Assessing the Impact of the Internet of Things Integration on the wellbeing of People in Office spaces, Nigeria: A Review

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ABSTRACT
The Internet of things technology is widely becoming an accepted cutting-edge innovation for buildings of various purposes. Because of the numerous benefits of the Internet of Things Technology for building owners, occupants and managers, the concept of integrating this data-driven innovation in residential and commercial spaces is a phenomenon that can be harnessed for the wellbeing of people. Reports have shown that there is a growing rate of mental illness in office spaces in Nigeria and across the globe. As such, this study assesses the impact of the Internet of Things technology on the wellbeing of office-space users. The methodology adopted by this study is qualitative in nature whereby parameters and variables gotten from literature on mental health illnesses were analysed categorized according to the IoT solutions in order gain insights on addressing mental health challenges in office spaces. The sampling technique used to collect qualitative data was non-random. It was discovered that the IoT technology offers an opportunity to understand and optimize space management for user comfort of office dwellers. Hence, it is recommended to incorporate the use of the Internet of Things technology in order to adequately adjust people-management structures to suit the various wellness needs of office-space users.

Keywords: *IoT, Wellness, Office Space, Mental Health, Literature Review, Internet of Things*

1. INTRODUCTION

The idea behind "Internet of Things" also known as IoT in short form is devised from two words which are firstly, "Internet" and secondly "Things" [1]. The IoT theory springs up from internet technology and computer science, with emphasis on interoperability, integration and interconnectivity of internet physical components [2]. This technology strives to implement a variety of application and services from significant number of smart devices [3]. As such, the Internet of Things (IoT) is a new paradigm that enhances the collection and exchange of data in such a way that was unattainable before [4].

Humans are currently confronted with a plethora of anthropogenic and natural problems. Illness is a problem that threatens human life. Mental illness is a type of illness that falls under the category of noncommunicable diseases (NCD) and has a wide-ranging impact on people's lives [5.] Mental illness is thought to have existed throughout human history [6]. Hence, mental health, like physical health, is not limited to specific geopolitical areas or social classes. It's a problem that can afflict anyone, male or female, young or old, wealthy or impoverished [7].

According to a report by the World Mental Health Day in 2017, over 80% of the people living in low- and middle-income countries suffer from the depression disease, countries amongst which is Nigeria. It was

therefore discovered that 10% of workers take some time off work for depression, and lose 36 days of workdays to deal with the illness[8]. Subsequently, despite the invention of IoT, modern workplace has been established to have an increased number of employees that seat for more than 50% of their working days [9], and this can have adverse effect on their mental health in the long run as stressful places of work can breed mental health illnesses but their manifestations are overlooked easily and a result their symptoms are usually attached to issues or stressors outside the workplaces [10].

Advantageously, the technology triggers employee happiness via intelligent lighting systems [11], mobile phones and tablets [12], virtual reality and augmented reality [13], ambient temperature control [14], ergonomics and wellness, and live mapping [15], room booking, availability and management [16], flexible work environment [17], increased energy efficiencies [18], and access control systems [19], which are productivity boosters for effective employee performances [20]. Nevertheless, despite the importance of IoT to the productivity, effectiveness and mental health of employees within their office spaces, there have been limited studies in this area.

As such, to understand the concept of analysing mental health illnesses by the Internet of Things technology, the aim of this study is to assesses the impact of the Internet of Things technology on the wellbeing of office-space users.

2. METHODS

The research method adopted by this study isqualitative in nature whereby data was obtained from literature and analysed. The scope of the study is specific to an office building setting, to be located in Nigeria. Thus, sample for the study was selected based on the non-random or non-probability sampling method whereby specific data was gotten from literature on mental health illnesses and IoT. As such, the review guide was employed as the research instrument for this study.

Data collected were secondary data from various literature relating to mental health illnesses and the IoT Technology. Therefore, the parameters measured included the embedded sensors which detect changes, such as occupancy, temperature, air quality or motion in a room and feed that information to building management systems highlighted by [21]. Mental health illnesses, according to [22], were highlighted as variables and analysed. They include: Increased absence from work, over emotional behaviour, unhealthy and unkempt appearance and withdrawal from social situations, especially with co-workers. Also, some mental health illness symptoms that can be detectable by IoT devices were analysed these included: Increased absence from work, over emotional behaviour, withdrawal from social situations, especially with co-workers, shaking, struggling to breathe, or experiencing a choking sensation.

Although the limitation to this study included time constraints and limited data available on Nigerian settings, the analysis on the variables and parameters can be applied to typical office settings in Nigeria.

3. RESULTS AND DISCUSSION

Presented in Table 1 is five related studies in the context of employee mental health and IoT in office spaces. One of the major limitations of this study is the unavailability of sufficient studies to adequately address the research. However, the few ones at the authors' disposal have formed basis for discussions throughout the sections of this study.

Table 1: Review of relevant studies

Source	Title	Objectives	Methodology	Main Findings
[23]	Internet of Things (IoT): Opportunities, issues and challenges towards a smart and sustainable future	To address and discuss the latest advancements in the above specified and key IoT application areas	Review editorial	The main outcomes of the article contributed to the better understanding of current technological progress in IoT application areas as well as the environmental implications linked with the increased application of IoT products.

