A STUDY ON THE FEASIBILITY OF APPLYING IOT TO IRAN WITH AN EMPHASIS ON ENVIRONMENTAL AND HEALTH COMMUNICATION

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ABSTRACT

This paper will address achievements of Web 3.0 recognized as Internet of Things (IoT), and will examine the effects of IoT in the field of health and environment in Iran. IoT is one of the applications of semantic Web that uses layered architecture and is a new platform that was completed in 2020. Web 3.0 makes omnipresence communication possible and can make all electronic apparatuses to communicate with each other while communicating with human agents. It also enables computers to generate data by communicating to each other. This can contribute to developments in many fields and field of health and environment are no exception and probably are on top of priorities. Here, we will launch a documentary study and will focus on IoT and how it is related to the field of health/environment and will enumerate the priorities that can be set in this field if IoT is applied. Some of the priorities that can contribute to prolonging life span, diminishing contagious diseases, facilitating medical care for chronic diseases, child care, preventing life-threatening epidemics, and promoting quality of life among elderly consist of: Diagnosis of falling, caring the physiological state of individuals, monitoring patients remotely, managing chronic diseases and controlling pollutions. Some results indicate: Iran needs to change its approach towards IoT; this will help Iran to respond to its development needs in the field of health and environment with regard to its long-term development plan known as Ofogh 1404 (2025 outlook). One of these needs is to move towards technologies that comply with IoT while taking distance from technologies that are associated with Web 2.0.

Keywords: ICT, virtual space, IoT, health, environment, intelligent systems

INTRODUCTION

This paper will provide arguments about the theoretical and documentary frameworks of Web 3.0 and the development of Internet of Things in Iran. We first need to explain that the widespread development of the Internet of Things (IoT) has taken place by the development of information and communication technologies and an expansion of ICT infrastructure. Omnipresence communication is possible by this new technology.

Today, "the internet has moved beyond the fixed-page (Web 1.0) model, passing through Web 2.0- known as social media networking- and moving toward Web 3, or the world of omnipresence processing" (Gubbi, et al. 2013, Abdollahyan, 1394 [2015]; Seyed Asgari, 1394 [2015]).

One of the current powerful technologies in the field of health and environment is placed in the domain of IoT, which uses semantic web. Internet of Things as one of the applications of Web 3.0 -with a layered architecture of semantic web- "ideally uses every route, network and service to connect to the internet at every time and everywhere, to everything and everybody. The Internet of Things is a new evolution of the internet representing an emerging area in which billions of smart objects across world are interconnected that use Internet for data and

resource sharing. These smart objects are generally used to sense various parameters such as temperature, motion of objects, and occupancy from the environment where these are deployed. In the last instance, the values and data are transmitted to the nearest access points to take intelligent decisions. However, with an increased penetration of smart objects in our daily life, these objects may also participate in social events using machine-to-machine or human-to-machine interactions that reflect a situation better called as Social Objects. This new paradigm of interaction among social objects is referred to as Social IoT (SIoT) (Chahala, et al., 2020: 13). Now, SIoT can help us to solve the social issues in a more effective and precise way.

Internet of Things is a new technology that pays attention to the pervasive presence of the environment" (Ghasemi et al., 1395 [2016]: 156). To study such an area, the structure of this article has been adjusted to show what the relationship between the Internet of Things, environment and health is, and which strategies Iran needs in order to apply the effective role of the internet in the field of health and environment.

First we start with the Millennium Development Goals (MDGs): Its aims are to eradicate poverty and starvation; to achieve basic academic knowledge; to support gender equality and women's empowerment; to reduce child mortality and promote maternal health; preventing the spread of AIDS, malaria and other diseases; promoting environmental conditions and global participation in development (Spence and Smith, 2010). Also According to a recent mandate from the Sustainable Development Goals of the United Nations (UN) countries should aim to provide universal health coverage and access to quality essential healthcare services to their population by 2030 (Bonina and Scrollini, 2020). In 1800, the most distance between rich and developed countries, in one hand, and poor countries, on the other hand, was 1 to 3. However this distance has become very big today by the development of industry and advanced technologies, so this distance has reached to a large number of 1 to 140 (Jalali, 1383 [2004]: 10). This gives us enough motivation to pursue new technologies in various fields to fill this gap.

