human and the environment is an important factor in reduction of environmental risks. This issue is so important in sustainable development that creates a dynamic society (Fathi and Batebi, 2018). On the other hand, IoT is a new form of inclusive calculations and macro data applications. Regarding the environmental sustainable development plans, this phenomenon has been increasingly adopted by smart cities. So, the potential of IoT and macro data analysis depends on the

ability of these cities to expand their information vision by implementing and combing the relevant frameworks to improve the processes, plans, and services proportional to environmental sustainability programs. Big data analysis is so effective in realization of the key properties of sustainable smart cities i.e., efficiency of services and operations, optimization of natural resources, and smart management of infrastructures and facilities. In fact, there are a lot of expectations from the environmental outcomes of studies and macro data analysis in scientific and industrial areas (Saadati and Mehrshad, 2017). Nowadays, wireless control systems and IoT technologies are widely used in environmental protection applications. The increased use of wireless control systems in environmental programs is one of the most promising sectors of future markets all over the world. IoT and wireless technologies can be used for promoting the efficiency and effectiveness of crowded cities and national environmental protection programs such as controlling the greenhouse gas production, air quality, using recyclable materials and electronic devices, and electronic waste discharge. The combination of cloud platforms and IoT can provide the opportunity of rapid development of different applications such as environmental controls including the water level measurement, air pollution, soil moisture, light condition, fire detection, and etc. The main challenges in this area include the environmental conditions and security of environmental sensors that are physically threatened (Gheysari and Vahdat, 2018).

In this condition, cities are important habitats that affect the fundamental changes in the environment. There is a high rate of consumption of resources in cities and it raises a question about the sustainability of cities in the future. Smart city can be defined as a technology platform that decreases the citizens' problems to provide them with a better life. Integration of information and communication technologies is a key strategy that can reduce environmental problems and promote cost efficiency and also, make the cities smart (Haleem and Shafana, 2018). Implementation of smart cities requires the expanded use of IoT. Waste management, smart parkings, smart maintenance, weather prediction, traffic control, smart light systems, and energy management, etc. can be done by IoT. Furthermore, in the environmental aspect, IoT provides the opportunity of reducing the consumption of natural resources and saving energy. Optimal energy control, detection of natural disasters in their early stages, risk detection, and protection against pollution are some of the values created by monitoring the environment by IoT technologies. Automatic warehousing, capital management, and active planning in logistic transportation can be achieved by lowering the fuel consumption and consequently, reduction of air pollution. In the concept of green information technology, measuring the carbon outcomes, controlling the effect of businesses on the environment, reducing the wastes of business processes, reducing the use of resources, improving the energy efficiency, and reducing the emission of greenhouse gases can improve the sustainability performance. In this way, green information technology provides the opportunity of producing new products and services and also using sustainable innovations (Nasiri et al, 2017).

Theoretical Frameworks

Sustainable development

Following the report of Brundtland Commission (Global Environment and Development Commission, 1987), sustainable development refers to sustainable social welfare and welfare refers to not only the current welfare, but also the welfare of future generations. Sustainable development is an economic program in which, the welfare of the present and future generations is not decreased over time. Therefore, sustainable development emphasizes the continuance of advances and improvement of human life, and consequently, reduction of pollutions, proper waste discharge, and proper use of energy and resources (Desgopta, 2007). Since the Brundtland Commission report was published, this definition has been modified and reformulated regarding the different attitudes. Therefore, different definitions of sustainability are significantly different. Although nowadays, there are more disagreements about the exact definition of this term, most of the definitions refer to the preservation of natural resources and ecosystems over time and also preservation of human life standards and economic growth (Keiner, 2005). Sustainable development means moving in a human-environment oriented pathway and it focuses on development of economic facilities regarding the environmental considerations and social justice. The process of sustainable urban development aims to provide a sustainable situation in urban societies. In this process, the ultimate goal is to strengthen the sustainability indicators in the economic, social,

cultural, and environmental aspects of urban life (Fathi and Batebi, 2018). The goal of sustainable development is a dynamic, purposive, and forward-looking development emphasizing that we need the environment for our survival and aching the goals of development. The main strategy of sustainable development is making economic growth and social justice companion. In fact, sustainable development includes the three principles of economic sustainability, social sustainability, and environmental sustainability. This concept has been proposed by Rene, a post economist (Sadegh et al, 2020; quoted by Ben Khalifeh et al, 2014). Popularity of sustainability originates from a simple model that is used for facilitating the understanding of this term. The triangle of environmental aspects (preservation of natural resources), economic aspects (economic growth), and social aspects (equality) constitute the basics of sustainable development (Keiner, 2005).