[24]	The Impact of Psychological Changes in Mental Health on Employees Performance	To explore the Impact of psychological changes in mental health on workers' productivity inside financial organizations	Questionnaire survey	The survey stated that workers were set unreasonable expectations with their employers and were expected to reach their targets, the human resource management needed to ensure there was a work-life balance.
[25]	Industry 4.0 and Health: Internet of Things, Big Data, and Cloud Computing for Healthcare 4.0	Addresses how the application of IoT, big data and cloud computing in the health domain is changing the way of providing traditional services and products	Review	Wearable devices and IoT are the most evident pillars sustaining HC4.0, being easily recognized as the newly improved, more powerful, and less constrained versions of medical sensors and equipment
[26]	Internet of Things for Mental Health: Open Issues in Data Acquisition, Self-Organization, Service Level Agreement, and Identity Management	To comprehensively survey works done at the intersection between IoT and mental health disorders	Review	Prevailing IoT systems for mental health Bipolar Disorder, Depressive Disorder, Schizophrenia Spectrum Disorder, Stress-Related Disorders. Challenges of IoT solutions for mental health: data acquisition issues, lack of self-organization of devices and service level agreement, and security, privacy and consent issues
(Zhang et al., 2022)[27]	Promoting employee health in smart office: A survey	To investigate the state-of-the-art smart technologies applied to the office for health pro- motion, and to identify the core challenges and future research opportunities.	Systematic Review	The smart office brings numerous opportunities for delivering prevention and control measures of health issues associated with office work (e.g., musculoskeletal disorders and computer vision syndrome)

Table 1 presents a combination of five randomly selected publications, showing their main objectives, as well as the main findings of these studies. Of note, the study of [24] observed that most workers usually deal with unreasonable expectations with their employers and were expected to reach their targets. This would definitely lead to mental stress, depression and other mental disorders on employees. Hence, with relevant IoT technologies, employees would be relieved of this stress and also improve productivity. Furthermore, [26] opined that IoT systems have been aiming at providing technological solutions to some of the most prevalent mental health conditions such as bipolar disorder, depressive disorder, schizophrenia spectrum disorder, stress-related disorders.

As such, a check list employable in Nigerian office settings was used analyze the mental health illness detectible by IoT devices placed strategically at locations in a typical office space. Below shows the check list highlighting various mental health symptom detectible by various IoT sensors.

Table 2. Mental Health Illnesses Detectible by IoT Sensors

IoT Detectable changes/Physical Symptoms of Mental Illness	Motion	Temperature	Air Quality	Occupancy
Increase Absence form work				●
Withdrawal from social situations	●			●
Over Emotional Behavior	●	●		

Shaking		
Struggling to breathe		
Chocking sensation		

From table 2, it is seen that mental health illness such as withdrawal from social situations and increased absence from work can be detected by motion sensors which can be placed at desk spaces where activities can be easily noticeable. Also, the temperature sensors place strategically can detect abnormal changes in workers temperature which can be an indicator for symptoms such as over emotional behavior and shaking where by heat is generated in both activities. Lastly, symptoms like struggling to breathe and chocking sensation can be checked by a measure of air quality where by anormal or spiked changes in the space around desk areas is observed. Hence, mental health illness can be potentially detected by IoT devices placed strategically around work spaces and frequently used areas in office buildings.

4. CONCLUSION

The IoT technology offers an opportunity to analyze and optimize space management and user comfort of office dwellers. Although not serving as an independent entity in contributing to the wellbeing of people, the IoT Technology creates an avenue to curbing the problem of mental health illness in office spaces. Hence, it is recommended to incorporate the use of the Internet of Things technology in people management structures, collaborating with existing ones to address mental health illness. The IoT technology should be optimized with other strategies that suit the various wellness needs of office-space users.

REFERENCES

[1] S. Madakam, R. Ramaswamy, and S. Tripathi, "Internet of Things (IoT): A Literature Review", Journal *of Computer and Communications*, *3*, 164-173, 2015. Available: https://doi.org/10.4236/jcc.2015.35021

[2] P. Radaliev, D. R. David, R. Nicolescu, and Huth, M. "A reference architecture for integrating the industrial Internet of Things in the Industry", 4.0, 2019.

[3] B. B. Gupta, Megha Quamara, "An overview of Internet of Things (IoT): Architectural aspects, challenges, and protocols", 2018. Available: https://doi.org/10.1002/cpe.4946

[4] M. A. Burhanuddin, R. Ismail, H. Basiron, A. A. Mohammed, "Internet of Things Architecture: Current Challenges and Future Direction of Research", 2017. Available: https://www.researchgate.net/publication/327417080_Internet_of_Things_Architecture_Current_Challenges_and Future_Direction_of_Research

[5] B. T. Woldearegai, and B. Das, "Perceived Causes and Treatments of Mental Illness: A Historical Review", *International Journal of Research and Analytical Reviews (IJRAR)*, 6(1), 329 – 334, 2019.

