SURVEY OF NIGERIAN LAW AND POLICY ON ARTIFICIAL INTELLIGENCE AND TECHNOLOGY LEARNING FOR SUSTAINABLE WASTE MANAGEMENT*

Abstract

The problem about waste generation started when the population of man is a defined structure increased. Since then, the trend in waste output has been on the increase both in form of absolute quality and per capita basis. Thus, with industrial revolutions new large-scale manufacturing processes produced increased waste and waste of a different kind. The growth of towns led to an increase in domestic waste and a decrease in the space available for disposal. Hence, the urgent need for the application of artificial intelligence in waste management and the need for law and policy standard and basic frameworks to regulate waste generation production, collection, disposal and of course, management in Nigeria for sustainable development. This paper examines the available Environmental and Waste Management Laws in Nigeria to see whether they make provision for the application of artificial intelligence for efficient and effective management of waste which abounds in our environment. This paper analyses Nigeria's legal capacity to optimize artificial intelligence from the point of the country's technological progress. We found that the use of computer and information technology is of recent existence in many strata of Nigerian economic, production and management settings. As such, Artificial intelligence is of recent origin in these areas in Nigeria when compared with developed economies like United States of America, United Kingdom, Singapore, Pakistan, India and Italy. It is the view of this paper that non determination on capacity for functionality of digital networks in the country distracts and undermines framework for standardization and optimization. We recommended an amendment of Nigerian Environmental Laws to provide for artificial intelligence in wastes management for sustainable development.

Keywords: Nigeria, Search, Law and Policy, Artificial Intelligence, Technology and Sustainable Development.

1. Introduction

In Nigeria today and with industrial revolution cum population explosion, generation of waste whether solid, gaseous or liquid is on the increase. The implication is that the application of the old methods of managing waste like composting and decomposition can no longer be sustainable, efficient and effective, hence, the need for artificial intelligence and technology to manage these wastes for sustainable development. Smart production systems require innovative solutions to increase the quality and sustainability of manufacturing activities while reducing costs.[1] In the context, artificial intelligence (AI) driven technologies, leveraged by 14.00key Enabling Technologies (e.g., Internet of Thing, advanced embedded system, cloud computing, big data, cognitive systems, virtual and augmented reality are ready to generate new industrial paradigms.[2] Generally, the term 'AI' is used when a machine simulates functions that humans associate with other human minds, such as learning and problem solving.[3] No one really knows how human intelligence works; so he can hardly expect to fare any better when we turn to artificial intelligence.[4] At the end of this paper, we shall see how the use of AI or computer technology application in all we do is better than the use of natural or human intelligence in Nigeria especially in waste management as obtainable in advanced countries of the world. Nowadays, the construction industry faces numerous problems, among which, managing construction and

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[1] R Cioffi, 'Artificial Intelligence and Machine Learning Applications in Smart Production: Progress, Trends and Directions available online at www.mdpi.com/journal/sustainability accessed on 11th November, 2020

[2] N A Gupta, 'Literature Survey on Artificial Intelligence, 2007 available online at https://www.ijert.orgresearch/a-literaturesurveyon-artificialintelligence-IJERTCONV51519015pdf accessed on 7 January, 2020

[3] A Moore, 'Carnegie Mellon Dean of Computer Science on the Future of AI' available online at https://www.forbes.com/sites/peterhigh/2017/10/30/carnegie-mellon-dean-of-computer-science-on-the-future-of-ai//#39283c652197 accessed on 7th January, 2020

[4] A Emerson and C Forbes, The Invasion of the Computer Culture: What you need to know about the new world we live in (United States of America: Interversity Press, 1989), 57

demolition waste are of key concern.[5] It is estimated that the construction industry is responsible for the production of 35% of the total generated wastes.[6] Despite several researchers have highlighted this issue and a lot of work is going to reduce the amount of construction waste, but still the percentage of construction waste in the US, Hong Kong, Canada, UK and Australia are 33%, 65%, 35%, 50% and 30% respectively.[7]

The construction industry is one of the mega consumers of natural resources,[8] though complete utilization of these resources in their natural form is impossible. An acceptable amount of waste is permissible which is unavoidable in any industry. Waste generated by the construction industry is termed as construction waste. The term construction waste is defined differently by various researchers as[9] defines all the waste produced as a result of construction activities like construction of building, bridges, road, their demolition, renovation, and other operations as construction and demolition waste (C&DW). Construction waste differs from household waste, as it contains hazardous matters as well. Heavy metals, asbestos, organic compounds, and other harmful organic materials are a threat to the environment so cannot be directly dumped. Furthermore, Construction activities may cause agricultural land loss, loss of soil, and air pollution.[10] It is reported that direct dumping of such waste into forests, riverine, and to water streams have shown erosion to the soil, contaminated water in and on the ground, and also enhanced tire hazards.[11] It is advised to minimize waste as among the produced waste, some of the waste can be reused as it is or after recycling rather than the disposal.[12] The techniques used to reduce the amount of waste are termed as waste management techniques[13] and Khahro et al[14] has described many of these techniques which are in correspondence with.[15]

In many countries, including Pakistan, rising levels of waste generation, increasing unregulated and illegal dumping of C&D waste, and the scarcity of landfill space has become critical issues. In order to protect the environment and guarantee sustainable development, numerous environmental regulations and initiatives have been developed. Most of these endeavors aim to prevent the generation of C&D waste and/or minimize it' as much as possible. Pakistan has recorded a continuous increase in the

[5] T H Ali, H U Imad et al, 'Application of Artificial Intelligence in Construction Waste Management: A Conceptual Framework for effective waste management system (Article in International Journal of Management Review, 2019) available at https://www.researchgate.net/publication/332091977 accessed on 11th November, 2020

