Influence of Technological Environment on Performance of Gated Community Housing Projects in Nairobi County, Kenya

Michael Chris Musyoka
Facility Mgt. Supervisor / Projects Manager,
General Motors East Africa Ltd
Prof. Christopher Gakuu
Director, Open &Distance e-Learning
School of continuing and Distance Education
Dr. Dorothy Ndunge Kyalo
Associate Dean, University of Nairobi
School of continuing and Distance Education

doi: 10.19044/esj.2017.v13n11p43 URL:http://dx.doi.org/10.19044/esj.2017.v13n11p43

Abstract

The principal objective of the study reported in this article was to empirically assess the influence of technological environment on performance of gated community housing projects in Nairobi County, Kenya. The study population comprised of all active gated community housing projects initiated in 2009 – 2014. A total of 572 respondents were drawn from 143 sampled gated community housing projects from the seventeen sub-counties of Nairobi County (four members were drawn from each sampled gated community project – client, consultant, contractor, and the gated community facility manager) using census, stratified, simple random, and purposive sampling techniques. A standardized open ended interview guide and a questionnaire with both open and closed-ended items with Likert-type interval scale anchored on a five point scale were used to collect data. Descriptive statistics show that respondents agreed that to a very great extent their projects used locally made plant and equipment (M=4.80, SD=0.40), to a great extent skills were available for operation of the plant and equipment (M=4.04, SD=0.47), to a great extent team members with necessary skills to operate and use the plant equipment were available (M=4.0, SD=0.43), to a very great extent use of information and communication technology (ICT) was satisfactory (M=4.49, SD=0.71), to a very great extent computer aided drafting (CAD) was used (M=4.62, SD=0.71), to a very great extend 3D visual illustrations - Building Information Modelling, was used (M=4.65, SD=0.48), and to a very great extent electronic mails and communication was used (M=4.86, SD=0.34. Results from inferential statistics show that r is equal to 0.559, indicating that technological environment has a moderately strong influence on performance in gated community housing projects. The value of r squared is 0.312, indicating that technological environment explains 31.2% of the variation in the performance in gated community housing projects in Nairobi County, Kenya. The β coefficient is 0.327, indicating that technology environment had statistically significant influence on the performance of gated community housing projects ($\beta=0.327$, $t= 4.758$, $p=0.000<0.05$). Considering the p value, it can be noted that the p value for technological environment ($p=0.000$) is statistically significant. The β value imply that one unit change in performance in gated community housing project is associated with 32.7% changes in technological environment.

Keywords: Technological environment, Computer aided design (CAD), Building information modeling (BIM), 4D models, Project environment, and Project performance

Introduction

Technology is an aspect of the environment that should be considered in developing strategic plans for running housing construction projects. Oladapo and Olotuah (2007) maintained that the appropriate housing construction technology can be measured by the availability of locally made plant and equipment, skilled manpower resources, extent of local material resources and the degree of utilization of such local construction resources as well as use of ICT in the design, communication and keeping and retrieving information. However, the housing construction industry in Kenya is characterized by the development projects which require the construction technology and resources of developed countries. The lack of technological know-how and the shortage of managerial manpower are considered to be one of the major problems and constraints facing the industry. The situation as at 1980's was described thus: ''lack of basic knowledge of production methods and design techniques for machinery constitute a serious constraint to rapid industrialization of the country. The situation is aggravated by acute shortage of managerial manpower''. As at today, the country still remains a net importer of technical manpower, virtually most spare parts are imported and most investment in research and development are made abroad, except those sponsored by the government in public owned institutions (World Economic Forum, 2014).

Based on the developed countries, technological environment in project management in housing construction industry has led to increased demand of project management solutions throughout the world as a fundamental force to complete projects within a defined scope, time, and within cost constraints. Most modern housing project systems deliver innovative solutions and its management process has the latest tools, techniques, systems, and schemes in use. The technological environment consists of the plant in use, computer software like Computer Aided Design (CAD), Building Information Modelling (BIM), 4 Dimensional models (4D), and communication tools like e-mails, skype and WebEx. Project data and information is stored on centralized servers and a standard web browser is used as a gateway to access, exchange, and share information from remote locations at any time, eliminating the problems that occur in linear communication schemes (Thorpe& Mead, 2001).

There has been massive growth in the Kenyan real estate sector with developers coming up with varied housing construction concepts to attract and accommodate the diverse needs of their clients. One concept that has been wholly embraced by various stakeholders in this industry is the idea of gated community housing. Landman (2012) states that a gated community is a type of housing estate that has strict entrances for its residents as well as their automobiles and is often characterized by a massive perimeter wall round the estate. Gated communities offer different types of buildings which include villas, bungalows, apartments as well as mansionnettes. For a housing construction project to be considered as successful it must meet certain performance measures such as timely completion, within budget as well as satisfying all the stakeholder's needs in the project. The absence of reworks as well as 'fitness of purpose' for the occupiers has also been considered as a housing construction project success indicator (Landman, 2012).

The Kenya National Bureau of Statistics (KNBS) has estimated the Kenyan growth population at 4.2% and is expected to reach 50 million by 2020. Based on these estimates there is an annual demand of 206,000 units of houses and the current supply is 50,000 units per year which creates a shortfall of 156,000 units every year (KNBS, 2013). The government of Kenya seeks to march the supply of houses to the existing demand by 2030 (GoK, 2005). Ministry of Housing, Land and Urban Development (2011) reported that, among all gated community developments initiated over the recent years, 48% of the housing construction projects in Nairobi County were still incomplete and 10% of these projects had completely stalled. This lead to slow uptake of housing construction projects. Failure of these housing construction projects has resulted in reduced supply of quality houses as well as a less vibrant economy which consequently contributes to a lower standard of living for Kenyans as well as increased unemployment (GoK, 2003).

A review of the results of hundreds of World Bank projects by Joseph (2009) indicated that success or failure of housing construction projects often depends on factors in the general environment, especially the technology employed. The review pointed out that in the management of projects, technological environment has an influence on the project performance and therefore should be given due attention to form a basis for analysis for overcoming or mitigating on its effect on project performance. Many studies though not conclusively indicate that among other factors, there exist a relationship between technological environment and project performance (Akanni et al 2014; Ling et al 2007 and Kim et al., 2008). It is against this background that this study sought to examine the influence of technological environment on the performance of housing construction industry, a case of gated community projects in Nairobi County, Kenya. The purpose of this study was to examine the influence of technological environment on the performance of housing construction industry, a case of gated community projects in Nairobi County, Kenya.

Objective of the Study

The objective of the study was to establish the extent to which technological environment influences performance of gated community housing projects in Nairobi County, Kenya.

Hypothesis of the study

The following hypothesis was tested:

$\mathbf{H_o}$ Technological environment has no significant influence on the performance of gated community housing projects in Nairobi County, Kenya.

$\mathbf{H_1}$ Technological environment has a significant influence on the performance of gated community housing projects in Nairobi County, Kenya.

