Modeling of Construction Safety Performance and Housing Markets in Kampala City, Uganda

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Abstract

The construction industry in Uganda is characterized by a high incidence rate of accidents. During the late 1990s, an annual average of 49 accidents were reported in the construction industry while during the period 2001 to 2005, the annual average for this sector was 103 cases. Between 2006 and 2010, more construction accidents were registered with a total of 49 fatalities reported in Kampala metropolitan area alone. This trend has continued up to the present date. Meanwhile, the demand for housing in Uganda exceeds supply resulting into a huge housing deficit. Rapid population growth without matching housing facilities has been cited as the main cause of the housing deficit. Land holding in Uganda is characterized by multiple rights of ownership, and high social costs including land conflicts and violent evictions. Reportedly, these developments are affecting the performance of the housing sector. Given the above background, the aim of this thesis is to propose policies and strategies for improvement of construction safety performance and the housing sector in Uganda.

The thesis is based on two broad themes i.e. construction safety performance and housing markets. Although the research themes are unique in their own right, they both address pertinent issues concerning the construction industry in Uganda. Whereas the first theme investigates accidents as events that affect the production of construction infrastructure (including housing), the second theme handles topical issues which affect the demand and supply for housing in Uganda. The study area is Kampala, the capital city of Uganda. In addition to the overview chapter, this thesis contains four research papers. The first two papers relate to theme on construction safety performance whereas the last two papers relate to theme on housing markets.

The first paper investigates the causes of construction accidents in Kampala, establishes the prevailing injury and fatality rates, examines spatial patterns in occurrence of accidents and thereafter, proposes strategies of mitigating accidents. The second paper investigates how undiscovered rework (defined as unnecessary effort of redoing a process or activity that is incorrectly implemented the first time) leads to accidents, develops a computer based model for simulating occurrence of accidents on projects and thereafter, proposes strategies of reducing rework related accidents. Evidently, the first paper is explorative investigating construction safety issues at industry level, whereas the second paper is more specific studying safety dynamics at project level. The third paper investigates how the choice of land tenure system affects housing values and thereafter, proposes strategies of mitigating the negative effects of land tenure on the housing market. Finally, the fourth paper examines how population changes affect the housing needs of a city, develops a computer based model for simulating the city population and housing needs, and experiments a plethora of housing policy proposals.

Overall, findings of this thesis such as the concept of spatial dependence in occurrence of construction accidents, where accidents at one location were found to be associated with those which occur in the neighborhood; the phenomenon of congestion, defined in this thesis as the existence of high building density amidst many fulltime workers on site, and its significant association with accidents occurrence; and the uniqueness of private mailo land tenure system and the 12% premium it offers in housing values amidst high social costs, are unique contributions to the existing body of knowledge.

Keywords: accidents, construction industry, housing markets, spatial regression modeling, system dynamics.
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Stockholm, May 2015

Richard Irumba
Dedication

This thesis is dedicated to the many Ugandans who lost their lives to tragic construction accidents. I pray that the Good Lord rests their souls in eternal peace. Amen.

Stockholm, May 2015
Richard Irumba
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Paper IV: Irumba, R. (2014), *Modelling the Dynamics of Housing and Population Change in Kampala City, Uganda*, manuscript (to be submitted to *Habitat International* for review).
1.0 Introduction

‘Construction’ is the term used to describe the activity of the creation of physical infrastructure, superstructure and related activities (Wells, 1985). Therefore, it comprises of all civil-engineering work, all types of building works (including but not restricted to housing), as well as the maintenance and repair of existing facilities (Wells, 1985). Various studies have demonstrated that there is a significant and positive relationship between construction industry outputs and the economic growth of developing countries (for example, Pheng and Leong, 1992; Wells, 2001 and, Giang and Pheng, 2011). In this regard, the classification of countries as ‘developing’ follows the World Bank’s guidelines by considering the level of gross national income (GNI) per capita. Notably, a low-income country had a GNI per capita of $1,035 or less, a middle-income country had a GNI per capita of more than $1,035 but less than $12,616 and a high-income country had a GNI per capita of $12,616 or more in 2012 (World Bank, 2014). A similar classification is also used by United Nations and its agencies. The low-income and middle-income countries are collectively referred to as developing countries (Ofori, 2000). Uganda as well as a host of many nations in Sub-Saharan Africa falls in the category of developing countries.

Construction in developing countries contributes a big share of capital formation as well as national income (Ofori, 2006). Besides investments in new factories, machinery, equipment and materials, investment in construction infrastructure including civil works such as roads, dams, water and drainage facilities, and buildings increases the physical capital of a nation and thus, expands the national output level (Giang and Pheng, 2011). In developing countries, new construction work represents between 45% and 65% of gross domestic capital formation and the value added in construction accounts for 3-7% of the Gross Domestic Product, GDP (Wells, 1985; Giang and Pheng, 2011). The construction industry plays an important role that goes beyond its share of the national output by creating employment opportunities as well as backward and forward linkages with various sectors of the economy (Lopes, 1998; Giang and Pheng, 2011). Since large quantities of building materials and components are purchased from a large number of supply industries, expansion of the construction industry can stimulate the expansion of these industries through backward linkages (Giang and Pheng, 2011). Forward linkages relate to those sectors of the economy which benefit from the services generated by construction infrastructure such as transport, water and electricity, amongst others (Giang and Pheng, 2011).

In Sub-Saharan Africa, South Africa (a country with a more industrialized economy compared to the other countries in the region) distinguishes itself with a higher GDP per capita of US$10,070 by 2004 (Ugwu and Haupt, 2007). During the early 1990’s, economic growth in South Africa was more than five times higher than that of the Sub-Saharan region and about eight times higher than that of Nigeria, despite its population being more than double that of South Africa (Lopes, 1998). Reportedly, construction value added as a share of GDP for countries in the Sub-Saharan Africa region was between 1.7% and 4.5% (Lopes, 1998). In Ghana, construction contributed
8.8% to GDP in 2003 and 2004, ranking third behind agriculture and government services in terms of economic performance (Anaman and Osei-Amponshah, 2007). While in Kenya, a country neighboring Uganda to the east, the share of construction output to GDP was 4.4% during the 1990’s (Wells, 2001). Construction output in Kenya (as quoted above), and Nairobi city in particular, is likely to be underestimated given the dominance of informal construction practices whose outputs are either not captured at all or not fully captured in official records (Wells, 2001). Similar to what prevails elsewhere in Sub-Saharan Africa, the construction industry in Uganda has been making significant contribution to economic growth especially following liberalization of the economy in 1990. Details on the performance of the construction industry in Uganda are provided in section 2.

Despite the steady economic growth patterns as highlighted above, the construction industry in developing countries faces many challenges, one of which is safety. Globally, it is estimated that 55,000 fatal accidents occur at construction sites per year or stated otherwise, that one fatal accident occurs every ten minutes (Lopez-Valcarcel, 2001). In Sub-Saharan Africa, the fatality and injury rates in the construction industry are at 21 and 16,012 per 100,000 workers, respectively (CIDB, 2010). The fatality rate for the construction industry in the United States of America (USA) during the year 2008 was 9.6 per 100,000 workers compared to the national (all sectors) fatality rate of 3.6 per 100,000 workers (USDL, 2009). In Spain, a country which has some of the highest accident rates in the European Union, the fatality rate in the construction industry during the year 2003 was 20.1 per 100,000 workers compared to the national (all sectors) fatality rate of 7.5 per 100,000 workers (Lopez et al., 2008). In Asia, the fatality and injury rates are at 21.5 and 16,434 per 100,000 workers, respectively (CIDB, 2010). Due to lack of proper recording and notification systems, construction accidents statistics in developing countries could be underestimated. Nonetheless, the above statistics demonstrate that construction safety is a global problem, and that the scale of the problem is bigger in developing countries compared to developed countries.

Meanwhile, housing construction plays an important role in meeting human settlement needs of both developing and developed countries. Universally, housing is recognized as the second most important human need after food. In urban areas of developing countries, the housing problem concerns both formal and informal housing provision, as well as policies that regulate housing provision. The informal sector is the biggest producer of housing stock in most developing countries (Plessis, 2002; Wells, 2007). Whereas it is recognized that informal housing faces problems of overcrowding, bad indoor air quality, inadequate services and insecure land tenure, the formal low-cost housing developments do not necessarily improve on these problems (Plessis, 2002). Shortage of housing (also called housing deficit) is prevalent in developing countries. Housing shortages, when they exist, are a result of fast growth in demand and of impediments to the supply of housing (Mayo et al., 1986). The rapid growth of the population and the heavy flow of rural migrants to many cities in the developing world are largely responsible for housing shortages (Rondinelli, 1990; Pugh, 2001). As noted by Okpala (1992), housing shortages in developing countries will persist and grow unless changes in housing policies and production systems evolve which would more effectively address this problem.
Housing in developing countries is not only inadequate but also unaffordable especially for low-income earners. Development costs are high due to high costs of land (especially in urban areas) and expensive imported building materials (Akinmoladun and Oluwoye, 2007). Many developing countries have adopted the more expensive industrialized (also called prefabricated) technology as well as reinforced concrete housing production technologies, and alternative cheap building technologies have not been widely explored (Okpala, 1992). Due to high building costs, rental charges for apartments and other formal housing are often high, and unaffordable by the majority of the urban population (Akinmoladun and Oluwoye, 2007). The impact of this development is the fast growth of informal settlements (also called slums). Housing supply in many cities of developing countries is negatively affected by limited land supply and acquisition obstacles including the inconsistent land tenure systems (Mayo et al., 1986; Akinmoladun and Oluwoye, 2007). The quality of housing is poor, and codes which ensure safety and health are non-existent or where they exist, they are not enforced (Mayo et al., 1986; Plessis, 2002). Developing countries have poor or inadequate infrastructure facilities required for housing development including roads, electricity, water, drainage channels and connections to municipal sewers (Akinmoladun and Oluwoye, 2007). Many developing countries have no housing policy and where such policies exist, the focus is on provision of the required quantity of housing and less on the quality (Plessis, 2002). The existing housing policies also ignore the most basic housing sustainability guidelines (Plessis, 2002; 2007).