Sustainable development can be considered as intellectual use of resources in a framework including the environmental, economic, and social factors. Sustainable development creates a balance between development and the environment, and urban sustainable development is a process that integrates the environmental, economic, and social goals by making policies and doing the necessary actions and supportive operations; where this integration is impossible, it makes a relationship between the mentioned factors (Sadeghian and Farokhian, 2017). The ecological aspect of sustainable development is related to the structure and performance of different systems such as physical, chemical, biological, and climatic processes in relation to biological variety. In this way, sustainable development includes all the aspects of human life (Farhadian Babadi, 2019). In the environmental aspect, sustainable development is a situation in which, consumption of natural resources is proportional to their reproduction rate, and production of pollution and waste is proportional to the capacity of waste absorption in the ecosystem. In this condition, natural capitals will not be reduced and inter-generation justice is realized. Ecological service supporting systems should not be disturbed (Etaat et al, 2013). On the other hand, sustainable urban development emphasizes the environmental properties and it has changed to an ecological attitude to urban sustainability. Urban sustainability is closely related to a spatial hierarchy from global levels to regional and local levels. Based on the definition of sustainability, the cities will reach a continuous dynamism (Navabakhsh and Motlagh, 2009; quoted by Kafashi, 2008, p 66). Urban development can be sustainable when both the economic and social dimensions are observed at all levels.

In this regard, health is one of the main goals and outcomes of sustainable urban development. Urban health is subject to having a healthy environment and appropriate social, economic, cultural, and environmental platforms that are founded by citizens.
The global Environment and Development Commission has proposed the following principles:

1. Increasing the economic and social opportunities to cover the citizens.
2. Decreasing the share of energy in urban growth
3. Optimal use of water consumption, land, and other resources that are necessary for urban growth
4. Minimization of waste and waste water production and maximization of waste recycling
5. Creation of powerful and efficient management systems to achieve the socioeconomic and environmental goals
6. The use of technologies for achieving the goals of sustainable development
7. Paying attention to empowerment of different urban regions for prevention of environmental threats and consideration of economic and environmental goals for improving the quality of life for citizens (Sadeghi and Farokhiyan, 2017)

Main question of the research
What are the environmental effects of IoT in Denmark?

Research Method
The research method is documentary analysis and the statistical population includes articles, documents and published reports on the effects and extent of the Internet of Things in Denmark with a focus on

environmental impacts. Sources are extracted from Danish scientific and news databases and purposeful sampling is used in the selection of articles.

Table (1): The studied papers and reports

Document Title	Date of publication	Author	Number of pages
The sustainable development goals: A World of Opportunities for Danish Businesses	2017	Dalberg[1] commissioned by the Ministry of Foreign Affairs and the Danish Ministry of Industry, Trade and Finance	19
Developing Disruptive Innovations for Sustainability: A Review on Impact of Internet of Things (IOT)	2017	Mina Nasiri, Nina Tura, Ville Ojanen	11
Growing Smart cities in Denmark	2016	Joint Arup and CEDI team commissioned by the Danish Ministry of Foreign Affairs	52
Every. Thing. Connected. A study of the adoption of 'Internet of Things' among Danish companies	2015	By Monitor Deloitte for Ericsson Denmark in collaboration with the Danish ICT and Electronics Federation	40
Understanding the Internet of Things (IoT)	2014	GSM Association	15

Qualitative analysis of findings

In this section, we study the extracted papers focusing on the environmental effects.

