Orientation towards Using Approved Devices as a Part of Artificial Intelligence Technology in Architecture and Construction Field

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Abstract:

This paper presented a modified framework for Artificial Intelligence (AI) technology through construction industry for sustainable city harvesting. The results were able to classify major challenges facing engineers which revolving project life cycle in the new building technologies; in order to set applicable solutions via using the Internet of Things (IoT), automated devices, Smart Building (SB) and Artificial Intelligence (AI) technology in architecture and construction industry. This paper aims to develop the feasibility of artificial intelligence (AI) devices in order to drive changes that impacts directly both architecture and construction field goals and objectives. The relevance is to face and develop project life-cycle construction processes and challenges to improve its precision. Determining drones and robots devices towards dealing with repetitive and physically demanding tasks and give guidance to the automated devices to make their municipalities smarter and digital, and to propose Machine Learning (ML) as a part of Smart Digital Sustainable City (SDSC) while preserving the sustainable building and construction experiences.

Keywords:

Artificial Intelligence (AI), Machine Learning (ML), Smart Digital Sustainable City (SDSC), Internet of Things (IoT), Smart Building (SB).

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1. Introduction:

Artificial intelligence (AI) has become one of the tools of architectural engineering at the present time, as many cities have sought to employ a huge amount of available information and exploit it in the most optimal ways, and saving workers and reducing their number has become one of the problems facing the project construction cycle and similar ones, to create a digital industry for building and construction. Smarter: Artificial intelligence has been relied upon in engineering projects to achieve high efficiency and accuracy in projects. Therefore, heading towards using (AI) technology and smart systems will face these challenges while describing when a machine mimics human cognitive functions.

Artificial intelligence (AI) has become increasingly prevalent in architecture, which has advanced reality and produced intelligent architecture by generating data and information quickly and accurately, spotting possible issues early on and coming up with solutions, perception of creating a more precise and enhanced the future, determining the best solutions, and ultimately creating designs that are more sustainable. The influence of artificial intelligence remains in place on architecture not only during the design phase, but rather the tendency benefit in construction industry.

Subsequently, this paper identifies project construction life cycle processes as one of the main returns for both architectural and economic bearings, keeping pace with continuous construction developments with the aim of enhancing the connection between machine learning (ML) and the growing economy in line with the objectives of future strategic approaches to construction.

2. Methodology:

Research methods employed in this research vary considerably depending on the particular aspect of approved devices as a part of (AI) technology in construction and its impacts from an organizational point of view and it is composed by proposing a futuristic technological framework for the project life-cycle to identify problems and to investigate and justify the value of the recommended solutions using (AI) techniques and devices. Based on the existence of the experimental method of future sustainable cities; and considering drones and robots in construction as an influential and integral part of this methodology, this paper allocated the role of project life-cycle for smart sustainable construction as the establishment for defining the framework methodology. Following that, the procedure for advanced robotics criteria in future cities' construction, this is done to outline the major challenges of project life-cycle and how it affects the construction industry. These inductive method efforts have been developed to a considerable extent in the context of the (AI) devices. In addition to this, Internet of Things (IoT) and machine learning (ML) based approaches are discussed in the field of architecture and construction.

3. Artificial intelligence (ai) in construction life-cycle processes:

Through Project management can be just as complicated as the technology itself in the quickly developing field of artificial intelligence (AI). Not for lack of technical ability, but rather because of poor project management, an astounding amount of

AI projects fail. By turning unprocessed data and creative concepts into workable, effective solutions, a clearly defined AI project life cycle can greatly increase the success rate of such initiatives. Construction life-cycle processes has been harvested in this research into three main phases as following:

3.1 Pre-construction phase:

The automation of management procedures is a potential way that artificial intelligence might enhance data analysis. The majority of the literature on the development of AI in project direction and management, and specifically in construction site management, comes from a scenario where AI is responsible for automating and integrating data input occurs in the construction projects.

