

TOWARDS GREEN OFFICE: A SYSTEMATIC LITERATURE REVIEW ON SMART OFFICE INTERIOR IN MALAYSIA

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ABSTRACT

Over the last few years, many Malaysian workers have spent more hours in the workplace, contributing to sleep-deprived, overworked, and ill-health among employees. Thus, the workplace plays a vital role in operating in a secure, productive, and comfortable working climate. As to improve the future working atmosphere, a smart office for workers, employers, and designers in Malaysia need to be set up. An intelligent workplace is a work environment where technology allows people to work more comfortably, quicker, and, of course, smarter. The systematic literature review (SLR) analyzes ideas to explicitly identify and make possible the availability of potentially relevant studies by one or more defined study questions. It needs careful assessment of databases and keywords for accurate documentation in an automated search engine. The SLR study has shown that few actual scientific results from access to the smart office interior in Malaysia than the foreign one. It proposed that most employees and builders should be established in a smart office in Malaysia to create a healthier working environment and better mental well-being. Physical and physiological influences play a crucial role in the implementation of this intelligent office in Malaysia. Besides, awareness of smart office interiors can promote the environmental problem's inclusion, contributing to the requisite practicality for sustainable interior design.

Keywords: Systematic literature review, smart office, office interior, Malaysia.

INTRODUCTION

This article will be discussing on the Smart office interior in Malaysia using current papers from databases by conducting systematic literature review (SLR). Office design is vital to both employees and customers. It is essential for workers who spend a substantial part of their day in an office to build an efficient, physically pleasing, relaxed and inviting environment. The Star (2019) has reported that "53 percent of Malaysian employees get less than seven hours of rest time in the 24-hour time span, which can cause overwork and feeling restless". In other words, overworked, and restless employees who spend a long time in the office will be affected especially on their operational performance. Smart office interior, therefore, plays a central role in creating an office environment to be more convenient, relaxed, and efficient. Other than that, smart offices combine physical equipment, people, and computing technology to create a safe, friendly, engaging, and smart atmosphere for employees (Tehseen et al., 2019). Therefore, this article aims to concentrate on the preceding papers to systematically determine if Malaysians are aware on smart office interior and how many publications are published within the subject area.

LITERATURE REVIEW

The office is essentially a location for a company or a firm's financial, technical, and bureaucratic work. Based on figure 1, office evaluation has started since the 1950s and changed every decade (Chen, 2020). An office assessment is essential to collect and analyse information about a program's activities, characteristics, and outcomes (Zint et al., 2012).