Given the above background, this thesis is based on two broad themes drawn from the construction industry i.e. construction safety performance and housing markets. The study area is Kampala, the capital city of Uganda, a country fondly referred to as the Pearl of Africa. In addition to the overview provided above, detailed discussions on the research themes within the context of the local construction industry in Uganda are provided in section 2.0. It is worthy to note that, although the research themes are unique in their own right, they both address pertinent issues concerning the construction industry in Uganda. Whereas the first theme investigates accidents as events that affect the production of construction infrastructure (including housing), the second theme handles topical issues which affect the demand and supply for housing in Uganda. Overall, the recommendations made in this thesis provide useful insights of improving the performance of the construction industry in Uganda. There is also a possibility that other cities in the Eastern Africa region, many of them with similar challenges and characteristics as Kampala, can draw useful lessons from this thesis.

Beyond the overview chapter, this thesis contains four research papers. Details, by theme, are provided below.

Theme One: Construction Safety Performance

Paper II: Irumba, R. (2010), A system dynamics approach to modeling of safety performance on construction projects, unpublished manuscript, Department of Real Estate and Construction Management, KTH Royal Institute of Technology, Sweden. Note that excerpts of this manuscript were presented at the CIB World Building Congress 2010 held in the United Kingdom (see Irumba et al., 2010 for details).

Theme Two: Housing Markets


Paper IV: Irumba, R. (2014), Modelling the Dynamics of Housing and Population Change in Kampala City, Uganda, manuscript (to be submitted to Habitat International for review).

This overview chapter is organized as follows, beyond this introduction. Section 2.0 gives an overview of the construction industry in Uganda while section 3.0 presents the study area i.e. Kampala city, Uganda. The theoretical framework of the thesis is presented in section 4.0, research objectives in section 5.0 and research methodology in section 6.0. A summary of research findings is provided in section 7.0 while policy recommendations are presented in section 8.0. Finally, concluding remarks are made in section 9.0.

2.0 An Overview of the Construction Industry in Uganda

To guide discussions in the thesis, the construction industry performance in Uganda was reviewed as follows. Section 2.1 presents the macro-economic performance indicators while section 2.2 discusses the construction industry policy framework. Finally, section 2.3 gives an overview of the challenges faced by the local construction industry.

2.1 Macro-economic performance indicators

The construction industry is an important sector in the macro-economic performance of Uganda. The per capita GDP for Uganda at current market prices was UGX1,638,939 (or an equivalent of US$635) in fiscal year, FY2013/14 (UBOS, 2014a). The value added in construction activities, which cover public and private sector construction services, contributed 14.9% to the total GDP at current market prices in FY2013/14 compared to 13.4% in FY2012/13 (UBOS, 2014a). In addition, construction works contributed 76% of the gross fixed capital formation in FY2013/14 (MOFPED, 2014). The balance of 24% of the gross capital formation in FY2013/14 came from machinery and equipment (MOFPED, 2014). Over the past four years, the construction sector recorded an average growth rate of 6.3% per annum markedly higher than the average GDP growth rate of 5.2% (see Table 1 for details).
Table 1: GDP growth in Uganda by economic activity

<table>
<thead>
<tr>
<th>Fiscal Year (FY)</th>
<th>2010/11</th>
<th>2011/12</th>
<th>2012/13</th>
<th>2013/14</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total GDP at market prices</td>
<td>6.6</td>
<td>3.4</td>
<td>6.0</td>
<td>4.7</td>
<td>5.2</td>
</tr>
<tr>
<td>Agriculture, forestry and fishing (overall):</td>
<td>1.2</td>
<td>0.8</td>
<td>1.3</td>
<td>1.5</td>
<td>1.2</td>
</tr>
<tr>
<td>Industry (overall):</td>
<td>7.9</td>
<td>2.5</td>
<td>6.8</td>
<td>5.6</td>
<td>5.7</td>
</tr>
<tr>
<td>Mining and quarrying</td>
<td>18.6</td>
<td>5.7</td>
<td>-0.4</td>
<td>4.3</td>
<td>7.1</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>8.0</td>
<td>-0.3</td>
<td>5.7</td>
<td>4.4</td>
<td>4.5</td>
</tr>
<tr>
<td>Electricity supply</td>
<td>10.7</td>
<td>7.4</td>
<td>9.9</td>
<td>0.8</td>
<td>7.2</td>
</tr>
<tr>
<td>Water supply</td>
<td>4.0</td>
<td>4.1</td>
<td>4.7</td>
<td>4.6</td>
<td>4.4</td>
</tr>
<tr>
<td>Construction</td>
<td>7.8</td>
<td>3.2</td>
<td>7.4</td>
<td>6.7</td>
<td>6.3</td>
</tr>
<tr>
<td>Services (overall):</td>
<td>8.2</td>
<td>3.6</td>
<td>6.5</td>
<td>5.6</td>
<td>6.0</td>
</tr>
<tr>
<td>Road, rail and water transport</td>
<td>7.9</td>
<td>3.0</td>
<td>3.3</td>
<td>4.9</td>
<td>4.8</td>
</tr>
<tr>
<td>Real estate activities</td>
<td>5.7</td>
<td>5.8</td>
<td>5.8</td>
<td>5.8</td>
<td>5.8</td>
</tr>
</tbody>
</table>

Source: MOFPED (2014)

The statistics given in Table 1 show that real estate services, road, rail and water transport services as well as electricity and water supply, both with forward linkages to construction, have continued to grow annually, at varying rates, probably due to multiplier effects of construction sector performance. Real estate activities, which include outputs of rental and owner occupied buildings, contributed 5.6% to GDP in FY2012/13 up from 5.2% in FY2011/12 (MOFPED, 2014). The real estate sector remained stable reflecting steady demand due to high population growth (MOFPED, 2013).

2.2 The construction industry policy framework in Uganda

To improve coordination, regulation and development of the construction industry, the government of Uganda formulated a national construction industry policy in 2010 (MOWT, 2010). The strategic objective of government in formulating this policy was that by June 2015, 80% of all construction services, in monetary terms, should be provided by the private sector (MOWT, 2010). The national construction industry policy provides for establishment of a corporate body, the Uganda Construction Industry Commission, to regulate and coordinate the local construction industry. A similar recommendation to form effective professional institutions and trade associations with a progressive agenda as a strategy of enhancing construction industry development in developing countries was made by Ofori (2006). It is also worthy to note that developing and strengthening the capacity of local firms as well as promoting new and appropriate technologies are some of the strategies recommended by the national construction industry policy to stimulate industry development in Uganda.

The national construction industry policy of Uganda is aligned to the national vision 2040, particularly, in respect of investment into, and management of, the physical infrastructure for sustainable development (MOWT, 2010). The Uganda’s national vision 2040 aspires to change the country from a predominantly low-income one to a competitive middle income country within 30 years, with a per capita income of US$9,500. In relation to construction infrastructure, the national vision 2040 aims at establishing quality stock of transport infrastructure in order to lower the cost of doing business and improve the business environment. The target in this regard, is to increase the percentage of standard paved roads to the total road network from 4% in 2010
to 80% in 2040. Vision 2040 provides for establishment of an integrated transport infrastructure network consisting of a standard gauge railway system, road network, water and air transport modes. Vision 2040 also plans to upgrade to international standards, the road network for the greater Kampala metropolitan area. Regarding housing, Uganda’s vision 2040 aspires to improve access to decent shelter by the population in both rural and urban settings. The target, to this effect, is to increase the percentage of the population living planned settlements from 51% (2010) to 100% (2040) in urban settings and from 0% (2010) to 100% (2040) in rural settings.

Beyond the national construction industry policy and Uganda’s vision 2040, other policies relevant for construction industry development in Uganda include the National Shelter Strategy of 1992 and the National Land Policy of 2013. The National Shelter Strategy traces its roots in the United Nations (UN) general assembly of December 1986 in which Uganda was nominated to participate in the shelter strategy support program implemented by UN-HABITAT (MOLHUD, 1992). The National Shelter Strategy adopted an enabling approach, where government facilitates and regulates private sector participation in housing development and improvement (MOLHUD, 1992). The Shelter Strategy has broad objectives of rehabilitating the housing industry, renovating factories producing building materials, increasing the housing stock, improving housing conditions, developing alternatives for housing provision to civil servants and fostering a healthy housing finance system (Mukiibi and Khayangayanga, 2014). However, because of limited resources, only few of these programs including formulation of the Condominium Act of 2001 and the National Slum Upgrading Strategy and Action Plan of 2008, have been successfully implemented by government (Mukiibi, 2011; Mukiibi and Khayangayanga, 2014).

On the other hand, land as a factor of production is a crucial resource for provision of construction infrastructure in Uganda. The National Land Policy 2013 provides that the government shall put in place mechanisms for efficient and equitable land market operations to support socio-economic development (MOLHUD, 2013). The operations of the land market hinge on an efficient and effective land registry system that guarantees titles, provides accurate information, and is open to public scrutiny (MOLHUD, 2013). For example, when the national land registry offices were closed for 3months in 2013 to enable installation of a computerized land information system, commercial bank lending to construction-related activities was negatively affected, and as a result construction industry growth slowed down from 7.4% in FY2012/13 to 6.7% in FY2013/14 (MOFPED, 2014). Finally, the National Land Policy 2013 provides for a transparent and expeditious process of acquiring land for investment in various business ventures including construction-related activities (MOLHUD, 2013).

