British Journal of Applied Science & Technology
13(1): 1-13, 2016, Article no.BJAST.21783
ISSN: 2231-0843, NLM ID: 101664541

SCIENCEDOMAIN *international*
www.sciencedomain.org

Effect of Perceived *Muda* on Perceived Job Productivity in Public Office Buildings in Nigeria

A. Adeyemi[1*], D. Martin[1] and R. Kasim[1]

[1]Faculty of Technology Management and Business, Universiti Tun Hussein Onn Malaysia, Batu Pahat, 86400 Johor, Malaysia.

Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/BJAST/2016/21783
Editor(s):
(1) Orlando Manuel da Costa Gomes, Professor of Economics, Lisbon Accounting and Business School (ISCAL), Lisbon Polytechnic Institute, Portugal.
Reviewers:
(1) Ioannis Makedos, University of Macedonia, Greece.
(2) Rebecca Abraham, Nova Southeastern University, USA.
(3) Tsung-Yu Hsieh, MingDao University, Taiwan.
Complete Peer review History: http://sciencedomain.org/review-history/12155

Original Research Article

Received 3rd September 2015
Accepted 10th October 2015
Published 7th November 2015

ABSTRACT

Aims: The lean thinking concept, especially the application of *muda* was claimed to apply to a vast range of operations in widely differing industries, with only "tweaking of details". Thus, varying industries adopted the concept including the built environment from whence terms such as lean construction and lean design emerged. The substantial argument was that the concept had delivered large improvements where already applied, this paper therefore looked into the practicability of applying lean thinking to perceived job productivity as a first step in determining its relevance to sustainable improvement of existing public office buildings in Nigeria, since job productivity was described as the quintessence of an office.
Study Design: The theoretical framework study adopted an objective positivist philosophy, using survey and case study strategy. The method is quantitative while the time horizon is cross-sectional.
Place and Duration of Study: Federal Secretariat office complex, Bauchi, Nigeria, between June 2014 and September 2014.
Methodology: AMOS regression was used for the confirmatory study on a sample size of 339 respondents from a diagnostic POE. The unique contribution, causal effect, effect size and practical

**Corresponding author: E-mail: babaguze@yahoo.co.uk;*

significance were used in determining the effect of *muda* on job productivity.
Results: Perceived *muda* was established as inherent in the case study and ranked based on their respective unique contribution which ranged from 0.848 to 0.472. *Muda* has a causal effect of 0.646 on job productivity and a strong effect size of 42%. All the results were significant with P-values of <.05.
Conclusion: Perceived *muda* has strong influence on perceived job productivity, especially by affording end-users to contribute to their requirements in office buildings, while it explained 42% of its variance; which is a strong effect size. This had confirmed that *lean thinking* is applicable to public office buildings in Nigeria and therefore relevant to their sustainable improvement.

Keywords: Lean thinking; Muda; job productivity; sustainable improvement; user requirement.

1. INTRODUCTION

In its bid for Sustainable Development (SD), the UN Earth Summit of 1992 in Rio de Janeiro, Brazil called on member States to adopt and integrate the principles of SD into their national policies and programmes which would build upon and harmonize the various sectoral economic, social and environmental policies and plans operating in their respective countries [1]. However, over 20 years later (termed Rio + 20) many countries, especially in the developing world were yet to make significant headway in their quest for SD of their built environment [2,3].

A major cause attributed to this was the neglect of existing buildings which form the bulk of built assets in our cities [4]; they were developed decades ago when sustainability was not a consideration [5]. According to Wood [6], sustainability cannot be achieved without addressing existing building stock as it is unlikely that new build alone would deliver a sustainable built environment in the near future. Mickaityte et al. [7] noted that current improvement of existing buildings excluded major inputs from end-users, thus sustainable improvement is a significant problem in current building stock. Public office buildings in Nigeria was chosen, because they are constant subjects of discussion by eminent Nigerians and scholars alike in the country, while they also form the bulk of Nigerian property news in publications and on the internet.

This paper thus look at the sustainable improvement of existing public office buildings, especially the impact of *muda* (from users' viewpoint) on perceived job productivity, which [8] described as the quintessence of an office building. Brandon & Lombardi [4] estimated that 87% of existing building stock will still be standing by 2050 which therefore goes without saying that existing building stock requires effective sustainable improvement that will sufficiently reflect users' requirements, especially in developing countries like Nigeria with an estimated population of over 170 million people [9], the 6th most populous country in the world, the most populous and largest economy in Africa [10].

2. LITERATURE REVIEW

2.1 Waste and Inefficiencies (*Muda*)

The basic function of a building (including offices) is to provide structurally sound and environmentally controlled spaces to house and protect occupants and contents, but this basic function is not achieved if some aspects of the building fail and the needs of the occupants are not met according to the definition of SD. Failures of basic building functions can range from defects in single components such as windows to extensive deficiencies in an entire exterior wall system. The source of these deficiencies can include inadequate design, improper execution of the work, defective materials, or simply normal and expected aging perhaps coupled with lack of maintenance [11].

Womack & Jones [12] likened these failures to waste and inefficiency, which they defined as any facility, which absorbs resources but does not create the required value. The AED [13] also defined waste as any material unused and rejected as worthless or unwanted, while inefficient was defined as not producing desired results, or lacking ability to perform effectively. An example of waste in a building is when utility costs incurred on a building could be reduced with proper design, which allows for day lighting to replace electrical lighting.

