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Aims and Scope

The Journal of Construction in Developing Countries seeks to provide a central vehicle for the exchange and dissemination of knowledge on issues relevant to the built environment of developing countries. The journal provides a wide range of original research an application papers on current developments and advances in the built environment as well as the economic, social, cultural and technological contexts of developing countries. It also publishes detailed case studies, as well as short communications and discussions. Topics covered include, but are not restricted to planning, urban economics, rural and regional development, housing, management and resource issues, sustiainability, knowledge and technology transfer, construction procurement, facilities management, information an communication technologies, strategies and policy issues, design issues, conservation and environmental issues.

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Review of Theory and Practice Literature on Women Entrepreneurship in the Tanzanian Construction Industry: Establishing the Missing Link

***Nyamagere Gladys Sospeter1, Pantaleo David Rwelamila2, Mariam Nchimbi3 and Muhsin Masoud32**

ABSTRACT

The paper presents a review of the theoretical and empirical literature on Tanzania women entrepreneurs in the construction industry. It also discusses and argues for the aspects that lead to the requirement for a study on women-specific issues. A systematic literature review approach was applied and the member check strategy was used to minimise the author's bias. The literature involved three aspects: motivational factors for women's entry into business, the current situation of women entrepreneurs and influencing factors for the under-representation of women in the industry. The under-representation of Women Entrepreneurs in the Construction Industry (WECI) in the construction industry is caused by various factors, such as cultural background, choice of business and level of confidence. Moreover, the social structures and cultural systems that reinforce the continued subordination and marginalisation of women have major implications in their motives and involvement in business. Given the barriers faced by WECI today, there is a pressing necessity to initiate gender-sensitive empowerment programmes to enable them to succeed in their endeavours. Based on the existing literature, this paper establishes the missing link and proposes a study to formulate a conceptual framework necessary to help the public and private sector initiatives in boosting women entrepreneurship in the Tanzanian construction industry.

Keywords: Construction, Women, Entrepreneurship, Barriers and Tanzania

INTRODUCTION

Women have similar entrepreneurial potential as men to contribute to wealth creation and employment by starting and developing their own businesses. Unfortunately, their potential has not been fully realised and utilised because of the systemic challenges that women entrepreneurs face (Hanson, 2009). Specifically, globally, women who choose to pursue entrepreneurial ventures have had limited representation in the construction industry, which limits their contribution to economic development (Wangle, 2009; Verwey, 2005; Worrall et al., 2008). Women Entrepreneurs in the Construction Industry (WECI) are owners of a firm who start, manage and develop firms to undertake construction activities in the face of risk and uncertainty for the purpose of generating profits. The underrepresentation of WECI has been caused by various factors, such as cultural background, level of confidence and choice of business (Lincolin, 2010). For countries to realise their entrepreneurial potential and for them to fully contribute to economic development, it is important to address the specific issues that WECIface.

The construction industry is a major component of investment with high growth potential and a sector with untapped opportunities; hence, expansion in construction activities is closely related to economic growth (United Republic of Tanzania [URT], 2005; International Labour Organisation [ILO], 2007). These activities may be new construction works or maintenance and repair works. By recognising the importance of infrastructure for economic growth, the government has continued and committed to

placing considerable focus on construction by allocating 13% and 18% of the 2010/2011 and 2012/2013 development budget to infrastructure, respectively (Contractors Registration Board [CRB], 2013). The construction industry is one of the main economic sectors that requires the skills and talents of everyone, including women. However, in Tanzania, fewer than 2% of 7,036 construction firms are owned by women (CRB, 2013). Of 129 WECI, five own large, 27 own medium and 68 own small construction firms. Women continue to be under-represented in the Tanzanian construction industry (TCI). It should be noted that this is a two-phased study. Phase one (on which this paper is based) reviews the literature and sets propositions. Phase two will have empirical data and a model as an approach to address the challenges.

THEORY AND PRACTICE

Justification for a Study on Women Entrepreneurs

The creativity and talents of women entrepreneurs are an invaluable resource, which can and should be developed for both their own self-realisation and society benefit (Kikwasi, 2005; Hodginkson, 2006). Females comprise 50.8% of the Tanzanian population (URT, 2009). Despite their majority, women are marginalised relative to men because of the existing structures and customary law. Consequently, their participation in salient sectors, such as education, is low, which partly explains the under-representation of females in decision-making positions and those that require high levels of professional and technical education (Mascarenhas, 2007), such as the construction industry. The lack of women in construction has been a concern for many years. The studies in these areas have attempted to examine the factors that affect the low level of women's participation in the industry (Gale, 1994; Amaratunga et al., 2009; Kikwasi, 2005; Hakala, 2008).

This paper is intrigued by the involvement of women in entrepreneurship, which is considered a male domain. The late entry of women into business has made male entrepreneurs the standard against which women's experience as entrepreneurs is judged (Rutashobya, 2000; Lincolin, 2010; Nchimbi and Chijoriga, 2009). More importantly is the involvement of women entrepreneurs in non traditional industry (NTI) since the 1980s. NTIs are industries with a low level of women's involvement, e.g., construction, mining and agriculture. This factor alone would be of no relevance except for the extensive evidence of the historical subordination and patriarchal pressures that are experienced by women worldwide (Kantor, 2003; Dainty, Green and Bagihole, 2007). Although there is a wealth of literature for women entrepreneurs in their traditional industries (Manolova et al., 2007; Nchimbi, 2003; Baker, Aldrich and Liou, 1997), the literature on women entrepreneurs' participation in the construction industry is lacking (Hunter and Kapp, 2008; Kikwasi, 2005). Women are historically disadvantaged compared to men and because entrepreneurship is considered culture-specific, it is of interest to analyse and develop an understanding by exploring their experiences in the construction industry.

Theoretical Literature

For the purpose of this paper, both foundational and post-modern human behavioural theories are reviewed. Evolving from human behavioural theories, the feminist theory evolved into the disadvantage, attribution, human capital, resource-based and cultural theories. The most prominent theory relevant to this paper is the feminist theory. Women's strategies to succeed vary from those of their male counterparts: the feminine strategies include collaborations, work-life and diversity strategies, whereas the masculine strategies are more businessfocused strategies (Kropf et al., 2003). To attract and retain female executives, the recommendation is to consider how women formulate strategies to address the barriers that confront women executives (Kropf et al., 2003).

According to Beauchamp and Bowie (2004), feminist theories recognise that subordination, inequality, or oppression of women is unethical and that women deserve equal political and legal rights, whereas Kantian and utilitarian theories neglect to acknowledge the importance that morals have in the value of other's well-being and do not consider virtues (Beauchamp and Bowie, 2004). An example of the issues raised by feminist theorists is the disparity between men and women advancements and earnings. This disparity may largely result from the disadvantage of women because of family issues and the requirement for flexible schedules (Orhan and Scott, 2001; Gale, 1994). Feminist theories argue that in society, the different treatments of men and women may explain why compensation is less for women than their male counterpart's earnings (Lowrey, 2006). This theory is relevant for this paper because it gives insights on the differences between men and women and some challenges for women to venture into any sector of the economy.

Evolving from the feminist theories, the deprivation argument states that societal views deprive women of education, industry experience, networking relationships and access to capital (Appelbaum, Audet and Miller, 2003; Cron, Bruton and Slocum, 2006). Deprivation of these opportunities can affect women in entrepreneurial successes. According to Shane (2003), feminist theorists supported the concept that there are existing organisationally based inequalities. This theory evolved to the human capital theory that provides possible explanations for women to be over-represented in some industries and under represented in other industries.

The human capital theory states that corporations invest less in women's education and training, which diminishes opportunities for women to advance in an organisation (Dreher, 2003). The resource-based theory states that a firm gains competitive advantage by effectively and creatively using resources (Hoopes, Madsen and Walker, 2003; Barney, 1991). Experience and education contribute to the resources required by entrepreneurs for a firm (Kantor, 2003), which is supported by the resource-based theory and is instrumental in determining how and what resources women entrepreneurs require to sustain successful operations. The theory is relevant because it posits important insights that are pre requisites for a successful entrepreneurship.

In addition, the concepts of the cultural theory of entrepreneurship hypothesises that compared to male counterparts, women are less successful in business based on cultural differences (Smith-Hunter and Boyd, 2004). Evolving from the cultural theory of entrepreneurship, the disadvantage theory theorises that women become entrepreneurs because of disadvantages in the labour market (Smith-Hunter and Boyd, 2004). The disadvantage theory also applies to the challenges that women in construction face, which place them at a financial disadvantage; for example, women finance their business ventures with personal savings instead of the traditional lending and financial institutions (Smith-Hunter and Boyd, 2004).