The sustainable development goals: A World of Opportunities for Danish Businesses. This report has been proposed by Dalberg following the order of Ministry of Foreign Affairs and the Ministry of Industry, Trade, and Finance. The report has suggested that population development accelerates urbanization. This progress intensifies the pressure imposed on urban infrastructures and it is accompanied by a wide range of environmental challenges. Also, it increases the demand for smart solutions and IoT in different areas such as transportation, green construction, installation, and waste management. Regarding the created advantages, it increases the demand for solutions that facilitate moving towards more resistive economies and reduction of carbon. Businesses of Denmark have a good potential to use the opportunities of sustainable development. So, Denmark is introduced as one of the dominant international patterns of promotion of sustainable solutions and trade. This research has investigated the environmental effects of IoT in Denmark as presented in the following table.

Table (2): IoT Environmental Impacts from the sustainable development goals: A World of Opportunities for Danish Businesses

title	Theme	Indicator
Environmental Impacts of IoT in	IoT application	Achieving the goals of sustainable development in the field of environment
	IoT application in smart city	Waste management and pollution reduction
		Reduce carbon emissions and pollution
	IoT application in transportation	Reduce energy consumption and pollution

[1] Dalberg Global Development Consultants is a strategy and policy consulting firm. The company was founded in 2001 and specializes in global development. Dalberg has worked in more than 90 countries with more than 400 clients, including governments, foundations, international agencies, NGOs and 500 companies, with the mission of raising living standards in developing countries and providing effective responses to the most important issues in the world.

	IoT application in buildings	Realize green building and reduce energy consumption and reduce pollution
	IoT application in the energy sector	Use of renewable energy
		energy saving

"Developing Disruptive Innovations for Sustainability: A Review on Impact of Internet of Things (IOT)" has been proposed by Nasiri, Tura, and Ojanen (2017) and published in the journal of "Technology Management in an Interconnected World". This paper suggests that transforming innovations aim to respond to complex problems of sustainability and transforming the existing markets. Innovations stimulate industrial growth and create the opportunity of making social and environmental transformations. Meanwhile, transforming innovations and sustainability are necessary for resilience under pressure of facing the challenges of the currently used business methods. From the environmental aspects, IoT provides the opportunity of reducing the use natural resources and saving energy. IoT-based solutions provide new opportunities for economic, industrial, and commercial development. These solutions improve not only social sustainability, but also environmental sustainability, and provide the possibility of creating safe installations. This paper has investigated the environmental effects of IoT in Denmark as presented in the following table.

Table (3): Environmental Impacts of the Internet of Things Taken from "Developing Disruptive Innovations for Sustainability: A Review on Impact of Internet of Things (IOT)"

title	Theme	Indicator
Environmental Impacts of IoT in Denmark	IoT application	Reducing the negative effects of the environment
		Improve energy efficiency
		Intelligent production without emitting carbon pollutants
		Increase resource productivity
		Save energy and reduce fuel consumption
		Reduce waste and waste
	IoT application in sensors	Increase environmental security and identify hazards and reduce the risk of accidents1
		Investigation of water pollution
		Reduce consumption of natural resources
		Energy saving and optimal energy control
		Protection against pollution
	Green IoT	Measuring carbon implications
		Monitoring the impact of business on the environment
		Reduce waste in business processes
		Reduce resource use
		Improve energy efficiency
		Reduce greenhouse gas emissions

Growing Smart cities in Denmark

Digital technology for urban development and national flourishing" was performed by Arup and CEDI joint team in 2016 based on the data obtained from the leader committee (including the governmental authorities of Denmark, academic specialists, and other public organizations. The research has suggested that Denmark is focused on urban city innovations and IOT in environmental issues to fulfill its commitment to elimination of carbon fuels in Copenhagen by 2025. One of the advantages of carbon-free cities is saving a billion kroners in electricity consumption annually. Commitment to the goal of elimination of carbon is obvious in the process of urban development in Copenhagen. For example, factors such as supplying renewable energies and green transportation equipment are observed in the new construction project of Nordhavn region of Copenhagen. Nordhavn is a pattern of energy

consumption in smart cities showing how electricity, heating, efficient buildings, and electrical transportation systems can be integrated into a smart, flexible, and optimal system. This research has investigated the environmental effects of IoT in Denmark as presented in the following table.