Literature review

Project performance indicators are defined as measures by which success or failure of a project will be judged (Cooke-Davies, 2002). Lim and Mohamed (1999) defined performance indicators as set of principles or standards by which success can be judged. Toor and Ogunlana (2009) suggested the following indicators for measuring project performance: project completion on time, within budget and to specified quality; safety, efficiency, effectiveness, free from defect, meets stakeholders' expectations, and minimal construction disputes and conflicts. Therefore, from this review, it can be noted that performance indicators for housing construction project success is beyond the traditional measures of time, cost and quality, which mainly measures project management success; however, additional indicators emerge that include end user satisfaction, stakeholder satisfaction, safety, environmental impact and minimal disputes or the absence of any legal proceedings. Based on the studies reviewed, this study will adopt project performance indicators as: - Project completed within the budgeted cost, within the scheduled time, within the specified quality, delivered with described safety and health standards, and within clients satisfaction levels.

Influence of technological environment on project performance

Technology is an aspect of the environment that should be considered in developing strategic plans. Oladapo and Olotuah (2007) maintained that the appropriate housing construction technology can be measured by the availability of locally made plant and equipment, skilled manpower resources, extent of local material resources and the degree of utilization of such local construction resources. However, the housing construction industry in Kenya is characterized by the development projects which required the construction technology and resources of developed countries (Sun and Howard 2004). The lack of technological know-how and the shortage of managerial manpower are considered to be one of the major problems and constraints facing housing construction in developing countries. The situation is aggravated by acute shortage of managerial manpower (Oladapo and Olotuah (2007). As at today, the country still remains a net importer of technical manpower, virtually most spare parts are imported and most investment in research and development are made abroad, except those sponsored by the government in public owned institutions (World Economic Forum, 2014).

Due to environmental concerns and the need to reduce costs, the housing construction industry worldwide has experienced increased innovation and modernization in terms of technology (Moavenzadeh, 1978; Wells, 1984; Marques, et al., 2007). However, Kenya has not fully taken advantage of this international know-how (Sun and Howard 2004). This is visible in the World Economic Forum technological performance indicator, where the country is ranked position 92 in the world, beneath South Africa, Rwanda, Tunisia and Egypt (Adriaanse et al., 2005, and World Economic Forum, 2014). Kenya's poor performance is as a result of the following factors: reduced degree of absorption of new technology associated with the lack of skills; low levels of innovation, weakness in protecting intellectual property rights; and reduced private sector investment in research and development, due to its relatively small size and undercapitalization (Elkhalifa, 2011, ANEMM, 2000, and AIMO, 2010). Indeed, the government industrial strategy for vision 2030 flagged this issue, pointing out the technology gap as one of the main factors behind the indigenous companies' inability to compete. The strategy called for urgent measures, but in a recent survey, World Economic Forum (2014), it was found that the situation has not changed much despite the fact that the implementation period of the industrial policy and the strategy paper was approaching its end. Over 62% of the companies surveyed in the course of the AIMO 2010 study (including producers of building materials, such as cement and heavy construction firms) had not made major acquisitions of new technologies since the 2000s, their machinery was over 20 years old and they were finding it hard to maintain and replace spare parts. This in turn impacted on the housing construction projects' prevailing environment hence it affects the performance.

In the present, information and communication technology (ICT) is responsible for the entire housing construction process from information being generated, transmitted and interpreted to enabling the project to be built, maintained, reused and eventually recycled (Chudley et al., 2006). The everyday life of individuals is increasingly relevant of ICT. This has totally transformed individuals and organizations to its wide spread use (Peansupap and Walker, 2005). The impact of ICT on modern society is profound, and its growing speed has enabled globalization especially through the introduction of a global system of interconnected computer networks known as the 'internet', used for communication between individuals, companies and institutions for sharing and exchanging information and data (Sun and Howard 2004).

The housing construction industry is faced with the ongoing challenge of changing and improving current work practices in order to become more client-orientated; more competitive as well as productive through adoption of ICT as an integral part of the construction process (Weippert et al. (2003). Much effort has been directed toward improving housing construction productivity and the use of ICT in construction and this is an area worth concentrating upon because it can decrease the time for data processing, communicating information and increase overall productivity. Modern structural design software applications, such as 3D modelling and building information modelling (BIM), provide an example where designing complex structures and organizing the electrical, mechanical, site, structural and quantifying of a project can be achieved in minimum time and increase the efficiency all in one data framework, whereas in the past this was almost impossible (Peansupap and Walker, 2005). ICT in construction industry can be broken down into different segments for its better understanding and its role in construction. The word Information, from different perspectives as well as towards an ICT view, has a whole new meaning of its own. Adriaanse and Voordijk (2005) give explanation from the functionalist (positivistic, 'scientific') perspective that "ICT is a neutral provider of input for decision making". In this point of view communication is no more than distribution of information. ICT may be adopted by specific groups of users within an organization. For example, use of computer aided drafting (CAD) by architects or estimating software used by engineers or project managers. Emmitt and Gorse (2003) identifies the reality that, communication between housing construction industry participants and organizations are concerned with information exchange, dealings with drawings, specifications; cost data, programs plus other design and management information. Conclusively, ICT can be the interaction of meaning to reach a mutual understanding between a sender and a receiver via technology (Day et al., 1986).

Influence of computer aided design (CAD) and building information modeling (BIM) on project performance

Different literatures have described and broken-down information and communication technology in relation to housing construction industry. The interaction touches on both the soft and hardware as used in modern ICT technology for purposes of communication and processing information at a speed formerly thought impossible. These include: Computer systems for building and architectural purposes which are so much faster now than they were when they first came in the 1970s (Howard, 1998).Specially configured systems can even be purchased specifically for different purposes ranging from speed to its ability to higher graphics. These computers can also be connected to different hardware such as a projector for projecting images (used during presentations), printers, light pens, scanners, telephones and fax etc. Software and applications have been a very huge development in the history of ICT and has changed the conditions within building design and procurement.

For construction industry, different applications have been built specifically for different purposes and some are compatible with others. For instance drawings created in AutoCAD by an architect can be transferred to modelling software such as 3DstudioMAX. There are also different applications such as those for contractors and surveyors which involve accounting and processing data for contracts and consolidating results for architects and engineers. Computer aided drafting (CAD), a major output of any architectural and engineering team refer to drawings generated by computers. Like any other CAD software, construction oriented CAD are based on the same principles but may differ to some extent in their designing and application methods. CAD systems provide drawing entities with powerful construction, editing and database techniques to produce drawings and models of what buildings will look like when finished (Dace, 2007). They are based on the foundation of drawing primitives (2D/3D lines, arcs, curves, 3D surfaces, text etc.).Its data can also be read and stored in by other applications software and hardware for analyzing the output information. For example, a CAD system could be used to generate 2Ddrawing, and can be linked to another or same software as the case maybe and generate the 3D model. It can be stored for future references, printed, projected, edited, modified, etc. any number of times.

System based spreadsheets, word programs and microcomputers have transformed information processing in construction organizations. They are used to solve problems and get round the long delays encountered in dealing with the traditional manual way of getting office works done (Sun and Howard, 2004). Spreadsheets like Microsoft excel, word and power point are very important office tools as they stand for the every day to day running of worksheets. They are frequently used for financial information and presentations as they can be used to create and edit charts, graphs and tables. They are a very important ICT tool in the housing construction industry as they are designed to perform general computation tasks using spatial relationships. Most documentation, letters, calculations and presentations are being done on spreadsheets and they are usually compatible to the CAD software and firms may independently operate small-group CT innovation such as planning and scheduling applications using spread sheets and word processors.