2.3 An overview of construction industry challenges in Uganda

Construction is often described as an industry with many problems and lack of efficiency (Alinaitwe, 2009). The Ugandan construction industry is not an exception despite the steady growth patterns and an enabling policy framework discussed in section 2.1 and section 2.2, respectively. The challenges faced by the local construction industry can be placed into two
broad categories i.e. project management related challenges and industry based challenges. Summary details of challenges based on the two categories are provided below.

**Project management related challenges:**

Project management challenges result from the failure of stakeholders to properly plan, design and execute a project. The most common indicators of poor project performance are cost and schedule overruns. Reportedly, the most significant factors causing schedule overruns on construction projects in Uganda include delays in assessing changes in the scope of work by the consultant, financial indiscipline/dishonesty by the contractor, inadequate contractor’s experience, design errors and inadequate site investigation by the consultant (Muhwezi et al., 2014). The other causes of schedule overruns identified by Apolot et al. (2011) include delayed payments, poor monitoring and control, and inadequate/inefficient equipment. The most frequent causes of cost overruns are changes in work scope, inflation, high cost of capital, poor monitoring and control, delayed payments to contractors, and fuel shortage (Apolot et al., 2011). Evidently, delayed payments as well as poor project monitoring and control are cross-cutting causes of schedule and cost overruns.

The scale of cost overruns on construction projects in Uganda can sometimes be severe, for example, the 21 km Kampala Northern Bypass highway project faced cost overrun of more than 100% of the contract price (Hussin et al., 2013). The low level of workers productivity is reportedly one of the causes of cost and time overruns on construction projects in Uganda, and the impact is much felt on building projects where work is still done manually (Alinaitwe et al., 2007a). The top five most significant factors affecting labor productivity on building construction projects in Uganda are: incompetent supervisors, lack of skills by workers, rework, lack of tools/equipment and poor construction methods (Alinaitwe et al., 2007a).

Rework due to poor quality work is increasingly becoming a challenge for the construction industry in Uganda (Kakitahi et al., 2013). In this context, rework refers to the unnecessary effort of redoing a process or activity that is incorrectly implemented the first time (Love et al., 1999). The significant causes of rework in public building construction in Uganda are ineffective stakeholder management, insufficient works supervision and use of non-compliant building materials (Kakitahi et al., 2013). Insufficient skilled workmanship is also a cause of rework during the construction and operation stages of buildings (Kakitahi et al., 2013). The mean percentage range for rework in Uganda is 12.5%-15.6% of the construction contract scope while the mean impact of rework on project budgets is 4.5% and on schedule it is 8.4% (Kakitahi et al., 2014).

The Ugandan construction industry is also characterized by a high incidence rate of construction accidents many of which have turned out fatal (Lubega et al., 2000; Mwakali, 2006). There are numerous causes of construction accidents but the major ones cited by Lubega et al. (2000) include inadequate supervision, use of incompetent personnel and the use of inadequate construction techniques. Regarding the building industry, in particular, the collapse of building
elements and improper use of machinery cause most of the fatalities, while workers being hit by objects and falls are the most common causes of major injuries on building sites (Alinaitwe et al., 2007b). In terms of impact, accidents in the building industry reduce the capacity of workers who are involved by 37%, on average (Alinaitwe et al., 2007b). From the economic perspective, accidents resulting in failed infrastructure mean loss of investment, while the social cost is mainly in terms lost and injured lives (Mwakali, 2006). Indeed, death is the ultimate loss, since human life is sacred (Mwakali, 2006).

As indicated earlier in section 1.0, construction safety is the one of the two themes of this thesis. In addition to the safety issues highlighted above, Papers I-II make substantial contribution to the discourse on construction safety performance in Uganda. Summary details, in this regard, are provided in section 7.0.

**Industry based challenges:**

Industry based challenges affect the performance of the construction sector, in general, and not necessarily, of individual projects. Therefore, their existence is many times beyond the control of individual project managers. The most visible cases of industry based challenges in Uganda include informal construction practices, building materials availability, cost and quality, environmental degradation, inadequate housing finance systems, a huge housing deficit, and challenges of land acquisition.

Informal construction embraces all unplanned or unregulated housing or building activity (Wells, 2001). In Kampala, the requirement to submit building plans, with accompanying proof of land ownership, for approval by the city authority is not met by many developers. Similarly, when the building is completed, the requirement to apply for a certificate of occupancy as proof that a building is fit for habitation is also not met by many developers in the city. Another type of informality is operating a construction business without accreditation to government agencies or the Ugandan National Association of Building and Civil Engineering Contractors (UNABCEC). As noted by Charlotte et al. (1997), the informal construction sector accounts for up to 70% of all construction in Uganda. Note that in an environment where informal construction is prevalent, adherence to standard technical practices is not guaranteed and the client may not get value for money.

Building materials availability, affordability and quality are a challenge for the construction industry in Uganda (Balu-Tabaaro, 2011; Nassingwa and Nangoku, 2011). A significant component of building materials (i.e. 60%), especially cement and steel, is imported implying that prices of materials are susceptible to fluctuations of the Uganda shilling against international currencies (Balu-Tabaaro, 2011; Nassingwa and Nangoku, 2011). Shortage and importation of materials is responsible for high prices of materials and in effect high construction costs (Balu-Tabaaro, 2011). There is also evidence to show that poor quality materials are partly responsible for cases of low-quality construction works registered in Uganda (Kakitahi et al., 2013). Traditional building materials such as burnt bricks are becoming more expensive due to
shrinking availability of fuel energy resources, especially firewood and the cutting down of forests to generate firewood is causing environmental degradation and also raising concerns of sustainability for the building industry in Uganda (Balu-Tabaaro, 2011). There are also concerns that wetlands in Kampala are being reclaimed for industrial and residential expansion, a development which compromises their economic value as well as the wetland services which they provide, such as purification and treatment of waste waters (Emerton et al., 1998).

The Ugandan housing finance market has grown from a single residential mortgage in 2002 to four types of mortgages by 2011 including residential, commercial, land purchase and construction finance (Kalema and Kayiira, 2011). However, there are challenges of the cost and availability of housing finance in Uganda (Kalema and Kayiira, 2008; Kalema and Kayiira, 2011). The interest rates charged by commercial banks in excess of 15% are high, and only five banks dominate the market (Kalema and Kayiira, 2011). In effect, these developments have affected the activities of private investors in the housing sub-sector (Kalema and Kayiira, 2008).

Uganda is facing a huge housing deficit estimated at 233,000 units by 2008 (Kalema and Kayiira, 2011). 160,000 units of this backlog are in urban areas with Kampala alone having an estimated deficit of 100,000 units by 2008 (Giddings, 2009; Kalema and Kayiira, 2011). Meanwhile, the population of Kampala is growingly rapidly at an average growth rate of 2.3% per annum over the past twelve years (UBOS, 2014b). Reportedly, rapid population growth in the city has been due to high fertility, decline in mortality and migrations (Nyahana et al., 2007). Rapid population growth without matching housing facilities is responsible for the huge housing deficit in Kampala city (MOLHUD, 2008; Kalema and Kayiira, 2011).

To achieve transformation of various business ventures and provision of public utilities in Uganda, Uganda’s Vision 2040 highlights that both government and private investors must have access to land for that purpose. However, land holding in Uganda is characterized by multiple land tenure systems (i.e. freehold, mailo, leasehold and customary) and multiple rights of ownership for the same land holding (MOLHUD, 2013). Due to land ownership conflicts, there are numerous cases of land evictions in Uganda many of which have turned out violent (Place and Otsuka, 2000; 2002). These constraints, amongst other issues, pose challenges to acquire land for construction (including housing) development in Uganda. Not much is documented about the impact of land tenure on housing values in Uganda. However, Bashaasha et al. (2008) and Alobo et al. (2012) show that land tenure systems have significant impact on agricultural land values in Uganda.

Note that, matters of the effects of land tenure on housing values as well as the relationship between population growth and housing deficit, as highlighted in the discussions above, form part of the thesis theme on housing markets and are discussed in Papers III-IV, respectively. Summary details of findings on these themes are provided in section 7.0.
3.0 The Study Area: Kampala City

Kampala is the administrative and commercial city of Uganda (see Figure 1 for location details). The name “Kampala” is derived from the Luganda language word “impala”, a type of antelope (*Aepyceros melampus*), which was reared and grazed on hill slopes of the current day Kampala (Omolo-Okalebo et al., 2010). Kampala as it exists today is a product of the 1968 amalgamation of the municipalities of Mengo (Kibuga) and Kampala (Nkurunziza, 2007). Mengo municipality (Kibuga), located on Mengo hill, was the royal capital of the kingdom of Buganda and was established before colonial rule, precisely, before the 10th March 1900 agreement between Buganda kingdom and the British colonial administration which marked the beginning of colonial rule in Buganda (Nkurunziza, 2007; Omolo-Okalebo et al., 2010). Meanwhile, Kampala municipality evolved as a colonial city, initially accommodating mainly Europeans and Asians under the colonial administration (Nkurunziza, 2007). This dual legacy has strongly influenced contemporary land development patterns and practices in Kampala city, notably, with the areas of the former Kampala municipality being well-planned and serviced compared to those of the former Mengo municipality (Nkurunziza, 2006). Notably, mailo land tenure is the dominant tenure in the areas of the former Mengo municipality, while most of the existing freeholds and leaseholds are in areas of the former Kampala municipality (Giddings, 2009).