The research on digital poverty done in developing countries shows that these countries do not use the vast potential of the internet to advance their country, although Iran has some differences. For example, many Africans often use internet at the micro level such as exchanging e-mail messages and checking out entertainment sites, but they do not use the various capabilities of the internet for research, education, and business (Obijiofor, 2015). Using the internet for health and improving environmental conditions is also a neglected issue in developing countries. In Iran, using internet for entertainment purposes is more common than using it for other purposes. This is while if Iran does not keep pace with technological advances in the world quickly, it will face digital poverty in near future and will have a deep digital gap compared to developing countries.

Problematic of the research
Based on the criteria of economic development and the use of information capital, Iran is one of the world's developing countries and possesses lower technological integration than the so-called first world countries and newly industrialized ones. Nevertheless, Iran plans to join the process of sustainable development based on the development of Web and information capital. One way for all Iranians to have access to comprehensive, information is to use internet, which can be helpful in empowering people, fighting against poverty, and moving towards global progress and development and improving health and environmental conditions.

In this context and with an emphasis on communication and development theorists such as that of Manuel Castells, it can be argued that new information and communication technologies help various aspects of development and, in fact, there is an almost direct relationship between technology adaptation in developing countries and diminishing economic deprivation. Accordingly, understanding and using technology can be logically considered a solution for eliminating poverty, improving health and environmental conditions. Under current circumstances with regard to the development of ICTs, being away from state-of-the-art technologies will fuel the digital divide in Iran. Thus, by empowering Iran and using the new technological developments of

Web 3.0, the digital divide can be reduced, web-based education can be promoted, and universal access to public services can be raised, as already has happened due to pandemic circumstances that forced on line education. However, it should not be ignored that one of the most important development indicators is the environmental situation in Iran. Deforestation is one of the major environmental threats in Iran; there were more than 18 million hectares of forest in Iran in 1979, while FAO (2015), based on satellite images, estimated the area of Iran's forests to be only 7 million hectares. This means that about two-thirds of the forests have been destroyed in less than a quarter of a century. Based on the World Bank estimates, this causes a reduction of 5-10% in GDP. Indiscriminate hunting and overgrazing are other environmental problems in Iran which threat 91% and 82% of protected areas, respectively. Land use change (79%) and logging (55%) are other causes of environmental destruction in Iran. The major shortfall in the category of forest ranging is related to the environmental protection, because the area covered by each ranger in other countries is 3000 hectares, while this figure in Iran is about 7-8 hectares. By using the sensors of the Internet of things, rangers can be helped and further degradation of the environment can be prevented.

The result was the degradation of Iran's environment (and health issues), which led to a fall in Iran's rank in the field of environment in the period between 2008 and 2012, something that continued into year 2021. This is caused by several factors such as air pollution, the phenomenon of dust, and encroaching upon forests, meadows, etc. All the above figures can be minimized through monitoring health and environment indicator and a precise control of the Internet of things.

In line with the protection of Iran's environment, many items have been emphasized in the Sixth Development Plan, such as development and enrichment of forests, soil protection, curbing desertification, promotion of forest conservation, state and national lands and pastures, green management, comprehensive program of fighting against dust, improving drinking water operation system, and consumption productivity enhancement. However, the realization of these programs requires research-based planning, which will be dealt with in the present paper.

It should also be noted that by development, we mean providing a better life for all and sustainable development is one that helps to meet our today's needs without compromising the ability of future generations to meet their own needs. The 2030 Agenda for Sustainable Development and its 17 Sustainable Development Goals (SDGs) set in motion the most ambitious global development agenda[1] (UN, 2017). It recognizes Science, Technology and Innovation (STI) as a key action area for the realization of the 2030 Agenda. Under its terms, Member States commit to set policies to incentivize the creation of new technologies and consider setting up innovation funds to support innovative enterprises (Dutta, et. al, 2020).

However, development has had devastating effects on the environment of Iran. To achieve sustainable development along with improving environment conditions, these damages should be reconstructed and further destruction must be prevented. This requires planning based on Web-oriented research through the Internet of Things that can also diminish the suffering of environment rangers who risk their lives to protect environment. The Internet of things (IoT) is an internet-centered data structure based on the semantic web, which can be beneficial in such a way to achieve sustainable development, especially in environment as well in health issues. In IoT, objects act as a ubiquitous information network and a basis for computations. Intelligent environments are able to recognize and identify objects and retrieve information from the internet. The objective of IoT is to give the ability to objects to communicate with each other everywhere and any time or with any device and network. IoT can manage and process current and past data, which leads to the improvement of environmental performance and awareness about natural disasters.