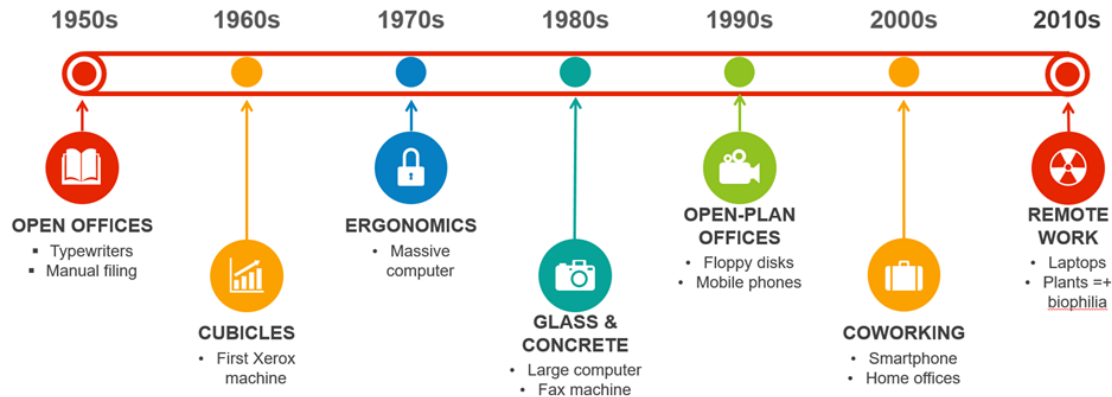


Fig. 1 Evaluation of an office

An office has a different number of office staff, depending on the size of an office. Thus, the office plays a significant role because it is the focal point of knowledge and offers information relevant to market changes to those around it. Smart space is proliferating in academia and industry due to its potential involvement in humans, computers, and physical objects (Zeng et al., 2015). According to Akyol et al. (1999), they use the word "smart space" to emphasize the office environment on three key elements that allow employees with a productive working atmosphere, the importance of the internet, and the smart space they create. Other than that, a smart office is a well-equipped office with IoT devices such as various sensors connected through the internet (Shinde et al., 2020). According to Shinde et al. (2020), with the aid of a machine and digital content, the smart bureau reduces all paperwork and intelligent offices, computerizing tasks, and information is converting to electronic form. Smart offices are also setting up to combine physical equipment, people, and computing technology to create a safe, friendly, engaging, and smart atmosphere for employees (Tehseen et al., 2019). The smart space design relates to the various challenges of technology to enhance the Quality of Experience (QoE) (Zeng et al., 2015). Furthermore, smart offices help to minimize the decision-making process providing, for example, access wherever the user is by aggregating expertise and information sources (Ramos et al., 2010). Office space operations will also be typically equipped with chairs, workrooms, PCs, and other equipment styles (Safian et al., 2012). Other than that, techniques such as hidden shelves and drawers inside walls, floors, stairs, or pieces of furniture that allow the area of the compartments to reduce and the room to be better equipped have highly efficient and adaptable furniture which can save some space (Barbosa et al., 2016). Several smart office applications, such as IoT sensors, smart lighting, intelligent climate control, smart meeting room, sleek desk, and indoor monitoring, can now be introduced in Malaysia's workplace. (*The Most Important Features for Your Smart Office in 2019*, n.d.). Apart from this, it helps decrease construction materials, waste production, and energy usage for construction air conditioning, encouraging sustainability (Barbosa et al., 2016). Smart space would also make work more comfortable (or quicker and easier) than the current systems or not be useful in the office environment (Akyol et al., 1999).

METHODOLOGY

The systematic literature review (SLR) is a literature review method that gathers and critically analyses several scientific studies or articles. A comprehensive manner includes criteria to be included, such as database sources, keywords, limits used (title, subject, and year) (Cruz-Benito, 2016). The study method included peer-reviewed papers published after 2010 from the Malaysian and international article and journal publications. Consequently, this analysis's scope has not been established in Malaysia than internationally, most of which are relevant to smart office interior publications from international publications. Therefore, the systematic literature review sought to illustrate Malaysia's intelligent office interior's previous literature systematically. It will lead to a greater understanding of workers, employers, and designers through this smart office interior.

Search Process

The searching process is a significant thing for findings in the literature. Any irrelevant information, specification is required since it involves numerous different sources. Furthermore, limit or expand the breadth of the analysis. Some considerations include selected databases, parts of publications (abstracts, full-text, or title), constraints and filters, and Boolean use. The results of the literature are valuable in interpreting and comparing the expertise of scholars. For instance, abstracts and keywords were used explicitly in this analysis to recognize research studies on the smart office interior in Malaysia. The central insight of the article written in Malaysia in smart office interiors is to be emphasizing. A total of three datasets of eight keywords have been extensively investigating.

Table 1 List of search databases, keywords, and inclusion criteria used for the literature review

Search database	Keywords	Inclusion criteria
<ul style="list-style-type: none"> • Google Scholar • Science Direct • ResearchGate 	smart office, office interior, Malaysia, smart office interior, smart space, office design, workplace design, office space	Initial screening (title, abstract and full report). English language. Scholarly publication articles and journals between 2010 until 2020. Peer-reviewed sources addressed smart office interior in Malaysia.