[6] X S Huang and X Xu, 'Legal regulation perspective of economic efficiency construction waste reduction and utilization', Urban Development Stud. 9, 2011, 90 - 94

[7] J Malinauskaite et al, 'Municipal Solid Waste and Waste to-energy in the context of a circular economy and energy recycling in Europe', Energy (4) 2017, 2013 – 2044. http://dio.org/10.101b/j.buildenv.2004.01.007

[8] L S Ng, L W Tan, and T W Seow, 'Current practices of construction waste reduction through 3R practice among contractors in Malaysia: a Case study in Penang,' In IOP Conference Series: Materials Science and Engineering, 2017, November, 27!(1), p. 012039). IOP Publishing. http://iopscience.iop.org/article/10.1088/1757-899X/271/l/012039/meta

[9] M Yeheyis, K Hewage, M S Alam, C Eskicioglu, and R Sadiq, 'An overview of construction and demolition waste management in Canada: a lifecycle analysis approach to sustainability,' Clean Technologies and Environmental Policy, 15(1), 2013, 81 -91. http://iopscience.iop.org/article/10.t088/1757-899X/271/l/012039/meta

[10] G Polat, A Damci, H Turkoglu and A P Gurgun, 'Identification of Root Causes of Construction and Demolition (C&D) Waste: The Case of Turkey,' Procedia Engineering, 196, 2017, 948-955. https://doi.org/10.1016/j.proeng.2017.0S.035

[11] J Wang, Z Li and V W Tain, 'Critical factors in effective construction waste minimization at the design stage: a Shenzhen case study, China,' Resources, Conservation and Recycling, 82, 2014, 1-7. https://doi.org/10.1016/j.resconrec.2013.11.003

[12] S H Khahro, N A Memon, T H, Ali and Z A Memon, 'Improving Material Waste Management Performance: An Attribute Study for Provential Projects,' International Journal of Civil Engineering and Technology, 7(6), 2016, 498-506. http://www.iaeme.com/IJCIET/issuesasp?JType=IJCIET&VType=7&IType=6

[13] J F Huang, Q B Liang, H Wang, S Y Xu, L S Zhang, and Y Xing, 'Comprehensive recycling of construction waste,' In Applied Mechanics and Materials, Trans Tech Publications, 17, 2012, pp. 385-389. https://doi.org/l0.4028/www.scientific.net/AMM. 117-119.385

[14] S H, Khahro, N A Memon, T H, Ali and Z A Memon, 'Improving Material Waste Management Performance: An Attribute Study For Provential Projects,' International Journal of Civil Engineering and Technology, 7(6), 2016, ' 498-506. http://www.iaeme.com/IJCIET/issues.asp?JType=IJCIET&VType=7 &IType=

[15] D Mmereki, 'Current status of waste management in Botswana: A mini-review.' Waste Management & Research, 36(7), 2018, 555-576. https://doi.org/!0.1177/0734242X18772097. See also K Ghafourian, Z Mohamed, S Ismail, M Abolghasemi, and A Bavafa, 'Sustainable Construction And Demolition Waste Management In Malaysia: Current Issues/'. Jurnal Kemanusiaan, 15(1), 2017, 21-31. httpsV/JLimalkemanusiaan.utm. my/index, php/keman us iaan/articfe/vie w/110.

population where it is reported that over 200 million people are living there.[16] With this increase in population, the generation of solid waste is also increased. As reported by[17] waste generation in Pakistan is around 0.23-0.61 kg/capita/day and a total of approximately 59,000 Tons every day. It has been highlighted that the generation of waste is due to mismanagement, and there are devastated environmental concerns of this waste which are being faced by all of us.[18] In an estimate, more than 10 billion tons waste is produced across the globe on daily basis. In the ten billion tons of total solid waste, the construction and demolition waste from various sources like domestic construction, commercial construction, and industrial construction waste, is more than two billion tons.[19] It is necessary to formulate such policies and strategies which could abide by the ill effects of construction waste. Prior to that the reduction in the waste production should be ensured to ensure a sustainable and healthy environment.

2. Clarification of Terms

Artificial Intelligence according to Merriam Webster is defined as 'A branch of computer science dealing with the simulation of intelligent behaviour…' and the capability of a machine to imitate intelligent of human behaviour.[20] Put differently, AI is the simulation of human intelligence processes by machines, especially computer systems.[21] These processes include learning (the acquisition of information and rules for the use of this information), reasoning (using rules to reach approximate or definite conclusion). AI relates to many sciences from computing, mathematics and data to psychology, philosophy and linguistics.[22] Artificial Intelligence is a research discipline which is trying to get machines (computers, usually) to do things which would require intelligence if done properly.[23] It is also the stimulation of or improvement of human intelligence processes by computer systems.[24] Many people point to Alan Turning as the first to determine whether a computer is Intelligent.[25] Turing suggested that if computers showed human level conversational abilities, we should be assured of their intelligence. Turning proposed a conversational test for human-level intelligence which has been named the Turning test. The Turing test is essentially a game played by three people, an interrogator, a man, and a woman. The interrogator stays in a separate room than the other two. The object of the game is for the interrogator to determine which of the other players is the computer. The computer is trying to fool the interrogator and the human participant is trying to help the interrogator. The test measures verbal! dexterity, background knowledge, and underlying reasoning ability.[26] According to the Committee on Technology. Subcommittee on Machine Learning and Artificial Intelligence,[27] there are many categories of AI. These include thinking like humans, acting like humans, thinking rationally, and acting rationally.