'Inefficiencies' in office buildings can also be seen as when a building or its components not having the ability to function effectively. An example given by Adeyemi et al. [1] is a building

having two-ply sliding window in a humid and hot environment without provision for artificial ventilation; in such situation, the window can only provide a maximum 50% opening as compared to louvres that can provide up to 95% opening. Thus the former has more of aesthetic value than functional value; the sliding window may therefore be regarded as inefficient because it does not have the 'ability' to provide enough ventilation in a hot and humid environment without further provision for artificial ventilation, whereas it can be more efficient in temperate regions or in built assets with further provision for artificial ventilation such as air conditioners. This problem is more pronounced in developing countries where electricity supply is very erratic and thus, even the provision of artificial ventilation may still not solve the problem of the 'inefficient' windows [1].

According to Spring [14], architects are often criticized for giving preference to aesthetics rather than functionality and in so doing are mainly responsible for most *muda* inherent in building designs. Improper use of day lighting due to wrong design or placement of window(s) can reduce productivity in offices and increase employee absenteeism due to the possibility of extremely high lighting levels, excessive glare, and high temperatures [8,11].

This paper appreciates that waste is extensively used in a different perspective in environmental management, especially for garbage, refuse, scraps, etc.; these could be termed tangible waste. However, in recent times emphasis is also given to intangible waste, and promoted by models such as Lean Thinking, Zero Emissions and Green Building. In this paper therefore, the intangible waste was emphasized above tangible waste and it is considered as anything that does not provide the required value to the ultimate user [12]. In order not to confuse the two, waste and inefficiencies in this study were henceforth referred to as '*muda*' (Japanese word for intangible waste and inefficiency, promoted by [15].

2.2 The Concept of *Muda* in Lean Thinking

Lean thinking has the underlying philosophy that by identifying and eliminating muda, standard (hence performance) can be improved to meet users' requirement [16]. The concept of muda (seen as the opposite of value) became one of the most important concepts in quality improvement activities primarily originated by Taiichi Ohno's famous production philosophy from Toyota in the early 1950s. He realized on his visit to Ford Motors, in USA that there was too much *muda* in the production line, which he classified into 7, namely: defect/error, inventory, waiting/delay, motion, transportation, over-processing and overproduction [15]; this Toyota production system is what is branded as lean thinking by [17]. Womack & Jones [12] later added the 8th driver - human talent.

According to Nicholas & Soni [18], the two overarching philosophy of lean thinking for sustainability are elimination of *muda* and continuous improvement (or *kaizen* in Japanese). Wang [19] explained that kaizen is a system of continuous improvement in quality, technology, and safety, while Jylhä & Junnila [20] defined it as the effort for perfection which is never reached, but creates the urge to make improvements, as there is no end to *muda* elimination. *Kaizen* works by utilizing everyone's knowledge to identify and implement improvements quickly [21].

The concept can be applied to varied operation and processes in widely differing industries, offices, health care, etc. with only "tweaking of details" [18]. Thus, varying industries have since adopted the concept, including the construction industry from whence terms such as lean construction and lean design emerged. The substantial argument was the claim that the approach had delivered large improvements in manufacturing, in particular the motor vehicle industry, and where already applied in construction.

Schipper & Swets [22] also opined that muda is universal, appearing in every situation and they remain constant, but the definitions of the terms will change and adapt to describe the situation to which it is applied. Likewise, Finch [23] argued that the tools and principles of *lean thinking* cannot simply be exported from one environment to another without carefully analyzing the nature of the new environment. Thus, the *muda* drivers adopted for in this paper were modified to suit the concept and objectives of the study as depicted in Table 1. Devellis [24] claimed that theory plays a vital role in the conceptualization of measurement variables.

Table 1. Concept of *Muda* drivers for office buildings [25]

S/N	*Muda* drivers	Modified description
1	Defect	Situation where one or more elements of a building do not perform their intended function [26]; and failure in the function, performance, statutory or user requirements of a building that manifests itself within the structure, fabric services or other facilities of the building [27].
2	Inventory	Storage facilities; and building materials kept for maintenance that are not necessary or have short life spans.
3	Waiting	Delay, due to inadequate provisions for access to carry out maintenance activities, etc.
4	Motion	Wasted human motion is related to workplace: ergonomic design negatively affecting productivity, quality & safety e.g. walking, reaching and twisting [28].
5	Transportation	Distant location of complimentary offices and other ancillary rooms causing unnecessary movements for users.
6	Over-processing	Adding Design Features not needed by users, e.g. bath tubs in general convenience; irregular office shapes that reduces functionality; etc.
7	Overproduction	Large spaces, too many corridors, etc. which are not appreciated by users.
8	Human talent	Non-inclusion of end-users' input (or talent) in design, maintenance or improvement policies. How could people be better involved in continuous improvement?

2.3 Job Productivity

Gou [29] reported that office workers nowadays spend almost 90% of their time indoors, implying that IEQ conditions (i.e. air quality, temperature, lighting and noise) would consequently have far-reaching implications on their health and job productivity. A leading argument for economic sustainability is the belief that sustainable office buildings are healthier and lead to job satisfaction, less employee absenteeism and higher levels of job productivity thereby boosting overall profitability of office occupiers [30,31]. Satisfaction with the physical working environment was also reported as directly related to job satisfaction and productivity [32].

Haynes [8] observed that the quintessence of an office is job productivity and thus developed a validated theoretical framework for the measurement of perceived job productivity based on 2 data sets of physical environment and behavioural environments (Fig. 1). In the framework, 4 components were identified, namely: comfort, office layout, interaction and distraction (Table 2); the framework is related to the superstructure of built office environment, in line with the scope of this study and was thus adopted.