Developments made by IoT in the current situation are dependent on the control, which provides faster responses than items

[1] UNGA A/RES/70/1 Transforming our world: the 2030 Agenda for Sustainable Development.

achievable through the monitoring, and control. This prevents further destruction and damages to the environment. Another application of IoT in the environment relates to energy consumption. These sensors are used in homes for the dynamic adjustment of temperature and light and energy saving. Waste management is another environmental use of IoT. Specifically, for the industrial and commercial waste, by applying business rules based on recoverable data of IoT, waste is disposed, because industrial hazards are of special importance due to creating a threat to human health and the environment in Iran. The key point here is the participation of all members of society. Development of efficient and clean technology of IoT needs drastic changes in the behavior of people. For community and social participation in the development of environmental sustainability, it is necessary to influence them in order to reduce harmful behavior and change strategies and low-risk behaviors.

The rapid development and implementation of smart and IoT-based technologies have provided various possibilities in technological advancements to serve various aspects of life. The main goal of IoT technologies is to simplify processes in different fields, to ensure a better efficiency of systems (technologies or specific processes) and finally to improve life quality (Nižetić, et al., 2020). Technically, IoT architecture is based on information exchange tools, the most important of which is tagged items of RFID (Radio Frequency Identification). RFID is a method for collection of high-volume data for the database. RFID technology allows the possibility to store data in circuits of small portable electronic transmitters. Communication between the RFID tag and a sensor is established via radio frequency waves and the stored data will be registered without contact. RFID plays an important role in applications related to the green world and reduces the carbon footprint in the environment. In cities of many countries, there are more than thousands of trees with a RFID tag which pave the way for oversight. In fact, this technology is a promise that helps the proposal of new solutions for having a greener world.

The arguments here follow a number of objectives as follows:

1. The paper will first review the IoT methods that have been used in environmental areas in developing countries.
2. The paper will offer a comparative study of the most beneficial uses of IoT in the environment of Iran, considering its special climate.
3. the paper will use the data collected through interviews with experts in the field of environment, to categorize environmental issues of Iran in accordance to the Sixth Development Program and 1404 (2025 AD) Outlook. The results can be used for strategic policymaking both in health and in environmental issues. From the perspective of national experts, the Internet of things can be also used for the prioritization of the Internet of things.
4. The paper will outline a type of lifestyle based on sustainable development that is useful in fastening the achievement of development objective in Iran, bridging the digital divide between Iran and developed countries. Prevention of deforestation, drying wetlands and rivers, loss of animal species and farms using the careful monitoring and control of IoT technology will be one of the achievements of this paper, each of which will be studied in an order of priority. In our view, such development objective is intertwined with health issues too because deterioration of the environmental conditions can affect production of foodstuffs and their qualities which in turn can worsen health issues at the national level.

The concept of the IoT and some conceptual considerations
We will use the theory of social relations with nature (and health issues) and the theory of the environment and sustainability from Adams (2001), and Art van der Wal and Adams [2] (2015) in order to propose a new charter of action for sustainable development in Iran. Since the United Nations Conference on Environment and Development, held in Rio in 1992[3], the title "development" has become one of the most sensitive and important words

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[2] Koen Arts, René van der Wal and William. M. Adams
[3] UNCED or "Earth Summit",United Nations Conference on Environment and Development

in the debates (Adams, 2001: 1-2). There are concepts behind this title; on the one hand, efforts to solve environmental problems, using ecological and natural sciences whose major concerns is with conservation of nature, and on the other hand, a general concern with solving the problems of poverty and misery in the Third World (Ibid: 51). Sustainable development is not a fixed and static concept, but it is a continuous and evolving movement towards compatibility and adaptation, during which the utilization of resources for investments and orientation of technological development is done in a way that can meet the potential and actual human needs. In this sense, human kind is the center of attention and this very concept encompasses all aspects of human life (Adams, 2001).

The Internet of Things is a global infrastructure for the information society and it is also the foundation of a growing network of physical objects or devices which have an IP address to connect to the internet. In such a way, communication is established between objects and other devices and systems that are activated by the internet. The Internet of Things allows the devices' operating system to communicate through the internet, people to objects as well as machine-to-machine (M2M) without human intervention (Information Technology Organization of Iran, 1394 [2015]). Internet of Things provides all technological requirements for a successful socio-economic transformation in developing countries. IoT is a low-power technology, so it is suitable for places with unreliable power sources. In addition, it does not require a high-speed internet network; nodes send a small amount of data and the servers can be local. It is also low cost and has an immediate impact on people's lives (Zennaro, et al, 2015; quoted from Zarei et al, 2015).

