The current issue and full text archive of this journal is available on Emerald Insight at:
https://www.emerald.com/insight/0306-8293.htm

Application of smart electronic systems, firm characteristics and efficient energy consumption – a case of public universities in Uganda

Received 7 February 2019
Revised 27 September 2019
6 February 2020
Accepted 2 June 2020

Juliet Isingoma-Wakaisuka
Department of Accounting, Makerere University Business School, Kampala, Uganda
Charles Kalvin Kikwanga Ibanda and Ruqqaiya Naluwooza
Department of Business Computing, Makerere University Business School, Kampala, Uganda, and
Christine Namaganda
Department of Entrepreneurship and Small Businesses, Makerere University Business School, Kampala, Uganda

Abstract
Purpose – The purpose of the study is to examine the relationship between the application of smart electronic systems, firm characteristics and efficient energy consumption: a case of public universities in Uganda.
Design/methodology/approach – The study adopted both quantitative and qualitative approach as well as descriptive cross-sectional survey design tantamounting to an experimental-observation approach. A sample of four public academic universities were explored using primary data. A semi-structured questionnaire together with an evaluation form and a tested experimental kit (from one of the leading electronics centres in Uganda) was used to examine the consumption rates of different electronic appliances of less than 30 Amps. Further, a Pearson product moment correlation (*r*) analysis was also used to determine the direction of a relationship among the variables together with a linear relationship (regression) to predict a linear association of one or more variables. Recommendations were also given.
Findings – Smart electronic systems make a significant determining factor to both firm characteristics (age, number of students, administrative staff and support staff) as well as efficient energy consumption. Nonetheless, there is no significant difference of efficient energy consumption as far as firm characteristics are concerned.
Research limitations/implications – Results support the contributions of the theory of technology and acceptance model by affirming that a number of factors influence the usefulness and ease of use of the smart electronic systems, which in turn influence energy consumption.
Practical implications – Universities' management should endeavour to install smart electronic systems. But still, government should try to lower taxes on smart electronic systems and genuine agents should be named for easy and affordable access of the users, universities inclusive.
Originality/value – The study contributes towards a theoretical position by affirming the usefulness of technology acceptance model for efficient energy consumption in public universities.
Peer review – The peer review history for this article is available at: https://publons.com/publon/10.1108/IJSE-02-2019-0083

Keywords Smart electronic systems, Firm characteristics, Energy efficiency, Public Universities, Uganda
Paper type Research paper

Introduction
Global energy is increasingly on demand to support economic growth, development and also provide adequate energy services for the rapidly growing world population predicted at 9bn by 2040 (The International Energy Agency, 2017). This necessitates adequate and proper measures

The Authors acknowledge Norad-NORHED Research Grant for Capacity Building in Education and Research for Economic Governance in Uganda (QZA-0486-13/0017).

International Journal of Social Economics
Vol. 47 No. 8, 2020
pp. 1023-1041

0306-8293
DOI 10.1108/IJSE-02-2019-0083

of energy efficiency, technologies that include energy-saving appliances and smart electronic systems. Energy is indispensable for economic development of various countries with development ultimately linked to energy availability and reliability. Faced with emerging challenges in the 21st energy market century, changes in electrical systems are probable. In the conventional ways of generation, transmission and distribution of power which come along with yet other new challenges that range from improvement in quality of power delivered, environmental concerns arise over conventional and centralized methods of power generation, security of the system against external cyberattacks, economics of power systems, maintenance costs to equipment renovation and network expansion (Erdener *et al.*, 2014) aimed at promoting energy efficiency. Significantly, the 21st century has come along with innovations and advancements in various sectors that allow enhancement of smart electronic systems which integrate functionalities such as sensing, actuation and auto-control in order to realize energy efficiency. This implies that smart electronics are a significant feature in future energy setting, with a central goal of attaining energy efficiency. Sekki *et al.* (2015) assert that universities are a sustainable declaration in creating a sustainable future, thereby a necessity for minimizing both the resources and energy consumption.

Without doubt, energy is indispensable in modern economies, particularly for industrial development, transport, infrastructure and information technology (smart electronics). However, the applicability of smart energy utilization indicates that Africa has one of the lowest per capita modern energy consumption rates and heavily relies on traditional biomass. According to UN-DESA (2004) report, the challenges faced by Africa in energy consumption is not probably the increased rate of energy consumption, but rather access to efficient energy services through smart electronics and energy efficiency that ultimately promotes sustainable consumption. An improvement in information technology and smart sensors should eliminate the restriction of precise consumption measurement for each consumer (academic institution) and allow adaptive billing mechanisms to financially motivate consumers shift their consumption to off peak times (Mohassel *et al.*, 2014).

There are findings that reveal that smart systems community conventionally categorizes smart electronics by their degree of autonomy in terms of reduced need of external supervision and control as well as energy self-sufficiency (Sassone *et al.*, 2016). This implies that there are three-generation smart systems; those that integrate sensing and/or actuation as well as signal processing which enables various types of actions, systems already deployed in many application domains but not limited to safety systems, automotive applications and personal devices to monitor health status of persons. Second is the second-generation smart system that endeavours to add perception features, predictive and adaptive systems with self-test capabilities which include network connectivity, advanced energy scavenging and management capabilities. Finally, is the third-generation smart system which adds human-like perception on top of the second-generation systems, interacts independently without external control or decision-making, implements systematically through self-calibration, self-test and self-healing. Notably, for this study, the first-generation smart systems are employed given the fact that they are already available, hence applicable to public universities (Tuhereze, 2017). Despite a remarkable progress in this area, concepts and principles, such a new trend is not elucidated as yet, a fact attributed to the apparent uniqueness of the concept and the numerous types of smart systems, technologies and devices available to students, learners, faculty and academic institutions (Uskov *et al.*, 2017).

It has also been noted that smart electronics have modernized the traditional concept and functionality of electrical grids that use information technology to obtain network components' data from power producers to consumers and also use it properly to maximize the efficiency and reliability of the system. This implies that the ideal smart electronics (sensors, actuation and auto-control systems) should address sustainability as well as prediction issues. As higher education services are a tradable product recognized by the World Trade Organization, yet are also engaged in training people on matters of intellectual importance and conducting research on those matters (Robbins, 2008). Thus, smart energy systems ought to be adopted by governments in partnerships with industry and in academia to develop systematic methodologies for efficient operating electronic systems, control resources, as well as managing workloads in order to attain optimal energy consumption. Notably, smart technologies can constitute a basic tool for survival of a country which ultimately enhance efficiency and transparency both in government and in private establishments (universities inclusive) as well as signify as a measure of economic development. Thus, technological innovations have become a strategic driving force in improving energy efficiency (Johansson and Thollander, 2018).