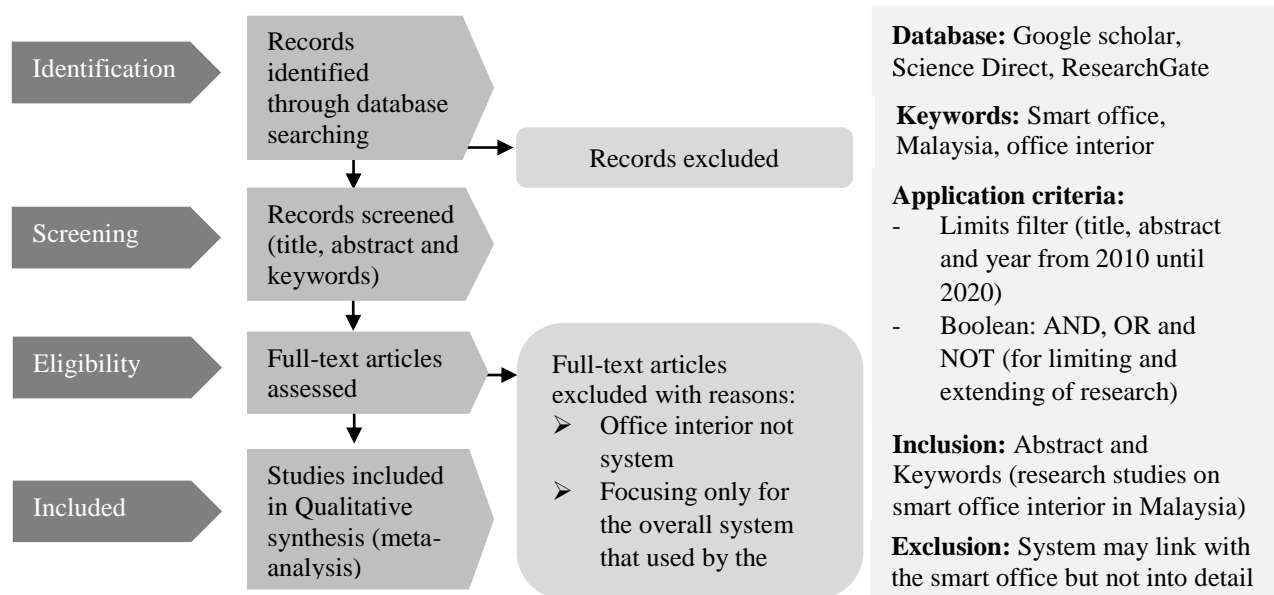


Fig. 2 Flowchart of data gathering for systematic literature review

Inclusion and exclusion

Only three databases that are relevant to the topic area for this research are studied. These databases contain the total number of articles for further research to be evaluated and obtained. Google scholar was a more prominent platform that provides a simple way to search for scholarly literature broadly. Other than that, Science Direct creates a platform for high-quality peer-reviewed scientific papers and reviews, which are typically open to everyone. Smart office, Malaysia, and office interior were the primary keywords used in this search. The abstracts and their entire selected articles should be reviewed manually and thoroughly to avoid publication bias to achieve an appropriate standard of the items. The inclusion of data evaluation will follow the requirements of a selected paper. These criteria include the terms of the search, limits (title, subject, and date), abstract screening, extraction of data, and so on. Most of the related articles can found in Google Scholar.

Table 2 List of the result from three databases with the necessary keywords.

Database	Keywords	Number results
Google Scholar	All fields (smart office AND Malaysia)	26 200
	(smart office AND office interior AND Malaysia)	7 420
ScienceDirect	All fields (smart office AND Malaysia)	595
	(office interior AND Malaysia)	441
	(smart office AND office interior)	1159
ResearchGate	(smart office AND Malaysia)	8
	(office interior AND Malaysia)	25

Data extraction

The data is collected and accordingly specified in columns. The first column suggested references to the analysis report. The second column then indicated that the article describes meanings and its description of the smart office (Y= Yes, N= No). Next, the third column illustrated the methodology of design used in the papers. Lastly, the results explaining the article are either related to the smart office's interior or not. The data are then extracted into two groups: first, under Malaysia's publication, and second, concerning the smart office interior, from the foreign publication. The table below shows a list of reviews of literature using different methodologies.

Malaysia publication articles and journals

Table 3 List of Malaysia article regarding the office interior

Research studies	Y/N	Methodology	Findings
Daylight performance and users' visual appraisal for green building offices in Malaysia, (G. H. Lim et al., 2017)	N		Equal consideration should be given to the interior design to facilitate daylighting, which is often beyond the designer's control, but in office end-users' hands. The comparison of design features between buildings has indicated the importance of interior design to allow daylight penetration and façade design to capture diffuse daylight.