Each object has a unique address by the Internet of Things, which can interact to the others to achieve a common goal ultimately. IoT is the predominance of the distributed computing systems that provide significant compatibilities for collecting, processing and disseminating information (Miazi, 2015: 1). It uses wireless and wired communicative systems (Ibid). IoT has evolved from communicative platforms that enable internet access anytime and anywhere: a network, which makes everything possible by collecting

and disseminating data in the physical world (Zennaro, et al, 2015). In short, we can define IoT as an integrated internet system that is compatible to dynamic global network infrastructure (Miazi, 2015: 1).

The history of IoT
Kevin Ashton first used the term "Internet of Things" in 1999 to describe a world in which everything (including people, animals, plants, and even inanimate objects such as machines) could have their own digital identity and allow computers to organize and manage them. The internet now connects all people, but IoT can connect all objects and they can be controlled and managed by the applications on smartphones and tablets (Ashton, 2009). The Internet of Things as a modern technology enables the data transmission through communicative networks, whether the internet or the intranet over everything like human, animal, or object (Chui, et al, 2010; Fox, et al, 2012). In fact, the Internet of Things is an approach that promotes the interactivity between object-to-object, object-to-human, and human-to-object, so new services will emerge by helping such an approach, (Mirandi et al., 2012).

Internet of Things (IoT) provides grounds for connection of people and things at any time, in any place, with anyone and anything, using any network and any service. Thus, IoT is a huge dynamic global network infrastructure of Internet-enabled entities with web services. One of the most important applications of IoT is the Smart Grid (SG) (Ghasempour, 2019). Smar Grid refers to increased penetration of smart objects in our daily life (Chahala, et al., 2020: 13) that makes smart societies. Internet of Things helps to develop smart city, smart transportation, smart building, smart energy (Zamani, et al., 1396), smart industry, smart health and smart life ... The applications of IoT can lead to increased health intelligence in the society (Ghasemi et al., 1395: 159-160). The Internet of things also provides the contexts of health improvement and disease prevention by continuous monitoring of the activities of individuals, weather normal or susceptible to disease (Vermesan & Friess, 2014). The applications of IoT can provide innovative services by increasing health intelligence for patients and those who need medical care. Therefore, in addition to improving the quality of life in the community, IoT can promote

health, safety, easy access to emergency medical services, ongoing care and fast support (Ibid).

METHODOLOGY

This study takes an applied, descriptive, and explorative approach towards research that uses a documentary method and adding some data from some 55 interviews and surveys with environment experts in Iran. Here, almost all previous research materials on IoT and its usage in various fields of societal institutions have been gathered as necessary data to analyse them in comparative fashion with the results of interviews with environmental experts in Iran. Then all these material were studied and the most important applications of IoT in developing countries and Iran have been discussed and analysed as secondary data.

RESEARCH FINDINGS

The findings are offered in two sections: 1- findings related to the documentary studies 2- findings related to field and survey research.

The Usage fields of IoT

We did some semi-structured deep interviews to 10 environmental activists to know their opinions about using new technologies to improve Iran's environmental conditions. Documentary analysis and findings from interviews indicate that younger generations of Iranians are aware of the Internet of Things and that it can have a significant impact on the economic and social sectors, including education, health, agriculture, transportation and industry. Most values of the Internet of Things come from the production, processing, and analysis the new data. IoT and big data analytics can stand against major development challenges, including ones related to metropolitan areas, climate change, food security, and resource management. The potential of the IoT is proportionate to the existing ICT infrastructure and data processing capacity. While some IoT applications can run at low speeds and low-capacity connections, some can run at high capacity of bandwidth connectivity (Information Technology Organization of Iran, 1394 [2015]).

ICT infrastructure developments are accelerating the development of the Internet of Things, and it is expected they have a significant impact on all industries of our society. The world of the IoT is based on the ICT infrastructure, which is needed to collect, transmit and disseminate data as well as facilitating the provision of efficient services for a large community in the fields like health and education. The overall economic impact of the Internet of Things is profound. The Internet of Things offers high expectations in many sectors, including education, healthcare, agriculture, transportation, water and electricity, and manufacturing (Ibid.).