Building information modelling (BIM) refers to the use of computers in construction industry to automate and simulate hand-drafting methods, and3D models have assisted in showing what building will look like by the time they are right on the drawing table. BIM software has the ability to directly and interactively present concepts of design in a form which represent physical and real images of the building to allow designers to identify clients' needs, and to promptly and effectively provide solutions to these needs (Dace, 2007). They involve more people from design, management, construction and operations during the design phase which helps a great deal in the lead to design improvement. They have the other personal computer-based construction planning packages such as spread sheets and CAD. They can build a project from the beginning to the end and be able to detect unclear flaws on the computer screen before actual field construction. It is a tool to assist in improving communication and collaboration for a successful overall productivity by designer and contractors (Eastman et al., 2008).

Influence of e-mails' use on project performance

E- Mail as is all known is simply the transfer of data from one person's computer files (or a mobile phone device) to another. It works via the internet. Nowadays, not only is text and pictures transferable via mails, but videos programs etc. In construction, electronic mails are very useful as they are very fast and convenient means of sending and receiving mails and files. Secured means and encryption are available too by third party software or hosts of the mailing site. Electronic mail does not simply speed up the exchange of information but leads to the exchange of new information as well Sun and Howard (2004).In 1993, the introduction of the graphically-based World Wide Web led to an explosion in Internet usage among non-scientists and paved the way for commercial uses Sun and Howard (2004). The World Wide Web can provide the graphically-based tool for sharing information (text, full-color graphics and photos, audio and video) through computers. Information on the Web can range from presentations to online publications to personal 'home pages' and can from any computer or electronic gadget equip to connect to the internet. Itis an interactive interface and provides a popular way to access information and networking.

Between construction teams, physical distance generates communication barriers and the variety of communication media and modes in construction further augments its communication difficulties. Onsite, simple radio signals can be used to communicate between participants but messages sometimes get distorted or delayed. Further, using long distance calls or overseas reproduction is very costly and the cost of using the Internet services (WebEx, skype for video teleconferencing, etc.) is much lower than that of express courier services. Messages can reach the recipients as soon as it is sent and can also be traceable. The Internet is a global network which is not restricted by locations, time or different computer operating systems (Tam, 1999).Networks in general and the internet in particular provide exceptional opportunities for communication and data exchange among and within construction firms. At a local scene, Safaricom's Mpesa transaction represent a technology which has affected every other sector of the economy. Walking distance has greatly reduced by use of internet and mobile phones e-commerce. Its easy today to source and purchase goods and services from your house by use of your handset/cell phone!

Influence of four dimensional (4D) models and project performance

The most recent addition to planning and scheduling tools available to the construction industry is computerbased4D technology. Four dimensional (4D) construction planning provides the ability to represent construction plans graphically (Heesom & Mahdjoubi, 2002). A 4D model results from the linking of 3D graphic images to the fourth dimension of time (Koo & Fischer, 2000). In the 4D model, the temporal and spatial aspects of the project are inextricably linked, as they are during the actual construction process (Fischer,1997).In recent years, 3D and 4D models have been used in more and more construction housing projects to support management tasks (Hartmann et al., 2008). Because of the presence of a direct link between 3D design and the project schedule, a 4D model has more areas of application than traditional 2D drawings and a CPM. Other advantages that 4D applications have over traditional 2D methods are, for instance, that they provide the possibility to represent construction plans graphically (Heesom & Mahdjoubi, 2002) and that the visualization of a construction project and its schedule helps planners in the process of identifying potential problems before actual construction starts (McKinney et. al, 1998).

Examples from literature of the areas of application of 4D technology are the visualization of a project for marketing and communication purposes, design review (clash detection), cost estimating, bid preparation/procurement (Hartmann et al., 2008),constructability review (Hartmann & Fischer, 2007), site management (Chau et. al, 2004),scheduling, and macro planning (location-based) work-flow (Jongeling &Olofsson, 2007). Heesom and Mahdjoubi (2004) remark that, in general, the utilization of 4D visualization allows a more intuitive comprehension of the construction process than traditional 2D drawings and schedule information. By visualizing the sequence of construction activities and the creation of various components of the construction project, project teams can determine whether the sequence is feasible and logical and whether there are clashes between the project components and activities before the project starts. This tool is very important at macro planning stage and gives the PM additional mileage in coming up with a sound workable and executable plan of the project beforehand.

Theoretical Framework

This study was guided by three Theories – McGregor's Theory of X and Y, Critical Chain Project Management Theory, and the Theory of Performance (ToP).

McGregor's Theory of X and Y

Douglas McGregor states that people inside an organization can be managed in two ways. The first is which falls under the category negative and the other one is positive. Under the assumptions of category negative, employees inherently do not like work and whenever possible, will attempt to avoid it. Because employees dislike work, they have to be forced, coerced or threatened with punishment to achieve goals. Employees avoid responsibilities and do not work until formal directions are issued. Most workers place a greater importance on security overall other factors and display little ambition. Persons in this category are detrimental to project execution and performance.

Under the assumptions of category positive, physical and mental effort at work is as natural as rest or play. People do exercise self-control and self-direction and they are committed to those goals. Average human beings are willing to take responsibility and exercise imagination, ingenuity and creativity in solving the problems of the organization. An organization that is run on category negative lines tends to be authoritarian in nature. In contrast, category positive organizations can be described as participative, where the aims of the organization and of the individuals in it are integrated; individuals can achieve their own goals best by directing their efforts towards the success of the project organization, hence promotion of the project performance. This theory will be best suited to guide the project teams for the success of the gated community housing construction projects.

Critical Chain Project Management Theory

Critical Chain Project Management is the Theory of Constraints logistical application for project operations. It is named after the essential element; the longest chain of dependent resourced tasks in the project. The aim of the solution is to protect the duration of the project, and therefore completion date, against the effects of individual task structural and resource dependency, variation, and uncertainty. The outcome is a robust and dependable approach that will allow completion of projects on-time, every time, and most importantly within at most 75% of the current duration for single projects and considerably less for individual projects within multi-project environments. The shorter duration provides a sterling opportunity in the marketplace to differentiate ourselves from our competitors who deliver poorer outcomes, and late at that, via other project management methods. It also offers the opportunity to deliver more projects over all, in the same amount of time, and at no increase in operating expense, thus significantly improving the bottom line (Ballard et al., 2002). Application of this theory will therefore improve and ensure project performance is enhanced in terms of completion on time. It will be used to guide the variable under study (technological environment) to capture all the critical tasks so as to deliver the project (s) within schedule.

The Theory of Performance (ToP)

The Theory of Performance (ToP) develops and relates six foundational concepts to form a framework that can be used to explain performance as well as performance improvements. To perform is to produce valued results. A performer can be an individual or a group of people engaging in a collaborative effort. Developing performance is a journey, and level of performance describes location in the journey. Current level of performance depends holistically on six components: context, level of knowledge, levels of skills, level of identity, personal factors, and fixed factors. Three axioms are proposed for effective performance improvements. These involve a performer's mindset, immersion in an enriching environment, and engagement in reflective practice. This theory encourages teamwork and a sense of belonging which is a recipe for housing construction projects' performance. It will be applied in to guide and strengthen the dependent variable. Performance levels can only be ascertained as the project progresses through scheduled and periodic reviews, hence this theory will be best suited for this purpose.