In terms of size, the city expanded from 21.4 square kilometers (an equivalent of 8.3 square miles) in 1968 to approximately 195 square kilometers (an equivalent of 75.3 square miles) today (Omolo-Okalebo et al., 2010). The expansion was mainly through annexing of adjacent townships and rural areas to the city (Omolo-Okalebo et al., 2010). Meanwhile, as the city boundaries expanded, the size of the population also increased. The city population increased from 330,700 in 1969 to 458,503 in 1980 and to 774,241 in 1991 (UBOS, 2014b). The city recorded the fastest annual growth rate of 6.3% during the period 1980 to 1991. This period was characterized by high levels of migration into the city because of political instability in the countryside. By 2002, the city population was 1,189,142 and according to the recent, August 2014 National Housing and Population Census, the current city population is 1,516,210 (UBOS, 2014b). During the period 2002 to 2014, the average annual growth rate of the city population was 2.3%, lower than the average annual growth rate of the national population of 3.0%, over the same period of time. Uganda has an urban population of six (6) million persons out of which 25% are in Kampala, and the rest in 22 municipalities and 174 town councils (UBOS, 2014b).

Geographically, Kampala which was standing on seven (7) hills by 1968, now occupies twenty-four (24) hills with an average altitude of 3,910 feet (or 1,120 m) above mean sea level (Omolo-Okalebo et al., 2010). Between hills and in the valleys, Kampala has extensive wetlands occupied by floating papyrus swamps (*cyperus papyrus specie*), cat tails (*typha specie*), common reeds (*phragmites specie*) and *miscanthidium* grass (Emerton et al., 1998). Wetlands in Kampala are not surveyed/demarcated and as result, their actual size is not known (Emerton et al., 1998).
Figure 1: Map of Uganda showing the location of Kampala (Source: UBOS, 2013)

Figure 2: Map of Kampala showing city divisions & infrastructure
Kampala, also, has many natural rivers/streams as well as lakes. To the south, Kampala borders with Lake Victoria, the largest lake in Africa and the second largest fresh water lake in the World, and elsewhere it is surrounded by Wakiso District. Regarding administration, Kampala, formerly a local government district, is now a corporate body established under the Kampala Capital City Act of 2010. Kampala Capital City Authority (KCCA) is made up of five administrative divisions i.e. Central (housing the Central Business District, parliament and many government ministries), Kawempe, Lubaga, Makindye and Nakawa. KCCA now has a well constituted Directorate of Engineering and Technical Services, and since its establishment in 1990, many road construction projects have been undertaken which have changed the face of the city. Figure 2 shows the spatial details of the divisions, water bodies, swamps and major transport infrastructure in the city.

The choice of Kampala as a study area was guided by three reasons. Firstly, in terms accident statistics, over 60% of reported cases in Uganda are from Kampala city alone (OSHD, 2009). Inevitably, this development makes Kampala a hot spot for construction accidents investigation. Secondly, as was reported earlier under section 2.3, Kampala is having an estimated housing backlog of about 100,000 units or 43% of the estimated housing deficit in Uganda (an equivalent of 63% of the housing deficit in urban areas). Similar, to the arguments above, this arrangement makes Kampala highly relevant for studies aimed at reducing the housing deficit in Uganda. Thirdly, mailo land, a tenure system unique to Uganda and a subject of investigation under the housing markets theme, has a long track record in Kampala. The system was introduced in Kampala by the 1900 Buganda agreement, well before it was extended to the neighboring kingdoms of Tooro and Ankole. Reportedly, a significant component of the land mass in Kampala (i.e. 52%) is held under mailo land tenure system (Giddings, 2009).

4.0 Theoretical Framework

Theory provides a framework for a research project, supposedly, similar to what steel or reinforced concrete frames do in buildings. In addition, theory depicts the evolving nature of the phenomenon and describes how certain conditions lead to certain actions or interactions, how those actions or interactions lead to other actions, and so on, with the typical sequence of events being laid out (Leedy and Ormrod, 2001). Theory helps to identify and explain facts and relationships between them as well as the points of issue and those of substantiation (Fellows and Liu, 2008). A framework of theory provides answers to questions such as, what are the most widely accepted models of the phenomenon being investigated? Or what do competing theories say about the phenomenon? Given the above discussions, it can be said that a framework of theory provides a perspective, or lens, through which a research project can be examined. In this thesis, theories related to the two research themes are explored. Accordingly, section 4.1 presents accident causation theories whereas section 4.2 gives an overview of the theories on housing markets.
4.1 Accident causation theories: a review

Construction accident investigation methods and reporting systems identify the type of accidents which occur and how they occurred. However, they do not properly address matters on why the accident occurred by identifying possible root causes (Abdelhamid and Everett, 2000; Howell et al., 2002). The effective use of accident causation models can identify the root causes of accidents (Lehto and Salvendy, 1991; Mitropoulos et al., 2005) and ultimately help to develop strategies to prevent accidents (Lehto and Salvendy, 1991; Arboleda and Abraham, 2004). This is possible because accident causation models represent, classify, and efficiently organise large amounts of safety-related knowledge (Lehto and Salvendy, 1991). In addition, they provide a theoretical framework for developing effective safety investigation systems. Several accident causation models exist (see Lehto and Salvendy, 1991 for details); however, in this thesis four categories of theories applicable to the construction sector are reviewed. These include the domino theory, multiple causation theory, human error theories and systems theory.

The domino theory:

The domino theory was pioneered by Heinrich in 1931. Henrich viewed an accident as the natural culmination of a series of events or circumstances (Lehto and Salvendy, 1991 citing Henrich, 1939). This theory illustrates the sequence of events believed to exist prior and after occurrence of accidents (Abdelhamid and Everett, 2000; Katsakiori et al., 2009). The domino theory has five factors (or dominos): ancestry and social environment, fault of person, unsafe act or unsafe mechanical or physical condition, accident and injury (Abdelhamid and Everett, 2000; Priemus and Ale, 2010). Based on the above narrative, it can be argued that removal of a particular domino breaks the chain leading to an accident. This implies that an accident is a result of a single cause, and if that cause can be identified and removed the accident will not be repeated (Qureshi, 2007). However, the reality is that accidents always have more than one contributing factors (Qureshi, 2007). Heinrich (1980) as cited by Seo (2005) suggests that removal of the domino on unsafe act or unsafe mechanical or physical condition is the easiest and most effective way to stop the sequence leading to an accident. The findings by Heinrich were based on case studies of 75,000 accident records which revealed that 88% of all industrial accidents were caused primarily by unsafe acts of persons; 10% by unsafe conditions and 2% by acts of God.

The domino theory has been criticized for emphasizing human behavior in causing accidents (Zeller 1986 as cited by Abdelhamid and Everett, 2000) and for assuming that the cause-effect relation between consecutive events is linear and deterministic (Qureshi, 2007). Over the years, the domino theory has been updated to focus on management responsibility for accidents. The resulting models are called management models or updated domino models (see Lehto and Salvendy, 1991 and Abdelhamid and Everett, 2000 for details). Despite its simplicity, the domino theory is the foundation of other theories including human error theories, epidemiological theories and systems theories, amongst others.
Multiple causation theory:

The multiple causation theory was introduced by Petersen as caution against narrow interpretations of the domino theory (Petersen, 1971). The multiple causation theory suggests that there are many contributing factors to every accident and that these factors combine together in a random fashion causing accidents (Petersen, 1971; 1988). These are the factors that should be targeted by an accident investigation (Petersen, 1971; 1988). The multiple causation theory suggests that root causes of most accidents are often related to management policies and procedures, supervision or training (Petersen, 1988).

To illustrate his theory, Petersen provided an example of an accident scenario involving a man falling off a defective step ladder (see Petersen, 1971). Based on interpretation of accident theories of the time, only one act (climbing a defective ladder) and/or one condition (a defective ladder) would be identified and the possible correction of the problem would be to get rid of the defective ladder. However, based on multiple causation theory the surrounding factors of the accident would be explored. The possible investigation questions would be: why the defective ladder was not found in normal inspections; why the supervisor allowed its use; whether the injured employee knew that he/she should not use the ladder; whether the employee was properly trained; whether the employee was reminded that the ladder was defective and whether the supervisor examined the job first. Petersen (1971) argued that answers to the above and other questions would improve the investigation process. Petersen (1971) emphasises that only finding an unsafe act or condition is dealing with the problem at symptomatic level. The unsafe act or condition may be the “proximate cause” but invariably not the “root cause”.

Human error theories:

Human error theories acknowledge the contribution of human errors to accidents occurrence. They are commonly classified as behaviour models and human factor models (Abdelhamid and Everett, 2000).

Behavioural models picture workers as the main cause of accidents (Abdelhamid and Everett, 2000; Howell et al., 2002). These models emphasize either inherent or situational traits as causes of behaviour which lead to accidents (Lehto and Salvendy, 1991). The inherent human traits considered by behavioural models are often personality-related, while the situational human traits are often stress-related (Lehto and Salvendy, 1991). The foundation of accident models is in the theory of accident proneness (Adelstein, 1952; Klumb, 1995). The main idea of the proneness theory is that permanent characteristics of some people leaves them more likely to have an accident and as a result a small number of people are involved in multiple accidents (Adelstein, 1952). With further study, this concept has been replaced with the notion of accident liability which recognizes that the probability of accidents between people varies acknowledging that accident repeaters are often people who are maladjusted having unconventional views, poor social relationships, poorly defined goals, dissatisfaction with life, low popularity and lack of control of hostility (Lehto and Salvendy, 1991 citing Surrey, 1968).
On the other hand, human factor models hold that human error is the main cause of accidents. However, the blame does not fall on the human unsafe characteristics alone but also on the design of the workplace and tasks that do not consider human limitations, and may therefore have harmful effects (Abdelhamid and Everett, 2000). The overall objective of the human factors approach is to arrive at better designed tasks, tools and work places, while acknowledging the limitations of humans’ physical and psychological capabilities (Abdelhamid and Everett, 2000). Human factors models are closely associated with the field of human factors engineering.

**Systems Theory:**

Systems theory is based on the concept of a “system”. Meadows et al. (1992:278) define a system as “a set of elements that is coherently organised around some purpose”, while Kerzner (2003:55) gives a broader definition of the concept, referring to it as “a group of elements, either human or non-human, that is arranged and organised in such a way that the elements can act as a whole toward achieving some common goal or objective”. A system receives input from its environment, and through a process of transformation, generates output (Irumba, 2007). The system output dissipated to the environment, or used as input into the system is referred to as feedback (Irumba, 2007).