Situation of Women Entrepreneurs, Policies and Affirmative Action Businesses headed by women contribute to employment, wealth creation and economic growth through their increasing numbers, diversity of activities and diversity of entrepreneurship in the economic process (Hakala, 2008; Manolova et al., 2007). The creativity and talents of women are an invaluable resource, which can and should be developed for both their own self-realisation and society benefit (Kikwasi, 2005; United Nations Industrial Development Organisation [UNIDO], 2005; Hodkignson, 2006). Because it was realised in the past decade that women are an important but untapped source of economic growth, the government, non-governmental and international communities have devised several initiatives to economically empower them (URT, 2003; ILO, 2004). Some initiatives directly target women, whereas others are indirect.

There are initiatives through affirmative action to redress inequalities worldwide. Basically, the

affirmative actions seek to address historical injustices and act against perceived social imbalances. They are essentially based on the principle of non-discrimination (Verwey, 2005). For example, the USA takes affirmative action to ensure that all people are fairly treated regardless of their ethnic or national difference and seek to eliminate discrimination. The order aims to bring equality to disadvantaged individuals, including women and therefore creates a friendly environment for business start-ups.

In South Africa, past policies and laws deliberately favoured men, particularly white men. As a system of national strategy, affirmative action legislation had to redress the past imbalances that were created by apartheid (Mathur-Helm, 2004). Hence, women's issues surfaced, such as their rights, equality, welfare and empowerment and the essential measures around these issues started gaining attention. Government policies and legislation have been created in favour of women and with good will. Most of these initiatives have not been successfully implemented for sustainable solutions (Verwey, 2005). The fact is that correct implementation of the strategies relies more on the fairness of the regulations and the legal protection of women's rights and welfare than on only constitutional implementation and imposition of these policies and strategies.

Tanzania is committed to development policies that promote entrepreneurship in all sectors of the economy to alleviate poverty, generate employment, contribute to the diversity of entrepreneurship and improve competitiveness. Efforts by the government to address poverty at the national level are enshrouded in many programmes, such as the Small and Medium Enterprises (SMEs) policy of 2003. After 10 years of implementation, The SME policy shows that it remains a valid development framework for the sector. Despite notable achievements in assisting the development of SMEs in the country, there are also challenges that impeded its effective implementation, e.g., inadequate coordination and weak synergy among stakeholders in this cross-cutting sector, insufficient resources to implement envisaged programmes, lack of prioritisation and inconsistencies in legislation (UNIDO, 2013).

The other two main frameworks are the National Poverty Eradication Strategy (NPES) of 2005–2010 and the National Strategy for Growth and Reduction of Poverty (NSGRP) phases I and II; phase I was during 2005-2010. NPES, which envisaged reducing poverty by half by 2010, was built on the Millennium Development Goals (MDGs) 1. The achievements of NSGRP phase I, which ended in 2010, were below targets; hence, it was unsuccessful (International Monetary Fund [IMF], 2011). NSGRP phase II envisions availing income opportunities across sectors through public investment and empowerment arrangements to introduce equitable participation in the production and sharing of outcomes by 2015. These National policies provide the opportunities for local communities to benefit from entrepreneurship in all sectors of the economy (URT, 2003; URT, 2005). Generally, the policies are not effective because specific measures to address gender-based obstacles to growth and poverty reduction are not identified.

Women in Tanzania are predominantly found in the informal sector; they are driven out of necessity to start entrepreneurial activities and normally enter the micro-level and low-growth sectors, where they encounter strong competition while earning subsistence incomes, particularly in traditionally women related industries, such as service and retail (Rutashobya, 2000; Nchimbi, 2003; Olomi, 2009). As a result, most of their businesses cannot generate new jobs, generate sufficient income and contribute meaningful to the economic development because the lack of exposure and socialisation restrict their ability to identify business ventures with higher growth potential (Hanson, 2009; ILO, 2007). This situation somehow challenges the macro-economic development policy objectives.

Influencing Factors for Women's Under-Representation in the Construction Industry

The under-representation of WECI in the construction industry is caused by various factors, such as

cultural background, choice of business and confidence (Nchimbi and Chijoriga, 2009; Dainty, Green and Bagihole, 2007). Women's choice of business activities is dictated by their reproductive roles, abilities in terms of education, entrepreneurial capacity and technical skills, limited start-up capital and their limited capacity to absorb the consequences of failure (Langowitz and Minniti, 2007; Nchimbi and Chijoriga, 2009). As a result, they choose activities that can be easily combined with their domestic chores and are culturally acceptable, which refers to self-imposed barriers when women (wrongly) perceive that they may not have the right opportunities and know-how to start and grow their own businesses. Self-perceptions are closely linked to the environment in which entrepreneurship occurs. For example, if a society mainly defines women through roles that are connected to family and household responsibilities, societal values implicitly interpret women's entrepreneurship as less desirable and provide lower normative support (Lowrey, 2006; Langowitz and Minniti, 2007).

Motivational Factors for Women's Entry into Business

Women become involved in businesses for a number of reasons, particularly since the economic crisis of the late 1970s and 1980s and the subsequent Structural Adjustment Programmes (SAPs) of the 1980s. The SAPs intended to address the economic recession of the mid-1970s. The implementation of SAPs resulted in a freeze on wages, devaluation and lower purchasing power. Therefore, employees and families were forced to establish income-generating projects to supplement salaries (Nchimbi, 2003; Rutashobya, 2000). They were motivated by necessity, such as the need for a living and no other economic options. Nevertheless, women are not a homogeneous group because they differ in many ways, i.e., in the role and control they have in business, level of wealth, level of education, entrepreneurial capacity and experience.

Thus, more educated women with more capital start businesses in the construction industry, whereas poor and less educated women enter the informal sector to operate in the women-traditional industries (Rutashobya, 2000; Hanson, 2009; Nchimbi and Chijoriga, 2009). They are motivated by the requirement for achievement, independence and challenge (Verwey, 2005). However, the social structures and cultural systems that reinforce the continued subordination and marginalisation of women have major implications in their motives and involvement in business and their perception of success (Lowrey, 2006; Nchimbi and Chijoriga, 2009). As a partial result, women are limited to educational and financial resources. The closer women are to men socially and economically, the stronger are their motives to start a business similar to those of men, such as a business in the construction industry.

Current Situation of Women Entrepreneurs in the Construction Industry

Compared with other countries, the level of WECI in the USA is above 30% (Verwey, 2005). WECI in the USA had the development fund earmarked for gender equity. A large percentage of these funds enters the construction industry and is earmarked for qualifying WECI (Verwey, 2005; Hanson, 2009; Hakala, 2008). The national association of women in construction (NAWIC) plays a bigger role in motivating more women to join the industry (Verwey, 2005; Hakala, 2008).

In developing countries, e.g., South Africa, which has learned a lot from the USA, the level of WECI is 22%; their success has been influenced by the window of opportunity and a strong association of women with construction, which has helped to motivate more women to enter the construction industry (Verwey, 2005). In East African countries such as Kenya, women's level of involvement as entrepreneurs is less than 1% (Dainty, Green and Bagihole, 2007). In Tanzania, women's level of involvement is low, as only 2% of 7,036 contracting firms are WECI(CRB, 2013).

Because of women's under-representation, the industry through its Construction Industry Policy (CIP), 2003 emphasises women's involvement in entrepreneurship and advancement in the industry (URT,

2005; UNIDO, 2005). Therefore, there is a necessity to involve more women to use their entrepreneurial potential to contribute to the macro-economic objectives and change the face of the industry in terms of profitability and productivity. Women involvement in business is consistent by achieving the macro-economic development policy objectives to improve competitiveness, such as the SME development policy; the CIP, for example the constitution in SA have a will to increase WECI and through the CRB strategic plan for 2010–2015, Tanzania aims to address cross-cutting issues to promote WECI (CRB, 2010).

Barriers and Challenges to Entrepreneurship

The on-going vision to reduce poverty requires the community and national participation in entrepreneurship. Every individual who is willing to start and run a business will encounter barriers/challenges. Gatewood et al. (2003) and Hakala (2008) summarised the barriers and suggested that the entrepreneurial challenges fall into three categories: (1) human capital, (2) strategic choice and (3) structural barriers. Obviously, the extent and severity of these problems vary by gender or type of entrepreneur, sector, nation and region. For example, it is reported that entrepreneurs in emerging nations face more formidable challenges than their counterparts in industrialised and developed nations and that women face greater challenges in most areas than men (Hunter and Kapp, 2008; ILO, 2007).

According to Hakala (2008), the barriers/challenges to women in the non traditional industries are the lack of technical knowledge and lack of confidence and ability to make strategic choices to improve their financial position. Entrepreneurs experience these challenges in different sectors and at different stages of their evolution from infancy to maturity (Worrall et al., 2008). In addition to these challenges, the social, cultural norms and beliefs have made patriarchal societies that reinforce continued subordination and marginalisation of many women entrepreneurs (Hodginkson, 2006; Manolova et al., 2007). As a partial result, women have limited access to financial resources and lack the prior entrepreneurial competency, which contribute to the specific challenges of starting and running a business (Orhan and Scott, 2001; Manolova et al., 2007).