On Post Occupancy Evaluation of the Preferred Luminous Environment and Occupants' Satisfaction for Office Buildings in Malaysia: A Survey, (Husini et al., 2011)	N	<ul style="list-style-type: none"> • Questionnaires • Observations 	Artificial light is a need in the office since the sky condition in Malaysia provides diffused daylight. The respondents from this observation preferred greenery view from their working space through the window, and this position will affect the occupants' perception toward the glare condition.
Application of advanced glazing to mid-rise office buildings in Malaysia (Sadrzadehrafiei et al., 2011)	N	<ul style="list-style-type: none"> • Experiment 	This paper evaluated the annual electricity consumption in a typical office building using IES software. The simulation results showed that advanced glazing would reduce the annual electricity consumption. The yearly energy saving would range from 46747 to 87311 KWh in the entire building by applying advanced glazing.
Occupant Density and Daylight Illuminance Level Fluctuation for Office Building in Malaysia, (Elina, 2016)	N	<ul style="list-style-type: none"> • Experiment • Questionnaire 	Findings from the experiment of visual performance and daylighting simulation showed fluctuation influenced by the number of occupants. It contributes towards improving an acceptable visual comfort range for Malaysian Standard of lighting conditions and helps architects and designers better understand the quality and quantity of daylighting and energy-saving strategies.
An Overview of the Influence of Physical Office Environments towards Employees, (Kamarulzaman et al., 2011)	N	<ul style="list-style-type: none"> • Existing data (literature review) 	Indoor environments in an office greatly influence employees' attitudes, behaviours, satisfaction, and work performance. Lighting and noise are considering, but the top management of organizations should consider indoor air quality, thermal comfort, and other factors.

Table 3 has indicated that most of the Malaysian articles and journals were published focusing on categories such as daylight efficiency, office setting, and office building. The Malaysian researchers have never posted smart office interior yet nowadays. The number of publications showed awareness among the designers as well as the researchers are still in the early stage. On the other hand, this shows just how important it is to introduce the smart office interior to Malaysia's perspective for the practice propose.

International publication articles and journals

Table 4 List of research studies about the smart office from the international article

Research studies	Y/N	Methodology	Findings
An Effective Energy Management System for Smart Office Cubicles using IoT (Rao Musala et al., 2018)	Y	<ul style="list-style-type: none"> Model analysis 	This paper represents the implementation of a new idea to help office employees automatically control their electric appliances and save energy. The use acquired by leaning toward this framework over comparable sorts of the existing framework is as follows. Firstly, the office cubicles are monitored as a unit wise rather than taking the office space as a whole. Second, the proposed model is cost-effective as the usage of microcontrollers like Node MCU is deploying. Third, a web page to monitor and control the office's appliances and security is initiating within the same website.
Comfort, Performance, Indoor Environment, Smart Building (Pilipová & Vilčeková, 2013)	Y	<ul style="list-style-type: none"> Questionnaires 	The impact of the monitored factors in the selected building with smart elements is received positively by users. Simultaneously, no significant adverse effects have been finding on pee indoor environment's perceived comfort. The workplace environment was rated as very well and well tolerable by users. Workplace characteristics were received positively by occupants, except privacy in the workplace. Results show that visual contact with the exterior, contact with plants from the exterior and interior, and stay in rest areas positively impact users' comfort and performance.
Integrated Semantics Service Platform for the Internet of Things: A Case Study of a Smart Office (Ryu et al., 2015)	Y	<ul style="list-style-type: none"> Prototype analysis 	This paper proposes an integrated semantic service platform (ISSP) to support ontological models in various IoT-based service domains of a smart city. To show the feasibility of the ISSP, they develop a prototype service for an intelligent office using the ISSP, which can provide a pre-set, personalized office environment by interpreting user text input via a smartphone.