To the time currently being, the project and construction managers base their estimates on already completed activities and historical data. This enables the project managers to anticipate future task completion times, associated costs, and risk levels. These professionals may find it difficult and time-consuming to register and analyse all of this data; nonetheless, by integrating project management software with an AI-based solution, we will be able to automate the entire process for the analyses of the historical data. The more dependable and business-process-compatible the AI solution, the easier it is to access the vast amounts of data that are available.

Project managers and their companies will benefit from significant time savings from artificial intelligence (AI) as a result of the automation of repetitive processes (1).

From a conceptual standpoint, an AI project life cycle is the orderly sequence of actions and choices that lead to the creation and application of AI solutions. The following figure shows the (AI) project construction life-cycle processes:

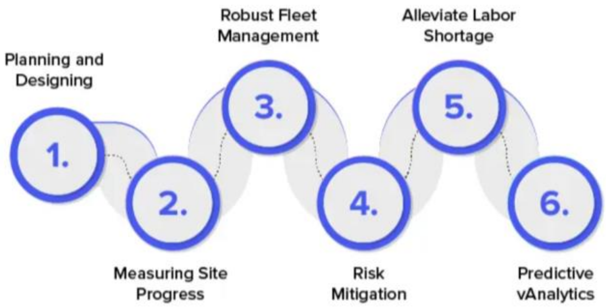

Fig.1: (AI) in construction life-cycle processes, Sudeep Srivastava, Year: 2023

After using the framework to investigate how artificial intelligence technologies, represented by smart drones, or the use of data, which is carried out according to intelligent, predictive and conditional interaction, can achieve the different levels of concerns related to privacy, which lead to a general idea of choosing smart technology and applying a specific set of data. Massive and analytical tools are one of the precise and critical variables for understanding individuals' concerns about smart building processes. (2)

3.2 Construction phase: Smart construction:

During the construction industry is currently buoyed by massive growth and expansion; there is four aspects in order to under-perform continues construction processes (3) as following:

1- Skills shortage
2- Data transparency
3- Productivity
4- Certainty real-time in delivery

3.3 Post construction phase:

Artificial intelligence (AI) can be utilized for building management even after construction is accomplished. Through the utilization of sensors, drones, and other wireless technologies that collect data about a structure, advanced analytics and AI-driven algorithms can gather important insights about the efficiency and effectiveness of buildings, bridges, roads, and nearly all other structures in the built environment. Thus, artificial intelligence (AI) can be used to track future problems, identify when preventative maintenance is necessary, or even guide behaviour in humans to ensure the highest levels of security and safety (4)

4. Drones in construction industry:

Following the introduction of (AI) in construction industry frame-work and its recommended implementation; thus, it is necessary to determine that drone technology have revolutionized the entire project life cycle as an important technology from inception to post-construction phase; which needs to be settled, upgraded and managed in order to provide real-time upgrades.

4.1 Land surveying using drones:

Drones have the ability to record data in real time and have a distinct aeronautical edge, which can increase productivity, save expenses, and simplify workflow. A few applications for drones in the construction industry as shown in Figure (2):