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[16] Paskistan Institute for Parliamentary Services, 'Parliamentary Research Digest', Volume 4, March 2017. https://www.pips.gov.pk/sites/default/files/PIPS_Parliamentary_Research_Digest_March_2017.pdf

[17] A R Khoso, A H Memon, A A Pathan and M A Akhund, 'Solid Waste Management Issues in Hyderabad City,' Mehran University Research Journal of Engineering and Technology, 37(3), 2018, 653-662. http://dx.doi.org/10.22581/muet1982.1803.18

[18] N Gobbi, V M L Sanches, E B AV Pacheco, M J D O C Guimarães and M A V de Freitas, 'Management of plastic wastes at Brazilian ports and diagnosis of their generation,' Marine pollution bulletin, 124(1), 2017, 67-73.https://doi.org/10.1016/j.marpolbul.2017.07.004

[19] G R Besen and A P Fracalanza, 'Challenges for the sustainable management of municipal solid waste in Brazil,' disP-The Planning Review, 52(2), 2016, 45-52. https://doi.org/10.1080/02513625.2016.1195583

[20] See Forbes, Feb. 14, 2018

[21] Ikenga K. E. Oraegbunam & Uguru Eme Uguru, 'Artificial Intelligence Entities and Criminal Liability: A Nigerian Jurisprudential Diagnosis', *African Journal of Criminal Law and Jurisprudence* 3(2018), 1-14.

[22] See M S S El Namaki, 'How Companies are Applying AI to the Business Strategy formulation. Available online at http://dx.doi.org/10/19085/journal.sijbpg050801 accessed on 14th August, 2020

[23] D Jarret, The Good Computing Book, (Hutchinson Computer Publishing, 1984) 140

[24] R Grigonis, Dictionary of IP Communications (VON Publishing LLC, 2004) 29

[25] Ann Gaisel, The Current and Future Impact of Artificial Intelligence in Business, International Journal of Scientific & Technology Research Volume 7, Issue 5, May 2018 accessed on 4th August, 2020

[26] L Hauser, 'Artificial Intelligence,' Internet Encyclopedia of Philosophy, (February 21, 2018) ISSN 2161-0002:http://www.iep.utm.edu/art-inte/#H2.

[27] Committee on Technology. Subcommittee on Machine Learning and Artificial Intelligence, 'Preparing for the future of artificial intelligence,' (Washington, DC: Office of Science and Technology Policy, 2016).

Sustainable Development is seen as constituting development that meets the needs of the present without compromising the ability of future generations. It is also defined as 'a requirement that the use of resources today should not reduce real income in the future.'[28] Sustainable development can only be successfully achieved if new processes are now utilized.

'Waste' is defined as unproductive, empty, rejected and superfluous.[29] Materials become wastes when their owner will give them away or pay to have them hauled away.[30] Healthcare wastes may also be viewed as an asset which may generate revenue through appropriate treatment and handling.[31] Gilpin in his *Dictionary of Environmental Terms* defines waste as 'materials of solid or semi solid character that possess or no longer considers of sufficient value to retain.' Therefore, a thing is a waste even if it may be a high value to another person, as long as the person generating it does not have sufficient interest to retain the thing. This definition is subjective and must be looked at from the point of view of the person possessing the objects.[32]

Management according to Harold Knoontz, management is getting things done through and with people. According to the Chambers Dictionary, Management is 'the skill or practice of controlling, directing, or planning something especially a commercial enterprise or activity.[33] According to Nwabueze,[34] management is the 'process of direction, controlling and monitoring material and human resources available to an organization in an effort to achieve set goals.'

Technology is the knowledge of the core productive activities of an organization. It is the knowledge of how to manipulate materials (raw materials) by applying complex of techniques to achieve a patterned stipulated or expected end. So, it is the knowledge of how to manipulate materials achieve some contemplated and (product).[35]

3. General risks of AI

Experts agree that there are two scenarios of how AI could pose the greatest risk. The first scenario would be when AI is programmed to do something devastating. A system could be 'programmed to kill. The programs could result in a war with mass casualties. Also, the programs could be coded to be extremely difficult to stop or turn off. The other scenario that experts are worried about is when AI is programmed to do something beneficial but uses destructive methods. For example, if the program was given a task such as getting a person to the airport as fast as possible, it may not consider safety.[36] These two scenarios provide an overview of risk for /basic AI, but as mentioned before, there are multiple types and levels of intelligence. To compare and understand the risks, Hintze's four types of AI will be used in the following risk assessments.[37]

Type I AI

Since Type I AI mainly involves process automation, the risks to society are minimal. The significant risk of AI performing tasks is the loss of jobs. According to an article in USA *Today*, 'Automation could destroy as many as 73 million U.S. jobs by 2030, but economic growth, rising productivity, and other forces could more than offset the losses, according to a new report by McKinsey Global Institute'.[38] The article goes on to explain that although specific jobs will be lost, there will be similar occupations