Other uses of the IoT include air quality monitoring devices for detecting pure particles, large-scale devices (such as agricultural health monitoring systems), climate monitoring devices, and energy management systems. Using these data provides many opportunities to improve the effectiveness of relief operations after the occurrence of natural disasters (Information Technology Organization of Iran, 1394). The other uses of the Internet of Things include "energy supply, water supply and sanitation" (ibid.).

Some applications of the IoT raised by Miazi (2015) are as follows:
- Aerospace and aviation industry in which the IoT promotes aviation safety and security;
- Intelligent Transportation Systems (ITC): This facilitates the current state of vehicle safety services and traffic management systems and also reduces road accidents;
- Pharmaceutical, health and medical industries: The IoT facilitates one-time diagnosis and emergency medical services in accidents by intelligent disease monitoring technology;
- Intelligent health care systems: Health monitoring assesses and predicts health issues and takes the necessary precautions. In developing countries, people often see a doctor when they are in the final stages of a cancer. IoT provides the methods of using e-health by cost-effective services for developing countries;
- Social security management: The conditions of developing countries indicate the lack of social security, especially for women. To get rid of such situations, a new general system of social

security networks must be provided (Miazi, 2015: 2-3).

All of the above affect the health of individuals and society indirectly. Therefore, the use of the Internet of Things in these areas leads to the promotion of health.

IoT for Iran and the developing countries

One of the advantages of the Internet of Things is low-power technology, which is suitable for places with unreliable power sources such as developing countries; IoT does not require a high-speed internet network. Low cost and immediate impacts on people's lives (Zennaro and Bagula, 2015) are other characteristics that make the use of the Internet of Things very suitable for developing countries.

Internet of Things (IoT) aims at connecting billions of devices and the IoT devices sense, collect, and transmit important information from their surroundings. This exchange of very large amount of information amongst billions of devices creates a massive energy need. To achieve a sustainable environment, Green IoT leads to reducing the energy consumption of IoT devices and making the environment safe (Arshad, et al, 2017). According to IERC European Research Cluster on the Internet of Things, there are three drivers for the development of the Internet of Things, including increasing economic prosperity, the quality of life, and environmental protection (Smith, 2012: 232). The above can be well promoted in Iran and developing countries using the Internet of Things. IoT applications also have many benefits for the Iranian population and other developing countries: the climate can be monitored, food safety is checked, water quality is analysed, air quality is assessed, and Earthquakes are studied. In addition, there are low-cost health kits for transportation to remote parts of the developing world to bridge the gap between urban and rural areas (Zennaro, et al, 2015).

In a few decades, food demand will increase 1.5- 2 times (Daily, et al. 1992). The situation is worse in developing countries. Natural disasters, lack of proper fertilization, overuse of chemicals and pesticides, and inefficient crop monitoring systems have endangered crop management systems (Miazi, 2015: 3);

Quoted from Zarei, et al, 2015). Proper agriculture (PA) helps to develop appropriate methods for maintaining food security: improving crop planning, facilitating land management decisions, preparing accurate farm records, reducing the use of pesticides and fertilizers as much as possible, and finally reducing the environmental pollution (Miazi, 2015: 3). As we know, all of the above can promote health and prevent many diseases in Iran and developing countries.

Some of the interviewees emphasized that we are highly in need of modern environmental monitoring in Iran. The rate of air pollution, noise pollution, industrial pollution and the range of man-made environmental pollution in Iran are significant. Accordingly, regular and constant environmental monitoring is important to predict the climate change and natural disasters such as monsoon winds, floods, droughts, etc. In our country, systems must be cheap and maintainable (see Miazi, 2015: 3). Given the above, the high capacity of the Internet of Things can be used to prevent natural disasters, prevent endangering human health and avoid wasting a lot of money on the treatment of deadly diseases.