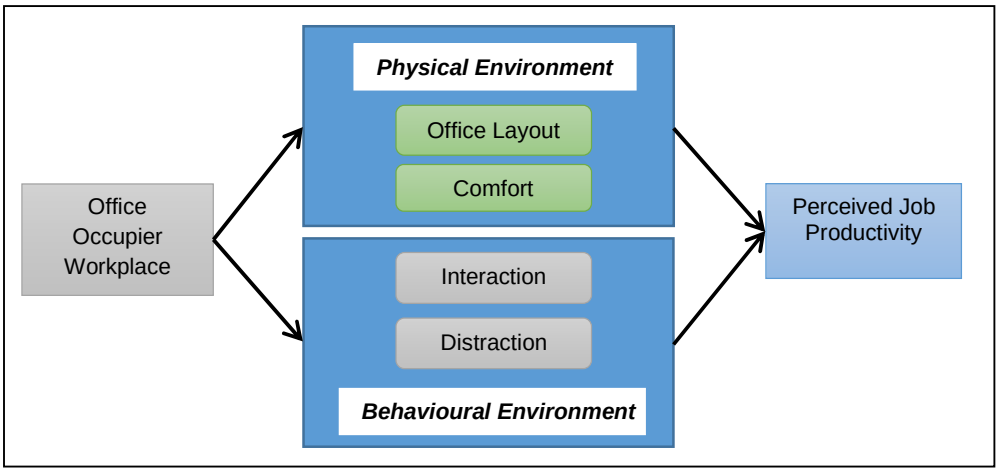

Fig. 1. Theoretical framework of perceived job productivity [33]

Table 2. Four components of job productivity [8]

S/No.	Components	Attribute
1	Comfort	Temperature; natural lighting; décor; c*lean*liness; security
2	Office layout	Storage facilities; office shape and size; ergonomics; circulation routes
3	Interaction	Social interaction; work interaction; aesthetically pleasing i.e. modern attractive with regular upkeep; creative physical environment; refreshment areas; creative environment
4	Distraction	Noise/concentration; toilet facilities; downtime; health; electricity

2.4 User Requirement and Self-assessed Job Productivity

According to Jylhä & Junnila [34], facility management literature in recent years had discussed the shift from bricks and mortar to an end-user-driven mindset; the focus is no longer only on cost minimization and real estate operations but rather on supporting end-users, while [35] opined that knowledge of the expectations of end-users is required in order to make proper decisions connected with the improvement of office buildings. Studies have shown that users' requirements were not well captured in purported sustainably improved buildings [36,37]. Jylhä & Junnila [20] thus rightly opined that the ultimate goal is to produce and deliver occupants' requirements and only the occupants themselves can define it.

Love & Bullen [38] opined that current assessment systems of performance of existing buildings pose challenging problems because they do not provide a full profile of sustainability since they excluded major inputs from end-users. Hebert & Chaney [39] also observed that very few published studies have reported the use of end-user surveys during the design process to inform the improvement of a facility.

Karna [40] defined users' satisfaction as when the quality of a service meets or exceed their expectations; thus they are not satisfied otherwise. From this perception, an important attribute of user satisfaction that could serve as a measure of performance is the reference to the user as a key determinant of quality [41]. Therefore, every quality improvement needs to be directed towards ensuring that products fulfill the requirements and specifications assigned from users' standpoint [42].

Thus, the most important factor as a benchmark for a building improvement to meet sustainability objectives is the level of users' requirements and satisfaction incorporated in it [43]. Black [44] observed that world class services/products incorporate intense end-user focus in which the end-user is an indispensable part of the process. He gave the example of Boeing (aircraft manufacturer) who involves users' views in its production process in what is termed *aggressive listening*; the building industry also needs to focus on end-users' satisfaction in order to generate world class facilities.

Veitch [45] also argued that the relationship between users and the office building cannot be reduced to functionality, as users do not assess their requirement on the basis of simple physical comfort, but bring their feelings, memories, expectations, and preferences into their assessment, which increases the complexity of the outcomes being measured. This had therefore led to the acceptance of self-assessed performance [37,29,46], and thus adopted for this paper. Haynes [8] argued that since there was no universally accepted means of measuring job productivity, there appears to be acceptance that a self-assessed measure of productivity is better than no measure of productivity, while Oseland & Bartlett [47] also opined that self-assessment of productivity was not a new measure, and went on to argue that perceived productivity could be as important as actual productivity. The relationship between user requirement and job productivity from literature is illustrated in Fig. 2.

3. METHODOLOGY

The confirmatory study adopted the quantitative method, supported by qualitative method, while the research strategy involved the use of survey, direct observation and case study approach. Qualitative method involved the review of relevant literature from which questionnaires were designed and administered to the occupants of case study building. Quantitative method involved the use of SPSS, AMOS (being a confirmatory analysis tool), while the causal effect, effect size and practical significance were used in determining the effect of perceived *muda* on perceived job productivity [48]. A preliminary