In this regard, a university will remain pertinent if it responds promptly to the mutable technology and the industry demands (Eshiwani, 1999), but not disregarding the fact that universities have become profit-oriented and disregard the industry where the consumer's knowledge and the products are generated. Consequently, it is vital to assess energy efficiency and its corresponding impact with improvement on the progression of the sustainable energy consumption (Venkatesh *et al.*, 2016). It has also been noted that sustainable energy consumption is a conscious choice of appliances regarding their duration and mode of use with the eventual goal of curbing overall consumption (Fischer, 2008). Yet there is a growing concern of stakeholders about the inconsistence in energy consumption in academic institutions (Chen *et al.*, 2009; Lawrence and McCullough, 2001). Therefore, there is a need to adapt great competition as a requirement to improve energy consumption. Besides, higher education and research are a precedence in the economy that effects sound and strategic investments in development of the economy's intellectual resources, a competent workforce, visionary leadership, gender equality and observance of human rights. Indeed, smart electronics contribute to evidence-based policies and decisions that enhance sustainable economic, social and environmental development.

Furthermore, universities are associated with unique characteristics that impact on their energy consumption, positively or negatively, viewed as attributes that are seen as "drivers" of business relations with an aim of achieving the institution's goals (Eriotis *et al.*, 2007). According to Zou and Stan (1988), firm characteristics are the institution's demographic and directorial variables that comprise part of the firm's internal environment. In such a case, the size of the university and how long it has existed are key as firm characteristics whereby the firm size is expected to have influence on the firm's energy utilization since large firms may exercise economies of scale, have good knowledge of markets and capable of employing competent managers (Driffield *et al.*, 2005). Similarly, Abore (2008) argues that the age of the firm has a great impact on its outcome, for when a firm stays longer in business, it institutes itself as a going concern and in turn increases its proficiency towards sustainable energy consumption. Further, firm ownership assumes that institutional investor demand leads to high-quality information (Kane and Velury, 2002) and that the greater the level of institutional ownership, the more likely a firm is to purchase better services for sustainable consumption. Also, the years of a firm's existence considered are statistically significant with a firm level of efficiency (Abor, 2007); hence, age is seen as a reputation measure of a firm. In this aspect, as a firm continues longer in business, it establishes itself as an ongoing concern and therefore increases its capacity in consuming sustainably. In this regard, the study will employ a theoretical extension of the technology acceptance model (TAM) that explains perceived usefulness and usage intentions (smart electronics) in terms of social influence and cognitive instrumental processes (Venkatesh *et al.*, 2016). Hence, the objective of the study is to investigate experimentally using a mobile laboratory (through observations) the need for smart electronics and firm characteristics in promoting efficient energy consumption.

Clearly, as Uganda advances from a low- to a middle-income country, by 2040, national mandate for energy is inevitably rising (Background to the Budget, 2016/2017) and attracts the largest private sector investment in the country, registering a significant input into other sectors as well as a major source of employment as highlighted by the energy and mineral development sector which is among the biggest benefiting sectors of resource allocation for F/Y 2017/18 and 2018/19 (10.5–11.5%) respectively (Background to the Budget, 2018/2019). Further, background to the budget indicates that the annual growth in demand for electricity (energy) is estimated at over 10% per annum, implying that energy is still among the top priorities of the Government of Uganda. Thus, Uganda's ICT opportunities should be functional and efficient in order to upgrade and improve competitiveness of the economy, more so, universities. Indeed, education performs a fundamental role in preparation of human capital equipped with relevant knowledge and skills that lead to improved productivity. Government of Uganda launched the Education and Sports Sector Strategic Plan (ESSP) 2017/18–2020/21 with the aim of improving the quality of education delivered to learners at all levels of education in the country. Nevertheless, little attention is given to issues of smart electronics and sustainable consumption of energy, with the worst that Uganda is still ranked low in the use of ICT to boost economic competitiveness, measured by the Network Readiness Index (Background to the Budget, 2016/17).

Notably, energy is the engine for economic growth and development for any society, especially for industrial development (education institutions inclusive), transport, infrastructure and information technology (Background to the Budget, 2016/17). The East African region has continued to face challenges of low electrification rates due to limited coverage of the power grid and low electricity consumption rates. Further, access to electricity has not been proportional to its population growth, implying that the region's power generation capacity must increase significantly in order to meet the rising demand. It is projected that Uganda's capacity will have grown to 37.7% by 2020 (Background to the Budget, 2018/19). Similarly, resolving to use modern energy is critical in the pursuit of increased productivity and improving living standards of Ugandans, a goal in line with National Development Plan II (NDP II) mission of targeting 30% access electricity by 2020, against the current level that stands at 22% (Background to the Budget, 2018/19).

Significantly, there is hardly any study that reflects energy utilization in universities, and despite noticeable progress in this area, the concepts and principles of smart electronic systems remain yet untapped, especially in the emerging economies, such as Uganda. With emerging challenges and issues in the energy market of the 21st century, changes in the electrical systems are inevitable (Mohassel *et al.*, 2014). This implies that fundamental changes in consumption of energy in society are central in realization of sustainable consumption. Therefore, governments, relevant international organizations, the private sector and all major groups (universities inclusive) should play an active role in promoting sustainable consumption (Background to the Budget, 2018/19; United Nations, 2010). It is known that higher education and research are a precedence in the economy that nurtures strategic investments in development of the economy's intellectual resources, competent workforces, visionary leaders, gender equality and human rights. Clearly, energy consumption contributes to evidence-based policies and decisions that enhance sustainable economic, social and environmental development, hence posing a need to promote the concept and numerous types of smart systems, technologies and devices to learners, faculties and academic institutions (Uskov *et al.*, 2017).

General objective

The purpose of this study is to examine the application of smart electronic systems, firm characteristics and energy efficiency: a case of public universities in Uganda.

Study objectives

The study considered three specific objectives, namely to determine:

(1) The relationship between application of smart electronic systems and efficient energy consumption;

(2) The relationship between application of smart electronic systems and firm characteristics;

(3) The relationship between firm characteristics and the efficient energy consumption (see Figure 1).

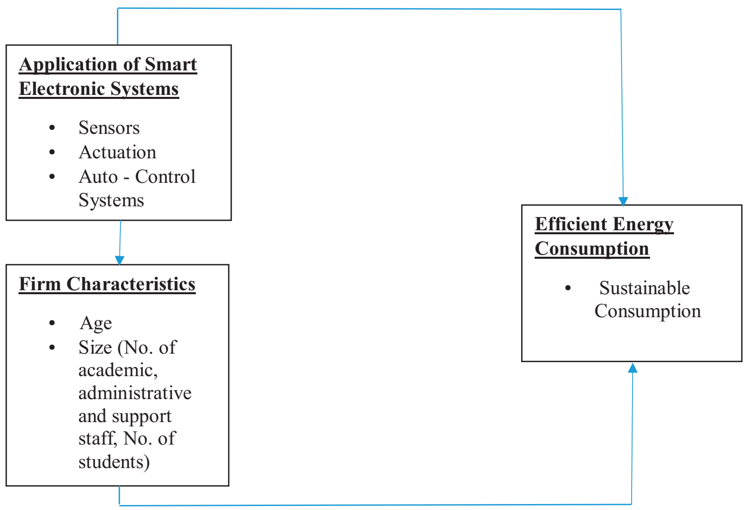
Significance of the study

The study examines the relationship among smart electronic systems, firm characteristics and efficient energy consumption: a case of public universities in Uganda. Thus, the study may be beneficial to different institutions: universities, Ministry of Education, the private sector, electricity companies and the general public. Clearly, the study has a significant contribution to theory building that affirms to the usefulness of TAM in efficient energy consumption.