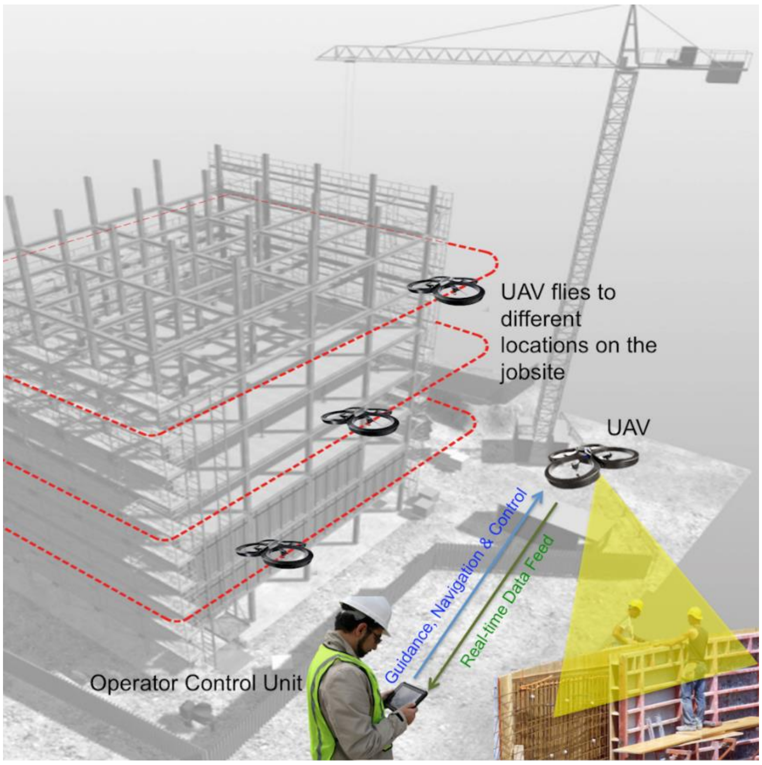

Fig. 2: Drones in construction. University of Florida news, Year: 2017

Before drones are as commonplace on building sites as bulldozers, there are still certain obstacles to overcome. Professionals in construction have expressed concerns about anything from liability to privacy (5).

4.2 Ways that drones have transformed the construction industry:

In the past decades, drones have recently become considered the most remarkable developments in building. Drone use in the industry has increased year over year by 239%, more than any other business sector (6).

The capabilities of drones today enable them to improve workflow, accuracy, communication, and efficiency while reducing costs, time, risk, and labour. The construction life cycle will only be further streamlined if these technologies are widely used in the future.

4.3 Remote monitoring and reports on progress:

The data industry is considered one of the most affected economic sectors, and successfully applied techniques that have been tested in intellectually rigorous data operations in the construction sector.

Artificial intelligence techniques have become a basic trend for technological development in the fields of industries, as they require the digitization of construction work regarding the digitization of work, so that there comes a transformation of the main technical and economic foundations of production, as well as important aspects of digital efforts according to the actual architecture and construction sector, as data has become in real time with chains. Digital sourcing, including procedures and automation on a large scale (7). Figure (3) shows the three main advances in drones according to the construction field:

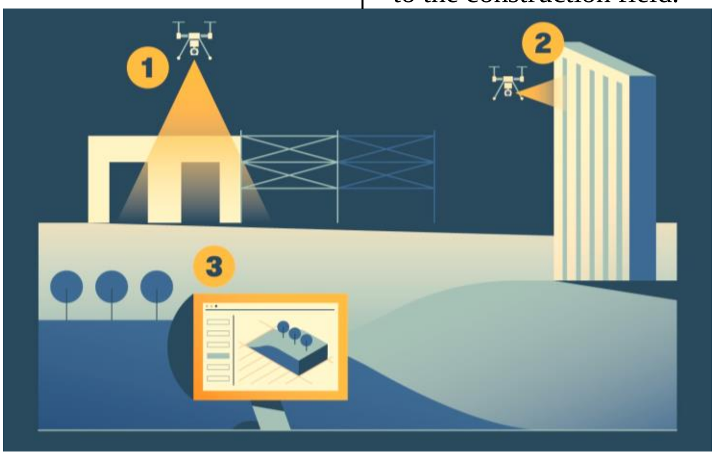

Fig. 3: Info-graph shows drones construction progresses, Liam Stannard, Year: 2020

1- First progress: Security improving on a worksite as a single drone operator which can take on aerial view of the site.
2- Second progress: Due to the aerial surveying drones can inspect and monitor hard to reach work sites.
3- Third progress: Drones are able to quickly survey land turning into a detailed 3D modelling of worksite on construction.

4.4 Using drones in construction benefits:

Aerial photography and the acquisition of high-quality visual content are two major advantages of drone imagery. For fast and high-resolution aerial footage, mapping is crucial for surveying and mapping. The stakeholders are happier about virtual tours and drone photography than they are about on-foot land surveying. Drone data, footage, and on-demand aerial imagery are incredibly sharp and perceptive when received by drones (8)

A sophisticated yet flawless representation of effectiveness and output including the following benefits:

1- Reliable and comprehensive real-time data
2- Cost and time decreasing
3- High infrastructure management
4- Reducing labor costs
5- Maintenance and analysis of resources
6- Post-construction documentation.