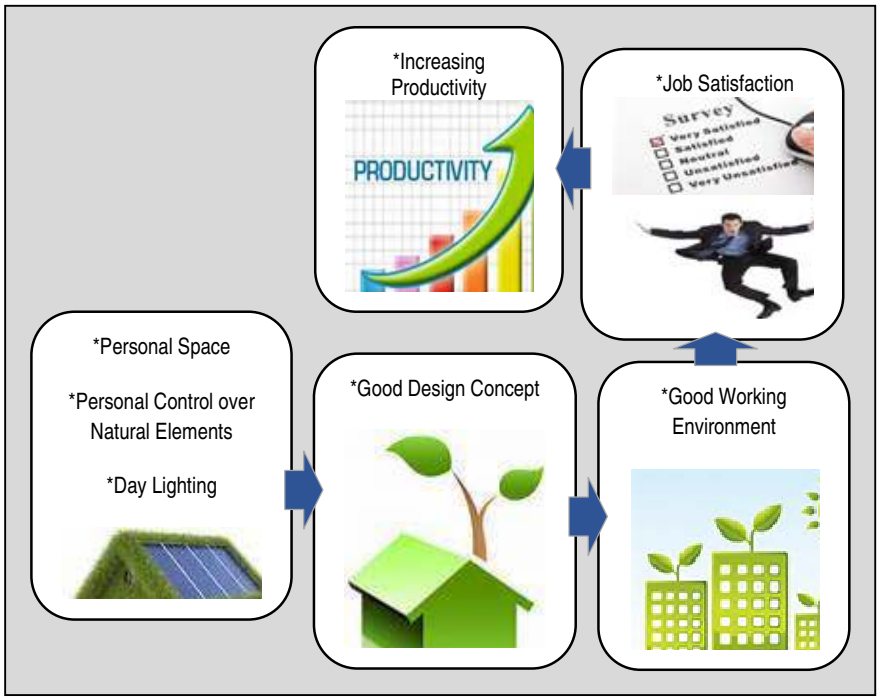

Fig. 2. Office environment and job productivity relationship impression

Confirmatory Factor Analysis (CFA) was conducted to ensure that there was no violation of the assumptions of unidimensionality, validity, reliability and normality, such that any item that does not fit the measurement model was removed.

The diagnostic POE tool was adopted for this study, while its working depth was limited to the systematic evaluation of opinion to establish perceived *muda* and its effect on perceived job productivity from occupants' perspective through questionnaires, in order to assess how well the building match their satisfaction, expectancies and needs, and identifies ways to sustainably improve the building standard, performance and fitness for purpose [49]. Acquired data relates to the SD triple bottom line (TBL) components of environmental, economic and social dimensions [50], but limited to:

(a) The 'environment' covering issues, which include temperature, ventilation, air quality, glare, daylight and noise [42];
(b) The 'economy' covered issues of occupants' satisfaction and comfort through the provision of adequate space, services and facilities thereby increasing job productivity. Satisfaction with the physical working environment seems to be directly related to job productivity [32].
(c) The 'social' covered the issue of aesthetics; where buildings having pleasing aesthetic qualities with prompt repair and regular upkeep, enhancing their surroundings and the well-being of humans [51].

Preliminary analyses were performed on all the measurement models using the

The Federal Secretariat complex, Bauchi (Fig. 3); a massive public building in Nigeria was chosen as case study because of more dire need for improvement in developing nations [52,53,3]. Eisenhardt [54] suggested that a single case study method tends to be more appropriate to confirm or challenge a theory or address a rare or unusual situation.

The case was selected because of the circumstances surrounding it and the researcher's in-depth local knowledge of the building as listed below:

i. The building was designed and constructed decades ago when sustainable development was not a consideration [5];
ii. It has not undergone any major improvement work since its construction;

iii. The building is still operational and not abandoned;
iv. A massive structure with 26 government offices with a combined staff strength of 971; and
v. The staff combination reflects the federal character and quota system of the nation.

According to McIntyre [55], a representative sample is crucial if evidence from the sample is being used to make generalizations about the larger population from which the sample was selected. However, all the occupants of the Federal Secretariat building, Bauchi, Nigeria were adopted as the research sample size, to reflect the *federal character* and *quota system* of the nation [56]. The questionnaire was distributed to the 971 staff at the case study, thus no sampling technique was employed. However, a sample size calculator was used to estimate the minimum sample size of 280 required for the study [57]. The retrieved and useable questionnaires was 339.

The variance in perceived job productivity was diagnosed from an integrated perspective [31], first using simple frequency distribution of the processed data from user standpoint based on the physical and behavioural environments data sets [33] after which AMOS regression analyses were conducted to determine whether the sub-constructs loads well and to evaluate the causal effect.

4. RESULTS AND DISCUSSION

4.1 Establishment of Perceived *Muda* and Ranking

Fig. 4 depicts the regression weights of the *muda* drivers predicting perceived *muda,* while Table 3 showed the summary of the good Fitness Indexes (FI).

The study confirmed that *muda* is inherent in the subject building thus confirming [18,22,23] who argued that *muda* is universal, appearing in every situation and they remain constant. Figure 4 and Table 5 showed the unique contributions of the drivers with their respective beta coefficients. According to Pallant [58], the driver with the largest beta coefficients makes the strongest contribution; the drivers were thus ranked based on their respective beta coefficients, which indicate the unique contribution of each sub-construct to explaining perceived *muda*.

The corresponding effect size of R^2 of the drivers are all strong, save Waiting (WAT) with a moderate range of 0.22. Table 4 shows the interpretation of effect sizes by Adams & Lawrence [48] and Awang [59], while Table 5 shows the regression weights of the *muda* drivers have significant coefficients.