Theoretical and empirical review and hypotheses development

Theoretical underpinning of the study

TAM explains how users come to accept and use a technology. The model suggests that when users are presented with a new technology, a number of factors influence their decisions about how and when they will use it, notably usefulness and ease of use (Davis, 1989). Basing on the reason that usefulness is critical with ample support that one can enhance his/her job performance, technology ease of use leads to less effort in doing work. Hence, the study considers application of smart electronic systems that bring out the usefulness and ease of use through sensing, actuation and auto-control systems together with appropriate firm characteristics aimed at promoting efficient energy consumption.



Source(s): From Literature Review

Figure 1.
Conceptual framework

Empirical literature review

This section lists out literature by the different scholars on smart electronics, firm characteristics and efficient energy consumption.

Smart electronics and efficient energy consumption

Tuchman (1980) reveals that efficient consumption is a goal aimed at realizing energy reduction that is required to provide products and services without compromising quality, whereas Praveen (2013) contends that smart electronic systems enable one to acquire information on consumption of an appliance. Further, George (2013) explains the contributions offered by smart electronic systems in controlling and transmitting energy when he reveals that smart electronic systems use data utility that receives and carries out commands such as disconnections from supply, monitors the supply for faults and automatically advises the consumer in case of a problem. In this case, smart electronic systems also act as a point of communication to the consumers and in turn lead to efficient energy consumption. Smart electronic systems may be more expensive but save money in lower energy costs in the long run, for example, use of appliances with energy star label (with in-built energy star functions) and energy guide labels (Intermediate Energy Infobook, 2012) can remarkably increase efficient energy consumption. Similarly, study findings by Biswas *et al.* (2013) reveal that smart electronic systems could reduce energy consumption by 65% of the total energy consumption in places that use electricity in the production process.

According to scholars Reddy and Ray (2011), smart electronic systems can lead to a reduction in energy consumption through improved technologies. This means that the benefit of improving energy efficiency extends far beyond financial saving, energy security and higher productivity for businesses (Birol, 2015), a view shared by Anju and Katiyar (2012) when they contend that smart electronic systems perform a vital role in day-to-day life and the concept of automatic control is distinct in its arrangement and physical elements are connected in a way to regulate, direct and command other systems to achieve their efficient consumption objectives, as (Anju and Katiyar, 2012) clarify that a good smart electronic system must be accurate, sensitive, noise-free, stable and fast to enable energy-efficient characteristics.

Further, Ryan and Pavia (2013) advance that sensors are elaborated centralized electronic systems that operate when need arises, can switch off when rooms are vacant and turn on when needed for use and explain that smart electronic systems can be controlled automatically and remotely by turning them on/off or adjusting at a predetermined time, a type of activity that can be done both on site and remotely. Thereby, a consumer can view the generated consumption information which can be transmitted to an inside display unit or directly to the automation controller depending on the system's energy-efficient functions. In this respect, the study used an experimental design that could both show and compare the difference in energy consumption between the smart electronic systems and ordinary electronics systems. The findings of (Wuppertal Institute, 2006) reveal that academic institutions have higher levels of energy consumption, a conclusion that is empirically attributed to considerable user behaviour. We strongly believe that institutions of higher learning need to promote creativity, innovations and technological advancement but also provide accessible physical facilities to all their users (Ministry of Finance, Planning and Economic Development, 2018) – a dictate towards the national development plan and hence expect efficient energy consumption. Still, African heads of state and decision-makers, through Agenda 2063, highlight science, technology and innovation as key enablers in promoting the ability of African countries to achieve their economic transformation and socio-economic development goals (Background to the Budget, 2019/20). Indeed, smart electronics systems through sensors, actuation and auto-control systems of an institution have a predictive influence on efficient energy consumption. *Thus, there is a positive and significant relationship between smart electronics and efficient energy consumption (H_1).*

Firm characteristics and smart electronics systems

Kisengo and Kombo (2012) postulate that firm characteristics are explained in various ways by diverse studies inclined on the criteria used to define it. However, most studies agree that firm characteristics are related with firm resources and organization characteristics among which are firm size and age. According to Sheriff and Khaled (2015), the age of the corporation is associated with responsibility since large firms tend to incur less marginal costs and subsequently, are usually diverse in the scope of their business, type of products and the geographical coverage, unlike the small firms. Furthermore, Charles *et al.* (2010) advance that firm size has a lot to do with uplifting the firm's production and reduced expenditures, whereas firm size signals how large an enterprise is, in terms of infrastructure, number of employees, capital investments and employment terms. Hence, size is viewed as a determinant of efficient consumption. Similarly, Gurria (2011) and Golan (2003) advance that there is a need for institutions to contribute to the demand in the technological energy efficiency struggle by adopting smart technologies that enable them become energy-efficient, enhance firm characteristics and influence performance of organizations. In that respect, Gurria (2011) suggests that academic institutions as stakeholders should aim at efficient energy consumption through strategies and action plans as well as understanding the energy consumption patterns. Still, the National Budget Framework Paper (F/Y 2019/20 – F/Y 2023/24) advocates for characteristics that can advance, transform, development and preserve knowledge in order to stimulate intellectual life in higher levels of learning. We hereby advance that usage of smart electronic systems and appropriate firm characteristics can stimulate efficient energy consumption. Hence, *there is a positive and significant relationship between smart electronic systems and firm characteristics (H_2)*.

Firm characteristics and efficient energy consumption

It has been revealed that smart electronics with appropriate firm characteristics promote patterns of energy consumption that reduce costs and meet the basic needs of a community (United Nations Conference for Environment and Development, 1992; United Nations 2002). Similarly, Hertwich and Katzmayr (2003) contend that sustainable consumption works according to different mechanisms (size and age of organizations) that in turn lead to reduced costs as also various scientific investigations on smart electronic technologies indicate that energy-saving measures represent a substantial resource for efficient energy consumption (Energy Information Administration, 2013). Loganthurai, Parthasarathy, Selvakumaran and Rajasekaran (2012) further advance that implementation of smart electronic systems, appropriate firm characteristics and efficient energy management can yield numerous benefits that can help universities in saving on the cash outflow, a view similarly shared by Singh (2016) when he states that adopting energy-efficient systems is a cost-effective approach to sustainable economic development and the simultaneous reduction of energy consumption within firms. This means that energy efficiency is an energy source that results from reduced energy consumption while retaining benefits that result in a reduction in energy consumption. Energy-efficient technologies imply the use of less energy than conventional technologies, as well as the upkeep of the same quantity and quality of output. In a firm-specific context, firm characteristics greatly influence the choice of smart electronics and the capability to execute efficient energy consumption.