In systems theory, an accident occurs when several causal factors (such as human, technical and environmental) exist coincidentally in a specific time and space (Hollnagel, 2004). According to systems theory, accidents are seen as emergent phenomena, which arises due to complex interactions between system components that may lead to degradation of system performance, or result in an accident (Qureshi, 2007). An alternative view of accident causation from the systems perspective is provided by Lehto and Salvendy (1991) based on evaluating the performance of open-loop and closed-loop systems. In this context, closed-loop systems make use of feedback regarding the effects of systems responses to determine how large the next response should be, while open-loop systems do not. Both loop systems make responses which are proportional to the deviation between the actual and desired states. If the deviations are too large or the time lag until a response is realised is too long, the system will fail to keep the system state within acceptable bounds and an accident will occur (Lehto and Salvendy, 1991).

In relation to event-based theories (for example, the domino theory) which emphasize linear causality relationships, systems theories incorporate non-linear relationships (Leveson, 2004). Unlike event-based theories which statically describe an accident as a causal series or as a causal net, systems theory is capable of accounting for the dynamic nature of the interactions and dependencies in the contributing factors (Hollnagel, 2002). Models built based on systems theory (for example, system dynamics models) are highly quantitative although their qualitative predictions appear to be of most value when evaluating safety issues (Lehto and Salvendy, 1991). In the construction industry, well structured systems (i.e. where a correct sequence of events can be identified) are not common and construction work often takes place in complex, dynamic conditions (Howell et al., 2002). Thus, tracing the root causes of accidents based on
standard practice is often impractical (Howell et al., 2002), and accident investigation techniques based on systems theory could be useful.

### 4.2 Theories on housing markets: an overview

Markets for housing are often referred to as completely product-differentiated because each product sold in the market is unique (DiPasquale and Wheaton, 1996). This is in contrast to commodity markets such as for oil or minerals, in which a uniform good is traded in bulk quantities (DiPasquale and Wheaton, 1996). Figure 3 presents a conceptual framework of how housing markets work.

Following from Figure 3 and Malpezzi (1990), inputs such as land, labor, finance, materials and infrastructure are combined by supply side agents such as land lords and developers to produce housing services. Homeowners and, to a lesser extent, renters are also producers, if they maintain and upgrade their houses. Relative prices inform producers of housing services about whether to provide more or less housing, and the input suppliers about providing more or fewer inputs.

Malpezzi (1999) notes that there are three important features of housing markets implicit from Figure 3. Firstly, that transactions within and across “boxes” are possible only to the extent property rights are defined, recognized and enforced. In a well functioning system, property rights will be transferable from seller to purchaser on payment of a consideration. The bundle of such rights can be largely complete (i.e. fee simple), or partial, including leasehold. Specific rights include the right to use or modify use of the real estate, the right to derive income or other benefits from its use, the right to bequeath ownership interest and the right not to be evicted, amongst other rights. Tenant and land lord rights must be well defined and there must be clear remedies for violation by either party. Secondly, that government interventions can have profound effects on the operations of the housing market. One practical way is through provision of infrastructure and related services including transport, water and sanitation, amongst other services. Often, infrastructure investments encourage new construction and upgrading of existing housing, including the provision of more houses for rent. Thirdly, that fully understanding the housing market requires analysis of key input markets and the regulatory environment especially...
housing policies. In this regard, input markets relate to the housing finance market and the land market. Because of its high costs in relation to incomes, housing must be financed. The cost and availability of housing mortgages are important elements of the housing market. On the other hand, because of its spatial fixity, housing markets are profoundly affected by the operation of the land market. Developments in land pricing, land rights and land tenure systems critically affect the performance of land and housing markets.

Meanwhile, empirical studies of the housing market have traditionally taken the orthodox view that equilibrium house prices can be thought of as the natural outcome of the demand for housing equating with its supply (Kenny, 1999). In this regard, the medium to long-run demand and supply for housing interact to determine the price of housing relative to the price of other goods and services (Kenny, 1999). Of course, several factors influence the demand and supply of housing services. The theory of consumer behavior suggests that the demand for a good or service is a function of income and of the price of the good or service relative to all other prices. This relationship is often expressed as income elasticity and price elasticity of demand for housing, respectively (for example, see Malpezzi, 1999). In the context of housing, income elasticity can be defined as the percentage change in the quantity of housing demanded compared to a percentage change in income, all else held a constant. For example, a value of 0.6 implies that should income change by 10%, the demand for housing would change by 6%. A similar definition and interpretation is applicable to price elasticity of demand for housing. Demographic factors affect the demand for housing services (DiPasquale and Wheaton, 1994; Mulder, 2006). A high population growth increases the demand for housing. The age structure of the population will influence the demand for clinics, hospitals, and retirement homes. Immigration and emigration levels as well as the headship and family formation rate influence the demand for housing. The headship rate can be influenced by changes in marriage and divorce rates, as well as the tendency for younger, single people to leave the family unit and establish their own households.

On the other hand, the supply-side of the housing market includes the construction sector. A developer’s decision to build a house (or a set of houses) is dependent, amongst other factors, on the expected selling price of a house compared to the cost of building a house. In addition, the decision may also depend on the expected profitability of residential construction compared to non-residential construction. These expectations are subjective and hence, it is difficult to assess them correctly. It is worthy to note that supply for housing is closely linked with the land market. Given that urban spatial theory defines a long run supply schedule for the stock of housing units, the average price of new units increases as this stock grows because usable land becomes more scarce (DiPasquale and Wheaton, 1994). In addition to new construction, housing supply is determined by the decisions made by owners of housing (and their agents) concerning the conversion of the existing stock of housing (DiPasquale, 1999). Owners can convert two units into one or convert a large family home into several small apartments. The government policy can directly impact on the supply-side of the market through construction of public housing and tax policies designed to encourage private construction of new rental housing (DiPasquale, 1999).
Extensive literature exists on the various economic models of housing markets (for example, see Fair, 1972; Smith et al., 1988; Kenny, 1999 and, Drudy and Punch, 2002). Many of the existing models recognize housing as a commodity that responds to market forces and can therefore be termed as market-dominated housing models, while some of the models focus on social or non-profit housing. A plethora of existing models are primarily concerned with demand for housing while others are concerned with housing supply, or both. As noted by Drudy and Punch (2002), existing models have different outcomes in terms of efficiency, equity, quality, cost and security. In this thesis, housing markets are modeled at aggregate level and the developed models are largely dynamic rather than static. You will note that dynamic models differ from static models in that the dimension of time must be explicitly incorporated, and at least some of the variables of the model must be linked across time (DiPasquale and Wheaton, 1994). In view of the above discussions, a Stock-Flow model structure was considered adequate as a theoretical framework for housing market analysis. Details are provided below.

The Stock-Flow model:
The development of the stock-flow model for real estate (including housing) markets is associated with researchers such as Kenneth Rossen, William Wheaton, Denise DiPasquale, and more recently, Patrick Hendershott, amongst others. The Stock-Flow(S-F) model is useful in real estate market forecasting and to derive classical principles of real estate market dynamics such as the potential cyclical nature of rental markets (Geltner et al., 2007). Although the S-F model was initially developed for office markets, it can be applied to any other real estate market sector. S-F models allow more rigorous and explicit quantitative forecasts of future rents and vacancies, and facilitates long-term forecasts (Geltner et al., 2007). The traditional assumption in the S-F model is that markets clear quickly and that, at any time, prices adjust to equate the demand for housing with existing stock (DiPasquale and Wheaton, 1994).

The S-F model can be represented by a system of six linked equations that reflect the relationship between supply, demand, construction, rent, and vacancy overtime (Geltner et al., 2007). The equations are linked by the fact that the output from each equation is an input into another equation, and that the equations illustrate attainment of market equilibrium over time. The S-F model allows simulation and forecasting of rents, vacancy, construction, and absorption in the market of each year (Geltner et al., 2007). The S-F equations are presented below. The layout and description of these equations is drawn from Geltner et al. (2007). Accordingly, equations 1 to 2 relate to the supply side of the market while equations 3 to 4 relate to the demand side of the market. Equation 5 relates to the vacancy rate and finally, equation 6 represents the landlord-tenant rental pricing behavior.

\[
C(t)=\begin{cases} 
\epsilon R_{(t-L)} & \text{if } R_{(t-L)}>R \\
0 & \text{otherwise} 
\end{cases}
\]

In equation 1, \(C(t)\) is the amount of new space completed in year \(t\). \(R_{(t-L)}\) is the rent prevailing in the market in the year \((t-L)\), \(L\) is the time it takes to complete a typical construction project on
the market, $K$ is the trigger rent (also called replacement cost rent) above which new construction will start and below which no new construction will start, and $\varepsilon$ is the supply elasticity whose greater values indicate that development responds more elastically to rents.

\[ S(t) = S(t-1) + C(t) \] \hspace{1cm} 2

Equation 2, simply states that the total stock of space supply in year $t$, labeled $S(t)$, equals the previous year’s stock, $S(t-1)$, plus the new construction completed in year $t$.

\[ D(t) = \alpha - \eta R(t) + \tau N(t) \] \hspace{1cm} 3

In Equation 3, $D(t)$ is the amount of space that potential users would currently like to occupy, $R(t)$ is the current rent level and $N(t)$ is the current level of the underlying need. For example, in the office market, $N(t)$ might be measured by the number of employees working in the market. The three parameters $\alpha$, $\eta$, and $\tau$, calibrate the demand model. The parameter $\alpha$ is a constant or the intercept of the model. The response sensitivity parameter $\eta$ reflects the price elasticity of demand, while the parameter $\tau$ reflects the quantity of space usage per unit of underlying need. For example, the number of square meters per employee in the office market.

\[ O S(t) = D(t-1) \] \hspace{1cm} 4

Equation 4 simply equates the amount of space actually occupied at time $t$, labeled $O S(t)$, to the demand in the previous year, labeled $D(t-1)$, which is the output of equation 3 applied in the previous year. The assumption in this regard is that it takes one year for space users to realize the level of space usage demand they desire.

\[ v(t) = (S(t) - O S(t))/S(t) \] \hspace{1cm} 5

Equation 5 expresses the definition of vacancy rate, $v(t)$, as the fraction of the currently available stock of space that is un-occupied. Note that the variables on the right hand side of equation 5 are outputs from equations 2 and 4.

\[ R(t) = R(t-1)(1-\lambda \{v(t) - V\}/V) \] \hspace{1cm} 6

Finally, in equation 6 which represents the landlord-tenant rental pricing behavior, landlords are assumed to raise or lower rents in response to perceived vacancy rates. If the current vacancy rates are above the natural vacancy rate for the market, $V$, then landlords will reduce rents. If the current vacancy rates are below the natural rate for the market, then landlords will raise rents. Meanwhile, the parameter $\lambda$ represents the sensitivity of rental response to vacancy rate deviations from the natural rate for the market.