Table (4): IoT Environmental Impacts from Growing Smart cities in Denmark

title	Theme	Indicator
Environmental Impacts of IoT in Denmark	IoT application in smart cities	Create environmentally friendly and livable cities
		Complete elimination of carbon fuel by 2025
		Renewable energy supply
		Green transport equipment
		Buildings with energy efficiency

"Every. Thing. Connected. A study of the adoption of 'Internet of Things' among Danish companies" was done by Monitor Deloitte in August and September 2015 with the cooperation of ICT and Electronic Federation of Denmark. Among the companies participating in qualitative interviews, 8 companies out of every 10 companies make the annual revenue of 5 billion kroners, and they are considered as the 100 top companies of Denmark. Evaluation tools were a questionnaire and qualitative interview. Some of the findings suggest the effective role of IoT in realization of development goals. For example, automation functions are observed in renewable energies where the sensor data immediately decide to set the wind turbine blades for better operation. The instance of this issue is Vestas Co. that had implemented IoT as an appropriate alternative for other energy resources claiming that "You can optimize the mechanics, but you will not progress without IoT". This research has investigated the environmental effects of IoT in Denmark as presented in the following table.

Table (5): Environmental Impacts of the Internet of Things Taken from the Research Analysis of Every. Thing. Connected. A study of the adoption of 'Internet of Things'

title	Theme	Indicator
Environmental Impacts of IoT in Denmark	Use of the IoT in transportation	Reduce fuel consumption and pollution
	Use of IoT and smart meters	Reduce energy consumption and pollution
	Using the IoT in energy production	Increase the production of renewable energy
	Use of the IoT in smart buildings	Awareness of weather conditions and pollution

"Understanding the Internet of Things (IoT)" is a report published by the Global Mobile Telecommunications System (2014). The report suggests that the connected life program is an industrial innovation-seeking for acceleration of the development of IoT services on mobile platforms. It hopes for industrial stakeholders to dominate the market for the consumers' and the societies' interests by the perception of IoT properties. Connected life will significantly affect the life quality and work. Its major social and environmental advantages include the improvement of health care, transpiration, better logistics, more efficient education, and more optimal energy consumption. Real-time information record, and remote connection can make different devices, machines, and vehicles more efficient and effective. Also, it can significantly decrease the wastes and improve time efficiency. This research has investigated the environmental effects of IoT in Denmark as presented in the following table.

Table (6): Environmental Impacts of IoT Taken from Understanding the Internet of Things (IoT)"

title	Theme	Indicator
Environmental Impacts of IoT in Denmark	Use of the Internet of Things in smart cities	Intelligent traffic management - reducing fuel consumption
		Significant reduction of waste
	IoT use in smart homes	Energy efficiency and savings
	Use of IoT and smart meters	Reduce emissions by 27 million tons of carbon Equivalent to planting more than 1.2 billion trees - reducing air pollution

Discussion and conclusion

Internet of things is being quickly expanded, advanced, and implemented in developed countries. In this situation, Denmark is considered an instance of successful implementation and application of IoT in terms of the connected equipment. Investigation of the documents related to Denmark shows that implementation of IoT has been so effective in realization of the goals of sustainable development goals in the environmental areas. The use of IoT in waste management and data-based waste collection can lead to saving the costs, reduction of carbon emission and environmental pollution. On the other hand, the use of IoT in smart cities and buildings improves the energy management and reduces the energy consumption, and finally, it will decrease the consumption of fossil fuels. Meanwhile, adoption of IoT in plants and renewable energy installations will help the optimal function and increased production of these energies. It should be noted that although the industrial life and the internet have increased the emission of greenhouse gases in the world, the use of green information technology and IoT has realized the carbon-free Copenhagen. Also, it can reduce the emission of greenhouse gases. The use of IoT in smart buildings and counters can regulate the temperature and light in an environment and consequently, energy consumption management can save energy and reduce air pollution. IoT can also reduce the consumption of fossil fuels and pollution by regulating fuel consumption and the use of traffic information. In general, the mentioned factors can realize achieving environmentally friendly and livable cities. Furthermore, the use of IoT in sensors can increase the safety by early detection and prevention of the risks and decrease the damages caused by unpredicted incidents. Sustainable development seeks for creating a balance between progress and development and protecting the environment for the present and future generations, and emphasizes the reduction of wastes and pollutions and optimal use of energy and resources for improving the society members' life. Based on studies, the use IoT aims to realize the mentioned goals. So, it can be stated that IoT can realize the environmental goals of sustainable development.

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