5. Smart and automated construction progress:

Towards more effectively leverage data-rich environments and workflows, machine learning techniques may form the basis of new architectural practices. It is possible to develop a variety of relationships between design, performance, and construction by making reference to recent architectural ways in which machine learning can be applied throughout the automated construction progress. The effects of machine learning on architectural practices that incorporate performance-based construction, as well as the future directions for this field of study (9).

5.1 Internet of Things (IoT) devices:

The Internet of Things (IoT) refers to the networking of physical items for the purpose of big data collection and sharing. A gadget that is connected to the internet and sends information to other devices is referred to as a (thing). A layered architecture is distinguished with many layers including application layer, connection layer, security layer, embedded layer, hardware layer, and integration layer in order to provide an efficient communication between the devices in the internet (10).

There are three paradigms that can be used to implement the Internet of Things: internet-oriented (middleware), things-oriented (sensors), and semantic-oriented (knowledge). Although the interdisciplinary nature of the topic necessitates this type of separation, the value of (IoT) can only be unleashed in an application domain where the three paradigms converge (11).

Things are active participants in information, architecture and construction processes can exchange data and information sensed about the life-cycle processes, interact and communicate with one another, and interact and influence the project while responding autonomously to events in the real physical world (12).

5.2 Machine Learning (ML) in architecture:

Artificial intelligence (AI) has advanced to the point where computers can think and behave like people, which makes it possible to comprehend and resolve issues. A branch of artificial intelligence called (machine learning) uses data to model and resolve issues with these computer-aided devices. (ML) algorithms can generate the most accurate answers and make decisions based on past experiences by gathering and analysing data. For the machine learning algorithms to solve the problem, the features in the problem-related data set must be appropriately chosen and present in sufficient quantities. Many professional domains, including science and medicine, automotive, engineering, sales and marketing, construction, and architecture, heavily rely on machine learning (13).

(ML) architecture is ultimately important because it makes it easier to create strong, effective, and scalable machine learning systems that can meet the demands of contemporary, data-driven enterprises (14).

The stream processing module can complete some tasks and return a result in a matter of milliseconds because it is made to meet the demands of time-sensitive applications. This module will typically use (ML) models that were previously constructed by the batch processor. As a result, it will apply a number of cutting-edge machine learning techniques in conjunction with the incoming data stream in real time to generate an output as shown in figure 4:

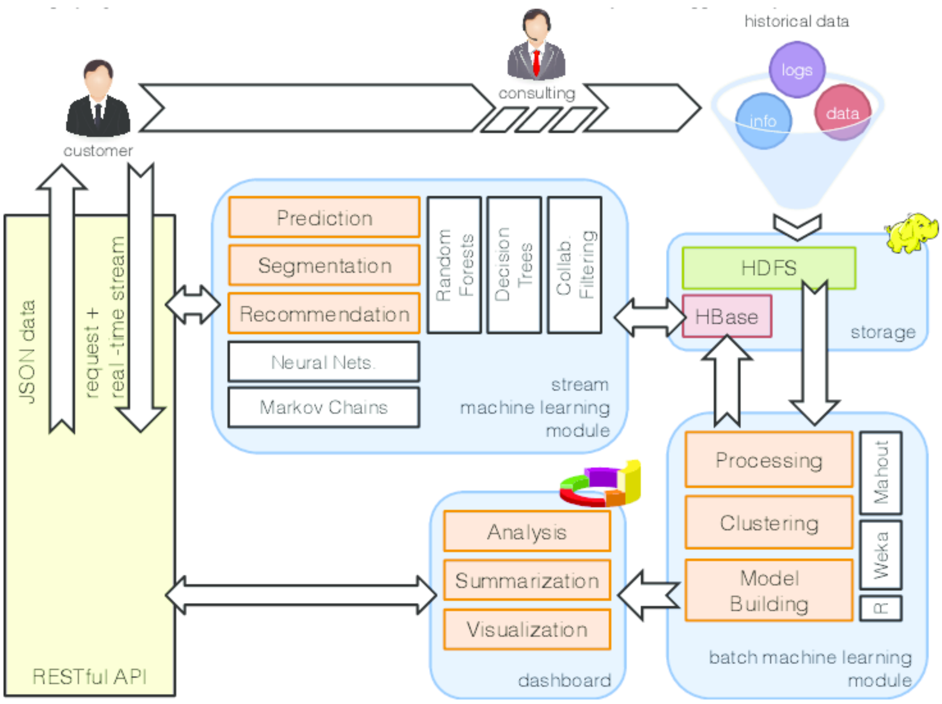

Fig. 4: Machine Learning for Big Data Real-Time Analysis, By: Alejandro Baldominos, Year: 2014

A storage module built over a distributed filesystem, batch and stream processing modules, a dashboard for displaying results and visualizations, and a REST API to bundle the systems supported by this architecture as a service comprise the architecture supporting machine learning over big data (15).

5.3 (ML) security, structure and frameworks:

Creating developed (AI) systems is one of the most important elements in the construction industry in order to illustrate and identify the project life-cycle. Building blocks for data preparation, validation, training, testing, and deployment are included in the machine learning framework. The majority of machine learning (ML) frameworks have the necessary programming languages.

It's challenging to develop a (ML) framework that works in our business environment. First, we must identify the problem that needs to be solved. Then, we must gather appropriate raw data, choose appropriate machine learning models, and finally identify an appropriate solution to the problem that has been defined. Gathering relevant data for (ML) is a crucial step in the machine learning life cycle since data is essential to the process of machine learning as well as its core (16). Since many of the vulnerabilities addressed in the principles arise at specific points in the project lifecycle, the principles are structured around a typical machine learning lifecycle to assist architects working on particular parts of the processes.

Thus, a structure that apply to all stages of the lifecycle are woven throughout principles. Applying principles to a particular situation will assist with considering risk and mitigation. The principles are designed to be used as a guidance for architecture and construction as following:

1- Turning on developers.
2- Develop with security in mind
3- Reduce the amount of information an adversary can access;
4- Secure detailing infrastructure
5- Track your assets
6- Allow developers to contribute (17)

6. Advanced robotics and the future of technology in architectural construction field:

Nowadays, improving robotics technology have been significant. Therefore; in order to achieve this improving; an in-depth exploration of the sophisticated robotic systems is a must for the futuristic progresses in the construction industry (18).

6.1 Robots versus human labour in construction:

The use of new robotic systems in the manufacturing sector with regard to the social dimension is the main topic of the article that follows. New work organization models are required as intuitive human-machine interaction (HMI) in robotic systems becomes an important goal of technological advancement.

Additional empirical and conceptual aspects of the technical dimension is necessary for the integration of such complex socio-technical systems. To fully comprehend the ramifications of the novel human-robot interaction currently found in industry, future research ought to take sociological and economic factors into account in addition to technological ones (19) as shown in figure 5:

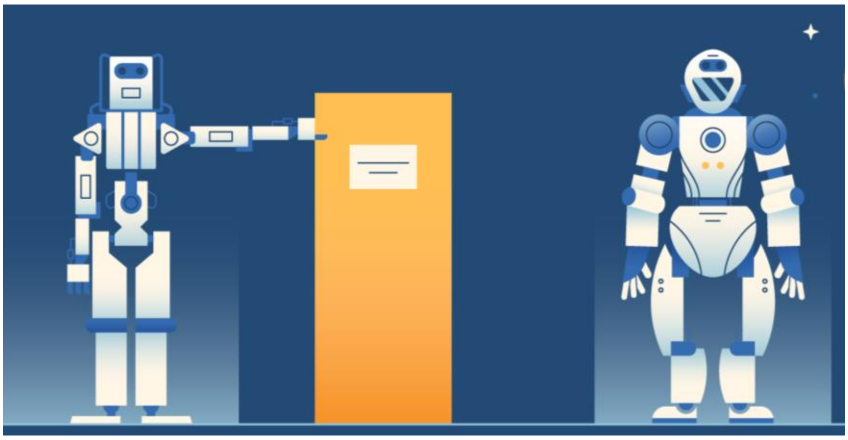

Fig. 5: Humanized labourers construction robots, Liam Stannard, Year: 2020

6.2 Construction robots market:

The introduction of a mobile robot on-site construction and 3D printing to improve efficiency and worker safety on construction sites consumers can add new tools and applications to their robots as they see fit, making the product genuinely versatile and appropriate for any manufacturing facility. Furthermore, the focus on shortening the time it takes to complete construction projects is encouraging industry participants to introduce novel and inventive products that operate faster and more efficiently (20). The market for construction robots is anticipated to be driven by the increasing focus of construction companies showing in the following figure 6 on cutting down on resource waste and overall expenses:

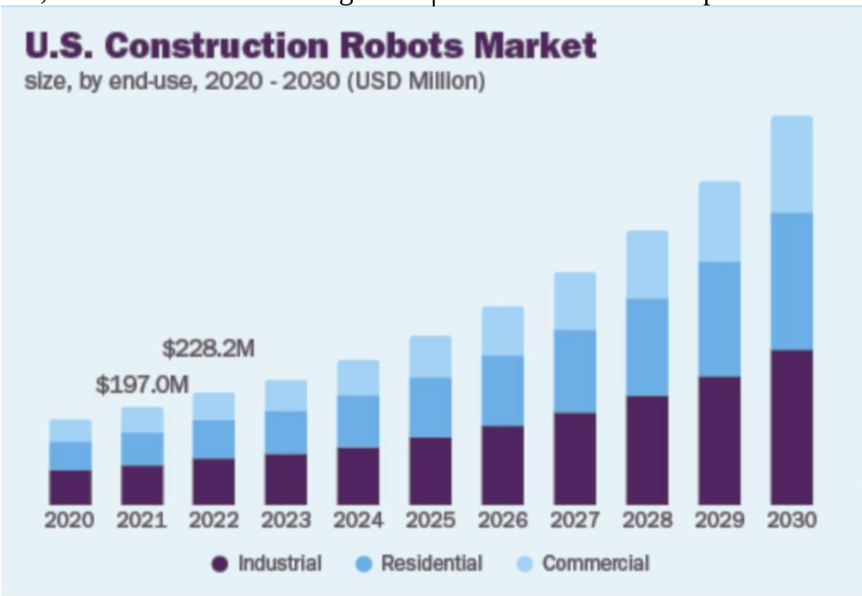

Fig. 6: Diagram shows the construction robots market, Grand View Research, Year: 2022

6.3 Robotics in future cities' construction and benefits:

Over the past decade, a significant increase in investment, research, and actual use of this technology. There are currently five key areas to be aware of as following:

1- Production robots on site
2- Prefabricated construction robots
3- Self-driving vehicles
4- Intelligent robots for quality inspection in construction
5- External structures

There are various advantages to using robots in construction. These include the following:

Safety on Construction Sites: The use of robotics and automation in construction sites enables improved worker safety protocols. There's no need to physically enter an unsafe place because the robots can be operated from a safer location. Enhanced productivity since robots are built and programmed to operate more efficiently, productivity at work increases as well as shown in figure 7:

Fig. 7: Using robots in construction, By: Archod, Year: 2020

Improved accuracy: robots are far more accurate than human labour. Robotics technology reduces the chance of human error and produces extremely accurate results. Time and economic effectiveness: robots are more productive and faster than humans at work, as we have discovered. In the end, it saves time and lowers the construction project's overall cost because the task has been completed rapidly.

Furthermore, robots on construction sites can be used by architects to test various materials. Large and small building sections are ground with extreme precision and finer details by robotic manufacturing tools. In less time, the entire process can be finished in one location (21).