Subsequently, energy efficiency facilitates a firm to achieve the usual level of output with lower costs (Reddy and Ray, 2011). It should be noted that firm characteristics also play a great deal to lower energy costs in firms, universities inclusive (Loganthurai *et al.*, 2012). Contrarily, Majumdar (1997) argues that older firms are susceptible to inertia, bureaucratic, lack flexibility to make rapid adjustments to changing conditions and are likely to lose out in the performance risk factors to younger and nimble firms. We therefore contend that public academic institutions in Uganda (especially large-sized) need to identify the possible threats and strategize so that they minimize high energy consumption rates. As deemed vital to conserve energy, (Schneider Electronics, 2007) explains that academic institutions must invest much in energy-efficient appliances so that they can outperform their competitors by as much as 10% in net operating income. Universities can also make use of abundant natural light which contributes more to creation of an effective learning environment. Indeed, research shows that students who learn in a natural light environment perform by over 20% better than those that do not. But still, the Sustainable Development Goals promote that nations should invest in cleaner energy sources to achieve affordable, reliable, sustainable and modern energy to all people by 2030 as technological process helps in addressing big challenges, such as creating jobs and becoming energy-efficient. *To this effect, we need to assess the significant differences of firm characteristics on the efficient energy consumption (H_3).*

Methodology

Research philosophy

This study adopts a critical realism paradigm to investigate the efficient energy consumption in public universities in Uganda due to the fact that efficient energy consumption is objectively understood through quantitative methods, such as conducting an experiment and use of questionnaires as well as taping the user's perception through interview. According to Cooper and Schindler (2006), positivism or empiricism is based on real facts, objectivity, neutrality, measurement and validity of results. Therefore, the study adopted a pattern of deductive reasoning beginning with a linear approach of formulating a hypothesis and an operational definition spelling the characteristics of a phenomena under observation and also based on the theory of technology and acceptance model (Davis, 1989). Yet, a testing of hypotheses based on statistical methods was done, leading to either rejecting or failing to reject the hypotheses. Besides, perception of efficient energy consumption depends on the users and hence better understood by interacting with the consumers. This means that knowledge on efficient energy consumption is subjective and based on experiences and interpretation of the user (Saunders *et al.*, 2007). So, the study considered collecting qualitative data from the consumer in their respective universities using a structured interview guide where descriptions regarding their perspectives on efficient energy consumption were considered (see Figure 1).

Research design

The study adopts a positivistic and interpretivist cross-sectional survey design whereby both experiment and questionnaire were used under positivistic paradigm while under interpretivism, a structured interview guide was given to participants to describe their perception of efficient energy consumption to further supplement the results. This allowed the researchers to collect and compare data from the different methods listed earlier in order to test the hypotheses, discuss and come up with expressive conclusions (Field, 2009; O'Sullivan and Abela, 2007). In the experiment, we assembled a mobile experimental kit which involved observing and comparing the consumption rate of the different appliances (Smart vs ordinary electronics). The experiment contains an infrared motion-detector smart switch with the different energy bulb holders for testing the various bulbs in the market with respect to a usage of 30 min (for both ordinary and energy-efficient). Additionally, in the experiment, there were power sockets that allow testing of other devices such as laptops, desk top computers, phones, lighting systems, projectors, television sets, percolators, fridges, air-conditioners and printers. The testing kit was inter-connected with various selector switches and consumption monitors to display the amount of power consumed with regard to the energy specifications of the tested equipment. As a parameter, all phases were available on the testing kit that would distribute energy to its various sections where a three-socket fuse rated less or equal to 30 Amps was equipped as part of the testing kit standard control measure, see Plate 1.

Population and sample size

The study population consisted of nine public universities in Uganda as per National Council for Higher Education (NCHE, 2015; Background to the Budget, 2018/19) though this experimental study was purposively conducted in four public universities: Makerere University Business School MUBS); Makerere University (MAK), Kyambogo University (KYU) and Busitema University (BUS); institutions considered because of reasons: MUBS is in partnership with NORAD – the funder of the project, MAK is Uganda's leading and oldest university while KYU and BUS were selected due to technical orientation (technical prominence of efficient energy consumption). Unit of analysis was the university and unit of inquiry were staff, academic, administrative, students (all contribute to efficient energy consumption of a university) while support staff were from estate department (are directly in charge with energy consumption monitoring). For the unit of inquiry, each university was sent an email requesting to select and send members to partake in the workshop. MAK and KYU were requested to send 15 while MUBS and BUS 10 members each respectively. Out of the targeted sample number of 50 participants, 35 of them reported (MAK, 11, KYU 10 MUBS and BUS 7 each).

Operationalization of research variables

Shabarati *et al.* (2010) contend that operationalization of variables is the measurement procedure bridging the conceptual–theoretical level with the empirical observation level. Thus, numerals, numbers or other symbols were assigned to the study variables. Smart electronic

Plate 1.
Assembled mobile experimental kit

systems were measured using sensors, actuation and auto-control systems. Firm characteristics were measured using age of the university (number of years of existence) and their size (number of students, academic, administrative and support staff). Similarly, energy-efficient consumption was defined using sustainable consumption (in terms of units consumed).

Data collection

To collect the required data, participants were assembled in one room and briefed about the procedure of testing the energy consumption by experiment which involved testing for both ordinary and energy-savers equipment. Thereafter, the participants were split into two groups for proper participation and vision. For each group an experiment was set up and lasted 30 min, then the participants were instructed to stop the metres and take the readings, where each group noted, recorded and compared results for both energy-savers and ordinary equipment. After the experiment, each group was requested to fill the questionnaire basing on the reading derived from the experiments. Note that the instrument was designed in such a way that it enabled the collection of both quantitative and qualitative data. Quantitative section required the participants to rate the items basing on the results of the experiment rather than their perception. Then the responses to instrument items were anchored on a five-point Likert-type of scale, where 1 was strongly disagree and 5 was strongly agree. On the other hand, a structured interview guide was given to the participants to account for the variation in their results for both energy-savers and ordinary equipment basing on their practical experiences. Data was collected in March 2018 and the responses were captured in SPSS for further analysis to test for the hypothesis.

Reliability and validity tests

Sekaran (1992) posits that reliability involves the extent to which a measuring instrument contains variable errors, that is, errors that appear inconsistently from observation to observation during any measurement attempt or that vary each time a given unit is measured by the same instrument. The reliability of experiment was estimated using a test-retest reliability assessment. Prior to the main study, two identical experiments were given to two respondents at two separate intervals. With the support of the trainer, the two respondents were involved and observed as the experiment was being performed for 30 min. After the session, a questionnaire and an interview guide were administered. The two scores on the two separate occasions were correlated and the coefficient of stability was +0.8, indicating a good reliability (Weir, 2005). But also, the reliability of data collection instruments (questionnaire and interview guide) was estimated using the Cronbach alpha coefficient which assesses the internal consistency or homogeneity among the research instrument items, with all scores above +0.7. Similarly, Nunnaly (1978) suggests that only constructs with a cut-off of +0.7 and more can be considered for further analysis. Further, we verified for validity in line with (Cabrita and Bontis, 2008) to check if the instruments are measuring what they purport to measure. In this regard, the measurement of the smart electronic systems, firm characteristics and efficient energy consumption was obtained from the analysis of the data that actually represent the phenomenon under study (Leedy and Ormrod, 2005).

