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Role of Information Communication Technology (ICT) in Sustainability and Industrialization: A Conceptual Analysis

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Abstract
In practice, industrialization and development are closely linked. The growth driven by industrialization has a detrimental impact on human and environmental health. The sustainability of the development is still questionable. We will not be able to treat the next generation fairly if we cannot achieve sustainable development. In order to make development sustainable, the idea of sustainable development is currently being emphasized. The current study aims to understand the connection between industrialization and sustainable development and explore the approaches to sustainable development. It turns out that the function of information and communication technology (ICT) in sustainable development can be a starting point in this direction. It is also exploring how numerous sustainable development techniques can be brought together using ICT for this use of systems analysis approach. This paper also sheds light on the question of whether industrialization and sustainable development can go together. A model will be built to show the role of ICT in predicting the environmental changes influenced by industrialization. This model will help in reducing the time gap between awareness and actual environmental damage.

Keywords: Industrialization, Sustainable development, Information and Communication Technology, Model, Environmental Damage

1. Introduction

This is a lively topic of research at present to find the relationship between sustainable development and industrialization. How to link industrialization with sustainable development is still a confusing topic. Industrialization is the period of social and economic change that transforms a human group from an agrarian society into an industrial society. This involves an extensive re-organization of an economy for manufacturing (O'Sullivan, et al., 2003). As a result of industrialization, harmful by-products are badly distorting the environment. Thus, industrialization is seen as a hindrance to sustainable development. In the words of the Society of International Development (SID), "Development is a process that creates growth, progress, changes or the addition of physical, economic, environmental, social and demographic components." Development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs (Brundtland, 1987). Achieving sustainable growth and environmental preservation is very difficult without the three key components: accountability, openness, and public participation via information flow, (Chemutai, 2009). The main objective of this paper is to analyze how ICT act as an interface between sustainability and industrialization.

1.1 ICT and industrialization

For the prosperity of any country, it is necessary to progress in its industrial production (Saba & Ngepah, 2021). ICT would play a crucial and widely acknowledged function in the economy to encourage industrialization and economic progress (Lerner, 2010). The world is evolving toward the fourth industrial revolution thanks to information and communication technology (ICT) (Anatory, 2018). In the words of Prakash (2019), “industrialization supported by ICT could be a chosen pathway for regional growth/development, and the integration into global markets for goods and services”.

1.2 ICT and sustainable development

In order to continue sustainable development, it is necessary to strike a balance between meeting individual needs and protecting the ecosystem and all natural resources (Hilty & Hercheui, 2010). Recent development in resolving environmental concerns brought on by human activities have stimulated research on environmental issues and the effects of information and communication technology (ICT) as a possible mitigating factor in this digital age (Leal-Filho, et al., 2019; Sabau, 2020). ICT has been shown to present a potential chance for policymakers to address problems with sustainable development, like environmental degradation caused by CO2 emissions (Asongu, 2018; Asongu, et al., 2018).

2. How ICT acts as an interface between sustainability and industrialization

ICT's role is currently well acknowledged. Our development won't be sustainable unless we conserve resources while satisfying everyone's needs. Industrialization helps to meet everyone's requirements, and ICT can be leveraged to create sustainability while protecting natural resources. This paper focuses on how this can be achieved. ICT can act as an interface between sustainable development and industrialization. We can achieve development through industrialization. To make development sustainable, we have to stop the side effects of industrialization for which ICT needs to be used. Indeed, there is evidence to show how ICT is used to lessen the negative effects of industrialization.

Industrialization has accelerated progress but at a cost of many negative side effects that have had a terrible impact on sustainability. Every sphere of the globe is observed to be filled with pollution (air, water, noise, and soil). There are numerous apparent effects on Earth that are obvious signs of declining sustainability. Strong storms, altered patterns of rain and snowfall, higher temperatures and more heat waves, an increase in droughts and wildfires, damage to reefs, a rise in sea level, warmer oceans, altered plant life cycles, less snow and ice, and thawing permafrost are just a few of the effects.

Our natural resources are being destroyed by all of these effects taken together. Because of this, we won't achieve our goal of sustainable development. As a result, resource conservation is necessary for sustainable growth, and to do so, industrial pollution must be curbed. These goals can all be accomplished via ICT.