The Entrepreneurial Process

To start and manage a business is not an easy task. Entrepreneurs actually create their own odds of success by taking incremental steps that move them closer to their goals (Sarasvathy, 2006). Therefore, the effectuation theory portrays the entrepreneurial process as consisting of three variables: the characteristics of the founder/s, business opportunity and environment. It involves all functions, activities and actions that are associated with the perceived opportunities and creation of organisations to pursue them. This process involves four distinct phases, through which entrepreneurs will pass in order for them to start and manage their new venture. These phases are to identify and evaluate the opportunity, develop a business plan, determine the resource requirements and finally start and manage the enterprise (Nieman and Bennet, 2002; Hisrich and Peters, 2002). It is little known whether the WECI go through the same process and how they behave and fare in the process.

DISCUSSION: ESTABLISHING THE MISSING LINK

As found from the literature, the construction industry is male dominated for three reasons: first, women have a low level of involvement. Second, the existing industry culture and image reflect masculinity, which makes women lack fit (Gale, 1994; Hunter and Kapp, 2008; Kikwasi, 2005). Third, the industry practices, such as construction activities, require long hours and working away from home and fail to combine domestic chores with business; thus, the geographical instability and other undertakings are in favour of men. The contributing factors for the low involvement of women entrepreneurs in the

construction industry are the following: lack of technical education, lack of confidence and lack of role models. Women that venture into the construction industry and grow their businesses can be considered role models who can inspire more women to choose a career in construction (Loosemore, Danity and Lingard, 2003; Lincolin, 2010).

In terms of entry, career development and retention, women face formidable barriers. Women have limited access to financial resources and lack prior entrepreneurial competency, which contribute to the specific challenges of starting and running a business (Orhan and Scott, 2001; Manolova et al., 2007). Failing to understand these factors may result in the under-utilisation of women's human capital, perpetuation of lower living standards and implementation of costly and ineffective policies. A major management dilemma is that WECI find it difficult to access business opportunities (Verwey, 2005), which introduces the question: are the enabling measures adequate? If YES, an important question is whether women are adequately equipped to compete for business opportunities. There are general barriers/challenges that WECI face in the context of a developed country, but there may be different or additional barriers that depend on the environment in a developing country.

Women have been marginalised; hence, their businesses have been largely ignored in the literature on entrepreneurship, most of which is about men (Hisrich and Peters, 2002; Hanson, 2009). When mentioned, women's businesses have been dismissed as insignificant because they are considered too small or in economy sectors (service and retail) that supposedly matter too little to economic growth (Baker, Aldrich and Liou, 1997; Lowrey, 2006; Organisation for Economic Co-operation and Development, 2004). As a result, male entrepreneurs have made the standard by which women entrepreneurs' experiences are judged. Some women have formalised and are growing their businesses in the construction industry with the evidence of patriarchal pressures that they experienced. It is important to note that the effectiveness of the programmes and policies that aim at promoting WECI depend on having a thorough understanding of the experiences of these women.

CONCLUSION

This paper has reviewed the literature on the general position of women entrepreneurs and further explained the situation of women entrepreneurs in construction. Each section has been elaborated and justified and the "missing link"has been established. The literature indicated that a large portion of entrepreneurial literature is gender-blind because it is based on the experience of males. There is a dearth of literature on entrepreneurial experiences in the construction industry. The existing studies in the area were conducted in developed countries (e.g., Verwey, 2005; Hodgkinson, 2006; Dainty, Green and Bagihole, 2007; Hakala, 2008; Worral et al., 2008, Wangle, 2009; Lincolin, 2010).

Decisions for WECI to leave their current positions to start up new business should be appreciated and promoted. Fortunately, the construction industry has formally partly acknowledged that the under-representation of women is an important issue and promoted initiatives in this area. However, most initiatives have not led to sustainable solutions because of the lack of understanding regarding women-related issues. Because there is no one size fits all policy solution, a thorough understanding of the experiences of WECI in terms of the motives, processes and challenges is significantly required for effective programmes and policies. Furthermore, it is vital to identify appropriate recommendations and guidelines to address some barriers/challenges. Hence, a model should be developed to help the public and private sector initiatives in increasing the level of WECI participation in the Tanzanian construction industry.

REFERENCES

Amaratunga, D., Haigh, R., Lee, A. and Elvitigala, E. (2009). Construction industry and women: A

review of barriers. Construction Management and Economics, 29(3): 559–571.
Appelbaum, S.H., Audet, L. and Miller, J.C. (2003). Gender and leadership? Leadership and gender? A journey through the landscape of theories. Leadership and Organization Development Journal, 24(1/2): 43–52.
Baker, T., Aldrich, H.E. and Liou, N. (1997). Invisible entrepreneurs: The neglect of women business owners by mass media and scholarly journals in the US.Entrepreneurship and Regional Development, 9: 221–238.
Barney, J. (1991). Firm resources and sustained competitive advantages. Journal of Management, 17(1): 99–120.
Beauchamp, T.L. and Bowie, N.E. (2004). Ethical Theory and Business. 7th Ed. Upper Saddle River, NJ: Pearson/Prentice Hall.
Contractors Registration Board (CRB). (2013). What is the Way Forward?: Building
Capacity to Local Contractors. Dar es Salaam, Tanzania: CRB.
———. (2010). Capacity and competence of contractors: A key to sustainable infrastructure development. In CRB Annual Consultative Meetings. Dar es Salaam, Tanzania: CRB.
Cron, W.L., Bruton, G.D. and Slocum, J.W. (2006). Professional service ventures, performance and the gender effect. Journal of Leadership and Organizational Studies, 12(3): 53–68.
Dainty, A., Green, S. and Bagihole, B. (eds.). (2007). People and Culture in Construction: Contexts and Challenges. London: Taylor and Francis.
Dreher, G.F. (2003). Breaking the glass ceiling: The effects of sex ratios and work-life programs on female leadership at the top. Human Relations, 56(5): 541.
Gale, A. (1994). Women in non-traditional occupations: The construction industry. Women in Management Review, 9(2): 3–15.
Gatewood, E.G., Carter, N.M., Brush, C.G., Greene, P.G. and Hart, M.M. (2003). Women Entrepreneurs, Their Ventures, and the Venture Capital Industry: An Annotated Bibliography. Stockholm: Entrepreneurship and Small Business Research Institute.
Hakala, S.R. (2008). Women entreprenuers: Challenges and successes in nontraditional industries. PhD diss. University of Phoenix.
Hanson, S. (2009). Gender and entrepreneurial networks. Regional Studies, 43(1):135–149.
Hisrich, R. and Peter, M.P. (2002). Entrepreneurship. London: McGraw-Hill.
Hodgkinson, E. (2006). An analysis of women in the New Zealand building and construction industry: Untapped resource, women in construction. Msc diss. University of Canterbury.
Hoopes, D.G., Madsen, T.L. and Walker, G. (2003). Why is there a resource-based view?: Toward a theory of competitive heterogeneity. Intro. Strategic Management Journal, 24(10): 889–904.
Hunter, S.A. and Kapp, J.M. (2008). Women Entrepreneurs across Racial Lines: Issues of Human Capital, Financial Capital and Network Structures. Cheltenham, UK: Edward Elgar Publishing.
International Labour Organisation (ILO). (2007). Entrepreneurship in Economic Development. Geneva: ILO.
———. (2004). Support for Growth: Oriented Women Entrepreneurs in Tanzania. Geneva: ILO.
International Monentary Fund (IMF). (2011). Annual Report: Pursuing Equitable and Balanced Growth. Washington DC: IMF.
Kantor, P. (2003). Women's empowerment through home-based work: Evidence from India. Development and Change, 34(3): 425–445.
Kikwasi, G. (2005). Increasing women employment in the construction industry. PhD diss. Beijing University of Technology.
Kropf, M.B, Moore, M., Galinsky, E., Salmond, K., Bond, J.T. and Harrington, B. (2003). Leaders in a