6.4 Major challenges in robotics:

Based on previous; many challenges are facing robotics industry as shown in the following figure. Most of the challenges settled determinates enabling artificial intelligence (AI) technologies, perception, power sources, etc. Thus, ethics also made the list diagram charts of surveying results; the researcher consolidates a combined data results into a diagram chart as shown in Figure 8, and conclusion pie-chart shows the main 10 major robotics challenges in the field of architecture and construction (22).

Consolidated diagram chart of 10 challenges in robotics that may have breakthroughs in 5-10 years. Science Robotics, Year: 2018

According to the consolidated diagram chart of 10 challenges, the researcher was able to classify ten major challenges facing citizens about robotics in 5 to 10 years, which revolving the construction industry as following:

1- New materials and fabrications tools.
2- Creating bio-inspired robotics
3- Energy for robotics and power sources
4- Communication in smart robotics system
5- Navigating accuracy of un-mapped locations and environments
6- (AI) underpinning for technology for robotics.
7- Brain-computer interfaces (BCIs)
8- Robots for long-term implementing engagement
9- Automated construction robotics
10- Management and security problems control

After completing the analyzes and showing the results to take into account artificial intelligence, the building and construction industry will be developed sufficiently to implement the following results (Construction life cycle: which is linked to the management of building planning data using devices connected to the network. Automated systems: which is linked to fully automated services, including information, analysis and data.

In real time, so that there is deeper participation in addition to saving time. And integration: which was linked to the shared information space of the smart city, integrating data from the infrastructure of future cities, and Agdara systems for big data. And government: a system for supporting decision-making, analysis and incident management, and providing municipal services. Digital, in addition to disseminating open data in identifying identity for artificial intelligence, and engineers: as it is linked to improving information services along with information distributors in smart sustainable cities in the future.

7. Smart digital sustainble cities:

Nowadays, improving (AI) technology have been significant. Therefore, in order to achieve this improving; strong initiatives to create smart and sustainable cities are being implemented worldwide as a result of the realization that these challenges must be met. While cities development is robust and well-organized in developed nations, there are a number of obstacles that developing nations face when developing smart cities.

These include delayed investments, difficulty coordinating stakeholders at the local, state, and construction levels, schedule conflicts, and funding allocations that are directed. Policymakers should give this issue their undivided attention in order to successfully develop architecture and construction life-cycle progresses in order to achieve the term of smart and sustainable city (23).

7.1 Definitions and challenges:

In order to encourage understanding among individuals and provide a foundation for future conversations about the goals of smart sustainable cities, a definition of the term must be provided. Although there is a growing awareness of the impact that human activity has on ecological systems around the globe and that urbanization is a result of people relocating to cities, sustainable development is still primarily considered technological progress (24).

The language used to categorize cities according to their level of intelligence has been changing; these other categories of cities include online cities, virtual cities, knowledge cities, broadband cities, digital cities, mobile or wireless cities, green or ecological cities, sustainable cities, cities for people, and alive cities. There is currently no consensus definition for the idea of smart cities, despite the term's recent rise in popularity.

When comparing definitions and real-world applications, it is clear that there is some ambiguity surrounding the term's usage. The definition proposed in recent years into two parts; the first part; contends that a smart city must function well in six areas: people, life, the environment, mobility, and governance. It is constructed using a smart combination of the skills and efforts to be autonomous, aware, and independent citizens. The second part present in documents of global guidelines focused on practice and regulation, understands that a smart sustainable city is an innovative city that uses ICTs and other means to improve quality of life, efficiency of architecture operation, construction, services and competitiveness; while ensuring that it meets the needs of present and future generations with respect to economic, social and environmental as well as cultural aspects (25).