Services and Applications for Smart Office Environments A Survey of State-of-the-Art Usage Scenarios (Röcker, 2010)	Y	<ul style="list-style-type: none"> • Scenario analysis 	This paper reported on a survey of state-of-the-art application scenarios for smart office environments. Based on an analysis of ongoing research activities, representative functionalities and future office systems' services extracted. The analysis results show that smart office environments' vision is not as vague and unclear as often argued, as current technological developments revolve around a few identifiable topics.
The Network Architecture Designed for an Adaptable IoT-based Smart Office Solution (Furdik et al., 2013)	Y	<ul style="list-style-type: none"> • Prototype analysis • Scenario analysis 	The scenario-based tests focused on the suitability of the provided technology and the overall acceptance of the involved users' solution. The system prototype's IoT network architecture has been evaluating as suitable and advantageous for the Smart Office system, namely scalability and installed devices' adaptability.
Smart Office Automation System for Energy Saving (Selvaraj, 2017)	Y	<ul style="list-style-type: none"> • Model analysis 	This article proposes a low cost and user-friendly smart office automation system for energy saving. This concept's main advantage is no need to care about fans and light because it is fully automated. The proposed idea is robust, reliable, and requires less maintenance.
Prototype of smart office system using based security system (Kao et al., 2018)	Y	<ul style="list-style-type: none"> • Software analysis • Prototype analysis 	The smart office system prototype in the security system consists of a security system inside the building and an autonomous robot designed using Arduino Mega 2560. It was integrated with Raspberry Pi using the Internet of Thing (IoT) transmission media with platform cayenne and system development stages using the waterfall method. The smart office system prototype's security system designing using several sensors such as metal sensor, fire sensor, vibrator sensor (SW-420 sensor), RFID sensor, passive infrared, keypad, and Magnet switch sensor.

International publications show quite a number of publications in smart office as compared to the Malaysian publications. Most of the papers have defined the term smart office for better understanding. This article and journal provide less focus in detailing the interior design part but focus more detailing in the system. As a reference in the future, all of these resources are good for a Malaysian guideline to implement.

RESULTS

The above literature findings have identified the meaning of smart office that has a great concern towards worker's performance. Other than that, using a smart office will also improve the quality of life, like workers' mental and physiological states such as sleepiness and concentration, and control the working environment (Kiyokawa et al., 2012). Enhancing the new technology and system into the smart office from the international publication might help implement Malaysia's smart office. Based on the systematic literature review above, Malaysian researchers were found to be lagging in terms of development of the smart office approach as compared to the international researchers. Most of the international articles discussing the smart office interior affect the functional performance of the employee. Working version among the employee plays an essential role as Malaysia has a relatively more significant number overworked, restless, and spend a long time in the office. Some of the articles also approached the system and features technology that is suitable for the smart office. Choosing the right technology and method for a smart office will be lowering the usage of energy consumption of that office that might reduce the effect of global warming. Different technology and system approach towards the smart office will have various advantages and outcome. Besides, an intelligent building can also be considered the more significant factor influencing the smart office interior. Some of the offices might be located inside the big building as an office has several office types. Other than that, the office interior's sustainability can also use as the primary point to become a smart office. They are using the term smart space for focusing the office environment with three goals: enable the workers with an efficient work environment, the internet's role, and trying to live in the smart space that they build (Akyol et al., 1999).

CONCLUSION

The systematic review enables future researchers to evaluate further and assess the vital role of the smart office interior in Malaysia. The findings above show that international publications have numerous papers approaching the smart office interior as compared to Malaysia. Hence, it creates a research gap in Malaysia that still has minimal awareness of Malaysia's intelligent implementation office. Most international papers focus on the technology and system they have been proposing to use for the smart office rather than an office's interior. Therefore, these examples from the researchers will help design the smart office based on their preferences to solve their employee issues. Apart from the office interior, their satisfaction becomes more and more critical in office design. Environmental psychology has been studied by empirical researchers from the ergonomics field, which generally gives immediate responses towards the working environment (Kwon & Remøy, 2020). Future research should detail each technology and system approach for the researchers' smart office to identify the right one for implementation suitable for an office, especially in Malaysia. The structuring of each example of technology and system proposed from the previous research is also an excellent analysis to recognize its advantages.