Ethical issues

Nachmias and Nachmias (2009) assert that ethical issues are related to research participants' rights and welfare and researcher's obligations as key issues in the social sciences. It is also known that the sole objective of research is to contribute to the development of systematic and verifiable knowledge. In this regard, names of informants/participants who supplied the information were kept private, anonymous and confidential.

Analysis, presentation and discussion of findings

After data collection from the participants, it was sorted, coded and entered into SPSS. Then, data was edited for accuracy, consistency and completeness. For the dependent variable, data was in ratio measurement level and was standardized using Z-scores (Cheadle *et al.*, 2003). Z-scores transformation was used given the nature of rigorousness required and could be used in multiple comparisons without further reference to the individual conditional standard deviations. So, a Z-score of +1.96 was considered as significant. Then data were subjected to diagnostic tests for suitability of the data, for conventions ordinary least square regression which included both multicollinearity and heteroscedasticity test as recommended by Field (2013). Multicollinearity was assessed through variance inflation factor (VIF) and heteroscedasticity was evaluated through establishing the significance of the Chi-square value (Breusch and Pagan, 1979). In addition, in order to answer hypothesis I which stated that "application of smart electronic systems positively and significantly related to efficient energy consumption", a zero-order correlation among study variables was performed, first before a linear relationship (regression) to determine the predictive power of the independent variable to the criterion variable (Field, 2009) (see the following theoretical regression model).

Regression models include

$$H_1 = \text{EEC} = \beta_0 + \beta_1\,\text{SES} + \varepsilon$$

where:

Dependent variable (EEC) = efficient energy consumption

Independent variable (SES) = smart electronics systems

β_0 = intercept

β_1 = coefficient

ε = error term

Furthermore, hypothesis II, was achieved by running bivariate correlation among the firm characteristics and smart energy electronics system (See Table 3). Similarly, to achieve hypothesis III, analysis of variance (ANOVA) was conducted through running a one-way test, a process done to evaluate whether there is a significant difference among the universities in terms of their characteristics on efficient energy consumption (See Table 4 below). Finally, in order to determine the areas participants perceived as important for the application of smart electronic system, we run frequencies and the most suggested areas are presented in Figure 2.

Results

Zero-order correlation application of smart electronic systems and efficient energy consumption

Table 1 reveals that application of smart electronic systems is positively associated with efficient energy consumption, ($r = +0.386, p < 0.01$). This implies that enhancement in the use of smart electronic systems improves efficiency in energy consumption of the universities, a finding that formed a basis for regression analysis.

The regression results (Table 2) illustrate that the application of smart electronic systems is a significant predictor of efficient energy consumption ($\beta = 0.386, p = 0.022$), accounting for 12.3% (Adj $R^2 = 0.123$; $p < 0.05$). Similarly, the VIF in the regression model is 1,000 which is below 5, an indicator that multicollinearity is not a problem as recommended by Hair *et al.* (2017). Similarly, the Chi-square value of heteroscedasticity test is 0.12 ($p = 0.72$), which designates that heteroscedasticity is probably not a delinquent in this study (Breusch and Pagan, 1979).

$$EEC = \beta_0 + \beta_1 \ SES + \varepsilon$$

where:

Dependent variable (EEC) = efficient energy consumption

Independent variable (SES) = smart electronics systems

β_0 = intercept

β_1 = coefficient

The aforementioned results reveal that universities that adapt the usage of smart electronic systems have the ability to enjoy efficient energy consumption, a finding that collaborates with (Biswas *et al.*, 2013), who advance that smart electronic systems could reduce energy consumption by 65% of the total energy consumption in places that use electricity in production process activities. In this case, universities are deemed as institutions that require energy in most of the activities undertaken. According to Praven (2013) and Tuchman (1980), application of smart electronic systems leads to accurate consumption, precise appliance utilization and reliable monitoring of energy utility systems. Further, smart electronic systems play a significant role in enabling the user to be informed about consumption rate of

Table 1.
Pearson's correlations for the application of smart electronic systems and efficient energy consumption

Variables		1	2
Application of smart electronic systems	1	1.000	
Efficient energy consumption	2	+0.386*	1.000

Note(s): * Correlation is significant at the 0.05 level (two-tailed)

Table 2.
Regression model for application of smart electronic systems and efficient energy consumption

	Unstandardized coefficients B	*Unstandardized coefficients* Std. Error	*Standardized coefficients* Beta	*T*	Sig.	95.0% confidence interval for B Lower bound	95.0% confidence interval for B Upper bound	Collinearity statistics VIF	Heteroscedasticity
(Constant)	4.327	0.352		12.28	0.000	3.610	5.044	1.000	0.12 ($p = 0.72$)
Application of smart electronic systems	0.221	0.092	0.386	2.40	0.022	0.034	0.408		

Dependent variable: efficient energy consumption

R	0.386
R squared	0.149
Adjusted *R* squared	0.123
Std. error of the estimate	0.5629
F statistics	5.777
Sig.	0.000

Source(s): Primary and secondary data an appliance within other activities such as actuation, sensing and auto-control of electronic appliances. Significantly, there is great contribution and achievement in the efficient energy consumption goal where the quality of a product or service is not compromised.

In addition, the Intermediate Energy Infobook (2012) shows that there are many things we can adopt either to use less energy or use energy more wisely. Holberg (2006) explains that the most obvious applications for which power consumption is critical are smart electrical applications, such as thermostats for heat sensing, security systems for automatic control and security light controllers for precise state (on/off) changeover. Ideally, this lowers the cost of the end product and service, a finding further supported by the qualitative data as discussed:

> …… involvement of management, an immediate effort of using smart electronic appliances, expanding on the scope of appliances, start a campaign of using more smart electronic appliances to create awareness, identify vendors who deal in genuine smart electronic appliances and make them known to the consumer would greatly improve our energy consumption usage……………

Firm characteristics and application of smart electronic systems

The results (Table 3) reveal that the number of students is positively related to the application of smart electronic systems, ($r = +0.489$, $p < 0.01$), indicating that an increase in the number of students in the university proportionally increases the usage of smart electronic systems. Similarly, the number of academic staff is positively associated with the application of smart electronic systems ($r = +0.367$, $p < 0.05$) signifying that an increase in the number of academic staff in a university effects a proportional increase in the usage of smart electronic systems. Similarly, the number of administrative staff is positively associated with the application of smart electronic systems, ($r = +0.367$, $p < 0.05$), which denotes that an increase in the number of administrative staff in the university proportionally increases the usage of smart electronic systems. Also, the number of support staff is positively associated with the application of smart electronic systems, ($r = +0.430$, $p < 0.05$) implying that an

Variables	1	2	3	4	5
Number of students (1)	1.000				
Number of academic staff (2)	+0.734**	1.000			
Number of administrative staff (3)	+0.830**	+0.839**	1.000		
Number of support staff (4)	+0.996**	+0.888**	+0.924**	1.000	
Application of smart electronic systems (5)	+0.489**	+0.376*	+0.376*	+0.430*	1.000