[28] L Atsegbua et al, *Environmental Law in Nigeria*: Theory and Practice (Lagos: New edition, AMBIK Press 2010), 69
[29] S Oliver, 'Waste management and disposal, in purchasing and supply management', (1991), 22-24
[30] S B Ogbola, *op.cit*, 33
[31] C G Gumerson and D C Jones, 'Costing and cost recovery for waste disposal and recycling, Discussion Paper Report No UDB-37, Waste supply and urban Development Department, Operation Policy Staff, The World Bank (1984), 33
[32] M Purdue, 'Defining Waste', *Journal of Environmental Law* 1990, Vol. 2
[33] Chambers 21st Century Dictionary, *Op.cit*, 838
[34] C Nwabueze, *Environmental Communication* (Enugu: Daisy Press, 2007), 25
[35] C I Onwuchekwa, Business Policy and Strategic Management (Onitsha: University Publishing Coy, 2000) p. 163
[36] Future of Life Institute, 'Benefits & risks of artificial intelligence,' Future of Life Institute (2018). https://futureoflife.org/background/benefits-risks-of-artificial-intelligence/
[37] *Supra*
[38]P Davidson, 'Automation could kill 73 million U.S. jobs by 2030,' USA Today, (November 28, 2017) https://www.usatoday.com/story/money/2017/11/29/automation-could-kill-73-million-u-s-jobs-2030/899878001/

with different tasks that employees will perform. Workers will be needed to operate the machines as well as manage the increased productivity and economic growth that automation will generate. Physical jobs are most susceptible to automation. High-level, people-managing tasks with unpredictable environments are the least susceptible. High-wage workers are also expected to be less affected. It is anticipated that the prominent challenge will be to retrain millions of workers.[39] Retraining employees may sound daunting, but historically when there has been an economic shift which impacts workers, retraining has been gradual and implemented with attrition.

Type II AI

Type II takes automation up a bit to include tasks that are not ordinarily thought of in the automation realm. Driverless cars are a good example. This type of AI could cost Americans another five million jobs. Unfortunately, the drivers who make their living driving taxis, buses, vans, and trucks could be out of a job. Drivers are generally from the same demographic as the workers who lost their jobs to factory innovation. Since 2000, five million manufacturing jobs have been lost to automation.[40] The impact to society is the same as in Type I AI; it just involves more workers and additional industries.

Type III AI

Type III AI or socially aware AI opens up a different area of risk. Socially aware AI machines may not be programmed to perform the most altruistic of tasks. In fact, these machines can be dangerous due to human beings. Humans tend to trust machines or computer programs more than they trust other humans. For example, on the mobile dating application, Tinder, there has been frequent infiltration by bots posing as real people. The bots gain a person's trust and then try to get them to share exploitable information.[41] It is not too challenging to imagine how some people could use this type of technology to break the law, without ever coming in contact with their victims.

Type IV AI

The risks of Type IV AI are vastly different than the previous three. As a self-aware entity, Type IV would be able to cause ail sort of havoc. According to Vincent Muller,[42] 'the estimation of technical experts is that by 2050 the probability of high-level machine intelligence (that surpasses human ability in nearly all respects) goes beyond the 50% mark.' Muller goes on to argue that without knowing what AI will look like in the future makes the problem of identifying the risks rather daunting. Elon Musk, Steven Hawking, Steve Wozniak, and hundreds of others issued a letter to the International Joint Conference in Buenos Aires, Argentina. The letter was a warning stating that 'artificial intelligence can potentially be more dangerous than nuclear weapons'.[43] Bill Gates is also concerned about artificial intelligence. Gates is worried about super-intelligent machines. He is not concerned with the other types of AI.[44] The intelligence of machines is currently increasing. An article in *Harvard Business Review* points to the fact that if a smart machine today has the intelligence of an average person, and IQ of 100, using the rate of technological progress would raise the IQ of these machines by 1.5 points per year. 'By 2025 these machines will have an IQ greater than 90% of the U.S. population'.[45] Technology continues to advance, and AI is becoming more intelligent. Self-aware AI machines will be able to create more machines, and there is always the danger of whether they will see the need for human beings at all. Regardless of how careful the creators of this type of AI are, there is always the possibility of not addressing every possible safety scenario. The real worry with superintelligent computers is not about

[39] Ibid

[40] S Greehouse, 'Autonomous vehicles could cost America 5 million jobs. What could we do about it?' Los Angeles Time (September 22, 2016) http://www.latimes.com/opinion/op-ed/la-oe-greenhouse-driverless-job-loss-20160922-snap-story.html.

[41] E Seliger & W Hartzog, 'The dangers of trusting robots: AI: The ultimate guide,' BBC, (August 12, 2015) http://www.bbc.com/future/story/20150812-how-to-tell-a-good-robot-from-the-bad.

[42] V C Muller, 'Risks of general artificial intelligence,' Journal of Experimental & Theoretical Artificial Intelligence, (vol. 26 no. 3, 2014) pp. 297-301

[43] M Sainato, 'Stephen Hawking, Elon Musk, and Bill Gates warn about artificial intelligence,' Observer, (August 19, 2015) http://observer.com/2015/08/stephen-hawking-elon-musk-and-bill-gates-warn-about-artificial-intelligence/

[44] *Ibid*

[45] W H Davidow & M Malone, 'What happens to society when robots replace workers?' Harvard Business Review (December 10, 2014) https://nbr.org/2014/what-happens-to-society-when-robots-replace-workers.

malevolence, but competence. The concern is a matter of aligning human goals with the goals of the program. Machines can have goals, those that were programmed into the machine. The problem may be how the machines reach their goals, rather than the machine having different goals.

4. Arrival of Experts Systems

Interest in perception died almost instantly, replaced by AI programs own as expert systems. These programs run on conventional computers and are radically different from the brain-modeling approach of neural computers.[46] Expert systems are programs that are supposed to perform expertly in limited areas, as human experts do. The dream is to program these systems to perform as well as, if not better than, their human counterparts. How? First, programmers pack them full of textbook knowledge. Next, a 'knowledge engineer' interviews human experts in the field, getting them to explain all the intuitive rules of thumb and exceptions they use in making decisions. A good example is a medical program that diagnoses diseases. Stored in its memory is a tremendous amount of information, perhaps far more than any human head could hold, as well as a number of complicated inferencing rules. Provided with a list of symptoms along with the results of a patient's medical history and tests, the program will suggest possible causes and even assign probabilities to each. Some expert systems are capable of carrying on a limited, free-form conversation with their users. Medicine is just one area where expert systems are used. Most commercial applications of artificial intelligence are found in financial planning, education, computer design, chemistry, surveying, and oil exploration and drilling.