Conceptual Framework for the study

The objective of this study was be to examine the extent to which technological environment influences performance of gated community housing projects in Nairobi County, Kenya. Three key indicators of technological environment were identified – availability of skilled manpower to operate the plant, use of system based computer aided design, building information modeling and 3D/4D models and use of system based communication tools like e-mails, teleconferencing, WebEx and skype. The inter-relationship between the study variables is shown in Figure 1.

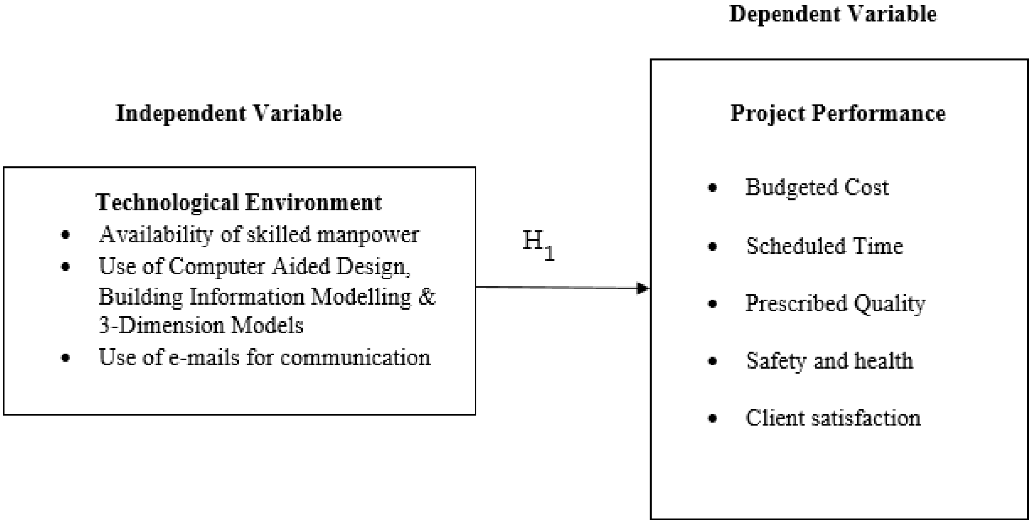

Figure 1: Conceptual framework for the study.

Research Methodology

The research paradigm used in this study was pragmatism derived from the work of Peirce, James, Mead and Davey (Creswell, 2013). As a philosophical underpinning for mixed mode studies, it conveys the importance for focusing attention on the research problem and then using pluralistic approaches to derive knowledge about the problem (Cresswell, 2013). Pragmatism also allowed the researcher to conduct both deductive and inductive logic which is middle path between positivism and constructive paradigms. Considering that questionnaires with both closed and open ended questions were used as instruments to collect both quantitative and qualitative data in this study, this paradigm was found to be the most suitable to be adopted

This study combined a cross sectional descriptive survey and correlational research design. The use of the two designs were suitable because the study used both descriptive and inferential analysis of data. On one hand cross sectional descriptive survey design was concerned with describing, recording, analyzing and interpreting conditions that existed. This design was the most appropriate for this study because of its ability to elicit a diverse range of information. Correlational research design on the other hand allowed the use of inferential statistics for measurement of two or more variables to determine the extent to which they were related or influenced each other (Fraenkel &Wallen, 2008).

The target population of the study comprised of 228 gated community housing projects which were active and running, initiated and completed between 2009 and 2014. The study employed a combination of census, stratified random sampling, and purposive sampling techniques. All the sub-Counties were included in the study (census) and this was the first stage. In the second stage, one hundred forty three (143) projects were randomly sampled from the 228 completed projects based on each stratum. The criteria to establish units to be included in the sample established by the researcher was as follows: “If number of active projects are less or equal to 5 in a sub-County, sample purposively the highest value project (1); and if the number of completed projects are higher than 5 in a sub-County, sample 66% of the total active projects by random sampling method. In the third stage, client (owner), consultant, main contractor, and gated community facility managers, were selected using purposive sampling method from individual construction housing projects which were sampled above. According to Walliman (2005), purposive sampling is a useful sampling method which allows a researcher to get information from a sample of the population that one thinks knows most about the subject matter. The total number of respondents was therefore 572, i.e. 143 projects x 4 people from each.

Data collection instruments for this study included use of structured questionnaire with both open and closed ended question, and a standardized open-ended interview guide for consultant(s) and main contractor(s). Four questionnaires were therefore administered to each of the 139 gated community projects, totaling to 556, anticipating for responses from each of the four professionals chosen from each gated community housing project. To ensure construct validity, the questionnaire was verified by a panel of experts made up of the researcher’s supervisors. Also peers were contacted to assist in establishment of the instrument validity. Internal validity was tested by use of triangulation method where the data collection instrument had the same question analyzed based on what the different categories of the respondents had answered (Merriam, 1998). To test for reliability, a pilot study was conducted in four (4) selected housing projects, involving sixteen (16) respondents. Internal consistencies were computed for the pilot study using Cronbach’s Alpha co-efficient. Kyalo (2007); Munyoki (2007); Mulwa (2012); Nganga (2014); and Ibua (2014) had used the same tool successfully to assess reliability of their research instruments. The housing projects selected for the purpose of the pilot study were not used at the data collection stage.

Findings and Discussions

The questionnaires returned from the clients were 92 out of the 139 administered. The same tread applied to consultants who returned 87 and main contractors 88 out of 139 questionnaires administered respectively. Facility managers returned 120 questionnaires out of the 139 administered, and 19 did not return theirs. On overall, out of the 556 questionnaires distributed, 387 were returned for analysis forming a response rate of 69%. Saunders et al. (2003) posed that above 50% response rate is reasonable for statistical generalization. The final study sample size is presented in Table 2

Table 2: Final study sample size

	Number of projects	Number of respondents
Sample size from population (n’)	143	143 x 4 = 572
Pilot study units	4	4 x 4 = 16
Final study sample (n)	139	139 x 4 = 556

Background information of the respondents

The background information of the respondents is shown in Table 3

Distribution of the respondents by gender

Gender	Clients (Frequency) n	Consultants (Frequency) n	Main Contractors (Frequency) n	Facility Managers (Frequency) n	Total Percent %
Male	70	62	80	78	75
Female	22	25	08	42	25
Total	**92**	**87**	**88**	**120**	**100**

Distribution of respondents by age

Age in years	Clients (frequency) n	Consultants (frequency) n	Main contractors (frequency) n	Facility managers (frequency) n	Total percentage (%)
< 26	0	0	0	0	0
26-30	0	5	7	30	10.85
31-35	03	25	10	42	20.67
36-40	06	32	27	22	22.48
41-45	15	11	29	15	18.09
46-50	25	09	13	11	14.99
> 51	43	05	02	0	12.92
Total	**92**	**87**	**88**	**120**	**100**

Distribution of respondents by level of education

Level of Education	Clients (Frequency) n	Consultants (Frequency) n	Main Contractors (Frequency) n	Facility Managers (Frequency) n	Total Percentage %
PhD	03	02	0	0	1.29
Masters	19	37	13	0	17.84
Bachelor's Degree	25	40	32	38	34.88
Diploma	15	08	37	62	31.52
Certificate	17	0	06	13	9.30
Secondary Certificate	13	0	0	07	5.17
Total	**92**	**87**	**88**	**120**	**100**