Global Economy: Study of Executive Women and Men. Executive summary. Available at: www.catalystwomen.org [Accessed on 20 October 2013].
Langowitz, N.S. and Minniti, M. (2007). The entrepreneurial propensity of women. Entrepreneurship Theory and Practice, 31(3): 341–364.
Lincolin, W.P. (2010). Impact of gender on economic development. Paper presented at the Women's Development Conference and Consultative Annual Meeting. Addis Ababa, Ethiopia, 23–25 March.
Loosemore, M., Danity, A. and Lingard, H. (2003). Human Resources Management in Construction Project: Strategic and Operational Approaches. London:Spon Press.
Lowrey, Y. (2006). Women in business: A demographic review of women's business ownership. Small Business Administration No. 280, August. Washington DC: Office of Advocacy.
Manolova, T.S., Carter, M.N., Maney, I.M. and Cryoshev, B.S. (2007). The differential effect on men and women entrepreneur's human capital and networking on growth expectancies in Bulgeria. Entrepreneurship: Theory and Practice, 31(3): 407–426.
Mascarenhas, O. (2007). Gender Profile of Tanzania: Enhancing Gender Equity. Dar es Salaam, Tanzania: Tanzania Gender Networking Programme.
Mathur-Helm, B. (2004). Women in management in South Africa. In L. Davidson and R. Burke (eds.). Women in Management Worldwide: Progress and Prospects. Aldershot, UK: Ashgate Publishing Company.
Nchimbi, M.I. (2003). Gender and entrepreneurship in Tanzania: A comparative analysis of male-female's start-up motivation, individual characteristics and perceptions of business success. PhD diss. Umea University.
Nchimbi, M.I. and Chijoriga M. (2009). Gender and entrepreneurship. In D.R. Olomi (ed.). African Entrepreneurship and Small Business Development: Context and Process. Dar es salaam, Tanzania: Otme Publishers.
Nieman, G. and Bennet, A. (2002). Business Management: A Value Chain Approach. Pretoria: Van Schaik Publishers.
Olomi, D.R. (2009). African Entrepreneurship and Small Business Development: Context and Process. Dar es Salaam, Tanzania: Otme Publishers.
Organisation for Economic Co-operation and Development. (2004). Women's entrepreneurship: Issues and policies. Paper presented at the 2nd OECD Conference of Ministers Responsible for Small and Medium-Sized Enterprises. Istanbul, 3–5 June.
Orhan, M. and Scott, D. (2001). Why women enter into entrepreneurship: An explanatory model. Women in Management Review, 16(5): 232.
Rutashobya, L.K. (2000). Female entrepreneurship in Tanzania and strategic considerations. Business Management Review, 32(2): 349–377.
Sarasvathy, D. (2006). What to do next: The case for non-predictive strategy. Strategic Management Journal, 27(10): 981–998.
Shane, S. (2003). A General Theory of Entrepreneurship: The Individual-Opportunity Nexus. Cheltenham, UK: Edward Edgar Publishing.
Smith-Hunter, A.E. and Boyd, L.R. (2004). Applying theories of entrepreneurship to a comparative analysis of white and minority women business owners. Women in Management Review, 19(1): 18–28.
United Nations Industrial Development Organisation (UNIDO). (2013). SME Policy 2003: After Ten Years of Implementation (Report). Vienna, Austria: UNIDO.
———. (2005). Women Industry and Technology: UNIDO's Task Force on Preparations for the Fourth World Conference on Women, Austria. Vienna, Austria: UNIDO.
United Republic of Tanzania. (2009). Economic Survey 2008. Dar es Salaam, Tanzania: Government of

the United Republic of Tanzania.
———. (2003). National Development Policy: SMEs Policy, Vice President's Office. Dar es Salaam, Tanzania: Government of the United Republic of Tanzania.
Verwey, I. (2005). A comparative analysis between SA and USA women entrepreneurs in construction. PhD diss. University of Pretoria.
Wangle, M.A. (2009). Perceptions of traits of women in construction. MSc diss. University of Florida.
Worrall, L., Harris, K., Thomas, A., Stewart, R., Jessop, S. and Platten, A. (2008). Organisational cultures: Retention and progression barriers to women in the UK construction industry. International Journal of Communities, 8(3):31–40

Factors Affecting the Capacity of Small to Medium Enterprises (SME) Building Construction Firms in Ghana

Isaac Offei1, *Ernest Kissi2 and Gabriel Nani2

ABSTRACT

There is a raft of factors that affect the capacity of local construction firms in Ghana, particularly those in the smaller contractor classifications. These factors render small to medium enterprises (SME) ineffective in administration of construction processes. As a result, these firms are not able to match with growing demands of stakeholders and end up collapsing. In this article, factors affecting the capacity of SME building construction firms in Ghana were empirically ascertained. This involved a review of published research works on the construction industry, generally in both developed and developing countries focusing on Ghana. Both qualitative and quantitative research methods were employed while conducting the study. The data obtained during the research were analysed using descriptive statistics and factor analysis. It emerged from the study, among other factors, the following as key factors affecting the financial, managerial and technical capacities of SME construction firms in Ghana: delay in payment for work done, limited access to finance, non-payment of interest on delayed payments and lack of fair competition. It is therefore recommended that if there is any policy that is directed at building the capacity of the SME Construction firms in Ghana, it should endeavour to mitigate the aforementioned factors.

Keywords: Capacity, Developing countries, Ghana, SME building contractors

INTRODUCTION

One of the major components of government's expenditure since Ghana gained her independence in 1957 is construction works as the government spends a lot of money in the provision of infrastructure in the various sectors of the country (Ampadu Asiamah and Ampadu-Asiamah, 2013). This is because the physical infrastructure, built through the various construction activities, is the nation's economic backbone. It forms the arteries for the facilitation of productive activities by enabling goods and services to be distributed within and outside the country (Ofori, 2012). This explains why the bulk of the expenditure programmes of ministries, departments, agencies (MDAs) and district assemblies (DAs) of the Republic of Ghana involve procurement of construction products (Anvuur, Kumaraswamy and Male, 2006). It must however be noted that exploiting the activities and outcomes of the Ghanaian construction industry (GCI) towards an anticipated socio-economic progress cannot be predicated upon a fragile developmental framework and ill equipped industry (Badu and Owusu-Manu, 2010; Ahadzie, 2009). Thus, the capacity of the local construction firms in the GCI needs to be strengthened enough to enable them serve the necessary demand for construction products.

In Ghana, both building and civil engineering contractors are respectively classified under categories D1, D2, D3, D4 and K1, K2, K3, K4 by the Ministry of Water Resources, Works and Housing in collaboration with the Registrar General's Department (Amoah, Ahadzie and Danso, 2011; Agyepong, 2012). This classification is done with reference to factors such as annual turnover, equipment holding and personnel. Thus, the D1K1 class of contractors are regarded as larger firms, whereas D2K2 construction firms are medium, and D3K3 and D4K4 are small firms (cf. Danso, 2010; Amoah et al., 2011). By this classification, firms in each category could tender for building contracts within a certain

financial threshold (Badu, Edwards and Owusu-Manu, 2012). In the context of this study, small to medium enterprises (SME) building contractors (SMEBCs) refer to firms within D4K4, D3K3 and D2K2 categories. A lot of studies have been conducted in Ghana that have identified and proposed solutions for the challenges that face the construction industry (Ahadzie, 2009; Badu and Owusu-Manu, 2010; Laryea, 2010; Danso, 2010; Amoah, Ahadzie and Danso, 2011). Notwithstanding, most of the writers have largely focused on relatively larger construction firms than the smaller construction firms (even though, the small-scale construction firms constitute a larger proportion of the number of firms in the construction industry) (Amoah, Ahadzie and Danso, 2011). Research has it that 90% of registered contractors belong to the lower classes in Ghana (van Egmond and Erkelens, 2007). Regardless of the sizes of these SME building construction firms, they collectively contribute significantly to the overall construction gross domestic product (GDP), especially in the development of decentralised and local government areas (Amoah, Ahadzie and Danso, 2011). However, in spite of the significance of the construction industry, with regard to national socio-economic development, construction firms, particularly those that belong to the SME categories are faced with a raft of challenges that affect their capacity (Anaman and Osei-Amponsah, 2007; Amoah, Ahadzie and Danso, 2011). These challenges that face the Ghanaian construction industry in general and the SMEBCs firms in particular go to affect their competitiveness and their survival in business. It is therefore imperative to empirically ascertain the key factors affecting the capacity of SME building construction firms. The term capacity is used in several contexts with deferent meanings, depending on the message that is sought to be conveyed (Morgan, 2006; Enemark, 2003). The Oxford Advanced Learner's Dictionary defines capacity as "the ability to understand or do something". The United Nations Educational, Scientific and Cultural Organization (UNESCO) (2006) however makes the definition much broader. It thus defines capacity as the ability of individuals, organisations, or systems to perform appropriate functions effectively, efficiently and sustainably. Indeed, the term capacity can be related to the abilities, skills, knowledge, learning attitudes, values, relationships, behaviours, motivations, resources and conditions that enable individuals, organisations, institutions and systems to carry out functions effectively, efficiently and innovatively in order to achieve their development objectives (Kululanga, 2012). Therefore, for the purposes of this article, capacity will be referred to as the technical knowhow, managerial skills and financial strength that are required by a firm in order to meet its client's demand effectively and efficiently. To meet this objective, the capacity of construction firms and the factors that affect their capacity are generally reviewed based on findings from previous studies and other literature information. The research methodology was then designed by taking a cue from the methods of data collection, analysis and inferences from literature of similar studies.