From the many studies, manifold application of ICT is found. One of the applications can be found in the study of Quinn, et al., 2010 in which the use of a sensor technology was described for computing water and salinity mass balance. Sensor technologies in alliance with conventional monitoring techniques have supported a successful implementation of real-time water quality and salinity management. It is also shown that the results of the system can be extrapolated for the missing data or where the data cannot be collected. Studying in San Joaquin (California) basin, sensor technology provided efficient means of collecting data. For example, weather station sensor array and ground-level sensors are deployed to compute wetland evaporation and seepage losses respectively

For "revolutionary contributions to our knowledge of complex systems," the Nobel Prize in Physics 2021 was given to Klaus Hasselmann, a German scientist from the Max Planck Institute in Hamburg, and Syukuro Manabe, a Japanese professor at Princeton University in the United States, "for physical modelling of the Earth's climate, quantification of variability, and accurate prediction of global warming" (Castlevecchi & Gaind, 2021, Oct 14; Tyutyunnik, 2021). Syukuro Manabe oversaw the creation of physical representations of the Earth's climate in the 1960s. His work served as a starting point for the creation of modern climate models (Tyutyunnik, 2021). In order to explain how climate models may be trustworthy despite the weather being chaotic and changeable, Klaus Hasselmann developed a model that relates weather and climate (Tyutyunnik, 2021).

The work of Klaus Haselman and Syukuro Manabe shows us that we can quantify the earth's environmental components and develop a physical model of the earth. At this time, sensors and sensor networks are crucial resources for supplying a wealth of data for the environmental component necessary to create models and studies (Schimak, et al., 2010) Environmental Information System (EIS) is typically a kernel component in environmental software solutions (see Fig. 1). EIS is essential to understanding the history, present, and future state of the environment for humans (Usländer, et al., 2010). EIS ranges from the analysis of past and present environmental conditions to the forecasting of future environmental parameter values as a basis for decision support or early warning (Usländer, et al., 2010).

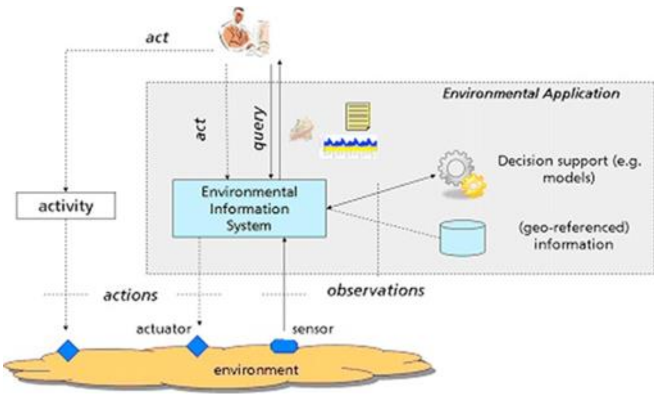

Fig. 1 Structure of environmental applications (Source: Usländer, et al., 2010)

Here in Fig.1 shows the simple structure of the environmental application. By installing the sensor anywhere inside the environment, we can receive data from it and send it to the user and he can perform operations on it. As a model architecture, use Sensors Anywhere (Klopfer and Simonis, 2009). According to Usländer (2009), SensorSA is an open architecture that

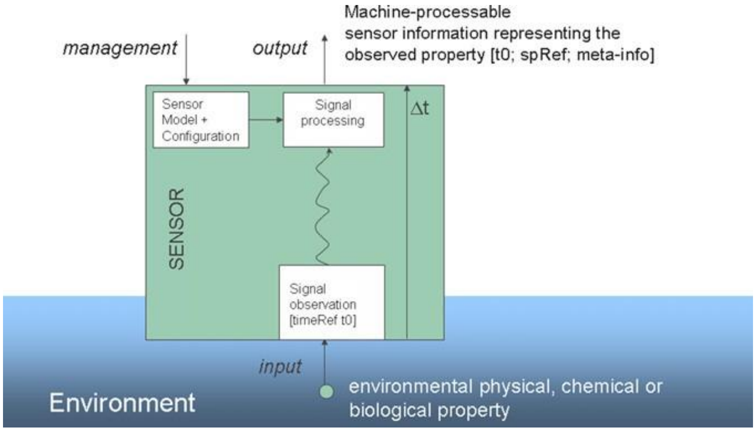

Fig. 2 Simple form of a sensor (Source: Usländer, et al., 2010)

includes a platform-neutral conceptual specification of the structural elements of a service network, including the administration and access to sensors, sensor networks, and sensor-related data.

Fig. 2 depicts a simple form of a sensor. Typically, a sensor estimates the underlying observed characteristic by combining physical, chemical, and biological methods. Be aware that similar tools could also be offered in the form of computer programs that simulate environmental processes. These programs are sometimes referred to as "virtual sensors" in this scenario (Usländer, et al., 2010). In its most basic form, a sensor observes an environmental attribute within a temporal and spatial context at a certain time (t0) and position (spRef). Keep in mind that the sensor's location might not match the location of the property being watched. All remote-observing sensors, such as cameras, radar, etc., are like this (Usländer, et al., 2010).