Fig. 3. Federal Secretariat Complex, Bauchi [25]

Table 3. Summary of fitness indexes for *Muda* constructs

Name of category	Name of index	Index value	Comments
Absolute fit	RMSEA	0.026	The required level is achieved
	GFI	0.911	The required level is achieved
Incremental fit	CFI	0.982	The required level is achieved
Parsimonious fit	Chisq/df	1.225	The required level is achieved

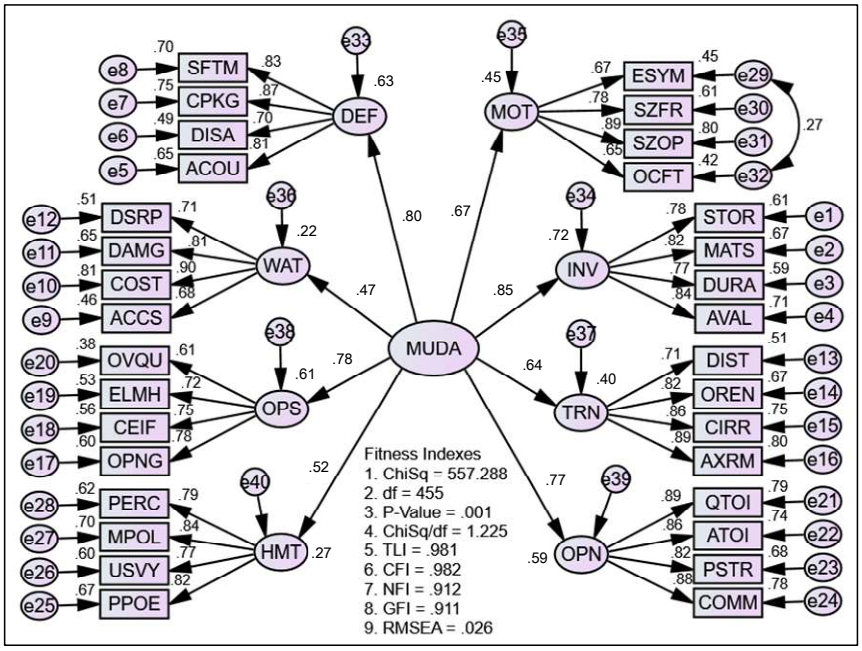

Fig. 4. Regression weights of sub-constructs predicting *Muda*

Table 4. Interpretations of R^2 effect sizes

Cohen (1988) [59]		Adams & Lawrence (2015) [48]	
Range of R^2	**The effect size**	**Effect size range**	**Interpretation**
Below 0.13 (i.e. 13%)	Small Range	1-4%	Weak
Between 0.13 to 0.26	Medium Range	9-25%	Moderate
Above 0.26	High Range	25-64%	Strong

Table 5. The regression weights and P-value of sub-constructs predicting *Muda*

Sub-Constructs	Path	Main Construct	Beta Estimate	S.E.	C.R.	P-Value	Result	R^2	Beta Ranking
HMT	←	MUDA	.523	.109	7.000	***	Significant	0.27	7
OPN	←	MUDA	.770	.231	7.082	.004	Significant	0.59	4
OPS	←	MUDA	.782		Reference Point			0.61	3
TRN	←	MUDA	.636	.101	7.531	***	Significant	0.40	6
MOT	←	MUDA	.669	.237	5.980	***	Significant	0.45	5
WAT	←	MUDA	.472	.057	3.814	.025	Significant	0.22	8
INV	←	MUDA	.848	.098	9.006	***	Significant	0.72	1
DEF	←	MUDA	.796	.092	5.730	***	Significant	0.63	2

**** indicates highly significant at <0.001 [60,61].*

4.2 Variance in Perceived Job Productivity from Users' Perspective

From the frequency distribution of the data acquired during survey (depicted in Table 6), users' perception of the variance of job productivity within the office complex revealed that apart office layout, all other components have negative impacts on perceived job productivity.

4.3 Job Productivity Construct Loads well on Its Sub-Constructs

Fig. 5 depicts the regression weights of perceived job productivity constructs with good FI (Table 7). The results indicated that perceived job productivity loads well on its four sub-constructs; the factor loading of Perceived Job Productivity on Comfort (CFT) is 0.78, Office Layout (OFL) is 0.65, Interaction (INT) is 0.96,

and Distraction (DST) is 0.71 (Fig. 5), they are all above the threshold of 0.6 and thus confirm that perceived job productivity consists of the 4 components and can thus be used for further analysis [60].

Table 6. Respondents' perception of perceived job productivity sub-constructs

S/No	Job productivity sub-constructs	Mean	Standard deviation	Users' perspective
Comfort component (CFT)		***2.94***	***0.743***	***Negative***
1	Level of illumination (DAYL)	3.02	0.808	Positive
2	Level of c*lean*liness (HYGN)	2.92	0.812	Negative
3	Level of décor (OVRF)	3.14	0.820	Positive
4	Level of security (SCTY)	2.88	0.834	Negative
Office layout component (OFL)		***3.14***	***0.795***	***Positive***
5	Storage facilities (STRR)	2.96	1.033	Negative
6	Office shape (OFSH)	3.13	0.946	Positive
7	Office ergonomics (OFEG)	3.28	0.921	Positive
8	Circulation routes (PSSG)	3.09	1.000	Positive
Interaction component (INT)		***2.75***	***0.794***	***Negative***
9	Social interaction SINT)	2.74	0.905	Negative
10	Work interaction (WINT)	2.70	0.879	Negative
11	Aesthetic qualities (AEST)	2.75	0.846	Negative
12	Refreshment areas (RFSH)	2.76	0.846	Negative
Distraction component (DST)		***2.59***	***0.818***	***Negative***
13	Noise and disturbance (NOIS)	2.76	0.881	Negative
14	Toilets' sanitation level (TOIS)	2.57	0.915	Negative
15	Frequency of downtime (DNTM)	2.62	0.910	Negative
16	Electricity supply (ELEC)	2.42	0.878	Negative