In sum, you will note that the theory of the S-F model as described above, in many respects, is closely related to the system dynamics models presented in papers II and IV of this thesis.
5.0 Research Objectives and Questions

Following the discussion on the challenges facing the construction industry in Uganda (see section 2.3), it is clear that there is urgent need for performance improvement in the sector. The cited challenges demonstrate that the industry is not well positioned to meet the expectations of government, developers, facility users and society as a whole. As recommended by Ofori (2006), developing countries, including Uganda, need to undertake research programs necessary to facilitate the development of appropriate strategies and policies to improve the performance of their construction industries. This thesis follows the same direction suggested Ofori (2006). Accordingly, the research objectives and questions are presented below.

Main objective:

Based on scientific evidence, to propose strategies and policies for improvement of construction safety performance and the housing sector in Uganda.

Specific objectives and research questions:

The specific objectives of the study, by theme, are indicated in Table 2. Also included in Table 2 are research questions corresponding to each objective. Finally, the relationships between research objectives and other components of the thesis are illustrated in Figure 4.

6.0 Research Methodology

Research methodology refers to the principles and procedures of logical thought processes which are applied to a scientific investigation (Fellows and Liu, 2008). Although the words methodology and methods are often mistakenly used in an interchangeable manner (Jonker and Pennink, 2010), they actually have different meanings. Methods concern the techniques which are available (for example, for data collection or analysis) and those which are actually employed in a research project (Fellows and Liu, 2008). Given the above definitions by Fellows and Liu (2008), it is clear that research methodology is broader than research methods. The research methodology should be appropriate to the objectives of the research and the type of knowledge to be discovered (Wing et al., 1998).

Scientific research can be quantitative as well as qualitative (Wing et al., 1998; Amaratunga et al., 2002). Quantitative approaches tend to relate to positivism and seek to gather factual data, to study relationships between facts and how such facts and relationships accord with theories and literature (Fellows and Liu, 2008). They utilize deductive logic directed towards development of testable hypotheses and theory which can be generalized across settings (Amaratunga et al., 2002). With quantitative approaches, scientific techniques are used to obtain measurements, data is analyzed to yield quantified results and conclusions are derived from evaluation of results in light of the theory and literature (Fellows and Liu, 2008). Meanwhile, qualitative approaches concentrate on words and observations to express reality, and they attempt to describe people in
natural situations (Amaratunga et al., 2002). In qualitative research, raw data is unstructured, detailed and hence rich in content and scope (Fellows and Liu, 2008).

**Table 2: Research objectives and questions**

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<tr>
<th>No:</th>
<th>Research objective</th>
<th>Research questions</th>
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<td><strong>Theme one: Construction safety performance</strong></td>
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<tr>
<td>I</td>
<td>To investigate the causes of construction accidents in Kampala city, Uganda.</td>
<td>What are the most prevalent causes of construction accidents in Kampala?</td>
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<td>What are the construction industry injury and fatality rates for Kampala?</td>
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<td>Do construction accidents in Kampala follow a spatial pattern?</td>
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<td>What are the possible strategies of mitigating occurrence of construction accidents in Kampala?</td>
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<td>II</td>
<td>To study the relationship between undiscovered rework and accident occurrence on construction projects, with particular focus on Kampala city, Uganda.</td>
<td>How does undiscovered rework lead to construction accidents?</td>
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<td>What strategies can be adopted to reduce rework related construction accidents in Kampala?</td>
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<td><strong>Theme two: Housing markets</strong></td>
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<td>III</td>
<td>To study the effects of land tenure on housing values in Kampala city, Uganda.</td>
<td>Does the choice of land tenure system affect housing values in Kampala?</td>
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<td>What strategies can be adopted to mitigate the negative effects of land tenure on the housing market in Kampala?</td>
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<td>IV</td>
<td>To study the relationship between housing needs and population change in Kampala city, Uganda.</td>
<td>How does population change affect the housing needs of Kampala city?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>What is the projected city population and housing needs over the medium-term planning period of 20 years?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>What strategies can be adopted to mitigate the effects of rapid population growth on the housing market in Kampala?</td>
</tr>
</tbody>
</table>
Figure 4: Flow of research activities

- **Objective I:** To investigate the causes of construction accidents in Kampala city, Uganda
  - Methods: Questionnaire survey; measurement; spatial analysis; spatial regression modeling.
  - Outputs: Published article: Spatial analysis of construction accidents in Kampala, Uganda

- **Objective II:** To study the relationship between undiscovered rework and accident occurrence on projects.
  - Methods: Case-study research; System dynamics modeling.
  - Outputs: Manuscript: A system dynamics approach to modeling of safety performance on construction projects

- **Objective III:** To study the effects of land tenure on housing values
  - Methods: Secondary data collection; measurement; spatial regression modeling.
  - Outputs: Published article: An empirical examination of the effects of land tenure on housing values in Kampala, Uganda

- **Objective IV:** To study the relationship between housing needs and population change
  - Methods: Secondary data collection; System dynamics modeling.
  - Outputs: Manuscript: Modeling the dynamics of housing and population change in Kampala, Uganda

**Theme I:** Construction safety performance

**Theme II:** Housing markets

**Thesis Report (including overview chapter)**
Quantitative and qualitative research approaches are both applied in construction research (Abowitz and Toole, 2010). However, each method has inherent strengths and weaknesses (Abowitz and Toole, 2010). For example, while the quantitative approaches are credited for being fast, economical and able to collect statistics from large samples of data, they are critiqued for not being able to understand processes or the significance which people attach to actions, and they are said not to be helpful in generating theories (Amaratunga et al., 2002). Similarly, while qualitative approaches are credited for being able to look at change processes over time, to understand people’s meaning and to contribute to theory generation, they are critiqued for being tedious during data collection, analysis and interpretation, and that policy makers may give low credibility to results from qualitative research (Amaratunga et al., 2002). What is clear from the discussion is that none of above scientific approaches has the ability to meet all the expectations of a research project, single handedly.

Given the above background, a mixed method (or balanced) approach was adopted in this thesis. Johnson and Onwuegbuzie (2004:17), provides a broad definition of the mixed methods approach as, “the class of research where the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts or languages into a single study”. The goal of mixed methods research is not to replace either of the approaches, but rather to draw from the strengths and minimize the weaknesses of both in single research studies and across studies (Johnson and Onwuegbuzie, 2004). Some authors also refer to the mixed methods approach as triangulation (for example, see Amaratunga et al., 2002 and Fellows and Liu, 2008). A mixed method approach is more expensive than a single method approach, in terms of time, money, and energy, but improves the validity and reliability of the resulting data and strengthens causal inferences by providing the opportunity to observe data convergence or divergence in hypothesis testing (Abowitz and Toole, 2010). In the words of Johnson and Onwuegbuzie (2004), if one prefers to think categorically, mixed methods research sits in a new third chair, with qualitative research sitting on the left side and quantitative research sitting on the right side.

Figure 4 illustrates how a plethora of methods adopted in the thesis fits within the paradigm of the mixed methods approach. Whereas, questionnaire surveys, measurement, spatial analysis and spatial regression modeling can be classified as quantitative research methods, case study research is a qualitative research method. On the other hand, the system dynamics method exhibits characteristics of both qualitative and quantitative methods. During the early stages of the system dynamics modeling process, in particular during system description and formulation of the dynamic hypothesis, qualitative methods such as case-studies are used (Forrester, 1994). The subsequent stages of formulating the model structure, model equations, simulating the dynamic behavior and policy design, apply quantitative approaches (Forrester, 1994). Note that the richness and holism of qualitative data together with its ability to reveal complexity (see Amaratunga et al., 2002), makes qualitative research approaches appropriate for identification and conceptualization of system dynamic problems.
7.0 Summary of Research Findings

Paper I: “Spatial analysis of construction accidents in Kampala, Uganda” by Irumba Richard.

Published in Safety Science (2014), Vol. 64, April 2014, pp. 109-120.

This paper investigated the causes of construction accidents in Kampala, Uganda using Ordinary Least Squares (OLS) regression and spatial regression modeling. Based on review of literature on the causes of accidents, six hypotheses were formulated as follows;

Hypothesis 1: occurrence of accidents on construction sites is dependent on the level of congestion on site. In this context, the level of congestion was measured in terms of building density (defined as the ratio of gross floor area to plot acreage) and size of workforce. Two sub-hypotheses were tested:

Hypothesis 1A: The number of accidents registered on a construction site is positively associated with building density.

Hypothesis 1B: The number of accidents registered on a construction site is positively associated with the size of workforce.