Distribution of respondents by number of projects involved

Projects involved in 2009 - 2014	Clients (Frequency) n	Consultants (Frequency) n	Main Contractors (Frequency) n	Facility Managers (Frequency) n	Percentage (%)
< 5	11	13	18	120	41.86
5-8	29	29	34	0	23.77
9-11	28	33	22	0	21.45
12-14	11	06	11	0	7.24
15-17	9	3	03	0	3.88
18-20	4	2	0	0	1.55
> 21	0	1	0	0	0.25
Total	**92**	**87**	**88**	**120**	**100**

The research findings in Table 3 indicated that 75% of the respondents were male while 25% of the respondents were female. These findings show that the housing construction industry in Kenya is dominated by male professionals. The highest number of women in this sector was observed from the facility managers' docket which had 42number whereas men were 78 in number. Though not mandatory and neither a requirement across all sectors, the constitution of Kenya requires that there should be at least a third of either gender in all forums, especially in elective posts! This requirement is slowly creeping in and getting roots across all governmental and non-governmental institutions.

On age, the findings in indicated that 10.85% of the respondents were between 26-30 years, 20.67% were between 31-35 years, 22.48% were between 36-40 years, 18.09% were between 41-45 years, 14.99% were between 46–50 years and 12.92% were 51 year and above. These findings shows that 68.5% of the professionals and project owners in the housing construction industry are above 36 years, hence experienced and knowledgeable in their respective fields. This trend implies that the older generation dominates this industry and not only affects building design and structure; but it also has a serious impact on the construction workforce. A great deal of knowledge and skills will be lost in the next few decades with fewer professionals lined up for replenishing the market.

On level of education, the research finding indicated that 1.29% of the respondents had a Ph.D. degree, 17.84% had master's degree, 34.88% had bachelor's degree, 31.52% had diploma, 9.30% had college certificate, whereas 5.17% had secondary school certificate. These findings show that majority of the respondents (34.88% and 31.52%) who dominated this industry had a bachelor's degree and college diploma, whereas those with Ph.D. and master's degree combined were 19.13%. Those respondents with college certificate combined with secondary school certificate as their highest qualification were 14.47%. The findings show that this industry is dominated by those with levels of education ranging from a bachelor's degree and a college diploma (66.4%). Those with education higher than the dominant group (master's and Ph.D. degree) were 19.13%, whereas, those below the dominant group (college diploma and secondary certificate) were 14.47%. From interviews with the selected respondents (consultants and main contractors), it was further revealed that the highest level of education (master's and Ph.D.) was solely by the consultants, whereas the dominant group (bachelor's degree and diploma) consisted mainly of the main contractor and the clients. The group with the least education consisted mainly of the facility managers/caretakers.

On number of projects involved in, the research findings indicated that within the period under consideration, 41.86% of the respondents had been involved in less than 5 projects, 23.77 % involved in 5-8 projects, 21.45 % involved in 9-11 projects, 7.24 % involved in 12-14 projects, 3.88 % involved in 15-17 projects, 1.55 % involved in 18-20 projects, and 0.25 % involved in over 21 projects. These findings show that the respondents drawn from consultants and main contractors were involved in more than 9 projects at an average, as majority of clients (52/92) owned more than 9 projects. All facility managers were involved in less than 5 projects – to be specific, each facility manager represented only the gated community project in question. No facility manager who had more than one gated community project under their watch.

Tests of assumptions and analysis of Likert type of data

Test of normality was conducted using Kolmogorov-Smirnov test statistics (KS-test) and Shapiro-Wilk test (SW-test). The variables of the study were further subjected to multi-collinearity testing using Variance Inflation Factor (VIF) and Tolerance Tests in the regression analysis. The values of Variance Inflation Factor (VIF) ranged from 1.00 to 4.6 which were within the criteria set by Meyers (1990), who suggest that VIF should be less than 10. The tolerance value was between 0.219 and 0.948 which was within Menard's (1995) criteria, who suggested that tolerance value of less than 0.1 can infer multi-collinearity. Further, referring to the rule of thumb by Garson (2008), the independent variable had a correlation of not more than 0.8, which suggested that there was no multi-collinearity. Garson (2008) posited that inter-correlation among variables of more than 0.8 indicates a possible problem of multi-collinearity.

Heteroscedasticity may occur when some variables are skewed and others are not. Further, measurement error can cause heteroscedasticity. Some respondents might provide more accurate responses than others, or there may occur sub-population differences or other interaction effects which may cause heteroscedasticity. Based on the assumptions of the classical linear regression model, the researcher will hold that there will be no issues of heteroscedasticity as the data have been assumed to be linear, and also normality distribution of the population has been checked by Kolmogorov-Smirnov and Shapiro-Wilk tests.

Analysis of Likert- type data and accounting for the error term

In this study, the following Likert Scale was used: 1=To a very little extent; 2=To a little extent; 3=To a moderate extent; 4=To a great extent; and 5=To a very great extent. The following scale was also used: 1=Strongly Disagree; 2=Disagree; 3=Neutral; 4=Agree; and 5=Strongly Agree. It was also assumed that Likert-type data has equidistant so that parametric methods of data analysis can be used (Lantz, 2013). Carifio and Racco (2007) indicates that when using a five point Likert scale the following is the scoring; strongly agree (SA) 4.2<SA<5.0; agree (A) 3.4<A<4.2; neutral (N) 2.6<N<3.4; disagree (DA) 1.8<DA<2.6 and strongly disagree (SDA) 1.0<SDA<1.8. The scale gives equidistant of 0.8. This weighting criterion was followed in data analysis of Likert-type of data in this study. The same scale was used successfully by Nganga (2014).

In order to minimize the error, the researcher ensured a complete understanding of all statistical techniques in use before creation of the question list. In this way, the survey questions will complement the planned data analysis, hence minimizing the error. Further, formulation of open ended questions to supplement the closed ended questions will make it difficult to overlook options from respondents, which in turn will complement the value of the results and reduce the error. All these tactics had been given consideration by the researcher to mitigate for the error term.

Analysis of project performance indicators in gated community housing construction

Project performance in housing construction industry was identified in this study as the dependent variable. Budgeted cost, scheduled time, prescribed quality, safety and health, and clients' satisfaction were identified as indicators of project performance in housing construction industry. Respondents were given items rated on a five point Likert scale ranging from: strongly agree (SA); agree (A); neutral (N); disagree (DA); strongly disagree (SDA) from which to choose relating to each indicator. The findings are presented in Table 4

Table 4: Frequencies and percentages for project performance indicators in housing construction industry

Statement	SDA F (%)	DA F (%)	N F (%)	A F (%)	SA F (%)	Total F (%) n
Budget/Cost Related.						
Cost of the project(s) was as per initial budget for the project	343 (88.6)	44 (11.4)	0 ()	0 (0)	0 (0)	387 (100)
No variation order (s) were raised for the project	303 (78.3)	84 (21.7)	0 (0)	0 (0)	0 (0)	387 (100)
No disagreements were raised on the valuation of work done	168 (43.4)	189 (48.8)	30 (7.8)	0 (0)	0 (0)	387 (100)
No funding issues were raised during the project time	0 (0)	0 (0)	27 (7)	287 (74.1)	73 (18.9)	387 (100)
Many provisional sums and prime costs were factored	0 (0)	0 (0)	42 (10.9)	334 (86.3)	11 (2.8)	387 (100)
Payments to the main contractor were released without delays.	20 (5.2)	329 (85.0)	38 (9.8)	0 (0)	0 (0)	387 (100)
Time Related.						