FACTORS AFFECTING THE CAPACITY OF SME BUILDING CONSTRUCTION FIRMS

Regardless of the acknowledged significant contributions small construction firms make to the economy in terms of employment, the challenges faced by these firms can be overwhelming (Amoah, Ahadzie and Danso, 2011). A study conducted by Donkor (2011) reveals that the determinants of business failure in the perspective of SMEBCs in the Ghanaian construction industry are suspension of projects of previous government, delay in collecting debts from new political heads, financial demands from political heads, non-payment of interest on delayed payments, assigning incompetent project leader at the site, lack of access to capital, undervaluing of work done, change in government policies, low profit margin due to competition and delay in collecting payments. Others include frauds/pilfering, lack of material control systems, poor monitoring and control, poor estimation practices, awarding contracts to incompetent political party members, poor tendering/selection procedure, high and unstable inflation and national slump in the economy.

In a related study that sought to find the factors that affect the performance of small construction firms in Ghana, Amoah, Ahadzie and Danso (2011) empirically revealed that the factors can be grouped under fiscal policies and managerial capacity. In that study, it was revealed from literature that chronic delay in the payments of contractors for work done, lack of credit facilities for firms, poor communication structures and an unreliable material supply base are some of the factors that can affect the performance of small building contractors in Ghana. That notwithstanding, the productivity of SMEBCs has been shown to be hampered by laid down procedures, delayed payments and resource constraints (Kheni, 2008). Besides, Kheni asserts that stiff competition that is faced by these SMEs go a long way to hamper their growth and hence their capacity. Research has shown that delay in payment has been identified as the severest factor constraining the finances of contractors (Eyiah, 2003), hence, their financial capacity. In South Africa, another African country such as Ghana, accesses to markets, credit, skills and supportive institutional arrangements have been identified as the basic constraints to the development in the small business sector (Govender and Watermeyer, 2000).

Bakar et al. (2012) also identified factors of management and product quality, human factor and customer orientation as the most significant factors that affect the turnover growth for construction companies. It has been reviewed in literature that about three decades ago, chronic delay in the payments of contractors for work done, lack of credit facilities for firms, poor communication structures and an unreliable material supply base, technical capabilities, high inflation rates are potential factors that can affect the capacity of small scale building contractors (Eyiah and Cook, 2003; Amoah, Ahadzie and Danso, 2011). Indeed, Cook and Nixson (2000) assert that most surveys have identified a plethora of factors that inhibit the capacity of smaller firms to include access to finance, poor managerial skills, lack of training opportunities and the high cost of inputs. Laryea (2010) asserts that contractors in the small and medium bracket in most developing countries have limited access to funding sources which prevents them from satisfying the financial requirements (e.g. bid and performance bonds) needed to win major contracts often awarded to their foreign counterparts.

It has been noted that high tendering costs worsens the plight of SMEBCs in that several criteria must be met in order for a tender to be compliant with bidding requirements. This compels owner/managers to develop strong friendship networks as tools for dealing with state bureaucracy (Kheni, 2008). Kheni stresses this point by revealing that the average number of documents required in order for a contractor to submit a tender that meets bidding requirements is in the Region of 15 to 25. Indeed, competitive tendering, as contained in the Public Procurement Act 2003 (Act 663), has become the usual way of procuring physical development projects in the public sector because of requirements of transparency and accountability in the management of public finance (Anvuur, Kumaraswamy and Male, 2006). This is likely to result in under-pricing by many SMEs in a bid to win contracts and subsequently not performing upon award of a public contract (Kheni, 2008). Research has also revealed that delays with interim and final payments, as well as onerous contract conditions faced by construction firms, can also impose a very significant challenge on the SME building contractors (Thwala and Phaladi, 2009). Thwala and Phaladi (2009) in their findings reveal that lack of financial management, lack of entrepreneurial skills, lack of proper training, lack of resources, lack of technical skills, lack of contractual and managerial skills, late payment for work done which are common with government contracts, inability to get credit from suppliers and fronting for established contractors are also contributing factors for the failure of emerging contractors in South Africa, a developing country such as Ghana.

It must be noted that the various factors that affect the capacity of the SMEBCs are not in isolation as each one of them may directly or indirectly lead to another. For instance, financial constraints impact upon the firms in satisfying plant and equipment capacity (Egbu, 2000; Thwala and Phaladi, 2009).

Indeed, building the capacity of SMEs has become a concern of many developing countries including Ghana (Komu, Kikwasi and Thwala, 2012). This is at the wake of acknowledging that the capacity challenges of SMEBCs need to be addressed by the various stakeholders and governments collectively (Amoah, Ahadzie and Danso, 2011; Komu, Kikwasi and Thwala, 2012). In summary, the following have been identified by Donkor (2011), Kheni (2008), Eyiah (2003), Laryea (2010), Cook and Nixson (2000), Thwala and Phaladi (2009), Eyiah and Cook (2003) and Amoah, Ahadzie and Danso (2011), as the most significant factors that influences and in most cases, hinders the development of small scale contractors:

1. Suspension of projects of previous government,
2. Delayed payments/delay in collecting debts from new political heads,
3. Financial demands from political heads,
4. Non-payment of interest on delayed payments,
5. Assigning incompetent project leader at the site,
6. Lack of access to capital/problematic or limited access to finance,
7. Undervaluing of work done,
8. Change in government policies,
9. Low profit margin due to competition,
10. Frauds/pilfering,
11. Lack of material control systems,
12. Poor monitoring and control,
13. Poor estimation practices,
14. Awarding contracts to incompetent political party members,
15. Poor tendering/selection procedure/long laid down procurement procedures/competitive tendering,
16. High and unstable inflation,
17. Delayed payments and resource constraints,
18. High tendering costs,
19. Poor managerial skills,
20. Lack of training opportunities,
21. High cost of inputs,
22. Onerous contract conditions,
23. Lack of financial management,
24. Lack of entrepreneurial skills,
25. Lack of proper training,
26. Lack of resources,
27. Lack of technical skills,
28. Lack of contractual skills,
29. Fronting for established contractors,
30. Lack of credit facilities for firms,
31. Poor communication structures and
32. Unreliable material supply base.

RESEARCH METHODOLOGY

Employing both qualitative and quantitative methods, the empirical investigation was conducted using structured interviews and survey questionnaires. The interviews were conducted prior to the survey to elicit in-depth information about the factors affecting the capacity of SME building construction firms in Ghana. Using purposive sampling technique, 10 respondents were selected for the semi-structured

interview. The obtained data was analysed using qualitative data analyses software, Nvivo 8.0, which enabled the establishment of relevant constructs from the data. This led to the identification of the key areas that SMEBCs in Ghana and other factors which were not mentioned in literature. These factors were later evaluated using survey questionnaires. In designing the questionnaires, efforts were made to ask questions, considering the background of respondents in order to generate understanding and interest and also the analytical tool to be employed in the data analysis. The questionnaires were distributed to construction industry professionals (quantity surveyors, project managers and procurement managers) in Ghana working with public client organisations, consultancy firms and contractors (D2K2, D3K3 and D4K4). These respondents were asked to rank on a scale of 1 = "Least" to 5 = "Highest". The significance of the various factors that affect the (identified from both literature and the semi-structured interview) capacity of SMEBCs in Ghana. The distribution of questionnaires was done using snowball sampling technique, due to the difficulty in identifying the various respondents, particularly, active SMEBCs in the country. Thus, a total of 125 questionnaires were administered to various respondents. However, 80 questionnaires were retrieved and were useable for analysis purposes, representing 64% response rate. One sample t-test with a test value of 3.0 was used to ascertain, whether or not the mean rating of a given variable is significantly different from the hypothetical mean, $\mu = 3.0$ (Ayarkwa, Dansoh and Amoah, 2010). The factors that did not meet the test criterion were discarded whereas those that met the test criterion were considered for further analysis.

ANALYSIS AND RESULTS

As it has been stated earlier, the research used both semi-structured interviews and survey questionnaires to elicit information from the various respondents. The factors presented in Table 1 are the additional factors that were obtained from interviews that were conducted. These factors were compared to those that were earlier obtained from the literature survey to avoid repetition and to add onto the list of unique factors. The factors were subsequently presented in the questionnaire survey for evaluation by a larger respondent group. This was for the purposes of establishing the significant factors affecting the capacity of SMEBCs in Ghana.

Key Areas Which SMEBCs in Ghana Lack Capacity

Literature has revealed that the capacity of contractors in Ghana is generally low and this has been the reason why most major public contracts are awarded to the few foreign construction firms that are operating in the country (Ahiaga-Dagbui et al., 2011; Amoah, Ahadzie and Danso, 2011; Badu and Owusu-Manu, 2010; Fugar and Agyakwah-Baah, 2010; Laryea, 2010). This assertion is a general reflection of the situation among the various developing countries (Gyadu-Asiedu, 2009). Indeed, the capacity of building contractors in Ghana is lacking in several areas. In a response to the question of the areas in which SMEBCs in Ghana lack capacity, a respondent put it as "almost everything; they don't have plants…even the technical expertise they don't have…even their financial levels too…so I think they lack almost everything…".