Hypothesis 2: Occurrence of accidents on a construction site is dependent on the availability and condition of safety equipment.

Hypothesis 3: Occurrence of accidents on a construction site is dependent on systems for appropriate handling of construction materials.

Hypothesis 4: Deployment of experienced workers is negatively associated with occurrence of accidents on a construction site.

Hypothesis 5: The provision of good working conditions reduces the number of accidents registered onsite.

Hypothesis 6: Occupational stress resulting from working overtime is positively associated with occurrence of accidents on construction sites.

Data collection involved a cross-sectional survey of 201 large-size building projects (i.e. with a minimum floor area space of 1000 m² and minimum building cost of Uganda shillings, UGX 200 million, an equivalent of US$80,000) commissioned by Kampala City Council in 2008. 132 questionnaires were returned giving a response rate of 66%. The questionnaire survey elicited the following categories of data i.e. demographic data on the project (i.e. building use, gross floor area, height of a building, number of storeys, building cost, project duration, plot acreage and number of workers), safety record of the project including type, number and impact of accidents,
and finally, data on the safety environment in the firm including availability and usage of safety and health policies, safety and health committee, employment of safety officer(s) and routine safety and health awareness campaigns. Accident statistics were expressed as major injuries (those which result into absence of a worker for more than 3 working days) and fatalities. Survey data was validated against building records kept by Kampala City Council and accident statistics from the Department of Occupational Safety and Health in the Ministry of Gender, Labor and Social Development. In addition, measurements of spatial positions (i.e. Northing and Easting coordinates) of individual construction sites were taken using Global Positioning System (GPS) equipment.

Following analysis of spatial regression modeling results, hypotheses 1, 2 and 4 as stated above were accepted while hypotheses 3, 5 and 6 were rejected. Results of this study reveal that the injury rate for Kampala is 3,797 per 100,000 workers and the fatality rate is 84 per 100,000 workers. The three most prevalent causes of accidents in Kampala are mechanical hazards (i.e. struck by machines, vehicles, hand tools, cutting edges etc.), being hit by falling objects and falls from height. Congestion, a phenomenon which arises when there is evidence of high building density amidst many fulltime workers on site, is positively associated with accidents occurrence. Through spatial statistical analysis (i.e. statistical methods that use space and spatial relationships in their mathematical computations), construction accidents that occur at one location were found to be related to those that occur in the neighborhood.

**Paper II: “A System Dynamics Approach to Modeling of Safety Performance on Construction Projects” by Irumba Richard.**

Unpublished manuscript, Department of Real Estate and Construction Management, KTH Royal Institute of Technology, Sweden.

This paper investigated the relationship between undiscovered rework and accidents occurrence on construction projects. Rework was defined as the unnecessary effort of redoing a process or activity that is incorrectly implemented the first time. The dynamic hypothesis tested in the paper was that high levels of undiscovered rework lead to a high frequency of accidents on projects. A triangulation (or multi-method) approach was adopted by combining case-study methodology and system dynamics modeling.

The case-study project was a hotel complex consisting of a high-rise apartment block, a hotel block, a queen’s suite, a swimming pool, cottages, a bar, an administration block, a health club, a conference centre and a shopping arcade. During construction, the apartment block which had reached third level suddenly collapsed resulting into the death of eleven workers and injuries to twenty-six others. A committee set up by government to investigate the cause of the accident reported that the accident was largely due to lack of approved building plans and weak concrete columns. The columns were 50% of expected minimum size, had insufficient steel reinforcement which was less than 45% of the expected minimum steel and concrete was poorly mixed resulting into 30-78% of expected strength. In addition to columns being undersize, five columns
were omitted in the design and this greatly compromised the strength of the structure. There was also evidence of poor workmanship especially in the segregation of aggregates and honeycombing during the construction of columns. The above events are typical indicators of low quality work which proceeded undetected and eventually resulted into an accident.

Following analysis of the case-study project and collection of the necessary project data, a computer based system dynamics model was developed. This model builds on the classical project management model by Richardson and Pugh (1981). In addition to the existing subsystems on workforce, real progress, rework and scheduled completion time, a safety subsystem was added. The classical model developed in DYNAMO was implemented in POWERSIM STUDIO 8 software, an environment with advanced programming capabilities. In order to build confidence in the usefulness of the model, validation was done following standard procedures in the system dynamics modeling process. To this effect, structural tests as well as behavior tests were conducted. The model was found to be robust when subjected to extreme condition and sensitivity tests.

Simulation results show that during the first 20 months, the project was perceived to be on schedule, most of the unsatisfactory work was not detected and very few accidents occurred. Between 20 and 40 months, unsatisfactory work grew to high levels and many structure failures occurred during this period. It was also evident that the project was behind schedule with only 57% of the work completed after 30 months and 72% of the work completed after 40 months, supposedly the baseline planned completion date. Between 40 and 60 months, the effort of attaining adequate workforce paid off, more of the unsatisfactory work was detected and corrected, and the accident frequency significantly dropped. Finally, the project was completed after 63 months with a workforce of about 58 persons. A slippage in schedule of 23 months and a workforce overrun of 28 persons were registered by the close of the project.

The results of this paper show that to attain a faster project progress rate (i.e. having many tasks executed within a shorter duration of time) while ensuring safety, there is need to optimize the workforce i.e. avoid over or under deployment. Model results also demonstrate that the tendency to accelerate projects (i.e. the practice of adjusting the project duration so that works are completed earlier than scheduled) can breed accidents. Accelerated projects tend to experience high levels of unsatisfactory work compared to projects implemented following their planned schedule. In this paper, it is shown that the time it takes to detect rework is a possible safety policy parameter. By strengthening quality inspection of a project, faults are detected and corrected early enough before they lead to accidents. From the management perspective, effective supervision of the design and construction process is recommended as the best strategy to avoid accidents.


This paper is based on the premise that higher housing market values are evident in places where there are higher levels of land tenure security. Following review of literature on land tenure systems and their effects on housing markets, three hypotheses were formulated as follows;

**Hypothesis 1:** The value of a house on public leasehold land is discounted compared to the value of a house with similar attributes on freehold land.

**Hypothesis 2:** The value of a house on mailo land is discounted compared to the value of a house with similar attributes on freehold land. Two sub-hypotheses were tested:

**Hypothesis 2A:** The value of a house on private mailo land is discounted compared to the value of a house with similar attributes on freehold land.

**Hypothesis 2B:** The value of a house on Kabaka’s (King’s mailo) land is discounted compared to the value of a house with similar attributes on freehold land.

**Hypothesis 3:** The value of a house on mailo land is discounted compared to the value of a house with similar attributes on public leasehold land.

A multi-method (or triangulation) approach was adopted during data collection. Two main categories of data were collected i.e. housing transaction prices and land tenure data. A cross-sectional dataset of transaction prices for 590 newly constructed residential houses traded in 2011 together with associated housing attribute data was obtained from the database of the Uganda Association of Real Estate Agents (AREA). The land tenure data for the properties traded in 2011 was obtained from the National Land Information System database at its zonal offices in Kampala and Wakiso. Meanwhile, spatial positions (coordinates) of individual properties sold in 2011 were measured using Garmin GPSMAP 76Cx global positioning equipment. A Geographical Information System (GIS) database for Kampala Capital City as well as a 2011 high resolution quick bird satellite image for the greater Kampala region was used to verify the location details of individual properties, and to extract distances to the Central Business District (CBD) and those to the main paved roads.

A hedonic model was used to empirically test the relationship between housing prices, land tenure and housing attributes. Housing price, the dependent variable, was modeled in the semi-log form because this specification is less likely to give raise to heteroscedasticity. Findings of this paper do not support hypothesis 1, given that public leaseholds offer a premium in housing values of 23% compared to freeholds. Two reasons could explain these results. Firstly, Kampala lacks formal systems for fair assessment of leasehold premium and ground rent charges, so that neither the lessor nor the lessee is left worse-off in the transaction. Under these conditions, it is possible that the existing arrangement where a lump-sum of 10% and 0.5% of the market value of land is charged as leasehold premium and annual ground rent, respectively, offer utility to the lessee at the expense of the lessor, thereby making leaseholds more popular in the property market. Secondly, given that issuance of freehold titles to private property in Uganda followed
enactment of the 1995 National Constitution much after public leasehold titles which were issued following enactment of the Public Lands Act of 1969, housing developers may not be fully aware of the benefits of freehold tenure causing them to value leaseholds higher than freeholds.

Similarly, findings of this paper do not support hypothesis 2, given that private mailo offers a 12% premium in housing values compared to freeholds. In addition, there is no significant impact of Kabaka’s (King’s) mailo tenure on housing values. These findings suggest that, at the moment, the high social costs on mailo land including land conflicts, litigations and evictions have not had a significant negative effect on housing values. Finally, findings from this paper show that housing values on private mailo are discounted by 11% compared to those on public leasehold tenure. In light of these findings, hypothesis 3 was accepted.

Beyond land tenure issues, the results show that structural attributes including the number of rooms, plot size, lake view, presence of a swimming pool and a servant’s quarter/guest house as well as neighborhood attributes including lake view, accessibility variables and the social economic status of residents jointly account for 83% variation in housing values. In addition, housing values in low income areas are discounted by 49% compared to those in middle income areas, while high income areas offer a premium in housing values of 23% compared to middle income areas. Regarding accessibility effects, this paper has demonstrated that by building a house an extra 1 km off the main paved road, the housing value is discounted by 3.9%. The variable of distance to CBD was not significant implying that Kampala is largely a polycentric rather than a monocentric city.

Paper IV: “Modeling the Dynamics of Housing and Population Change in Kampala City, Uganda” by Irumba Richard.

Manuscript to be submitted to Habitat International for review.