Project was not executed within the planned time	0 (0)	0 (0)	3 (0.8)	20 (5.2)	364 (94)	387 (100)
Set project duration was not enough for the project	0 (0)	0 (0)	7 (1.8)	13 (3.4)	367 (94.8)	387 (100)
There were delay in mobilization by the main contractor	0 (0)	5 (1.3)	30 (7.8)	352 (90.9)	0 (0)	387 (100)
Many change requests were placed related to design	0 (0)	0 (0)	8 (2.1)	321 (82.9)	58 (15)	387 (100)
There were lengthy routine of government authorities	0 (0)	0 (0)	0 (0)	100 (25.8)	287 (74.2)	387 (100)
Irregular attending of project review meetings were recorded	0 (0)	0 (0)	0 (0)	75 (19.4)	312 (80.6)	387 (100)

Quality Related.						
There were issues arising from quality of materials	0 (0)	55 (14.2)	33 (8.5)	299 (77.3)	0 (0)	387 (100)
Many re-work issues were raised	0 (0)	79 (20.4)	35 (9.1)	273 (70.5)	0 (0)	387 (100)
Inspection schedules were not followed	0 (0)	75 (19.4)	11 (2.8)	301 (77.8)	0 (0)	387 (100)
Changes in drawings and specifications were many	0 (0)	95 (24.5)	32 (8.3)	260 (67.2)	0 (0)	387 (100)
Inadequate skill of contractor’s staff were noticed	0 (0)	99 (25.6)	42 (10.9)	246 (63.5)	0 (0)	387 (100)
There were frequent design changes	0 (0)	0 (0)	39 (10.1)	267 (69)	81 (20.9)	387 (100)

Safety and Health Related.						
No fatalities were reported during the project time	0 (0)	0 (0)	0 ()	4 (1)	383 (99)	387 (100)
No injury compensation issues were raised	0 ()	87 (22.5)	40 (10.3)	260 (67.2)	0 (0)	387 (100)
No work related injuries were reported	0 (0)	78 (20.2)	13 (3.4)	296 (76.4)	0 (0)	387 (100)
Safety orientation and talks were mandatory	0 (0)	0 (0)	18 (4.7)	67 (17.3)	302 (78)	387 (100)
Use of personal protective equipment (PPE’s) was a must	0 (0)	0 (0)	0 (0)	97 (25.1)	290 (74.9)	387 (100)
Daily Pre-task planning before start of work with the team (s) was done	0 (0)	0 (0)	40 (10.3)	127 (32.8)	220 (56.9)	387 (100)
Permits were issued for working at heights	0 (0)	0 (0)	50 (12.9)	187 (48.3)	150 (38.8)	387 (100)
Scaffolding, personal fall arrest systems (PFAS), and Ladders had an inspection schedule	0 (0)	31 (8)	65 (16.8)	72 (18.6)	219 (56.6)	387 (100)

Permits were issued for working in confined space	0 (0)	14 (3.6)	33 (8.5)	193 (49.9)	147 (38)	387 (100)
Permits were issued for hot works	0 (0)	20 (5.2)	29 (7.5)	189 (48.8)	149 (38.5)	387 (100)
Safety officer was required full time at site	0 (0)	0 (0)	60 (15.5)	177 (45.7)	150 (38.8)	387 (100)
Client satisfaction related.						
No repeat jobs after completion	0 (0)	60 (15.5)	0 (0)	327 (84.5)	0 (0)	387 (100)
No legal issues raised by owner	0 (0)	314 (81.1)	0 (0)	73 (18.9)	0 (0)	387 (100)
Defects liability for workmanship was set for more than six months	0 (0)	0 (0)	0 (0)	69 (17.8)	318 (82.2)	387 (100)
Client was satisfied with final finishes of the facility (s)	0 (0)	54 (14)	0 (0)	333 (86)	0 (0)	387 (100)
There was smooth information coordination between owner and project parties	0 (0)	171 (44.2)	0 (0)	216 (55.8)	0 (0)	387 (100)
No Conflicts encountered among involved parties	0 (0)	91 (23.5)	33 (8.5)	263 (68)	0 (0)	162 (100)

The research findings in Table 4, based on the project budgeted cost show that 88.6% of the respondents indicated that they strongly disagreed with the statement that projects completed as per initial budget, 78.3% strongly disagreed that there were no variation orders raised for their projects, 48.8% disagreed with the statement that there were no disagreements raised on the valuation of work done at their projects, 74.1% agreed that no funding issues were raised during their project time, 86.3% agreed there were many provisional sums and prime costs factored in their projects, and 85.0% disagreed with the statement that payments to the main contractor were released without delays.

On project schedule, the research findings on Table 4 show that majority of the respondents strongly agreed that the projects were not executed within the planned time (94.0%), set project duration was not enough for the project (94.8%), there were lengthy routine of government authorities (74.2%), and irregular attending of project review meetings were recorded (80.6%); agreed there were delays in mobilization by the main contractor (90.9%), and many change requests were placed related to design (82.9%). These research findings imply that there were schedule delays and the initial schedule was not antiquate to complete the project. Government routine and permitting process is depicted as a bottleneck in meeting the initial project schedule due to lengthy and tedious procedures. Project review meetings with all stakeholders is implied to be an issue as absenteeism is noted and said to affect effective implementation of the project schedule. Finally, delays in mobilization from the main contractor and many change request schedules raised by the contractor due to design constructability were also cited as issues contributing to delay in meeting the project schedule as per the initial plan. From the open ended questions, the respondents were in agreement with the questionnaire respondents as they cited performance challenges as among others as; lengthy government routine in permits processing, delay in main contractor mobilization, and many changes from the original design and scope through change requests. This reflects that both interviewed respondents and those from the questionnaires were in agreement that project performance in meeting the initial timeline was a real issue.

Based on the quality related indicator, the research findings in Table 4 show that 73.3% of the respondents agreed that there were issues arising from quality of materials, 70.5% agreed that many re-work issues were raised, 77.8% agreed that inspection schedules were not followed, 67.2% agreed that changes in drawings and specifications were many, 63.5% agreed that inadequate skill of contractor's staff were noticed, and 69.0% agreed that there were frequent design changes in their project (s). The findings indicate that the respondents were in agreement that quality related issues touching on materials, re-works, missed inspection schedules, changes in drawings and specifications, inadequate skills of the contractors' staff, and frequent design change. All these put together are giving rise to the fact that the projects had quality issues.