The Usage of IoT in the field of health

Iranians are aware that IoT technology has a variety of applications in the field of health. Applications of the Internet of Things in the field of health (smart health) include:

1. Fall diagnosis: This application focuses on the elderly and disabled and seeks to help them, so that they can live independently;
2. Observing the physiological condition of people (especially the elderly). In this case, data can be obtained from these people over time and analysed;
3. Medical refrigerators (internal temperature control of protectors): Some organic elements must be stored in containers with special (temperature) conditions. The Internet of Things can do it and create the objects interaction;
4. Athlete care: This application is used to measure weight, sleep, exercise, blood pressure and other important parameters for professional athletes;
5. Patient monitoring: It is used for in-hospital monitoring, remote or home care of patients (especially elderly);

6. Chronic Diseases Management: Caring the patients with chronic diseases, without presence. This technology reduces the attendance of people in hospitals, so it costs less.
7. Reducing hospital stays and commutes (even reducing fuel consumption);
8. Ultraviolet ray: Measure the ultraviolet ray and inform people not to enter certain areas or avoid exposure to ultraviolet ray at certain hours;
9. Pollution control (hand hygiene control): Connecting devices such as RFIDs designed to measure contamination in hand, body or environment;
10. Sleep control: Connecting devices to a person to detect the symptoms such as heart rate, blood pressure, etc. during sleep. Then this data can be analysed;
11. Dental health: Bluetooth-equipped toothbrushes that record individuals' brushing information by smartphone applications. So, a person's brushing habits can be examined by the data as personal information or the statistics can be shared with a dentist (Vermesan & Friess, 2014: 32-33); Quoted from Ghasemi et al., 1395 [2016]).

According to a research (Ghasemi et al., 1395 [2016]: 168), the priority of using the Internet of Things in the field of health is as follows: chronic diseases management, patient monitoring, infection control, fall diagnosis, dental health, ultraviolet rays, monitoring elderly physical activity, athlete care, sleep control and medical refrigerators. Since an approach towards disease-prevention is preferable to the treatment of diseases and all the above cases can be easily done using the Internet of Things. This is how people's health is monitored and improved by IoT.

The most important indicator for the sustainable development of the Internet of Things in the health sector is the economic success index with a weight of 52%, followed by an increase in quality of life with a weight of 45% and finally the environmental protection index estimated with a weight of 2.43% (Ghasemi et al., 1395 [2016]). Therefore, in the development of new technologies, including Internet of Things technology in the health sector, policy makers should focus on economic criteria, such as job creation, preventing the currency outflow, and income

generation. After such needs are met, they need to pay attention to social criteria (such as increasing the welfare of patients and citizens, and increasing the satisfaction of medical staff in the use of medical devices). In addition, the environmental effects of these technologies (such as radiation, harmful radio waves, prevention of waste generation and wastewater) should not be forgotten (Ghasemi et al., 1395).

Iran Outlook 1404 shows that in order to be ranked first in the Middle East region, Iran must improve the quality of life (Iran Outlook 1404, 2015). This is something that a number of interviewees also referred to it.

For example, Iran ranks 76th out of 144 countries with an average of 73.8 in the life expectancy index (Schwab, 2014: 217). To achieve the first place in the region, Iran has a significant distance with Israel (Zarei, et al 2016: 436). Many IoT applications in the field of health, increase life expectancy, reduce infectious diseases, facilitate medical care for chronic diseases and for children, prevent dangerous diseases, improve the quality of life for the elderly and focus on monitoring the public health of the community (ibid) that helps the prevention of wasting money and time, and guarantees the health of people in the society.

Challenges facing IoT development in Iran
The IoT needs to interact to the other stakeholders outside the ICT sector (for example, car manufacturers, utilities, home appliance manufacturers, government offices and many other places) to meet expected needs. Gathering all these stakeholders together significantly adds to the complexity of IoT development, but it is a key factor to interact between all sectors (McKinsey, 2015; see also Miorandi, D., Sicari, Sellegrini, F.and Chlamtac, 2012).

Processing the big data generated by the Internet of Things requires bandwidth. Fixed broadband connection along with international internet bandwidth and sufficient backbone capacity are the most suitable options to meet this need. There are similar challenges in terms of data management and analysis for the other big data applications (Information Technology Organization of Iran, 1394 [2015]).

Other challenges facing the development of the Internet of Things include technical and financial challenges (Miazi, 2015: 3; quoted by Zarei, 2015) that should be fixed through policy-making and management.

RESEARCH FINDINGS THE SURVEY

This study uses two methodological approaches: quantitative and qualitative method. First, we look at the findings of quantitative study.