Note(s): ** Correlation is significant at the 0.01 level (two-tailed)

Table 3. Pearson's correlations for firm characteristics and application of smart electronic systems

Variable		*N*	Mean	Std. deviation	Std. error	df	*F*	Sig.
Efficient energy consumption	Makerere University Kampala	11	5.0909	0.53936	0.16262	3	2.154	0.113
	Kyambogo University	10	5.4000	0.69921	0.22111	31		
	Makerere University Business school	7	5.2857	0.48795	0.18443	34		
	Busitema University	7	4.7143	0.48795	0.18443			
	Total	35	5.1429	0.60112	0.10161			

Table 4. ANOVA for the firm characteristics and efficient energy consumption

increase in the number of support staff in the university correspondingly increases the usage of smart electronic systems. Ultimately, firm characteristics effect an upshot on the usage of smart electronic systems, a view shared with Charles *et al.* (2010), Golan (2003), Gurria (2011) and Kisengo and Kombo (2012), who posit that firm characteristics are a great resource to an organization. In addition, they affirm that firms need to adopt smart electronic systems in order to contribute to the demanding technological energy efficiency struggle. Indeed, stakeholders in the academic institutions should yearn to equip their institutions with efficient energy consumption appliances as well as understand the consumption patterns.

To assess significant differences of firm characteristics on the efficient energy consumption among public universities

The findings reveal that there are no significant differences on efficient energy consumption among the public universities, ($p > 0.05$) (See Table 4) implying that there is no difference in the energy consumption for all the public universities. The aforementioned findings also reveal that, regardless of the university, firm characteristics and consumption behaviour do not largely differ irrespective of the number of students, academic, administrative and support staff as similarly noted by (Fabi, 2016), who clarifies that user behaviour needs to be linked to user sensitization to create smart consumption with the compliance for adoption to automation configuration of utility systems. Yet, the resources used to pay energy costs are funded by government. In a similar view, Ahuja and Tatsutani (2008) assert that the energy sector in most developing countries has been in big turmoil with an attempt to restructure but has faced challenges that pertain to issues of implementing reforms in the energy sector. Furthermore, the state of resources for sustainable energy in developing countries is constrained with limited access to basic energy services which is lacking as a significant part of their population. For that matter, many sustainable energy-efficient technologies are likely to remain expensive due to deprived electronic systems in the markets.

Besides, Gurria (2011) suggests that stakeholders in academic institutions should aim at efficient energy consumption through strategies, action plan, as well as understanding the energy consumption patterns. In addition, Loganthurai *et al.* (2012) note that the application of smart electronic systems promotes efficient energy management and can yield numerous benefits as well as assisting universities in saving on the cash outflow. Hence, universities ought to adopt energy-efficient systems as a cost-effective approach in the reduction of energy consumed (Singh, 2016). Energy efficiency is a form of energy source that results from a reduction of energy consumption while maintaining a certain level of benefits. In this regard, smart electronic systems should be adopted for efficient energy consumption as well as upkeep of the same quantity and quality of output rather than conventional technologies.

The quantitative findings are further supported by the information expressed as follows:

> . . .. . . the respondents suggested that though universities have differing firm characteristics in form of size and age, they should test the consumption energy ratings and genuinely purchase standardized items. In addition, irrespective of the size and age of universities, management needs to consider smart appliances in place: computer labs, general lighting, air conditioners, printers and other electronic appliances in their various offices. . .. .

This is further demonstrated in Figure 2:

Conclusion

The study had three objectives and the conclusion is shown as follows:

The first objective was to examine the relationship between application of smart electronic systems and efficient energy consumption among public universities in Uganda. It was

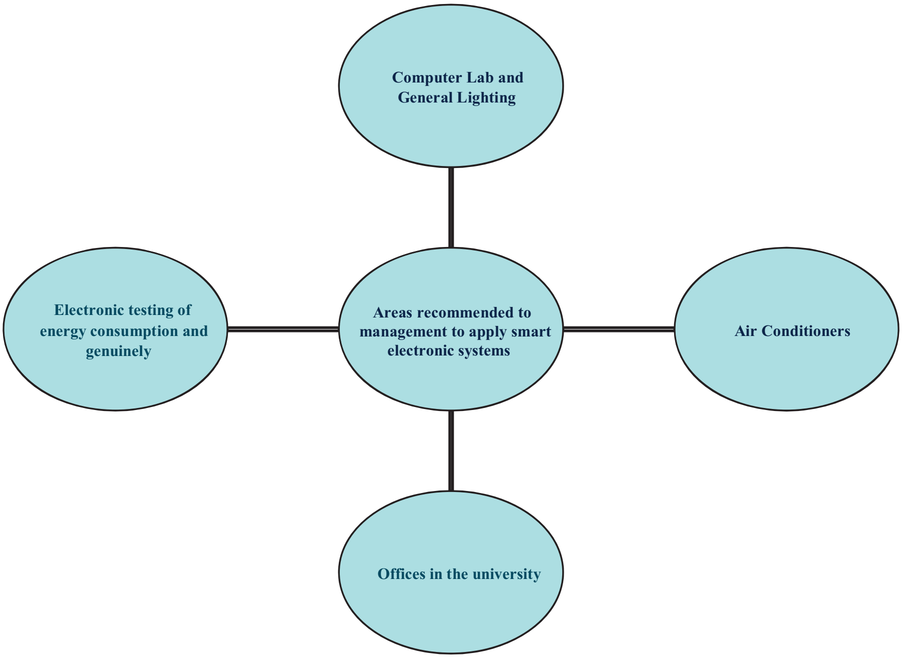


Figure 2. Key areas recommended to management regarding smart electronic systems and firm characteristics

discovered that the application of smart electronic systems is positively associated with efficient energy consumption, implying that enhancement in the use of smart electronic systems improves efficiency in energy consumption of a university. This implies that the application of smart electronic systems is a significant predictor of efficient energy consumption in a public university.

The second objective was to assess the relationship between application of smart electronic systems and firm characteristics in a public university in Uganda. The results reveal that the number of students, academic staff, support staff and administrative staff is all positively related with the application of smart electronic systems in a public university. This implies that an increase in the number of students, academic staff, support staff and administrative staff would proportionally increase the usage of smart electronic systems in a public university.

The third objective was to evaluate if there was a significant difference of firm characteristics on the efficient energy consumption among public universities in Uganda. The findings reveal that there are no significant differences on efficient energy consumption among public universities. The findings therefore indicate that behaviour of usage of energy consumption for all the public universities is the same irrespective of their size and age.

Theoretical, policy and managerial contribution

Theoretically, the study has established the fact that smart electronic systems are a significant predictor of efficient energy consumption among public universities. At policy level, government should come up with a policy that encourages the usage of smart electronic systems in the country and specifically in universities. Likewise, the policy should state the minimum standards of smart electronic systems, the ease and access by the users, universities inclusive. Of importance, the guidelines should address awareness on use of smart electronic systems in the country as this will help universities reduce on overhead costs of energy consumption. Finally, universities' management should endeavour to install smart electronic appliances within their premises.