7.2 Smart digital solutions for construction:

The purpose for construction site of the future will be ubiquitous, intelligent, and aware of its surroundings. The application areas relevant to construction, such as augmented reality, labour tracking, supply chain tracking, safety management, mobile equipment tracking, schedule and progress monitoring, and visualisation based on building information models, form the basis of the hierarchical classification. The criteria were used to evaluate the research papers: user acceptability testing, onsite application, and validation of technological feasibility. Conclusions: The technologies discussed in the research evaluate made it possible to envision the ubiquitous construction site of the future (26).

In the construction industry, productivity is a major challenge. Construction productivity has stagnated over the past 20 years, despite manufacturing productivity's steady increase. A recent analysis indicates that the sector's productivity differs from the average of other sectors. It's not required to have imagination due to digital technologies and related procedures. To optimize the build phase and make efficient use of assets, companies can get the design, planning, and execution right by running a number of tests and creating predictions (27).

7.3 Future (AI) cities for sustainable development:

Based on previous; many challenges are facing smart construction industry. Rather; the goal is to provide tangible input to the foresight process in order to support construction processes for viable cities. This research is a component of the process that will guide the construction's subsequent steps. Describe the present scenario of artificial intelligence (AI) in cities and how developed consider the situation will be in 20 years (28) ; the following figure 9 describes the smart cities life-cycle for future cities:

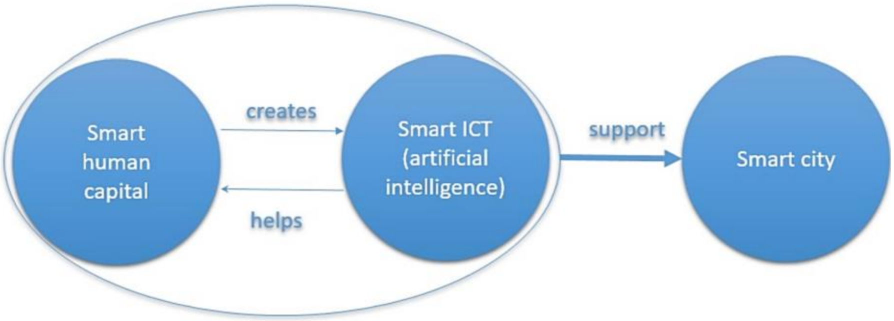

Fig. 9: Smart cities cycle, By: Ana Iolanda Vodă and Laura-Diana Radu. Year: 2018

Furthermore; it's feasible that artificial intelligence (AI) will someday run or at least control entire businesses. (AI) systems may also file patent applications, certify protocols, operate drones that check the security of buildings, and carry out other tasks currently done by humans. Taxation, labour unions, employment, accountability laws, intellectual property rights, and many other areas would all be impacted by this. A virtual AI infrastructure might function as a sandbox, or an AI experimentation area. In instance, AI is widely used and reasonably priced for event logistics optimization. It then becomes possible to break down barriers in collaboration by realizing what drives partnerships.

AI provides real-time resource location, allocation, and access. All things have the capacity to become online and connect to networks of sensors that offer open interfaces to flows of people, energy, water, air, and wind. (AI) methods enable greater distribution in production and consumption of energy. (AI) assistance for world energy and climate efficiency will always be functional, giving decision-makers credible data with reliable networked information (28).

8. Conclusions:

This paper presents a frame-work of artificial intelligence technology in project construction life-cycle harvesting from pre-construction process up to composite post-construction and implementation. The aim of using (AI) technology and based automated devices in construction industry is to contribute to enhance the labor shortages process through improving big-data collecting and management methods for engineers. (AI) technologies aim is to upgrade survey data harvesting with network and architects' needs inferred from the use of machine learning (ML) techniques.

Applying of drones and robots devices has grown to be a crucial part of the optimization techniques used in construction and architectural industries. AI has not yet started to visually shape our cities, but it is starting to be used as a design and planning derivative from design to planning scale, especially in the context of smart sustainable cities, the diversification and development of algorithms, the developments in computer vision, natural language processing, deep learning, neural networks, and machine learning. Thus; the deployment of (AI) devices in construction could mitigate the harmful effects of globalization and population growth and while establishing sustainability; in order to achieve the objectives of future smart digital sustainable cities.

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