Our findings on the use of new technologies in Iran through this study and recent studies (Abdollahyan, Asadi, 1397 [2019]) show the increasing tendency of citizens to use new technologies. The findings based on the theoretical model of research prove it. The results of a significant coefficient show that the use of ICT has a relatively high impact on the growth of individuals' information capital. Also, the average impact of ICT on the variables of information capital (t=22/84), awareness (t=3/796), empowerment (t=7/869), and citizen participation (t=9/685) is high, which means that there is a high level of awareness about the use of ICTs in Iran. Structural equation modeling analysis also confirms these findings. The other findings include:

- The average impact of information and communication technologies on citizens' information capital (22.84) is higher than the expected average (18).
- The average impact of information and communication technologies on environmental awareness of citizens (25.62) is higher than the expected average (20).
- The average impact of information and communication technologies on environmental empowerment of citizens (26.40) is more than the expected average (24).
- The average impact of information and communication technologies on environmental participation of citizens (53.61) is higher than the expected average (48).

Research findings indicate that new technologies have a positive impact on increasing citizens' information capital. This is a basis for empowerment and participation of Iranians in improving the environmental situation in Iran, so that citizens' information capital has a positive impact on environmental sustainable development. ICTs create a double power for social actors to involve citizens in their social affairs, such as social health and environmental development.

The results of the structural equation model for the effect of ICT on the environmental compatibility of citizens show standard coefficient (β = 0.41) and significance coefficient (t-value= 5.61). Considering that, the significance coefficient of the above model is not outside the range of -1.96 to 1.96, it is concluded that ICT and environmental compatibility of citizens are correlated (with a positive correlation). On the other hand, considering the beta coefficient of 0.41, we conclude that for one unit of increase in standard deviation of using ICT, we have 0.41 standard deviation of increase in citizens' environmental compatibility. In addition, since the direction of this correlation is positive, the change is direct and increasing. In other words, whereas citizens' use of ICT increases, their environmental compatibility will be increased in a middle intensity. The result of the above findings is that new technologies have a positive effect on environmental compatibility of citizens. On the other hand, awareness of citizens can improve the quantity and quality of ecosystems and ultimately lead to sustainable environmental development. The findings therefore reaffirm the theoretical claim that citizens' environmental compatibility is increased by using ICTs.

In the qualitative part of this study, we interviewed environmental activists. The findings of the qualitative part are as follows:

On the impact of ICTs on citizen participation, environmental activists believe that the ICT infrastructure should be developed and the active presence of the private sector in the field of infrastructure should be supported. They also believe that by producing digital content, supporting information technology-based businesses, developing culture and training to use this infrastructure and developing access, and providing communication and information services, ICT can be used to improve the environmental development in Iran.

Environmental activists suggest using ICT to involve people in solving environmental problems, as follows:

- Development of cyberspace and environmental applications;
- Dissemination of environmental culture and environmental institutionalization in the society;
- Strengthening the social capital;
- Using the environmental instantaneous cameras and monitoring systems; and
- Equipping rangers with satellite and drone equipment.

Experts also proposed using some technologies to improve Iran's social status in the field of environment which the most important ones are monitoring and informative technologies, such as Internet of Things, VGIS (people-centred participation GIS), and RS (using the satellite data). Citizen participation, both in monitoring and using new technologies such as VGIS, applies the potential power of people to protect the environment.

People awareness of their duty in social issues, such as environmental protection and social health, is the first step suggested in this study. The direct correlation between awareness and the increase of social capital and information capital was proven, which creates trust and mutual understanding and it eventually leads to citizens' cooperation and participation.

As we mentioned, the theory of the environment and sustainability from Adams is used in this paper. This theory emphasizes on these concepts:
1. Sustainable development has become a central concept in development studies, building on environmental, social and political critiques of development theory and practice.
2. There is no simple single meaning of 'sustainable development': a wide range of different meanings is attached to the term. Far from making the phrase useless, it is precisely because of its ability to host divergent ideas that sustainable development has proved so useful and has become so dominant.
3. One reason for the complexity of concepts of sustainable development is the confused and contested meaning of development itself. The idea of sustainable development has gained currency in the 1990s at a time when development thought is widely held to have reached an impasse.
4. The use of the term 'sustainable development' reflects in particular the prominence at the end of the 20th century and the beginning of the twenty-first about the problem of acute global poverty and global environmental degradation. Although it is now acknowledged that these crises are linked, problems of environment and development are often addressed independently. They have to be tackled in an integrated way; the challenge of doing so is inevitably political. There are choices to be made between reformist and radical ideas about sustainability and development.