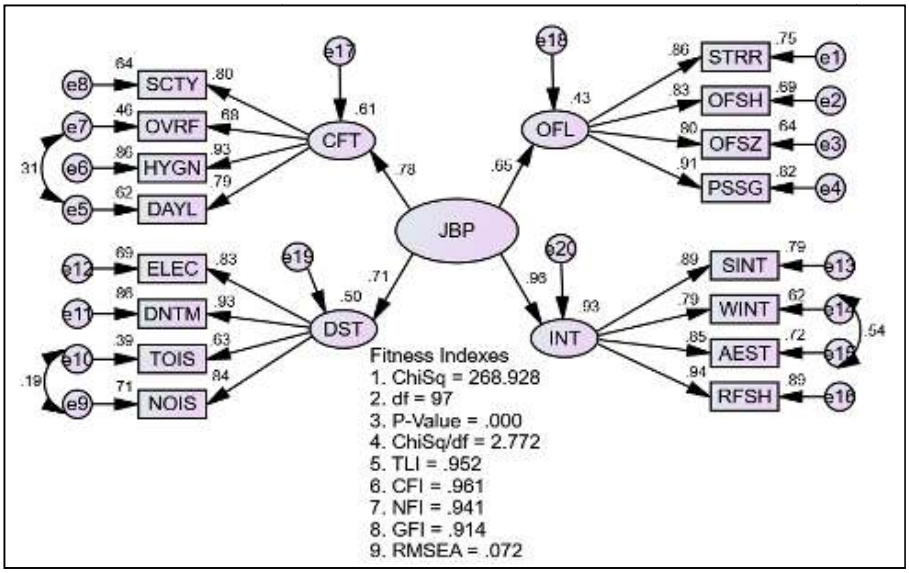

Fig. 5. Regression weights of perceived job productivity sub-constructs

Table 7. Summary of FI for job productivity constructs

Name of category	Name of index	Index value	Comments
Absolute fit	RMSEA	0.072	The required level is achieved
	GFI	0.914	The required level is achieved
Incremental fit	CFI	0.961	The required level is achieved
Parsimonious fit	Chisq/df	2.772	The required level is achieved

Table 8 shows the path analysis of perceived job productivity on its sub-constructs, together with their respective level of significance and beta estimate.

4.4 Causal Effect of Perceived *Muda* on Perceived Job Productivity

Fig. 6 is the proposed structural model with good FI (Table 9), and it depicts the causal effect of perceived *muda* on perceived job productivity (Table 10), with a highly significant coefficient. The standardized beta estimate of 0.646 reflects the amount of causal effect of perceived *muda* on perceived job productivity, thus when *muda* goes up by 1 unit job productivity will also go up by 0.646 unit. Furthermore, the R^2 of 0.42 (Fig. 6) indicated a strong effect size of *muda* on job productivity, implying that inherent perceived *muda* explains 42% of the variance of perceived job productivity within the office complex.

Table 8. Effect of perceived job productivity on sub-constructs and significance

Sub-Constructs	Path	Main-construct	Beta estimate	S.E.	C.R.	P-value	Result
DST	←	JBP	.710	.103	10.213	***	Significant
INT	←	JBP	.964	.129	11.988	***	Significant
OFL	←	JBP	.653	.120	9.734	***	Significant
CFT	←	JBP	.783	Reference point			