Despite the effort by government to provide an enabling policy framework, the supply of housing in Kampala is still lacking both in quality and quantity. The low quality of housing is largely due to low quality building materials, is associated with low income levels, and the use of own savings to undertake construction incrementally. The demand for housing exceeds supply resulting into a huge housing deficit. Based on available literature, population dynamics appear to explain the observed housing deficit in Kampala. There are reasonable grounds to hypothesize that this housing deficit is bound to increase in the coming years unless appropriate interventions are designed by government and/or the private sector to mitigate the situation. In order to contribute to the above discourse, this paper presents a computer based model to forecast the city’s population and housing needs over the medium term planning period of 20 years following the national population and housing census of 2014.

This study was undertaken through secondary data collection and computer simulation modelling. Population and housing statistics were obtained from census reports and housing sector periodic reports. On the other hand, the computer model was developed using system
dynamics methodology in ithink Stella software environment. The model consists of two subsystems i.e. the population subsystem and the housing subsystem. It is made up of four stocks i.e. the infant population, childhood population and adult population which jointly form the population subsystem; and the housing stock which forms the housing subsystem, together with related parameters that cause changes in the stocks. The model was calibrated using available housing and population data taking 2002 as the base year for simulation experiments. Thereafter, it was validated by carrying out structure and behavior tests. The period 2002-2014 was taken as a testing period. The model was found to be robust when subjected to extreme condition and sensitivity tests.

Behavior validity was examined by analyzing the historical fit of model projections and available population and housing data for the period 2002 to 2014. The forecasting error in city population was 45,425 people (or 3%) markedly lower than a forecasting error of 339,290 (or 22%) obtained using Uganda Bureau of Statistics (UBOS) population projections for 2014. In other words, the model provided a better fit compared to UBOS population projections. Regarding validation of the housing subsystem, forecasting errors of 1% and 5% were noted in housing stock projections for 2004 and 2008, respectively. The results also show an error of 2% in housing deficit projections for 2004. A forecasting error of 25% was noted in housing deficit projections for 2008. However, this error was treated as an isolated case given that convergence of results was obtained elsewhere. In terms of behavior pattern validation, model projection results and actual census survey data show growth in city population, housing stock and housing deficit over time.

Results of this study show that the city population shall grow from 1,516,210 in 2014 to 2,313,996 by 2034 (growth rate of 2.4% per annum). The young population (aged less than 18 years) shall increase by 3.6% while the adult population (aged 18 years and above) shall decrease by the same percentage during the period 2014 to 2034. The adult female population shall reduce by 2% during the same period. Housing stock shall increase from 326,317 units in 2014 to 485,898 in 2034 (growth rate of 2.5% per annum). The housing deficit shall increase from 84,639 units in 2014 to 123,049 units in 2034 (growth rate of 2.3% per annum). Present housing supply strategies appear to have capacity to meet future housing needs provided the present housing deficit is reduced to a minimum or brought to zero, and rapid population growth is controlled. Private sector investment in housing shall rise from 9,167 units per year in 2014 to 20,309 units per year by mid 2033 presenting the best opportunities for housing stock improvement in the city.

8.0 Policy Recommendations

To improve the performance of the construction industry (including housing) in Uganda, this thesis has made policy recommendations based on the findings of Papers I-IV. Summary details, by theme, are provided below.
Strategies of improving construction safety performance in Uganda:

(i) There is need to develop standards for provision of safety equipment (including personal protection gear and scaffolds). This recommendation is based on findings from Paper I which show that occurrence of accidents on buildings sites in Kampala is dependent on the availability of safety equipment.

(ii) Provisions for regular maintenance of construction equipment should be included in the standard conditions of contract. This recommendation is based on the findings from Paper I which show that that occurrence of accidents on buildings sites in Kampala is dependent on the condition of safety equipment.

(iii) Safety risk planning and assessment should to be regulated. One option is to have presentation of a safety risk plan as a condition for approval of building plans by the relevant authority. This recommendation is based on empirical findings from Paper I which show that mechanical hazards (i.e. struck by machines, vehicles, hand tools, cutting edges etc.) on building sites in Kampala are associated with lack of guard railing systems and the failure to mitigate hazards through risk planning and assessment.

(iv) There is need to develop standards of acceptable building densities for various categories of projects. This recommendation is based on empirical findings from Paper I which show that the number of accidents registered on a construction site in Kampala is positively associated with building density (i.e. ratio of building area to plot size).

(v) There is need to strengthen quality inspection of projects so that faults are detected and corrected early enough before they lead to accidents. Typically, quality inspection would entail regular testing of materials, regular testing and calibration of construction equipment, regular checks to ensure that safe methods of work are employed, and regular skill audits to ensure that workers have the required skills to execute work safely. The Government of Uganda needs to collaborate with professional bodies including the Uganda Institute of Professional Engineers, the Uganda Association of Civil Engineering Consultants and the Uganda Society of Architects, amongst others, to develop guidelines of implementing a safety program as suggested above. Note that this recommendation is based on empirical findings from Paper II which show that shorter durations of detecting rework as well as higher values of the probability to detect rework through quality inspection result into lower accident frequencies on projects.

(vi) Construction activities in Uganda are labor-intensive for example, as per statistics presented in Paper I, a building site in Kampala employs 63 workers on average. Whereas project managers may desire to have a bigger workforce so as to attain a faster project progress rate, there is need to optimize the size of workforce and avoid cases of over deployment in order to minimize accidents. As illustrated in Paper II, a bigger workforce size is associated with a high accidents frequency. These findings are in
agreement with test results of hypothesis 1B in Paper I. Government of Uganda through the Department of Occupational Safety and Health needs to develop standards on the optimal size of workforce required for different categories of industry activities with due consideration of working space and technology.

Strategies of improving the performance of the housing sector in Uganda:

(i) Whereas the Uganda National Land Policy of 2013 advocates for freehold as the land tenure for the future, the results of Paper III show that leasehold tenure in Kampala, a city holding 24% of the national urban population according to census records of 2014, offers a premium in housing values compared to freehold tenure. The government should advance leasehold as the urban land tenure for Uganda. Adoption of leasehold in urban areas will provide an opportunity for land to change ownership upon expiry of the lease contract or when the lease conditions are not fully met.

(ii) Based on findings of Paper III, housing values on mailo land are discounted compared to those on leasehold land. Therefore, there is need to remove barriers which stifle housing development on mailo land. One option is through formulation of appropriate policies aimed at disentangling the multiple layers of ownership on mailo land. A number of options can be explored in this regard including provision of incentives for issuance of leasehold titles to lawful and bonafide tenants and rolling out the land fund, as provided for in the Land Act (1998), so as to buy out registrable rights of absentee landlords as a strategy of freeing the land for unencumbered ownership and use by tenants. It is worthy to note that issuing leasehold titles to lawful and bonafide occupants will stimulate economic development because at the moment commercial banks have failed to recognize the certificates of ownership and certificates of occupancy issued to lawful and bonafide tenants, respectively, as adequate collateral for issuance of long-term credit and housing mortgages.

(iii) To mitigate rapid population growth and hence, reduce the housing backlog, there is need to develop an effective child spacing policy as demonstrated in Paper IV. The theory behind this policy is that there is an inverse relationship between child spacing and birth rates. Therefore, by increasing child spacing, you reduce birth rates and hence, the city population. Subsequently, a reduced city population will lead to reduced housing needs and a lower housing deficit. This policy could be implemented through adoption of contraception and other family planning methods. The Government Ministry of Health is best suited to take a leading role on this matter.

(iv) Based on policy experiments conducted in Paper IV, Government of Uganda in liaison with the private sector needs to develop a housing life-span policy which advocates for the improvement of the quality of housing so that houses can have a longer life-span. This can be achieved by adopting building technologies which preserve the life-span of houses, for example, reinforced concrete technology. Note that Kampala city and its
neighborhood lie along a seismically active zone and therefore, mandatory enforcement of the earthquake design code can produce buildings with a longer life-span. It is worthy to note that adoption of appropriate building technologies will not only ensure that buildings have a longer life-span but also that they are safe during and after construction.

(v) As documented in Paper IV, the average construction time for residential buildings in Kampala is six (6) years. This duration is long in essence resulting into a slow building rate which shall ultimately not help stakeholders to substantially reduce the housing backlog within the shortest time possible. The Government of Uganda in liaison with the private sector needs to remove the barriers leading to long construction times. Matters on adoption of capital intensive building technologies, and on the availability and cost of building materials, need to be addressed.

9.0 Concluding Remarks

The main objective of this thesis was to propose strategies and policies for improvement of the performance of the construction industry (including housing) in Uganda. The study themes were identified after reviewing the challenges hindering performance improvement and thereafter, specific study objectives were formulated to fit within the realm of the main objective. A mixed methods approach was used to gather data, analyze it and report findings in form of research papers. The climax of the long, but fruitful, journey has been a summary of policy recommendations presented in section 8.0. The above narration of events, as they unfold, would typically place this thesis in the category of applied research defined by Fellows and Liu (2008) as research directed towards end uses and practical applications.

However, there is evidence of testing theories, mainly grounded in the deductive-reasoning paradigm or otherwise called positivism. Different hypotheses are formulated within the research papers, data is collected and analyzed, so as to accept or reject the prepositions put forward in form of hypotheses. This kind of approach would qualify the thesis as pure research, defined by Fellows and Liu (2008) as research directed towards discovery and testing of theories. My own assessment is that this thesis is grounded in both pure and applied research- a combination of theory and applications.

It is worthy to note that specific findings of this thesis such as the concept of spatial dependence in occurrence of construction accidents, where accidents at one location were found to be associated with those which occur in the neighborhood; the phenomenon of congestion, defined in this thesis as the existence of high building density amidst many fulltime workers on site, and its significant association with accidents occurrence; and the uniqueness of private mailo land tenure system and the 12% premium it offers in housing values amidst high social costs, are unique contributions to the existing body of knowledge.
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