Limitations and areas for further research

The study adopted an experimental cross-sectional design. Future studies should therefore consider a longitudinal study of public universities by comparing different periods in time. Also, this study considered only four (4) public universities in Uganda, hence a need to extend the study in all public universities. Finally, a comparative study of public and private universities using the same variables is desirable. Notwithstanding the aforementioned limits, the study results remain valuable to the stakeholders of public universities.

References

Abor, J. (2007), "Debt policy and performance of SMEs: evidence from Ghanaian and South Africa firms" *Journal of Risk Finance*, Vol. 8, pp. 364-379.

Abore, J. (2008), *Determinants of the Capital Structure of Ghanaian Firms*, AERC Research Paper 176, African Economic Research Consortium, Nairobi.

Ahuja, D. and Tatsutani, M. (2009), "Surveys and perspectives integrating environment and society", in: Schaffer, D. (Éd.), *Sustainable Energy for Developing Countries*, Vol. 2 No. 1, Paris.

Anju, S. and Katiyar, M. (2012), "Design of butterworth and Chebyshev lowpass filter for equalized group delay", *International Journal of Advanced Research in Computer Science and Software Engineering*, Vol. 2 No. 5, pp. 524-528.

Background to the Budget (2016/17), *Enhanced Productivity for Job Creation*, Ministry of finance, planning and economic development, Republic of Uganda.

Background to the Budget (2019/20), *Industrialisation for Job Creation and Shared Prosperity,* Ministry of Finance, Planning and Economic Development, Republic of Uganda.

Birol, F. (2015), *Market Trends and Medium-Term Prospects; Energy Efficiency and Market Report*, OECD/IEA, Paris.

Biswas, B., Mukherjee, S. and Ghosh, A. (2013), "Conservation of energy: a Case study on energy conservation in campus lighting in an institution", *International Journal of Modern Engineering Research*, Vol. 3 No. 4, pp. 1939-1941.

Breusch, T.S. and Pagan, A.R. (1979), "A simple test of heteroscedasticity and random coefficient variation", *The Econometric Society*, Vol. 47 No. 5, pp. 1287-1294.

Cabrita, R. and Bontis, N. (2008), "Intellectual capital and business performances in Portuguese banking industry", *International Journal of Technology Management*, Vol. 43, pp. 212-237.

Charles, H., Dionisius, N. and Oum, S. (2010), *Firm Characteristic Determinants of SME Participation in Production Networks*, ERIA Discussion Paper Series , Sentral Senayan: ERIA, p. 53.

Cheadle, C., Vawter, M.P., Freed, W.J. and Becker, K.G. (2003), "Analysis of micro-array data using Z-score ttransformation", *Journal of Molecular Diagnostics*, Vol. 5 No. 2, pp. 73-81.

Chen, K.H., Wong, J.T. and Su, C.T. (2009), "Design of supply chain networks with multi-phased discount price and service level: formulation, complexity, and algorithm", *Journal of Information and Optimization Sciences*, Vol. 30 No. 2, pp. 311-334.

Cooper, D.R. and Schindler, P.S. (2006), *Business Research Methods*, 9th ed., McGraw-Hill, Irwin, New York.

Davis, F.D. (1989), "Perceived usefulness, perceived ease of use, and user acceptance of information technology", *MIS Quarterly*, Vol. 13 No. 3, pp. 319-340.

Driffield, N., Mahambare, V. and Pal, S.B. (2005), *How Ownership Structure Affects Capital Structure and Firm Performance? Recent Evidence from East Asia*, Department of Economics and Finance, Brunel University, Munich.

Energy Information Administration (2013), *Managing Energy Costs in Colleges and Universities*, E Source Companies LLC, Canada and USA Energy Information Administration.

Erdener, B.C., Pambour, K.A., Lavin, R.B. and Dengiz, B. (2014), "An integrated simulation model for analysing electricity and gas systems", *International Journal of Electrical Power and Energy Systems*, Vol. 61, pp. 410-420.

Eriotis, N., Dimitrios, V. and Zoe, V.N. (2007), "How firm characteristics affect capital structure: an empirical study", *Managerial Finance*, Vol. 33 No. 35, pp. 321-331.

Eshiwani, G.S. (1999), *Education in Kenya since Independence*, East African Educational Publishers, Nairobi.

Fabi, G.S.V. (2016), *Insights on Smart Home Concept and Occupants' Interaction with Building Controls*, Elsevier, p. 769.

Field, A. (2009), *Discovering Statistics Using IBM SPSS*, 3rd ed., Sage, London.

Field, A. (2013), *Discovering Statistics Using SPSS Statistics*, 4th ed., Sage, London.

Gurría, A. (2011), *Organisation for Economic Co-operation and Development (Green Growth Studies)*, International Energy Agency.

Hair, J.F., Matthews, L.M., Matthews, R.L. and Sarstedt, M. (2017), "PLS-SEM or CB-SEM: updated guidelines on which method to use", *International Journal Multivariate Data Analysis*, Vol. 1 No. 2, pp. 107-123.

Hertwich, E. and Katzmayr, M. (2003), "*Examples of sustainable consumption review, classification and analysis", Industrial ecology programme, NTNU, report 5/2004*, Norwegian University of Science and Technology, ISSN 1501-6153, ISBN 82-7948-037-4 (trykt), ISBN 82-7948-038-2 (pdf).

Holberg, A.M. (2006), *Innovative Techniques for Extremely Low Power Consumption*, Atmel Corporation, Tiller, Norway.

Intermediate Energy Infobook Fact sheets about energy (2012), *The Major Energy Sources, Electricity, Energy Consumption, and Energy Efficiency and Conservation*, National Energy Education Development Project, Manassas, Virginia.

Johansson, M.T. and Thollander, P. (2018), "A review of barriers to and driving forces for improved energy efficiency in Swedish industry: recommendations for successful in-house energy management", *Renewable and Sustainable Energy Reviews*, Vol. 82, pp. 618-628.

Kane, G.D. and Velury, U. (2002), "The role of institutional ownership in the market for auditing services: an empirical investigation", *Journal of Business Research*, pp. 1-8, .

Kisengo and Kombo (2012), "Effect of firm characteristics on performance of the microfinance sector in nakuru Kenya", *International Journal of Science Research*, Vol. 3 No. 10, pp. 1791-1799.

Leedy, P.D. and Ormrod, J.E. (2005), *Practical Research – Planning and Design*, 8th ed., Pearson Upper, Saddle River, New Jersey.

Loganthurai, P., Parthasarathy, S., Selvakumaran, S. and Rajasekaran, D.V. (2012), "Energy conservation measures in a technical institutional building in tamilnadu in India", *Energy procedia*, Vol. 14, pp. 1181-1186.

Majumdar, S.K. (1997), "The impact of size and age on firm-level performance: some evidence from India", *Review of Industrial Organization*, Vol. 12, pp. 231-241.