**** indicates highly significant at <0.001 [58,61].*

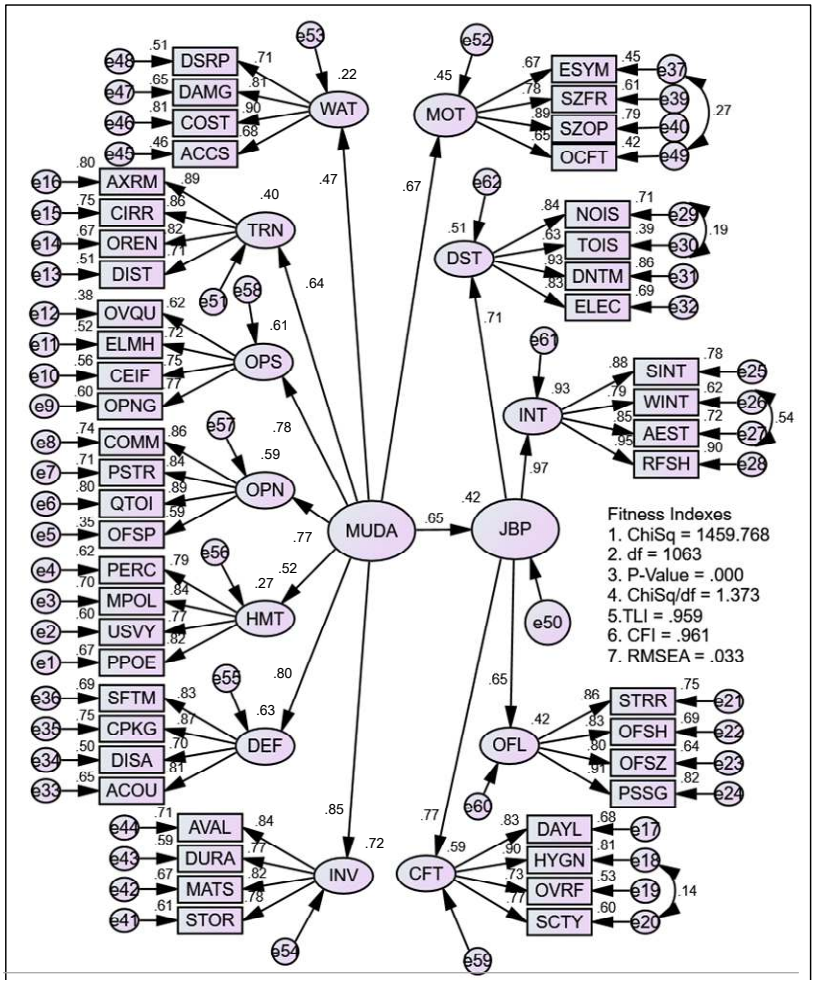

Fig. 6. The proposed structural model in standardized estimates

Table 9. Summary of FI for the structural model

Name of category	Name of index	Index value	Comments
Absolute fit	RMSEA	0.033	The required level is achieved
	TLI	0.959	The required level is achieved
Incremental fit	CFI	0.961	The required level is achieved
Parsimonious fit	Chisq/df	2.772	The required level is achieved

Table 10. Causal effect of perceived *Muda* on perceived job productivity

Construct	Path	Construct	Estimate	S.E.	C.R.	P-Value	Result
JBP	←	MUDA	.646	.133	6.163	***	Significant

**** indicates highly significant at <0.001 [60,61].*

5. CONCLUSION

This paper concludes that *muda* is universal and inherent in public offices in Nigeria as claimed by Nicholas & Soni [18], Schipper & Swets [22] and Finch [23], and that it has strong influence on perceived job productivity, which is the quintessence of an office building, especially by affording end-users to contribute to their requirements in office buildings [7]. The *muda* drivers are ranked in the order – Inventory, Defect, Over-processing, Overproduction, Motion, Transportation, Human Talent and Waiting, based on their unique contributions and effect sizes.

Perceived *muda* explained 42% of the variance in perceived job productivity, which is a strong effect size. All the result have practical significance with P-value of <0.05. This had confirmed that *lean thinking* is applicable to public office buildings in Nigeria and therefore relevant to their sustainable improvement. Although, there are a number of other factors and barriers that affect the ability to sustainably improve existing building stock, however, until the major issue of *muda* is addressed from end-users' perspective, the pace of SD may remain slow, especially in developing countries.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Adeyemi A, Martin D, Kasim R. Elimination of waste and inefficient facilities in existing buildings for sustainability in developing nations. International Journal of Architecture and Urban Development. 2014;4(1):5-16.
2. Jiboye AD. The challenges of sustainable housing and urban development in Nigeria. Journal of Environmental Research and Policies. 2009;4(3):23-27.
3. Wood B, Muncaster M. Adapting from glorious past to uncertain future. Structural Survey. 2012;30(3):219–231.
4. Brandon P, Lombardi P. Evaluating sustainable development in the built environment. New York: John Wiley & Sons; 2010.
5. Miller E, Buys L. Retrofitting commercial office buildings for sustainability: Tenants' Perspectives. Journal of Property Investment & Finance. 2008;26(6):552–561.
6. Wood B. The role of existing buildings in the sustainability agenda. Facilities. 2006;24(1/2):61–67.
7. Mickaityte A, Zavadskas EK, Kaklauskas A, Tupenaite L. The concept model of sustainable buildings refurbishment. International Journal of Strategic Property Management. 2008;12(1):53–68.
8. Haynes BP. An evaluation of the impact of the office environment on productivity. Facilities. 2008;26(5/6):178–195.
9. National Population Commission NPC. Available:www.population.gov.ng (Accessed 13 July 2013)
10. Available:www.reuters.com/article/2014/04/11/thinksecurityafrica. (Accessed 15 April 2014)
11. Chanter B, Swallow P. Building Maintenance Management. Oxford: John Wiley & Sons; 2008.
12. Womack JP, Jones DT. Lean thinking: banish waste and create wealth in your organization. New York: Simon & Schuster; 1996.
13. Advanced English Dictionary AED). apps.microsoft.com/.../advanced-english-dictionary/ 3206ef20-ac28-400; 2013.