[6] A. M. Foerschner, "The History of Mental Illness: From 'Skull Drills' to 'Happy Pills'". *Inquiries Journal/Student Pulse LLC*, 2(09). ISSN: 2153-5760, 2010.

[7] Z. Steel, C. Marnane, C. Iranpour, T. Chey, J. W. Jackson, V. Patel and D. Silove, "The global prevalence of common mental disorders: A systematic review and meta-analysis 1980-2013". *Int. J. Epidemiol.* 43(2): 476-493, 2014.

[8] World Mental Health Day Report, "Mental Health in the Work Place", 2017. Available: https://wfmh.global/img/what-we-do/publications/2017-wmhd-report-english.pdf

[9] N. Pronk, "Physical Activity Promotion in Business and Industry: Evidence, Context, and Recommendations for a National Plan", p. 220-235, 2021.

[10] L. Crawshaw, "Workplace bullying? Mobbing? Harassment? Distraction by a thousand definitions" In A. B. Miller (Eds.), *Violence and abuse in society: Understanding a global crisis*, pp. 361-370, Portland, Oregon, 2009.

[11] L. Rosencrance, *Real world visible light communication applications*, Tech Target - IoT Agenda, 2016.

[12] P. Willer. *How the Internet of Things Will Impact HR*. Retrieved from Talent Management and HR, May 2016. Available: https://www.tlnt.com/how-the-internet-of-things-will-impact-hr/

[13] A. Bhattaram, *IoT Redefining HR? Time is Already Telling*, 2018. Available: https://zalaris.com/insights/blog/iot-redefining-hr-time-is-already-telling/

[14] D. Meana-Llorián, G. C. González, G-B. B. Pelayo, , L. J. Cueva and N. Garcia-Fernandez , "IoF Clime: The fuzzy logic and the Internet of Things to control indoor temperature regarding the outdoor ambient conditions", *Future Generation Computer Systems*, 275–284, 2016. Available: https://doi.org/10.1016/j.future.2016.11.020

[15] A. Nair, *How Smart Offices Improve Employee Satisfaction*. 2019. Available: https://iotforall.com/working-smarter-intelligent-office/

[16] O. Mikhalchuk, *Smart office: How IoT can improve the day-to-day life of your employees*, 2022. Available: https://gethppy.com/workplace-happiness/smart-office-how-iot-can-improve-the-day-to-day-life-of-your-employees

[17] R. Kumar, *How IoT Improves Employee Engagement and Retention*. 2018. Available: https://sightsinplus.com/hrtech/artificial/how-iot-improves-employee-engagement-and-retention/

[18] J. Stradley, *IoT Workplace Trends to Watch*. Buildings Smarter Facility Management, 2018. Available: https://www.buildings.com/news/industry-news/articleid/21670/title/five-iot-workplace-trends.

[19] S. Coppol, *How Internet of Things is changing things at the workplace*. 2018, Available: https://hackernoon.com/how-internet-of-things-is-changing-things-at-the-workplace-29a4fe945449

[20] R. Savaram, *how is Data Transforming the HR Universe?* 2019, Available: https://theiotmagazine.com/how-is-datatransforming-the-hr-universe-7f0e1acac463.

[21] John Hatcher, The impact of the internet of things on buildings, 2018. Available: https://smartbuildingsmagazine.com/features/the-impact-of-the-internet-of-things-on-buildings

[22] [5] Health Assured Team, How to Spot Mental Health Issues at Work, 2018. Available: https://www.healthassured.org/blog/spot-mental-health-issues-work/

[23] S. Nižetić, P. Šolić, G. López-de-Ipiña, D., and L. Patrono, "Internet of Things (IoT): Opportunities, Issues and Challenges Towards a Smart and Sustainable Future," *Journal of Cleaner Production,* 274, 122877. 2020. Available: https://doi.org/10.1016/j.jclepro.2020.122877

[24] S. Panchal, S. Singh, A. Chaudhari, E. Ramirez-Asis, E. D. Zarzosa-Marquez and J. Castillo-Picon, "The Impact of Psychological Changes in Mental Health on Employees Performance. International", *Journal of Early Childhood Special Education,* 14(1), 1089–1098, 2022. Available: https://doi.org/10.9756/int-jecse/v14i1.221123

[25] G. Aceto, V. Persico, and A. Pescapé, "Industry 4.0 and Health: Internet of Things, Big Data, and Cloud Computing for Healthcare", *Journal of Industrial Information Integration*, 18, 1–14, 2020. Available: https://doi.org/10.1016/j.jii.2020.100129

[26] L. J. Gutierrez, K. Rabbani, O. J. Ajayi, S. K. Gebresilassie, J. Rafferty, L. A. Castro, and O. Banos, "Internet of things for mental health: Open issues in data acquisition, self-organization, service level agreement, and identity management*", International Journal of Environmental Research and Public Health*, 18(3), 1–19, 2021. Available: https://doi.org/10.3390/ijerph18031327