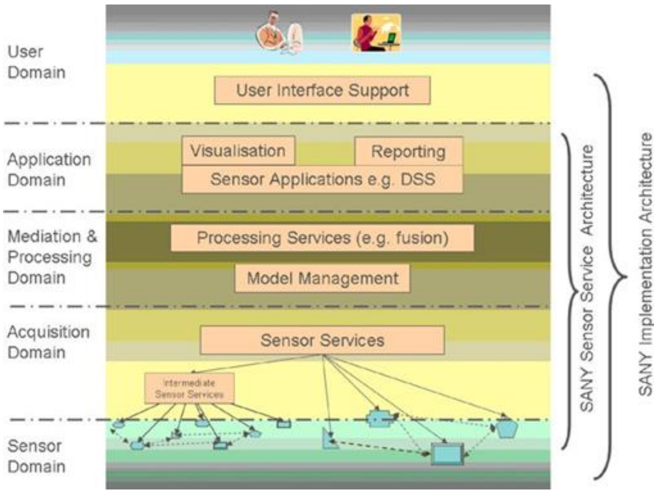

Fig. 3. Functional domains of the SensorSA. (Source: Usländer, et al., 2010)

Functional domains of the SensorSA divided into five different domains

- ❖ In the first domain (Sensor Domain) individual sensor is organized
- ❖ Observation is collected in the second domain (Acquisition domain)
- ❖ Fusion of information is done in the third domain (Mediation and Processing)
- ❖ In the fourth domain (Application Domain) information is rendered in the form of maps, images, and reports.
- ❖ The fifth domain (User Domain) acts as an interface on the user side.

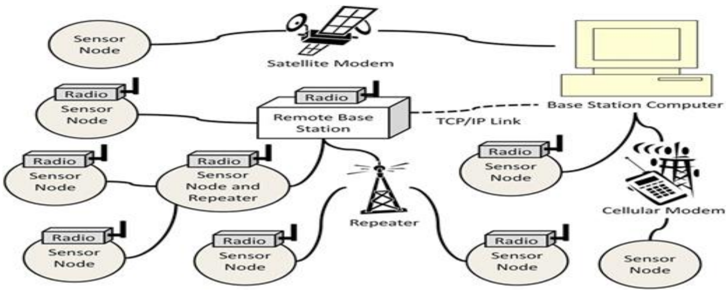

Fig. 4. Common communication pathways in environmental sensor networks. (Source: Horsburgh, et al., 2010)

Common communication pathways in environmental sensor networks are shown in fig no 4. There are numerous technologies available for creating networks that link sensor nodes (e.g., radio frequency, cellular phone, satellite). The amount of data collection nodes, line-of-sight restrictions caused by the physical topography where the sensors are positioned, etc., as well as other considerations, such as the complexity of the resulting data transmission system, will all influence the specific technology that is used (Horsburgh, et al., 2010). Based on the information provided above, we can conclude that ICT is used to rapidly identify the places of occurrence of industrial pollution and provide guidance for our policies.

3. Methods how to Achieve Sustainable Development

A common path is given in fig 5 to achieve sustainable development. For this, resource conservation and industrialization have to be brought together as shown in the figure here ICT will act as an interface.