Although researchers have worked with expert systems for more than two decades, they have not made the progress they anticipated. There is good reason for that, say philosopher Hubert Dreyfus and his mathematician brother Stuart, long-time critics of artificial intelligence, particularly expert systems. Although they have won some battles and lost others, they delivered a telling blow to expert systems in their book *Mind over Machine: The Power of Human Intuition and Expertise in the Era of the Computer*. The problem with expert systems, they say, is inadvertently exposed by Edward Feigenbaum, the developer of DENDRAL (one of the most interesting and successful expert systems around, which uses mass spectrography to analyze the molecular structures of a limited class of chemical compounds). Feigenbaum says that the knowledge engineer is supposed to sit down with the experts and 'mine those jewels of knowledge out of their heads one by one.' But as soon as the knowledge engineer thinks he finds a bona fide rule of thumb or nugget of genuine wisdom, the expert says, 'That's true, but if you see enough patients/rocks/chip designs/instrument readings, you see that it isn't true after all.'... At this point, knowledge threatens to become ten thousand special cases.'[47]

5. Legal Framework for Artificial Intelligence in Nigeria

International: Internet Corporation for Assigned Names and Numbers (ICANN), International Telecommunications Union, World Trade Organization (Commitments under Telecommunications Basic Services)

Regional: Commonwealth Telecommunications Organization

Sub-regional: WATRA

National: Wireless Telegraphy
Nigerian Communication Act, 2003[48]
Let us concentrate on Nigerian Communications Act, 2003. The primary object of this Act is to create and provide a regulatory framework for the Nigerian communications industry and all matters related thereto and for that purpose and without detracting from the generality of the foregoing**,** specifically to.....

[46] A Emerson & C Forbes, 'Creating Intelligence in the invasion of the Computer Culture (United States of America: Intervarsity Press, 1989) 58-61
[47] *Ibid*
[48] P C Obutte et al, Artificial Intelligence and the Law in Nigeria: Framework for Optimization and Standardization, NALT Conference Lecture by Faculty of Law University of Ibadan, Ibadan, 2019

(a) promote the implementation of the national communications or, telecommunications policy as may from time to time be modified and amended;
(b) establish a regulatory framework for the Nigerian communications industry and for this purpose to create an effective, impartial and independent regulatory authority;
(c) promote the, provision of modem, universal, efficient, reliable, affordable and easily accessible communications services and the widest range thereof throughout Nigeria;
(d) encourage local and foreign investments in the Nigerian communications industry and the introduction of innovative services and practices in the industry in accordance with international best practices and trends;
(e) ensure fair competition ill all sectors of the Nigerian communications industry and also encourage participation of Nigerians in the ownership, control and management of communications companies and organisations;
(f) encourage the development of a communications manufacturing and supply sector within the Nigerian economy and also encourage effective research and development efforts by all communications industry practitioners;
(g) protect the rights and interest of service providers and consumers within Nigeria;
(h) ensure that the needs of the disabled and elderly persons are taken into consideration in the provision of communications services ; and
(i) ensure an efficient management including planning, coordination, allocation, assignment, registration, monitoring and use of scarce national resources in the communications sub-sector, including but not limited to frequency spectrum, numbers and electronic addresses, and also promote and safeguard national interests, safety and security in the use of the said scarce national resources.[49]

Establishment of the Commission

(1) There is established a Commission to be known as the Nigerian Communications Commission with responsibility for the regulation of the communications sector in Nigeria.
(2) The Commission shall be a body corporate with perpetual succession and a common seal, capable of suing and being sued in its corporate name, and shall have the power to do the following-
(a) enter into contracts and incur obligations;
(b) acquire, hold, mortgage, purchase and deal howsoever with property, whether movable or immovable, real or personal; and
(c) do all such things as are necessary for or incidental to the carrying out of its functions and duties under this Act.

Concept of Waste

The concept of waste is not new; it has been addressed for decades. This term is defined differently by different researchers like[50] defines waste as the final product which has no worth for the owner at the end. Similarly,[51] describes waste as the unwanted products and material which exist but are of no use. This waste may be physical or non-physical. Physical waste is the type which has its physical appearance like materials, things and good, while non-physical waste is termed as the waste having no physical appearance but leads to produce physical waste. Like lime layover, delays and waste of money;[52] described the term of waste as any product that is needed to be disposed of.[53]

[49] See S. 1(a)-(i) of Nigerian Communication Act, Act No. 19, 2003
[50] P Rajendran and C Pathrose, 'Implementing BIM for Waste Minimisation in me Construction Industry: A Literature Review,' 2nd International conference on management, 2012, 557-570. 11th - 12th June 2012. Holiday Villa Beach Resort & Spa, Langkawi Kedah, Malaysia, www. internationalconference.com.my
[51] S Nagapan, I A Rahman, A Asmi and N F Adnan, 'Study of Site's Construction Waste in Batu Pahat, Johor,' Procedia Engineering, 53: 2013, 99-103.https://doi.org/10.1016/j.proeng.2013.02.015
[52]T V Ramachandra, 'Integrated Management of Municipal Solid Waste, 2002. Retrieved from http://wwwces.iisc.ernet.in/energy/paper/integrated_management_msw/index.htm
[53] C T Formoso, L Soibelman, C De Cesare, and E L Isatto, 'Material Waste in Building Industry: Main Causes and Prevention,' Journal of Construction Engineering and Management, 128(4), 2002, 316-325. https://doi.org/10.1061/(ASCE)0733-9364(2002)128:4(316)