Ministry of Finance, Planning and Economic Development (2018), *The National Budget Framework Paper FY 2019/20 – FY 2023/24*, The Republic of Uganda, Kampala, Uganda.

Mohassel, R.R., Fung, A., Mohammadi, F. and Raahemifar, K. (2014), "A survey on advanced metering infrastructure and its application in smart grids", *International Journal of Electrical Power and Energy Systems*, pp. 1-8, doi: 10.1109/CCECE.2014.6901102.

Nachmias, C. and Nachmias, D. (2009), *Research Methods in the Social Sciences*, Hodder Education, London.

NCHE (2015), *Publication of Accredited Higher Education Institutions*, National Council for Higher Education, Kampala.

Nunnaly, J. (1978), *Psychometric Theory*, 2nd ed., McGraw Hill, Newyork.

O'Sullivan, D. and Abela, V.A. (2007), "Marketing performance measurement ability and firm performance", *Journal of Marketing*, No. 71, pp. 79-93.

Praveen, N. (2013), *NON-LINEAR STRUCTURAL DESIGN USING MULTISCALE TOPOLOGY OPTIMIZATION*, Dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Mechanical Engineering in the Graduate College of the University of Illinois at Urbana-Champaign, Urbana, Illinoi.

Reddy, B.S. and Ray, B.K. (2011), "Understanding industrial energy use: physical energy intensity changes in Indian manufacturing sector", *Energy Policy*, Elsevier, Vol. 39 No. 11, pp. 7234-7243.

Sassone, A., Grosso, M., Poncina, M. and Macii, E. (2016), "Smart electronic systems: an overview", in, Bombieri, N., Poncino, M. and Pravadelli, G. (Ed.), *Smart Systems Integration and Simulation*, Springer, pp. 5-21. ISBN: 978-3-319-27-390-7.

Saunders, M., Lewis, P. and Thornhill, A. (2007), *Research Methods for Business Students*, 5th ed., Pearson.

Schneider Electronics (2007), *Leading Techniques for Energy Saving in Colleges and Universities*, Schneider Electronics, North Andover.

Sekaran, U. (1992), *Research Method for Business: A Skill Building Approach*, 2nd ed., John Wiley & Sons, New Jersey.

Sekki, T., Airaksinen, M. and Saari, A. (2015), "Measured energy consumption of educational buildings in a Finnish city", *Energy and Buildings*, Vol. 87, pp. 105-115.

Shabarati, A., Jawad, J. and Bontis, N. (2010), "Intellectual capital and business in pharmaceutical sector of Jordan", *Management Decision Journal*, Vol. 48 No. 1, pp. 105-131.

Sheriff, E. and Khaled, H. (2015), "The determinants of social accountability disclosure: evidence from Islamic banks around the world", *International Journal of Business*, Vol. 20 No. 3, pp. 202-223.

Singh, R. (2016), "An investigation into the barriers to energy efficiency within medium to large manufacturing firms operating withinin the ethekwini municipal area", *South African Journal of Industrial Engineering*, Vol. 2 No. 4, pp. 302-320.

The International Energy Agency (2017), *Energy Access Outlook: From Poverty to Prosperity*, OECD/IEA, Paris, available at: www.iea.org.

Tuhereze, E. (2017), *Makerere University to Take Lead in the Adoption of Israel Technology in Uganda*, News and Announcements for Makerere Community, Makerere University, Kampala.

UN-DESA (2004), "The United Nations in the area of coordination of economic and social development policies: preparatory meetings for the economic and social council High-level Segment", Vol. 8 No. 2, pp. 28-30, New York.

United Nations (2002), World Summit on Sustainable Development, Johannesburg, available at: http://www.johannesburg.org.

United Nations (2010), *Trends In Sustainable Development: towards Sustainable Consumption and Production*, Department of Economic and Social Affairs, New-York.

Uskov, V.L., Bakken, J.P., Karri, S., Uskov, A.V., Heinemann, C. and Rachakonda, R. (2017), "Smart university: conceptual modelling and systems' design", *International conference on smart education and smart E-learning*.

Venkatesh, V., Bala, H. and Sambamurthy, V. (2016), "Organizational implementation of an information and communication technology in developing countries: a multi-method longitudinal study in a bank in India", *Information Systems Research*, Vol. 27 No. 3, pp. 558-579, .

Weir, J.P. (2005), "Quantifying test-retest reliability using the intraclass correlation coefficient and the SEM", *The Journal of Strength and Conditioning Research*, Vol. 19 No. 1, pp. 231-240, doi: 10.1519/15184.1.

Wuppertal Institute (2006), *Analyse und Bewertung der Nutzungsmoglichkeiten von Biomasse – Band 1: Gesamtergebnisse und Schlussfolgerungen, Untersuchung im Auftrag von BGW und DVGW.*

Zou, S. and Stan, S. (1998), "The determinants of export performance: a review of the empirical literature between 1987 and 1997", *Journal of Marketing Review*, Vol. 15 No. 5, pp. 333-356.

Further reading

Brohmann, B., Stefanie, H., Klaus, R., Joachim, S. and Wustenhagen, A. R. (n.d.), *What's Driving Sustainable Energy Consumption? A Survey of the Empirical Literature*, Discussion Paper No. 09 -013, Centre for European Economic Research- ZEW, Mannheim.

International Energy Agency (2017), *World Energy Outlook-2017 (WEO-2017) France*, IEA.

Kevin, B., Hendricks, a. and Vinod, R.S. (2000), "Firm characteristics, total quality management, and financial performance", *Journal of Operations Management*, Vol. 17.

Mawejje, J. and Mawejje, D.N. (2016), "Electricity consumption and sectoral output in Uganda: an empirical investigation", *Journal of Economic Structures*, Vol. 5 No. 21, ISSN 2193-2409, Springer, Heidelberg, pp. 1-16, doi: 10.1186/s40008-016-0053-8.

Mgeni, T.O. and Nayak, P. (2016), "Impact of structural firm characteristics on business performance of SMEs: evideence from agribusiness firms in dares salaam, Tanzania", *Arabian Journal of Business and Management Review*, Vol. 6 No. 5, pp. 1-8, doi: 10.4172/2223-5833.1000246.

Ministry of, ICT and National Guidance (2017), *Overview of the Digital Uganda Vision: Vision Document For the Digital Uganda Movement*, Kampala.

Patrick, K. (2008), *Campus Sastainability Best Practices*, St. Ollaf College, Massachusetts.

Tauringana, V. and Chithambo, L. (2014), "The effect of DEFRA guidance on greenhouse gas disclosure", *The British Accounting Review*, Vol. xxx, pp. 1-20.

The National Council for Higher Education (2013), *The State of Higher Education and Training in Uganda 2011:* A Report on Higher Education Delivery and Institutions, Kyambogo, Uganda.

Theraja, B.T. (2002), *Electrical Technology*, S.Chand & Company, New Delhi.

Vadda, P. (2013), *Smart Metering for Smart Electricity Consumption*, Blekinge Institute of Technology, Sweden.

Corresponding author

Juliet Isingoma-Wakaisuka can be contacted at: jwakaisuka@mubs.ac.ug