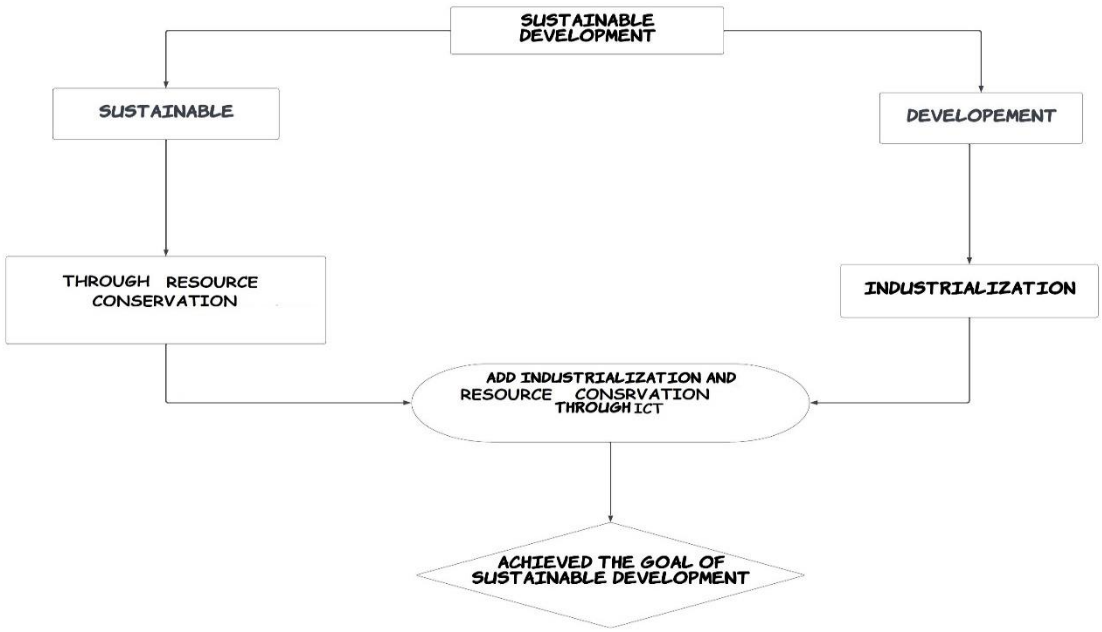

Fig. 5. Common pathway how to achieve sustainable development through the use of ICT (Compiled by Author)

The Industrial Revolution allowed humans to advance further into the twenty-first century. Industries produce garbage that is dumped on land and in water, which has a negative impact. These industrial pollutants cause a significant release of dangerous and unnatural substances into the air, water, and soil. So, this industrialization harms our resources and sustainability also.

Figure 6 below demonstrates how we can combine industrialization with sustainable growth. To do this, we must first build the infrastructure needed to put sensors. These sensors will provide data on the soil, water, and air quality for those locations. Using the data collected, we will be able to pinpoint the regions that are most vulnerable to resource depletion and environmental damage. We are able to estimate pollution and take action against it based on these statistics. For this, we need a task force that focuses on national disasters, like the NDRF (National Disaster Response Force), or a department that strives to conserve forests, like the forest department. Comparably, we can create NRMT (National Resource Management Taskforce).

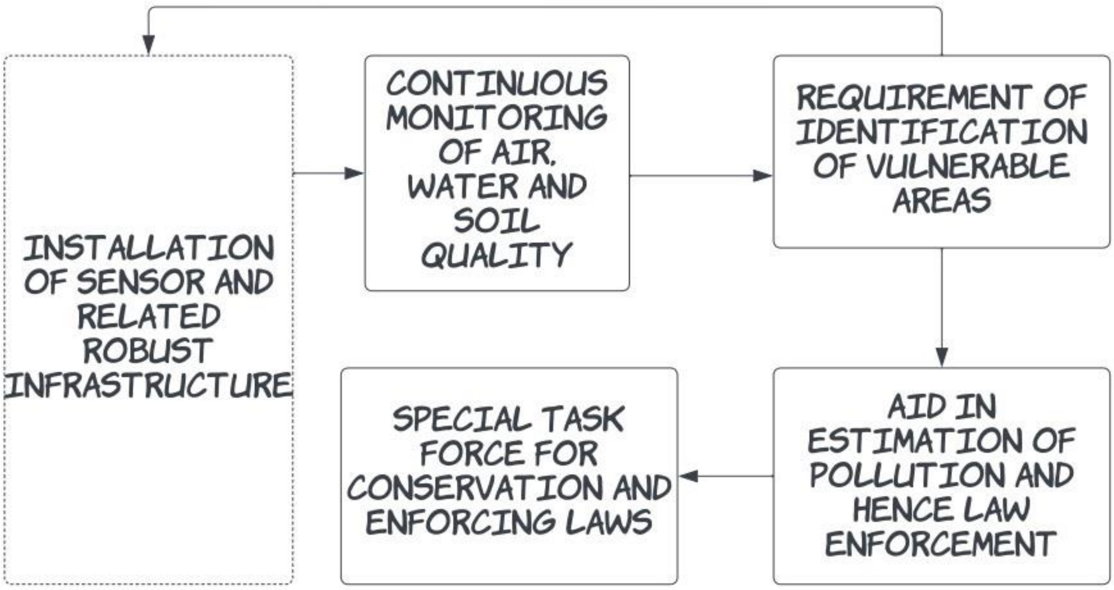

Fig. 6. Structural solution for sustainable development (composed by author)

4. Conclusion

To sum up from the above discussion, this paper presents a conceptual analysis of how ICT can be used to achieve sustainability while reducing the negative effects of industrialization. ICT is acknowledged as the fourth revolution but sustainability has been a serious cause of concern. The knowledge gap has brought forth that many models have been developed to compute the changes on earth, however, it is not mentioned how these models can be used to make judicious use of resources and their conservation. The sensor model help in gaining insight that sensors can be installed for continuous monitoring of pollution and finding the vulnerable areas based on resource deflation. Through strict laws, the conservation of vulnerable areas needs to be done while keeping in mind the objectives of sustainability. Thus, a model is suggested for computing the real-time data of quality of air, water, and soil which further helps in reducing the negative effects of industries to a considerable amount and hence it will play role in achieving sustainability.

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