Construction Waste

The most common source of solid waste is construction waste. This waste is referred as one of the most common and main causes of environmental degradation and health problems. This waste includes asbestos, debris and other waste generated in the result of construction and demolition activities. Building materials which remain unused in any construction project are the main source of this waste.[54]

Construction Waste Management

Construction waste management can be defined as the reduction and minimization of construction waste by applying waste management techniques. It is also defined as minimizing any kind of disposal of construction materials like debris, rubbish, and other construction 'waste. It also includes the reusing, the materials, recycling it or reducing the procurement by sophisticated estimations of materials.[55] It has been observed that construction waste management has been compromised and given low priority when there are limited financial resources and technical professionals. It is highlighted by[56] that sufficient waste reduction can be attained by applying the proper waste management technique and imposing these techniques as a functional part of the project.[57] Construction waste management is a skill and legislation which require the intensive cooperation of all professional personnel involved in the specific project. Despite their rank, designation and experience, designers, engineers, contractors, workers, clients, material suppliers, planners, and supervisors need to work in a collaborative manner from concept level to the final stage for the surety of effective management plans.

Environmental management, being a raising issue, is not possible except effective construction waste management.[58] Yuan[59] highlights the importance of construction waste management by linking it to the environment. Negative environmental impacts can be minimized by properly managing waste contributors, and construction wastes are one of the major contributors.[60] Waste management includes several steps like transportation, monitoring, disposal, and collection techniques. Nagapan et al,[61] defined waste as tools which identifies the suitable waste stream, targets the generation of waste and decides the best suitable technique accordingly. While CIDB[62] defines this term as an organization and planning to reduce waste production is actually waste management.

Construction Waste Management Hierarchy

Rapid urbanization in old cities results in increased demand for infrastructures. Multistory building, shopping malls, tall commercial buildings, and other social amenities are made to fulfill this demand. These structures undoubtedly produce massive construction and demolition waste.[63] This waste makes

[54] N Saadi, Z Ismail and Z Alias, 'A review of construction waste management and initiatives in Malaysia,' Journal of Sustainability Science and Management, 11(2), 2016, 101-114. http://soe.umt.edu.my/wp-content/upIoads/sites/51 /2016/12/10-web.pdf

[55] F H Chowdhury, M T Raihan, G M S Islam and F Ramiz, 'Construction Waste Management Practice: Bangladesh Perception,' 2016. http://www.cuet.ac.bd/icace/papers/structure/289.pdf

[56] *Supra*

[57] The American Institute of Architects (AIA). 2008. Construction Waste Management Strategies: Best Practices', AIAP072739- BP 10.05.36. [Online] Available at http://www.aia.org/aiaucmp/groups/secure/document5/pdf/aiap07273 9.pdf. [Accessed 24 July 2016].

[58] D Kralj, 'Environmental Waste Management in Construction Industry,' Environmental Management, 2010, 36-68, Retrieved from https://www.researchgate.net/publication/221908893_Environmental_Waste_Management_in_Constructions

[59] H H Yuan, 'A SWOT Analysis of Successful Construction Waste um,' Journal of Cleaner Production, 39: 2013, 1-8. https;//doi.org/10.10l6/j.jclepro.2012.08.016.

[60] M. Abn Eusuf, M. Ibrahim and R. Islam, 'The Construction and Demolition Waste in Klang Valley, Malaysia,' Journal of the Malaysian Institute of Planner, 2012, 99-124. http://irep.iium.edu.my/id/eprint/27086

[61] S Nagapan, I A Rahman, A Asmi, A H Memon and R M, Zin, 'identifying Causes of Construction Waste - Case of Central Region of Peninsula Malaysia,', International Journal of Integrated Engineering, 4(2), 2012, 22-28. http://penerbit.uthm.edu.my/ojs/index.php/ijie/anicle/view/190/347

[62] Construction Industry Development Board (C1DB) Malaysia. (2015). Construction Industry Transformation Programme (CITP) 2016-2020 (p. 184). Construction Industry Development Board (CIDB)Malaysia. Retrieved from http://www.cidb.gov.my/cidbv4/index.php? lang=en.

[63] M Osmani, J Glass, and A D Price, 'Architects' perspectives on construction waste reduction by design,' Waste Management, 28(7), 2008, 1147-1158. https://doi.org/l0.1016/j.wasman.2007.05.011. See also H Yuan and L Shen, 'Trend of the research on construction and demolition waste management,' Waste Management, 31(4), 2011, 670-679. htrps://doi.org/10.1016/j.wasman.2010.10.030

a huge contribution to solid waste of an area and has severe environmental and social impacts. Presence of enormous building waste in the society is waste of precious resources like building materials as well as of time & money, which are been spent to manage such waste. Furthermore, massive landfill space is occupied by this waste which adds up the land shortage for other residential and recreational purposes. Presence of harmful substances in various construction materials jeopardizes the wellbeing of human being and environment. It is quite difficult and impossible to completely eliminate the ill effects of waste even after treatment. This is the reason many researchers are in opinion to avoid producing waste. Therefore, the most practical approach to minimizing the effect of waste on the environment is to prevent generating waste.[64] The second most feasible approach may be eliminating waste completely by converting it in such things which can be decomposed like soil. If it is not possible to avoid production of waste nor it is possible to eliminate the waste, then waste should be reduced to its minimal level. Though it is also not recommended, but due to unavoidable nature of waste, it is the third step that a manager could take. Furthermore, it is always recommended at any stage if anything from the waste can be reutilized then a manager should go for it and reuse the material which could be reused. After that it should be tried upon to reuse the produced waste after recycling it, means produced waste should be reused after recycling. And if nothing is possible then at the last stage it can be dumped to a landfill for final disposal but before disposal, proper treatment of the waste must be ensured.[65]