According to the various interviewees, most of the contractors in the country, particularly those in the SME categories lack capacity in the areas of financial, technical, managerial and plants, and equipment levels. One of the interviewees asserted that the various areas that the contractors lack capacity are interrelated in that one may lead to another. This is consistent with an assertion revealed in literature (Egbu, 2000; Thwala and Phaladi, 2009). Figure 1 illustrates the various areas that SMEBCs in Ghana lack capacity as explained by the various respondents.

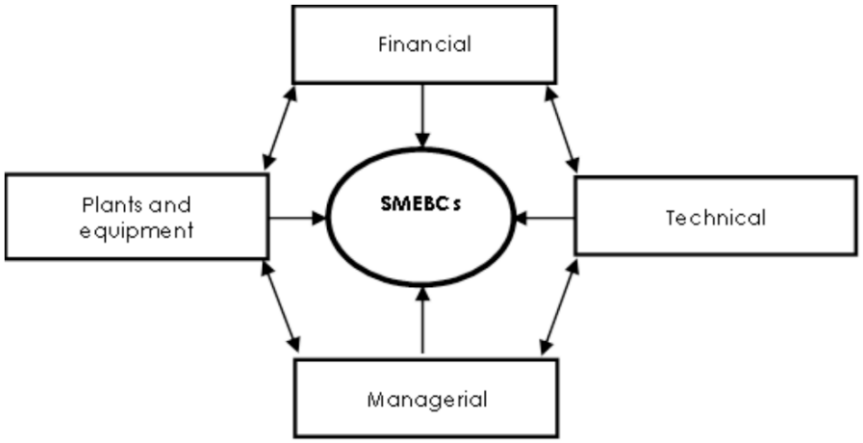


Figure 1. Key Areas that SMEBCs in Ghana Lack Capacity

As it has been explained, the various areas that SMEBCs lack capacity are interrelated. From Figure 1, the double arrows illustrate these interrelationships between the various areas. However, the single arrows show that all the four areas are lacking by SMEBCs. For instance, if a contractor is financially constrained, it will be difficult for him to purchase the requisite plant and equipment in order to execute his jobs effectively. The four areas (financial, managerial, plant and equipment and technical) have been ascertained as the key areas that SMEBCs lack capacity in Ghana and for these construction firms to continue to be relevant in the socio economic development of the nation, these areas need to be addressed. Indeed, for these capacities to be built, much effort is required from the contractors themselves and the state (that is, providing an enabling environment by putting certain policies and strategies in place).

In Table 1, the various factors which were obtained from the semi-structured interview that was conducted have been presented. These factors were added up to those factors which were obtained from the literature review for the design of the questionnaires which made it possible for broader opinions to be elicited from a larger number of respondents. The data that was obtained from the questionnaire survey has firstly analysed using mean score ranking (as shown in Table 2).

Table 1. Additional Factors obtained from Semi-Structured Interview s Respondents

No.	Factors Affecting the Capacity of SMEBCs in Ghana
1.	Structure of the companies
2.	Lack of fair competition
3.	Lack of understanding of the procurement processes
4.	Lack of mobilisation
5.	Lack of qualified personnel
6.	Non-business-like style of contractors
7.	Lack of continuous training
8.	Low return on operation
9.	Weak enforcement of rules and regulations
10.	Lack of support for training and development
11.	Poor networking within industry

Factors Affecting the Capacity of SMEBCS in Ghana

In this regard, five out of 27 factors, namely, poor communication structures (mean = 2.92), inadequate access to public contracts (mean = 2.90), structure of the companies (mean = 2.84), unreliable material supply base (mean = 2.78) and high tendering cost (mean = 2.72) were discarded. These factors were discarded because they did not meet the test criterion as stated earlier (i.e. their mean values were lower than the hypothetical mean, $\mu = 3.0$). Hence, 22 of the factors were considered for further analysis. Table 2 presents the mean score of the factors affecting the capacity of SMEBCs in Ghana.

Table 2. Mean score of the Factors Affecting the Capacity of SMEBCs in Ghana

No.	Factors Affecting the Capacity of SMEBCs	N	Mean	Std. Deviation	Rank
1.	Delay in payments for work done	80	3.94	1.083	1st
2.	Limited access to credit	80	3.90	1.051	2nd
3.	High and unstable inflation	80	3.68	1.016	3rd
4.	Non-payment of interest on delayed payments	80	3.61	1.248	4th
5.	Lack of fair competition	80	3.54	1.018	5th
6.	Poor project preparation	80	3.46	1.067	6th
7.	Change in government policies	80	3.45	1.005	7th
8.	Lack of contractual and managerial skills	80	3.44	0.898	8th
9.	Lack of training opportunities	80	3.42	0.925	9th
10.	Poor monitoring and control	80	3.41	0.910	10th
11.	High cost of construction inputs	80	3.40	0.866	11th
12	Lack of financial management skills	80	3.39	1.000	12th
13	Poor estimation practices	80	3.22	0.993	13th
14	Low returns on operations	80	3.19	0.943	14th
15	Lack of material control systems	80	3.18	0.897	15th
16	Inadequate supportive institutional arrangements	80	3.14	0.882	16th
17	Long laid down procurement procedures	80	3.12	0.905	17th
18	Lack of technical skills	80	3.11	1.043	18th
19	Non-business-like lifestyle of contractors	80	3.10	1.051	19th
20	Lack of entrepreneurial skills	80	3.05	0.926	20th
21	Weak enforcement of contract rules and regulations	80	3.01	1.097	21st
22	Complicated contract conditions	80	3.00	0.955	22nd
23	Poor communication structures	80	2.92	0.938	23rd

24	Inadequate access to public contracts	80	2.90	1.026	24th
25	Structure of the companies	80	2.84	1.049	25th
26	Unreliable material supply base	80	2.78	0.981	26th
27	High tendering costs	80	2.72	1.018	27th

Factor Analysis

In this section, the 22 factors affecting the capacity of SMEBCs that were retained in previous section were subjected to further analysis using Principal Component Analysis (PCA). This step made it possible, among other things, for the empirical relationships among the various variables to be statistically manipulated in order to reveal conjectural constructs of the relationships (Neumann and Kreuger, 2003; Field, 2005). Prior to the PCA, Kaiser-Meyer-Olkin (KMO) measure of sample adequacy, KMO test was conducted. The sample adequacy test is passed when the KMO test value is greater than 0.5 (Field, 2005). Consequently, the KMO measure of this study achieved a value of 0.727, indicating the adequacy of the sample for the factor analysis. Again, the Bartlett's test of sphericity was ascertained to be significant, indicating that the original correlation matrix was not an identity matrix, hence, there are some relationships between the variables that are intended to be included in the analysis (Field, 2005). Indeed, Bartlett's test is highly significant ($p < 0.001$) and therefore factor analysis is appropriate (Field, 2005; Ahadzie, 2007). Table 3 presents both the KMO and Bartlett/s test values.

Table 3. KMO and Bartlett/s Test: Factors Affecting the Capacity of SMEBCs

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.727
Bartlett/s Test of Sphericity	Approx. chi-square	670.569
	df	276
	Sig.	0.000

After establishing the sample adequacy of the data and whether or not there exist some relationships among the variables to be included in the analysis, PCA (with Varimax rotation) was conducted. In Table 5, the rotated component matrix indicates that 14 out of the original 22 variables could be the underlying themes of the four principal components (using a cut-off point of 0.50). It is to be noted that in an earlier rotation 2 out of the 22 variables vis-à-vis: poor project preparation and lack of material control systems loaded onto two factors which made the interpretation of the findings rather messy. Subsequently, these variables were deleted and the PCA re-ran. Thus, the findings presented in Table 5, on which the discussion is based, emerged after the second round of running the factor analysis. In the second round of the PCA, four principal components with eigenvalues greater than 1, in line with the latent root criterion on the number of principal components were extracted (Field, 2005; Ahadzie, 2007). The initial eigenvalues indicate that if all the factors are ranked, Principal Component 1 accounts for 22.228% of the variance, while Principal Component 2 accounts for 11.511% of the variance. In addition, Principal Components 3 and 4 account for 8.868% and 8.297% respectively. In all, the four identified principal components account for 50.905% of the total variance explained (as shown in Table 4).

Table 4. Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.446	22.228	22.228	4.446	22.228	22.228	3.365	16.825	16.825
2	2.302	11.511	33.740	2.302	11.511	33.740	2.545	12.725	29.549
3	1.774	8.868	42.608	1.774	8.868	42.608	2.207	11.036	40.585
4	1.659	8.297	50.905	1.659	8.297	50.905	2.064	10.320	50.905

Note: Extraction method: PCA

DISCUSSION

Based on the PCA and critical examination of inherent relationships among the various factors identified, the various components were named (Table 5). The names of principal components were formed based on the factors with the highest loadings and the understanding of the relevance of these factors in the context of the study.