On safety and health, the research findings in Table 4 show that majority of the respondents strongly agreed with the statement(s) that no fatalities were reported during the project time (99%), safety orientation and talks were mandatory (78%), use of personal protective equipment (PPE's) was a must (74.9%), daily pre-task planning before start of work with the team (s) was done (56.9%), and scaffolding, personal fall arrest systems (PFAS), and Ladders had an inspection schedule (56.6%). The remaining portion of the respondents agreed with the statement(s) that, no injury compensation issues were raised (67.2%), no work related injuries were reported (76.4%), permits were issued for working at heights (48.3%), permits were issued for working in confined space (49.9%), permits were issued for hot works (48.8%) and safety officer was required full time at site (47.5%).

The findings imply that the projects were delivered within specified safety and health parameters as respondents pointed out – no fatalities, safety orientation and safety talks were mandatory, use of PPE's was mandatory, daily pre-task plans were done before starting the work, scaffolding, personal fall arrest systems as well as ladders had an inspection schedules, no injury compensation issues were raised, no work related injuries were reported, permits were issued for working at heights, confined spaces and for hot works, and a full time safety and health officer. This further indicates that safety and health is highly regarded as an indicator of project performance, and measures and checks have been put in place at the construction sites to prevent injuries at the working sites.

On Client satisfaction, the research findings in Table 4 show that 84.5% of the respondents indicated that there were no repeat jobs after completion, 81.1% disagreed there were no legal issues raised by owner, 82.2% strongly agreed defects liability for workmanship was set for more than six months, 86% agreed client was satisfied with final finishes of the facility (s), 55.8% agreed there was smooth information coordination between owner and project parties, and 68% agreed no conflicts were encountered among involved parties. The respondents' results portray that the projects were delivered within above average quality based on how each item was scored; a small percentage (15.5%) indicated that there were repeat jobs after completion, 18.9% agreed there were legal issues raised by the owner, 17.8% agreed defects liability for workmanship was set for more than months, 14% disagreed the client was satisfied with the final finishes of the facilities, 44.2% disagreed there was smooth information coordination between owner and project parties, and 23.5% disagreed with the statement that there were no conflicts among project parties. These findings imply that client satisfaction though highly rated was wanting and needed to be addressed for projects to deliver as per the clients' expectation.

Overall analysis on Project performance indicators

The overall findings on the project performance indicators in gated community housing construction industry is shown in Table 5

Table 5: Means and standard deviations for project performance indicators

Indicator	n	Min	Max	M	SD
Budgeted cost	387	1	5	2.40	0.27
Scheduled time	387	1	5	4.01	0.19
Prescribed quality	387	2	5	3.48	0.55
Safety & Health	387	2	5	4.33	0.45
Client satisfaction	387	2	5	3.53	0.54
Overall composite index	387	1	5	3.55	0.20

The research findings in Table 5show that the mean score for the five performance indicators was 3.55 and standard deviation of 0.20.Based on individual composite implementation mean and standard deviation for each indicator; to a very great extent (M=4.33, SD=0.45) projects did perform in health and safety issues; to a great extend projects did perform as per scheduled time, prescribed quality, and client satisfaction (M=4.01, SD=0.19), (M=3.48, SD=0.55), and (M=3.53, SD=0.54) respectively, and to a low extend projects did perform as per budgeted cost (M=2.40, SD=0.27).

From the observed small standard deviations, the implication is that the respondents were concentrated around the mean and didn't have significant variations. The respondents scored the items at or close to the center of the scoring scale. The overall composite index for the indicators combined takes and follows the same trend, portraying a concentration of the responses around the mean. The group of respondents being studied emerged to have a similar scoring trend that did not have a wide variation from the mean, and the results generally imply that the project indicators combined were highly regarded by the respondents and needed to be taken into consideration to have projects in housing construction industry perform as per client and other stakeholders' satisfaction.

From the open ended questionnaire items, the researcher had required the respondents to list two performance challenges encountered in implementation of gated community housing projects, and suggest ways in which implementation of gated community housing projects could be made more effective. The summary of the research findings from the responses indicated that the respondents had similar answers to the closed ended questions in the questionnaire. The responses were in agreement with the closed ended questionnaire items. The respondents listed schedule and budget overruns, design constructability issues resulting to many changes from the initial plan, unrealistic project schedule that do not take into account all the tasks required to deliver the project, quality issues of the finished product resulting to client dissatisfaction. Suggesting ways in which implementation of gated community housing projects can be made more effective, the respondents listed the following; development of a project schedule that takes care of all tasks required to deliver the project, matching tasks with resources and required skill to execute them, employing a sound pre-construction planning process to come up with a workable project schedule, development of a quality system and procedure to achieve the desired level of quality, coming up with regular site project review meeting to evaluate progress with the concerned stakeholders, and use of computer aided design tool (CAD) to makes the project designs accurate and easy to store for referencing purposes. The responses were complimentary to the closed ended questionnaire items' responses.

For triangulation purposes, the researcher also had items related to the project performance indicators in the standardized interview guide which were meant for consultants and main contractors. The research findings from the respondents showed that the interview with the consultants and the main contractors produced results that were in agreement with those given for the open ended questionnaire items and also complimented the results to the closed ended questionnaire items though in a different version.

Influence of technological environment on project performance

The respondents were requested to indicate the extent to which technological environment influenced performance in the housing construction industry. They were given seven items rated on a five point Likert scale. The responses are presented in Table 6 and Table 7

Table 6: Frequencies and percentages for technological environment

Statement	VLE F (%)	LE F (%)	ME F (%)	GE F (%)	VGE F (%)	Total n (%)
Project used locally made plant and equipment (Not imported)	0 (0)	0 (0)	0 (0)	77 (19.9)	310 (80.1)	387 (100)
Skills were available for operation of the plant and equipment	0 (0)	0 (0)	35 (9)	302 (78.1)	50 (12.9)	387 (100)
Team members with necessary skills to operate and use the plant equipment were available	0 (0)	0 (0)	34 (8.8)	320 (82.7)	33 (8.5)	387 (100)
Use of Information and Communication technology (ICT) was satisfactory	0 (0)	0 (0)	49 (12.6)	99 (25.6)	239 (61.8)	387 (100)
Computer Aided Drafting (CAD) was used	0 (0)	0 (0)	25 (6.5)	25 (6.5)	337 (87)	387 (100)
3D visual illustrations - Building Information Modelling, was used.	0 (0)	0 (0)	0 (0)	137 (35.4)	250 (64.6)	387 (100)
Electronic mails and communication was used	0 (0)	0 (0)	0 (0)	54 (14)	333 (86)	387 (100)

The research findings on Table 6 show that majority of the respondents indicated that to a very great extent their projects used locally made plant and equipment (80.1%), to a great extent skills were available for operation of the plant and equipment (78.1%), to a great extent team members with necessary skills to operate and use the plant equipment were available (82.7%), to a very great extent use of information and communication technology (ICT) was satisfactory (61.8%), to a very great extent Computer Aided Drafting (CAD) was used (87%), to a very great extend 3D visual illustrations - Building Information Modelling, was used (64.6%), and to a very great extent electronic mails and communication was used (86%). However, a small part of the respondents had a slightly different opinion; availability of skills to operate plant and equipment (9%), use of ICT (12.6%), and use of computer aided drafting (6.5%) was rated ‘to a moderate extent’ when all the others had a rating above ‘to a great extent’. This implied that in some of the projects there were issues with these items and they needed to be addressed to have all the respondents operate at a common and level ground.