6. Contemporary Artificial Intelligence Applications in some Countries

India Swachh Bharat Mission: Some of the key technologies relevant to achieve objectives include:

- Online platforms: Online platforms provide options and alternatives to the user to look into reusing old stuff. The existing user is also encouraged to look for options to sell and regain value from the product before discarding the product as waste.
- Analytics: Accurate projections on total waste generated, waste type and identification of high waste generation areas enable effective planning and management of solid waste management services. Use of analytics during events with large citizen involvement such as festivals and fairs can ensure smooth collection and transport of waste.
- Crowd-sourcing: Citizens can be encouraged to report (web/mobile/social channels) waste-related activities which need urgent attention from the authorities.
- Sensor-based waste collection: Sensor-based waste bins to identify status of waste bins if it is empty or filled so as to customise the waste collection schedule accordingly and save costs.
- Automated waste collection system: Automated Waste Collection System (ACS) is a long-term solution and can take care the conventional methods like door-to-door, curb-side, block, community bins collections and transportation via chute system from high rise buildings with waste sucked through pipes and minimal human intervention.
- GPS devices and sensors on waste truck: GPS technology to route the waste collection trucks to optimize the collection efficiency and ensure contractors dump waste in designated places. It will also give a clear picture of waste generated per ward.
- Sensor-based sorting: Sorting waste material with the use of sensor technology helps in smart sorting. The sensor technology can recognize materials based on their visible spectrum or colour with infrared/ultraviolet spectra or based on their specific and unique.
- Spectral properties of reflected light, or atomic density or conductivity/permeability or atomic characteristics
- Pollution sensors: Leverage the pollution sensors to guage pollution levels at landfills.
- Energy simulation (waste to energy): Use of energy simulation software and analytics can provide accurate projections of waste generation and energy production from waste.
- Analytics-based landfill management: Accurate waste generation and collection projections along-with break-up of type of waste can enable smart landfill management.

[64] Ibid
[65] See T H Ali, et al. *op.cit* at p. 51

- Integrated asset management solutions: Integrated asset management of all waste infrastructure assets including the associated data, processes, information systems and governance for manageable operations and higher sustainability.
- Business process automation: Re-engineer, optimize and automate business processes using business process management solution to have a fully integrated and policy-driven set of automated business processes that increases efficiency and reduces service delivery costs.
- Workforce and resource management: Leverage the workforce and resource management solutions to improve workforce engagement and task management. Optimise the workforce with the help of workforce management solutions like planning, forecasting and scheduling, shift management, mobile applications to execute tasks and efficiency performance management tools.
- City of performance management: Monitor the performance of city subsystems through the use of digital technologies and big data analytics to manage city governance, efficient performance and proactive crisis management.
- Integrated command and operations centre: Leverage integrated command and operations centre to monitor city services on real-time. Improve/synchronize maintenance activities to reduce downtime and improve maintenance effectiveness.
- Geospatial dashboard: Bin locations, landfill locations, waste management assets need to be mapped in geospatial system.

The Swachh Bharat Mission will cover 4041 urban areas in India in next 5 years. Meeting the Swachh Bharat mission objectives will require a huge social change and change in the way cities handles waste and sanitation. Technology will become the key enabler in improving efficiency and capacity of city services to improve waste and sanitation value chain. Technology will also enable real time governance and control of waste and sanitation value chain for Swachh and Smart Bharat.

Achieving a Smarter Sorting System: AI in recycling facilities

With approximately 1.3 billion tons of waste generated every single day, it is extremely difficult to truly comprehend the scale of the challenges involved in attaining a viable level of recycling worldwide. Successfully sorting different types of rubbish is one of the stickiest (often quite literally) problems that municipal recycling facilities (MRFs) face and it's an area where AI is ideally suited to make a big difference. Think facial recognition, but for waste, as AI systems successfully sort rubbish items with the kind of accuracy and economy of effort previously undreamt of. Already, solution providers are developing AI systems which have the capacity to improve their understanding and recognition of different types of material via machine learning. The ability to successfully identify and separate a far greater range of material types is essential for improving the efficiency and long-term sustainability of MRFs.

Starting the Sorting at Source: Smarbins

The South Korean city of Songdo is known colloquially as the 'City in the box', as it was designed and built from the ground up as a smart city. One of its landmark innovations is the introduction of RFID tags for different waste and recycling bins used by its inhabitants. Once collected, the waste management facility can read these tags and instantly determine the best method of disposal or recycling use.[66] Going beyond the RFID approach, the advent of the true 'smartbin' is coming closer to commercial realization. Solution providers are looking to develop intelligent waste receptacles with sufficient sensory and AI Computing power to analyse the rubbish items that are thrown into them, and then feed the data back to a central system which can then identify all of the elements in the smartbin, ready for sorting and appropriate processing once the bin is picked up. While it may be some time before we see such sophisticated smartbins deployed in homes on an impactful scale, the ambition behind this concept shows how much more efficient AI can make the entire management process.