Table 5. Rotated Component Matrix

Factors Affecting the Capacity of SMEBCs	Component			
	Technical and Managerial Related Factors	Procurement Related Factors	Financial Related Factors	Project Related Factors
Lack of entrepreneurial skills	0.695			
Lack of technical skills	0.678			
Lack of contractual and managerial skills	0.665			
Lack of financial management skills	0.663			
Inadequate supportive institutional arrangements	0.580			
Lack of training opportunities	0.561			
Weak enforcement of contract rules and regulations		0.747		
Non-payment of interest on delayed payments		0.654		
Lack of fair competition		0.568		
Limited access to credit			0.802	
High cost of construction inputs			0.763	
Delay in payments for work done			0.635	
Poor estimation practices				0.780
Poor monitoring and control				0.736

Notes: Extraction method: PCA; Rotation method: Varimax with Kaiser normalisation; a. Rotation converged in six iterations.

The various principal components with their respective factor loadings (indicated in brackets) have been presented and discussed as following:

Principal Component 1: Technical and Managerial Related Factors Six factors loaded were onto Principal Component 1. These are lack of entrepreneurial skills (0.695), lack of technical skills (0.678), lack of contractual and managerial skills (0.665), lack of financial management skills (0.663), inadequate supportive institutional arrangements (0.580) and lack of training opportunities (0.561) (as shown in Table 5). The underlying themes that were loaded onto this principal component are mainly related to technical and managerial factors. Literature has revealed that most of the SMEBCs operate a personalised style of management without due regard to effective modern management practices and recruitment methods (Amoah, Ahadzie and Danso, 2011). This may cause them to recruit personnel who do not have the requisite technical and managerial skills. More so, the findings have revealed that there are inadequate supportive institutional arrangements and this has accounted for the low capacity of the indigenous construction firms, particularly SMEBCs. For this reason, lots of researchers and some contractors have called for the formation of an agency that will help address issues pertaining to the development of the Ghanaian construction industry (Ahadzie, 2009; Gyadu-Asiedu, 2009).

Principal Component 2: Procurement Related Factors

The following factors loaded onto this principal component: weak enforcement of contract rules and regulations (0.747), non-payment of interest on delayed payments (0.654) and lack of fair competition (0.568) (as shown in Table 5). The various factors loaded onto this principal component go to affirm the discrepancies in the Ghanaian public procurement that affect the capacity of contractors observed from literature (Anvuur, Kumaraswamy and Male, 2006; Laryea, 2010; Donkor, 2011; Kheni, 2008). The literature review and semi-structured interview suggest that there is lack of fair competition, for instance in the award of contracts, where contracts are awarded to contractors who have political affiliations and not on meritorious grounds (Donkor, 2011). Indeed, one of the interviewees decried how pretentious the Ghanaian public procurement is, where rules are only pretended to be followed. These lapses go a long way to pollute the business environment within which these SMEBCs operate and hence, stifle their development.

Principal Component 3: Financial Related Factors

The following factors emerged: limited access to credit (0.802), high cost of construction inputs (0.763) and delay in payment for work done (0.635) (as shown in Table 5). The various factors loaded on this component go directly or indirectly to affect the financial capacity of SMEBCs in Ghana. This tends to corroborate the assertion that finance is a constraining factor to contractor development (Cook and Nixson, 2000). Limited access to credit for instance, has been identified as a major factor that affect the financial capacity of SMEBCs as most of these contractors face a raft of challenges in accessing credits from banks (Cook and Nixson, 2000; Badu and Owusu-Manu, 2010). The situation gets exacerbated when contractors capital gets eroded by delays in payment for work done, which has characterised most government projects (Eyiah, 2003). Indeed, one of the interviewees asserted "contractor capacity has been drastically eroded due to delay in payment of work done. Indeed, in some instances, it can take three to four years before a contractor is paid for work done". This goes in line with literature where delay in payment for work done has been identified as a factor that affects the capacity of contractors in Ghana and other parts of Africa (Amoah, Ahadzie and Danso, 2011; Laryea, 2010; Ofori, 2000; Bakar et al., 2012).

Principal Component 4: Project Related Factors

The following factors emerged: poor estimation practices (0.780) and poor monitoring and control (0.736) (as shown in Table 5). According to Donkor (2011), these factors contribute to the failure of SME

BCs and how they monitor the resources available to them. It has been revealed in research that small firms do not put into considerations the controlling of equipment cost and usage and employee's benefits and compensations which go a long way to affect their capacity (Donkor, 2011).

CONCLUSION

Capacity of SME building construction firms in developing countries remains imperative especially as these SMEs serve as economic backbone worldwide. In addition, it has been touted that SMEs in developing countries are the engine for growth for various economic transformation. Thus, the current study revealed significant factors that affect the capacity of SME building construction firms in Ghana. These are broadly clustered as technical and managerial factors, procurement related factors, financial related factors and project related factors. Furthermore, conscious efforts should be made by government to address the issues that have been raised in this paper, to facilitate building of capacity of the SME construction firms in the country. It is recommended that further studies should be carried on by ascertaining the impacts of the various factors that affect the capacity of the SME building construction firms. In addition, strategies for building the capacities of these SME building construction firms in Ghana can be researched into. Lastly, policy makers should increase the capacity of SMEBCs in Ghana through continuing professional development for the various professionals working under the various infrastructures oriented ministries.

REFERENCES

Agyepong, A.S. (2012). Are contractor classifications in Ghana accurate? The Quantity Surveyor: An Official Magazine of the Quantity Surveying Division of the Ghana Institution of Surveyors, No. 1.

Ahadzie, D.K. (2009). Ghanaweb. Available at: http://www.ghanaweb.com/GhanaHomePage/NewsArchive/artikel.php?ID=170462 [Accessed 10 February 2014].

———. (2007). A model for predicting the performance of project managers at the construction phase of the mass house building projects. PhD diss. University of Wolverhampton.

Ahiaga-Dagbui, D.D., Fugar, F.D.K., McCarter, J.W. and Adinyira, E. (2011). Potential risks to international joint ventures in developing economies: The Ghanaian construction industry experience. In B.O. Uwakweh (ed.), Proceedings of the CIB W107 Conference on Innovation and Sustainable Construction in Developing Countries. Hanoi: Construction Publishing House.

Amoah, P., Ahadzie, D.K. and Danso, A. (2011). The factors affecting construction performance in Ghana: The perspective of small-scale building contractors. The Ghana Surveyor, 4(1): 41–48.

Ampadu-Asiamah, A.D. and Ampadu-Asiamah, O.K. (2013). Management of government funded construction projects in Ghana: Stakeholders' perspective of causes of delays in construction of public buildings. Developing Country Studies, 3(12): 149–156.

Anaman, K.A. and Osei-Amponsah, C. (2007). Analysis of the causality links between the growth of the construction industry and the growth of the macro-economy in Ghana. Construction Management and Economics, 25(9): 951–961. https://doi.org/10.1080/01446190701411208.

Anvuur, A., Kumaraswamy, M. and Male, S. (2006). Taking forward public procurement reforms in Ghana. Paper presented at the International Council for Research and Innovation in Building and Construction (CIB) W107 Construction in Developing Countries International Symposium Construction in Developing Economies: New Issues and Challenges . Santiago, Chile, 18–20 January.

Ayarkwa, J., Dansoh, A. and Amoah, P. (2010). Barriers to implementation of EMS in construction industry in Ghana. International Journal of Engineering Science, 2(4): 37–45.

Badu, E. and Owusu-Manu, D. (2010). Improving access to construction finance in Ghana. The Journal of Business and Enterprise Development, School of Business, 2: 111–128.

Badu, E., Edwards, D.J. and Owusu-Manu, D. (2012). Trade credit and supply chain delivery in the Ghanaian construction industry: Analysis of vendor interactions with small to medium enterprises. Journal of Engineering, Design and Technology, 10(3): 360–379. https://doi.org/10.1108/17260531211274729.

Bakar, A.H.A., Tabassi, A.A., Razak, A.A. and Yusof, M.N. (2012). Key factors contributing to growth of construction companies: A Malaysian experience. World Applied Sciences Journal, 19(9): 1295–1304.

Cook, P. and Nixson, F. (2000). Finance and Small and Medium-Sized Enterprise Development. Manchester: Institute for Development Policy and Management, University of Manchester.

Danso, F.O. (2010). Occupational health and safety issues involving casual workers on building construction sites in Ghana, a Kumasi study. MSc diss. Kwame Nkrumah University of Science and Technology (KNUST).

Donkor, S. (2011). Determinants of business failure: The perspective of SME building contractors in Ghanaian construction industry. MSc diss. Kwame Nkrumah University of Science and Technology (KNUST).