14. Spring M. Beauty is but skin deep. Building. 2004;269(24):pp. 26-28.
15. Ohno T. Toyota Production System. Portland: Productivity Press; 1988.
16. Kempton J. Can lean thinking apply to the repair and refurbishment of properties in the registered social landlord sector? Structural Survey. 2006;24(3):201-211.
17. Womack JP, Jones DT, Roos D. The Machine that Changed the World. New York: Maxwell Macmillan International; 1990.
18. Nicholas J, Soni A. The Portal to Lean Production: Principles and Practices for Doing More with Less. Boca Raton: Auerbach Publication; 2006.
19. Wang JX. Lean manufacturing: Bottom-line based. Boca Raton: CRC Press; 2011.
20. Jylhä T, Junnila S. The state of value creation in the real-estate sector – Lessons from lean thinking. Property Management. 2014;32(1):28–47.
21. Askin RG, Goldberg JB. Design and analysis of lean production systems. New York: John Wiley & Sons Inc; 2007.
22. Schipper T, Swets M. Innovative Lean Development. New York: Productivity Press; 2010.
23. Finch E. Lean facilities management - Transplanting a manufacturing approach? Paper presented at ARVO workshop, Aalto University, Espoo, 22 June; 2010.
24. DeVellis RF. Scale Development: Theory and Applications. 3rd ed. Los Angeles: SAGE Publications; 2012.
25. Adeyemi A, Martin D, Kasim R. Research framework for identification of waste and inefficiencies in existing public office buildings in developing nations for sustainability. British Journal of Applied Science & Technology. 2015;5(1):60-75.
26. Georgiou J. Verification of a building defect classification system for housing. Structural Survey. 2010;28(5):370-383.
27. Ilozor BD, Okoroh MI, Egbu CE. Understanding residential house defects in Australia from State of Victoria. Building and Environment. 2004;39(3):327-337.
28. Dennis P. Lean Production Simplified. 2nd ed. New York: Productivity Press; 2007.
29. Gou Z. Addressing human factors in green office building design: Occupant indoor environment quality survey in the subtropical climate of China. University of Hong Kong: Ph.D. Thesis; 2012.
30. Clements-Croome D. Creating the Productive Workplace. 2nd ed. London: Spon Press; 2006.
31. Olanrewaju AL. Quantitative analysis of defects in university buildings: User perspective. Built Environment Project and Asset Management. 2012;2(2):167–181.
32. De Been I, Beijer M. The influence of office type on satisfaction and perceived productivity support. Journal of Facilities Management. 2014;12(2):142–157.
33. Haynes BP. Job productivity: A theoretical framework. Journal of Corporate Real Estate. 2007;9(2):97–110.
34. Jylhä T, Junnila S. Learning from lean management – Going beyond input-output thinking. Facilities. 2013;31(11):454–467.
35. Israelson N, Hansson B. Factors Influencing Flexibility in Buildings. Structural Survey. 2009;27(2):138-147.
36. Monfared IG, Sharples S. Occupants' perceptions and expectations of a green office building: A longitudinal case study. Architectural Science Review. 2011;54(4): 344-355.
37. Deuble MP, de Dear RJ. Green occupants for green buildings: The missing link? Building and Environment. 2012;56(1):21-27.
38. Love PED, Bullen PA. Toward the sustainable adaption of existing facilities. Facilities. 2009;27(9):357-367.
39. Hebert PR, Chaney S. Using end-user surveys to enhance facilities design and management. Facilities. 2012;30(11/12): 458–471.
40. Karna S. Concepts and attributes of user satisfaction on construction. Helsinki University of Technology: Ph.D. Thesis; 2009.
41. Rotimi FE. An evaluative framework for defects in new residential buildings: The New Zealand Case. Auckland University of Technology: Ph.D. Thesis; 2013.
42. Kim G, Lim HS, Lim TS, Schaefer L, Kim JT. Comparative advantage of an exterior shading device in thermal performance for residential buildings. Energy and Buildings. 2012;46:105-111.
43. Birkeland J. Design blindness in sustainable development: From closed to open systems design thinking. Journal of Urban Design. 2012;17(2):163-187.
44. Black J. Lean production: Implementing a world-class system. New York: Industrial Press, Inc; 2008.

45. Veitch JC. Towards a user-centered theory of the built environment. Building Research & Information. 2008;36(3):231–240.
46. Feige A, Wallbaum H, Janser M, Windlinger L. Impact of sustainable office buildings on occupant's comfort and productivity. Journal of Corporate Real Estate. 2013;15(1):7-34.
47. Oseland N, Bartlett P. Improving job productivity: A guide for business and facilities managers. Singapore: Longman; 1999.
48. Adams KA, Lawrence EK. Research Methods, Statistics and Applications. Los Angeles: SAGE Publications Inc; 2015.
49. Shah S. Sustainable Practice for the Facilities Manager. Oxford. Blackwell Publishing; 2007.
50. Pope J, Annandale D, Morrison-Saunders A. Conceptualizing sustainability environmental impact assess. Review. 2004;24(6):595-616.
51. Wilkinson SJ, Reed R, Jailani J. User satisfaction in sustainable office buildings: A preliminary study. In PRRES 2011: Proceedings of the 17th Pacific Rim Real Estate Society Annual Conference. Pacific Rim Real Estate Society; 2011.
52. Haddad HM. A Framework of sustainable design for the region of Palestine. The Pennsylvania State University: Master's Thesis; 2010.
53. Nwokoro I, Onukwube HN. Sustainable or green construction in Lagos, Nigeria: Principles, attributes and framework. Journal of Sustainable Development. 2011;4(4):166–174.
54. Eisenhardt KM. Building theories from case study research. Academy of Management Review. 1989;14(4):532–550.
55. McIntyre LJ. Need to know: Social science research methods. New York: McGraw-Hill; 2005.
56. Strzelecka E. Urban development versus sustainable development in Poland. Management of Environmental Quality. 2008;19(2):243–252.
57. Guthrie G. Basic research methods: An entry to social science research. London: SAGE publications; 2010.
58. Pallant J. SPSS Survival Manual. 4th ed. Crow's Nest: McGraw-Hill; 2011).
59. Cohen J. Statistical Power Analysis for the Behavioral Sciences. 2nd ed. New Jersey: Lawrence Erlbaum Associates Publishers; 1988.
60. Awang ZA. Handbook on Structural Equation Modeling. Selangor: MPWS Rich Resources; 2014.
61. Byrne BM. Structural Equation Modeling with AMOS: Basic Concepts, Applications and Programming. 2nd ed. New York: Routledge; 2010.

Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/12155