Table 7: Means and standard deviations for technological environment

Statement	n	Min	Max	M	SD
Project used locally made plant and equipment (Not imported)	387	4	5	4.81	0.40
Skills were available for operation of the plant and equipment	387	3	5	4.04	0.47
Team members with necessary skills to operate and use the plant equipment were available	387	3	5	4.00	0.43
Use of Information and Communication technology (ICT) was satisfactory	387	3	5	4.50	0.71
Computer Aided Drafting (CAD) was used	387	3	5	4.62	0.71
3D visual illustrations - Building Information Modelling, was used.	387	4	5	4.65	0.48
Electronic mails and communication was used	387	4	5	4.86	0.35
Extent to which technology environment influence performance in housing construction industry	387	3	5	4.50	0.31

The research findings in Table 7show that the mean score for the seven statements for technological environment was 4.50 and standard deviation of 0.31.From individual items’ mean and standard deviation, it is clear that respondents agreed that to a very great extent their projects used locally made plant and equipment (M=4.80, SD=0.40), to a great extent skills were available for operation of the plant and equipment (M=4.04, SD=0.47), to a great extent team members with necessary skills to operate and use the plant equipment were available (M=4.0, SD=0.43), to a very great extent use of information and communication technology (ICT) was satisfactory (M=4.49, SD=0.71), to a very great extent Computer Aided Drafting (CAD) was used (M=4.62, SD=0.71), to a very great extend 3D visual illustrations - Building Information Modelling, was used (M=4.65, SD=0.48), and to a very great extent electronic mails and communication was used (M=4.86, SD=0.34).

The findings show that the standard deviations are all lying approximately one standard deviation away from the mean. The overall mean and standard deviation (M = 4.5, SD = 0.31) imply that the respondents had responses which were not scattered away from the mean. They were in agreement and of the same mind regarding the issues raised through the questionnaires, hence their responses concentrated around the mean. These research findings imply that technological environment is widely used in housing construction industry, and has an influence on project performance.

Table 8: Correlation table for technology environment and project performance

		Technology Environment
Performance of housing construction projects	Pearson Correlation	0.428**
	Sig. (2-tailed)	0.000
	N	387

** Correlation is significant at the 0.01 level (2-tailed).

The correlation results in Table 8 indicate a correlation of 0.428 and a significance of 0.000 (two tailed test), implying a positive and significant coefficient. The results indicate presence of a moderate positive and significant relationship between technological environment and performance of gated community housing projects in Nairobi County, Kenya (r=0.499, p-value<0.01). Therefore, technological environment can be said to have a positive moderate and significant relationship with project performance in housing construction industry.

Inferential analysis of influence of technology environment on performance of gated community housing projects

The objective of the study was to determine the extent to which technological environment influences performance of gated community projects in Nairobi County, Kenya. Technological environment in housing construction industry projects was the independent variable in the study. The null hypothesis ($\mathbf{H_0}$: Technological environment has no significant influence on the performance of gated community projects in Nairobi County, Kenya) was tested using the following linear regression model: $Y = a + \beta_2 X1 + e$

Where;

Y= Project performance in gated community projects

a=constant

β_2= Beta coefficient

X1= Technology environment

e= error term

The results are presented in Table 9.

Table 9: Regression results of influence of technological environment on performance of gated community housing projects

Model	Unstandardized Coefficients		Standardized Coefficients	t	P-Value
	B	Std. Error	Beta		
Constant	1.512	0.136		11.105	0.000
Technology environment	0.136	0.29	0.327	4.578	0.000
Predictors: (Constant), Technology environment					
Dependent Variable: Performance in gated community housing projects					
R = 0.559					
R square =0.312					
t = 4.758 at level of significance p = 0.000 <0.05					

The study findings in Table 9 show that r is equal to 0.559, indicating that Technological environment has a moderately strong influence on performance in gated community housing projects. The value of r squared is 0.312, indicating that technological environment explains 31.2% of the variation in the performance in gated community housing projects in Nairobi County, Kenya. The β coefficient is 0.327, indicating that technology environment had statistically significant influence on the performance of gated community housing projects (β=0.327, t= 4.758, p=0.000<0.05). Considering the p value, it can be noted that the p value for technological environment (p=0.000) is statistically significant. The β value imply that one unit change in performance in gated community housing project is associated with 32.7% changes in technological environment.

The overall t=4.578 with p = 0.000<0.05 suggested that there was a statistically significant relationship between technological environment and performance in gated community housing projects in Nairobi County, Kenya. Based on the research findings we reject the null hypothesis which stated that technological environment has no significant influence on the performance of gated community projects in Nairobi County, Kenya and conclude that technological environment has a statistically significant influence on the performance of gated community projects in Nairobi County, Kenya. Using the statistical findings the regression model can be substituted as follows;

$$Y = 1.512 + 0.327\ X1 + e$$

Where;

Y= Project performance in gated community projects

X1= Technological environment

e = error term

Findings from this study agree with Ikechukwu et al (2011) that technological environment has a relationship with project performance. The findings also support Juliet and Ruth (2014), who argued that to a great extend technological environment has an influence on housing construction projects by giving out a clear picture of the completed houses in advance by use of 3D's. The findings of this study further agrees with a study carried out by Thomas et al. (2002),which reaffirmed that technological environment has a positive and stable influence on the project performance and therefore should be put into consideration whenever planners are working on an housing construction project.

The summary of the research findings from open ended questions indicated that the respondents had similar answers to the closed ended questions in the questionnaire. The respondents further mentioned other key items that needed to be considered for improved performance of the gated community housing projects like duplication of regulatory requirements – NCA registration, County government permits, dumping permits, EIA requirements, City planning approvals, electricity connection approvals, water connection approvals, etc. The responses for the technological application were skewed on the positive side on how performance is enhanced by the technology. Respondents were also of the opinion that the project manager's personal attributes –academic qualifications, experience, management abilities, leadership abilities, relationship with the top management as well as with the project teams were very important recipe for project performance. The responses complimented the closed ended questions in the questionnaire.

For triangulation purposes, the researcher also had items related to the project environment in the standardized interview guide which were meant for consultants and main contractors. From each category (consultants and contractors), five respondents were chosen for the interviews. The findings from the respondents showed that the interview with the consultants and the main contractors produced results that were in agreement with those given for the open ended questionnaire items and also complimented results to the closed ended questionnaire items. The standardized interview guide was meant for triangulation purposes and this requirement was achieved.

Conclusion and Recommendations

This section presents the conclusions made in the study in the context of the findings. The conclusion was made in line with the objective and hypothesis testing. The objective of this study was to examine the influence of technological environment on the performance of housing construction industry; a case of gated community projects in Nairobi County, Kenya. The indicators for technological environment were: availability of skilled manpower; use of computer aided design (CAD), building information modelling (BIM) & 3-Dimension Models; and use of e-mails for communication. These indicators were tested using seven questionnaire items. The research findings were R^2= 0.312, t =4.578, P = 0.000<0.05.The null hypothesis was rejected and was concluded that technological environment had a statistically significant influence on the performance of gated community projects in Nairobi County, Kenya. It's recommended that the construction industry should empower key practitioners – project owners, consultants and contractors in the use of technology in their designs to make the output workable with minimal change requests which in turn will assist in performing at the budgeted cost as well as in schedule.

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