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REFERENCES

- Akyol, B. A., Jackson, A. W., Krishnan, R., Mankins, D., Partridge, C., Shectman, N., & Troxel, G. D. (1999, March). Smart Office Spaces. In USENIX Workshop on Embedded Systems (pp. 29-31).
- Barbosa, J. A., Araújo, C., Mateus, R., & Bragança, L. (2016). Smart interior design of buildings and its relationship to land use. *Architectural Engineering and Design Management*, 12(2), 97–106. <https://doi.org/10.1080/17452007.2015.1120187>
- Chen, G. (2020). *Office Space Timeline: Past, Present, and Future [INFOGRAPHIC] | HubbleHQ*. <https://hubblehq.com/blog/office-space-timeline-past-present-future-infographic>
- Cruz-Benito, J. (2016). *Systematic Literature Review & Mapping*. <https://doi.org/10.5281/zenodo.165773>
- Furdik, K., Lukac, G., Sabol, T., & Kostelnik, P. (2013). The Network Architecture Designed for an Adaptable IoT-based Smart Office Solution. *International Journal of Computer Networks and Communications Security*, 1(6), 216–224. <http://sourceforge.net/projects/linksmart/>,
- Kao, K., Chieng, W., Jeng, S., Sari, M. W., Wahyu, P., & Hardyanto, R. H. (2018). *Prototype of smart office system using based security system* *Prototype of smart office system using based security system*.
- Kiyokawa, K., Hatanaka, M., Hosoda, K., Okada, M., Shigeta, H., Ishihara, Y., Ooshita, F., Kakugawa, H., Kurihara, S., & Moriyama, K. (2012). Owens Luis - A context-aware multi-modal smart office chair in an ambient environment. *Proceedings - IEEE Virtual Reality, Figure 1*, 1–4. <https://doi.org/10.1109/VR.2012.6180951>
- Kwon, M., & Remøy, H. (2020). *Office employee satisfaction : the influence of design factors on psychological user satisfaction*. 38(1), 1–19. <https://doi.org/10.1108/F-03-2019-0041>
- Pilipová, I., & Vilčeková, S. (2013). Occupants' Comfort and Performance in a Building with Smart Elements-A Case Study. *International Journal of Construction Engineering and Management*, 2013(4), 113–121. <https://doi.org/10.5923/j.ijcem.20130204.03>
- Ramos, C., Marreiros, G., Santos, R., & Freitas, C. F. (2010). *Smart Offices and Intelligent Decision Rooms*. 851–880. <https://doi.org/10.1007/978-0-387-93808-0>
- Rao Musala, V., Musala, #, Rao, V., Rama Krishna, T. V, Ganduri, R., & Roohi, A. (2018). An effective energy management system for smart office cubicles using IoT Content addrebale memory View project An Effective Energy Management System for Smart Office Cubicles using IoT. In *Article in Journal of Advanced Research in Dynamical and Control Systems* (Vol. 10). Special Issue. <https://www.researchgate.net/publication/327046635>
- Röcker, C. (2010). Services and applications for smart office environments - A survey of state-of-the-art usage scenarios. *World Academy of Science, Engineering and Technology*, 61, 385–401. <https://doi.org/10.5281/zenodo.1078842>
- Ryu, M., Kim, J., & Yun, J. (2015). Integrated semantics service platform for the internet of things: A case study of a smart office. *Sensors (Switzerland)*. <https://doi.org/10.3390/s150102137>
- Safian, M., Ezwan, E., & Hadi, A. (2012). *Munich Personal RePEc Archive The characteristics of purpose built offices in Malaysia : a review of issues*. 39422.
- Selvaraj, K., & Chakrapani, A. (2017). Smart office automation system for energy saving.

- International Journal of Advances in Computer and Electronics Engineering*, 2(9), 8-12..
- Shinde, R. M., Deval, N. D., & Kadam, S. S. (2020). *Smart office*. 11(6), 1006–1009.
- Tehseen, M., Javed, H., Mehmood, A., Amin, M., Hussain, I., & Jan, B. (2019). Multi Modal Aptitude Detection System for Smart Office. *IEEE Access*, 7(January), 24559–24570. <https://doi.org/10.1109/ACCESS.2019.2893202>
- The Most Important Features for Your Smart Office in 2019*. (n.d.). Retrieved June 10, 2020, from <https://www.askcody.com/blog/the-most-important-features-for-your-smart-office-in-2019>
- What Is a Smart Office? History, benefits and hot desking apps. — Do You Want To Optimise Your Workspace?* (n.d.). Retrieved March 12, 2020, from <https://www.iotSPACE.co.uk/blog/2018/7/20/what-is-a-smart-office>
- Zeng, J., Yang, L. T., Ning, H., & Ma, J. (2015). A systematic methodology for augmenting quality of experience in smart space design. *IEEE Wireless Communications*, 22(4), 81-87.
- Zint, M., & Montgomery, N. (2012). Evaluation: What is it and why do it. available online on <http://meera.snre.umich.edu/plan-an-evaluation/evaluation-what-is-it-and-why-do-itc> last accessed 27th Jan.