Studying the basic concept of sustainable development, Adams discusses the nature and extent of the 'greening' of development theory. He believes that 'sustainable development is essentially reformist, calling for a modification of development practice' (Adams, 2001). He attempts to draw a link between theory and practice by discussing the nature of the environmental degradation and the impacts of development. It argues that ultimately 'green' development has to be about political economy, about the distribution of power, and not about environmental quality.

Our findings fully support this theory. The issue of natural resources and environment has been always tied to politics, because the environment is rich in natural resources and power has been always trying to dominate the resources. Environmental activists believe that Iran's environment has been sacrificed to political issues and that environmental health has been ignored in order to make more money. Therefore, as Adams emphasizes on political issues for the preservation of the environment, in order to achieve sustainable environmental development, we need to start with politicians and the powerful to avoid using more resources.

Also, based on our findings, increasing the social and information capital helps to make mutual trust between people and government.

On the other hand, as presented in the quantitative data, increasing information capital leads to citizens' environmental compatibility. Therefore, the government and policymakers must first take the proper action to help increasing the social capital of citizens. In this way, the citizens will also be more active in preserving the environment.

CONCLUSION

Using the research findings, we could gain a great deal of knowledge about Internet of Things technology and know the innovative applications of the Internet of Things in various fields and, most importantly, in the field of health and environment.

Unfortunately, the Internet of Things has not received much support in Iran. On the other hand, only a few universities and research centres have realized the importance of it. The importance and potential of the Internet of Things in Iran has not yet been properly understood and the applications of the Internet of Things are limited to machine-to-machine communication or the development of technologies based on radio frequency detectors (Telecommunication Research Center of Iran, 1394 [2015]). Although the first IoT laboratory and educational and research platform was unveiled in 2015 at University of Science and Technology (Research Institute of Communication and Information Technology, 1394 [2015]), but many steps are still required to develop the IoT.

Based on a survey conducted at the Telecommunication Research Center of Iran, the healthcare industry has been identified as the main priority for the development of the Internet of Things in Iran (Telecommunication Research Center of Iran, 1394). However, no priority of IoT applications in this industry has been identified yet and it seems that the use of IoT technology in the healthcare sector needs to define and prioritize the application areas (Ghasemi et al., 1395 [2016]: 158). The various areas of health in which the use of the Internet of Things is essential should be identified and prioritized.

So far, no program or legislation has been proposed to develop IoT in the health industry as a selected one. The challenges of policymakers for the development of the IoT in various industries, including health, should be identified and the problems of IoT development should be fixed in Iran.

According to Adams' theory of the environment and sustainability, our efforts to solve environmental problems and preserve the nature must be considered in conjunction to the poverty in the Third World simultaneously. Therefore, we must look for technologies which are also compatible with the economic situation of any given country, including Iran, while solving environmental problems. As mentioned earlier, IoT technology is a new evolution of the Internet that adapts to the low speed Internet and the lack of enough bandwidth in Iran, meanwhile it requires relatively reasonable costs to provide infrastructure. Therefore, it brings about the most adaptive technologies that are compatible with the conditions of Iran and it can be used in various fields such as health and environment. The combination of efficiency and low cost of this technology makes it the best option to solve environmental and health problems in Iran.

Adams, on the other hand, believes in the dynamism of the concept of sustainable development and the direction of technology development so that it can meet real human needs. As mentioned before, technologies derived from the Semantic Web- such as the Internet of Things- can reduce Iran's problems in important economic and social areas, so as to help preserve the country's natural resources and environment. There is also a critique of Adams' theory, on the ground that he sees human as the centre of attention, while this approach can lead to the destruction of environmental resources. We focused on the environment so that all creatures, including animals and plants, are in the spotlight and we do not sacrifice the other life forms in favour of human issues. Such an approach will help to have a healthy society and a sustainable environment that uses technologies in a way that does not lead to irreparable damage to nature. The Internet of Things is a clean technology while helping humans; also helps preserving and improving the environmental conditions.

SUGGESTIONS

First, Iran needs to create the foundations for Web 3.0 development. Lagging behind in this area is irreparable. In the development

process, after strengthening the foundations of Web 3.0 development, it is necessary to conduct numerous researches in the fields of technology and social sciences for policy-making and long-term planning in the field of IoT application. One of the uses of the Internet of Things is to reduce poverty and improve health in the country; therefore, we need to make many efforts in this sector in various fields. Considering the priorities of IoT application, the results of using the Internet of Things in our country have been determined to take big steps towards the development of IoT by integrating various researches and studies.

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