[66] Application of Artificial Intelligence to Automated Waste Recycling, https://www.worldfutureenergysummit.com/en-gb/future-insights-blog/ai-cleantech-applications-part-2-ai-in-waste-management.html accessed on 24th November, 2020

Taking the waste out of waste disposal: Smart Waste Trucks

If the bin is smarter, and the sorting centre is smarter, it's only natural to want the transporter – the midway point – to be smarter as well. This is the impulse behind several initiatives to create AI-empowered smart waste management and disposal vehicles including the intelligent internet of Things Integration Consortium (13), launched by the University of Southern California (USC). 13 want to be able to hook up waste trucks to a city-wide system of sensors and cameras so that they are not only informed of the most reliable and efficient routes to take, but also have the data necessary to carry out further strategic actions. 13's future applications for smart waste trucks include tagging graffiti for clean-up squads and detecting waste that has been left outside of bins. By utilizing AI for automating and extending the operations of waste disposal vehicles, another crucial step in the waste management cycle can be massively and permanently improved.

Moving towards the circular economy: AI can change the future of waste management

100% effective waste management is an essential element in bringing us closer to a truly circular economy where the maximum value of very resource is extracted along with the minimum of waste and long-term ecological impact. In every case, closing the gap between current recycling and waste disposal efforts and this target state for the industry requires a holistic overview of the data involved in every operational step, and AI is beginning to help us get there. With a much deeper understanding of the data at hand, operators in every part of the waste management ecosystem can make the right decisions about how we deal with waste in all its forms.

The U.S. Environmental Protection Agency has recommended that a program of waste treatment consisting of source reduction, recycling, volume reduction and landfilling be applied, in that order, in the treatment of municipal solid waste (MSW). Effective recycling of the various recyclable components of MSW presents numerous challenges. Automated technology exists for efficient extraction of steel, aluminum, compostable food waste, and some paper products from MSW. These items make up the bulk of MSW. However, the only method known to effectively recover whole glass and plastic containers from MSW is to manually handpick them from the waste as it passes on a conveyor belt along a series of manned handsorting station.[67] The innovation explored in the Phase I research program and proposed to further developed as a prototype in Phase II utilizes the ability of high speed electronics coupled with sophisticated computer and mechanical technology to automatically identify and extract whole glass and plastic containers from MSW. This system can be used to emulate the major techniques used by humans to identify the containers during the handpicking operation. This could result in a high speed cost effective method of automatic removal of glass and plastic containers from MSW.

Related Work[68]

Garbage has become a major problem worldwide due to uncontrolled disposal of household waste from citizen's home and industries without an effective and efficient waste management program that can result in health risks and a negative impact on the environment.[69] A waste management with efficient classification plays an important role in ecologically sustainable development by ensuring that waste is properly disposed of. Efficient selective collection is often implemented to improve recycling and reduce environmental impact,[70] especially in developing countries where waste management is a serious problem for economic development.[71] Over the years, many works have been implemented with the

[67] Application of Artificial Intelligence to Automated Waste Recycling, https://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/1547 accessed on 24th November, 2020

[68] B S Costa, et al, Artificial Intelligence in Automated Sorting in Trash Recycling, Department of Computer- Federal Institute of South of Minas Gerais (IFSuldeMinas) CEP 37.550-000-Pouso Alegre-MG-Brazil, available online at file:///c:users/USER/Downloads/ENIAC2018.pdf accessed on 11th November, 2020

[69] Islam et al Overview for solid waste bin monitoring and collection system. In Innovation Management and Technology Research (ICIMTR), 2012 International Conference on, pages 258-262 IEEE.

[70] Y Glouche and P Couderc. A smart waste management with self-describing objects. In the Second International Conference on Smart Systems, Devices and Technologies, 2013 (SMART 13)

[71] Arebey et al, Integrated technologies for solid waste bin monitoring system. Environmental Monitoring and assessment, 2011, 177(1-4): 399-408

aim of minimizing the impact of the waste uncontrolled disposal of. Technologies such as Radio Frequency Identification (RFID) and Sensor Network (SN) have been used to provide a new way to optimize waste management systems.[72] Some authors have used RFID technology to identify and track selective collection by storing owner data and information about their bins.

7. Conclusion and Recommendations

This paper clearly justifies that the application of Artificial Intelligence and its technology of learning on human activities is indisputable. Artificial intelligence has the potential to create a better world for humanity; its effects notwithstanding. Thus, in legal parlances there are good and bad justifications for its legal frameworks. Thus, it is useful in satellite communication and orbit, tracking, depths and heights beyond human capacity rescale of astronauts in space etc. However, evidence shows that its usage can led to hackers sinister and pernicious demobilization of electronically power systems, vogue and criminal interceptions of communications in breach of statutorily protected privacy and human dignity rights. All in all, the advantages derived in the application of Artificial Intelligence is waste management is too much when compared with human capacities and their intelligence; both in analytics, smart sorting, recycling and data processing, the use of artificial intelligence display innovation and is therefore, imperative and indisputable.

Sequel to the above conclusion, there is urgent need to enact innovative laws on the application of Artificial Intelligence in many human activities and programmes. The adoption of AI in many corporations is necessary looking at the level of competition in all strata of human endeavours. Thus, Communication Act, Electricity Act, Computer Act and many others need to be reformed and make the application of AI clearer. Nigeria government should develop political will in waste management and one of the ways to bring this into existence is to make urgent provisions in Nigerian Laws for AI in waste management through online platforms, analytics, sensor based waste collection and sorting, automated waste collection system, smart waste bulks, automated waste recycling and Radio frequency identification (RFID) as obtainable in India, South Korea, Brazil and United States of America. This will not only be efficient, effective, innovative but will give rise to sustainable waste management in Nigeria as obtainable in India, South Korea, Pakistan, Canada, United States of America and United Kingdom.

[72] *Ibid*