Egbu, C.O. (2000). Knowledge management in construction SMEs: Coping with the issues of structure. In A. Akintoye (ed.), Proceedings of the 16th Annual ARCOM Conference. Belfast: Association of Researchers in Construction Management (ARCOM).

Enemark, S. (2003). Understanding the concept of capacity building and the nature of land administration systems. Paper presented at the International Federation of Surveyors (FIG) Working Week. Paris, 13–17 April.

Eyiah, A.K. (2003). Construction bank in a developing country: The way forward. In D.J. Greenwood (ed.), Proceedings of the 19th Annual ARCOM Conference. Belfast: Association of Researchers in Construction Management (ARCOM), 329–335.

Eyiah, A.K and Cook, P. (2003). Financing small and medium scale contractors in developing countries: A Ghana case. Construction Management and Economics, 21(4): 357–367. https://doi.org/10.1080/0144619032000111241.

Field, A. (2005). Discovering Statistics Using SPSS. 2nd Ed. London: Sage Publications.

Fugar, F.D. and Agyakwah-Baah, A.B. (2010). Delays in building construction projects in Ghana. Australasian Journal of Construction Economics and Building, 10(1/2): 103–116. https://doi.org/10.5130/ajceb.v10i1-2.1592.

Govender, J.N. and Watermeyer, R.B. (2000). Potential Procurement Strategies for Construction Industry Development in the SADC Region: Procurement Strategies in SADC Region. Pretoria: Department of Public Works.

Gyadu-Asiedu, W. (2009). Assessing construction project performance in Ghana: Modelling practitioners/and clients/perspectives. PhD diss. Technology University of Eindhoven.

Kheni, N.A. (2008). Impact of health and safety management on safety performance of small and medium-sized construction businesses in Ghana. PhD diss. Loughborough University.

Komu, N.S., Kikwasi, G.J. and Thwala, W.D. (2012). Assessment of management contracting procurement system towards enhancing capacity building for small and medium contractors in Tanzania. In G. Nani, R.K. Nkum, E. Awere, E. Kissi and E. Bamfo-Agyei (eds.), Proceedings of the 1st Applied Research Conference in Africa (ARCA) Conference. Elmina, Ghana: ARCA.

Kululanga, G. (2012). Capacity building of construction industries in Sub Saharan developing countries: A case for Malawi. Engineering, Construction and Architectural Management, 19(1): 86–100. https://doi.org/10.1108/09699981211192580.

Laryea, S. (2010). Challenges and opportunities facing contractors in Ghana. In S. Laryea, R. Leiringer and W. Hughes (eds.), Proceedings of the West Africa Built Environment Research (WABER)

Conference. Reading, UK: WABER, 215–226.
Morgan, P. (2006). The Concept of Capacity. Maastricht, The Netherlands: European Centre for Development Policy Management, 1–19.
Neumann, W.L. and Kreuger, L.W. (2003). Social Work Research Methods: Qualitative and Quantitative Applications. Boston: Allyn and Bacon.
Ofori, G. (2012). Developing the Construction Industry in Ghana: The Case for a Central Agency. Singapore: Singapore University Press.
———. (2000). Challenges of construction industries in developing countries: Lessons from various countries. In 2nd International Conference on Construction in Developing Countries: Challenges Facing the Construction Industry in Developing Countries. Delft, The Netherlands: International Council for Research and Innovation in Building and Construction (CIB), 15–17.
Thwala, W.D. and Phaladi, M.J. (2009). An exploratory study of problems facing emerging contractors in the North West province of South Africa. Proceedings:
The Fourth Built Environment Conference. Bellville, South Africa: Association of Schools of Construction of Southern Africa (ASOCSA).
United Nations Educational, Scientific and Cultural Organization (UNESCO) (2006). Capacity building. In Guide Book for Planning Education in Emergencies and Reconstruction. Paris: International Institute for Educational Planning, 1–10.
van Egmond, E. and Erkelens, P. (2007). Technology and knowledge transfer for capability building in the Ghanaian construction industry. In CIB World Building Congress. Delft, The Netherlands: CIB, 1393–1405

The Application of Open Building Principles in Popular Residential Buildings in Iran

***Mohaddeseh Khosravi, *Leila Mirsaeedie and Ali Emami**

ABSTRACT

Recently large numbers of housing units have been built in Iran; however, the lack of compliance with the changing needs of different users is regarded as the main problem. The "open building" approach allows the units to be tailored to the needs and lifestyles of the users, which are flexible and adaptable. The present study aimed to investigate the possibility of using the open building approach in popular residential complexes in Gonad-e-Kavoos in north of Iran. In this study, by using the descriptive method, 40 popular residential plans were evaluated by inviting 20 designers and developers based on semi-structured interviews were examined. Based on the results, in the field of structures and facilities, there are a few limitations on the application of open building, but there are many problems related to the open unit internal separators during the process of designing and implementation. In this regard, some suggestions were recommended for these separators based on the current situation. Further, there are many capabilities and limitations in the popular designs by which design suggestions were suggested such as location and suitable proximity to fixed and open building spaces, optimal design and spatial organisation, which makes it possible to benefit from open buildings by using these items by designers.

Keywords: Open building, Mass construction, Design and building, Residential building, Iran

INTRODUCTION

Statement of Problem

Traditional housing was designed and implemented in such a way that it can adapt to the changing needs of residents and the architect and the beneficiary had a common language in the past in Iran. In traditional Iranian homes, spaces were multifunctional and their names were not determined based on the space usage. The spaces of these houses were very flexible. However, in the last century, it was necessary to build many residential complexes with increasing demand for housing, which in most cases, it was not possible to know the future residents. Contemporary housing, in most cases, is unable to meet the needs of different families as well as the changing needs of a family, unlike traditional homes. This issue, along with the high economic importance of housing as a capital asset, has caused many problems for Iranian families like social and economic problems leading to the family movement in some circumstances. Therefore, using the methods for increasing flexibility such as "open building" approach will have many benefits for residents and the community, and can increase social sustainability, reduce economic and social costs and constantly shift housing, increase the ownership and identity of the residential spaces.

The study area is the Gonbad-e-Kavoos city located in Golestan province in north of Iran and its popular residential buildings are similar to many urban areas in Iran. In this area, the ethnic diversity and lifestyle, migration from villages to cities, the formation of colonial regions around cities and adjacent villages, the formation of small towns which were previously villages, the transformation of rural housing and rural imagery, the existence of large families with regard to culture and traditions, making a lot of changes in housing, fluctuations in the housing market, the diversity of demand and customer

demands are regarded as some characteristics of the current situation which can justify the use of open building. The present study aimed to evaluate the possibility of using open building approach based on the contexts and adapting their related properties. Finally, suggestions are presented in the areas of design and construction in this regard.

OPEN BUILDING APPROACH

"The open building theory was first presented by Nicholas John Habraken, as a Dutch architect, in which the building is divided into supports and infill. The supports usually include skeleton and installation channels while infill or movable elements usually encompass the walls of the internal separator which are available to the house residents" (Mirmoghtadaei, Talebi and Ershad, 2007).
In another definition, the open building is the proposition of an architect who can detect a variable from a permanent one (Setien, 2015). Habraken, in his book Diversity in Housing, mentioned three following key issues in housing as a design problem in the 21st century (Habraken, 1987):

1. The house should be diverse.
2. The house should adopt changes.
3. The house should contribute to the decision making process for the user.

A lot of research has been conducted about open building approach and many residential complexes have been built around based on this approach (refer Table 1). Adopting the principles related to open building in mass housing design is not regarded as new phenomenon. Habraken suggested this approach to mass housing design by categorising the built environment into a number of levels. Based on the hierarchical levels, any given or fixed elements are called "support" and any element the user/designer is free to add in or change is known as "infill" (Kendall, 1987; Wong, 2010).
Recently, a large number of projects have been conducted based on residential open buildings, which are expanding worldwide. In some European countries, real estate companies have started developing open building projects, due to local government incentives and competitions, as well as satisfying the market. Among these countries, we can refer to Finland, Switzerland, the Netherlands (Kendall, 2015a) and Russia (Kendall and Kiseleva, 2013).
Regarding the use of open buildings in Asia, Japan and Korea are regarded as the pioneers for constructing open building projects called "Skeleton/Infill in Japan". Some pioneering architects like Yositika Utida at Tokyo University and Professor Kazuo Tatsumi at Kyoto University in Japan directed some architects and researchers working in private offices, universities and government agencies to play a significant role in constructing open building in Japan. In 1994, the next NEXT 21 project funded by Osaka Gas started to build open building, new energy systems, as well as building technology (Kendall, 2015a).
Like Japan, the use of open building is very popular in South Korea although they implemented more simple construction systems. According to Mirmoghtadaei et al. (2007), a large number of residential complexes have been constructed by adopting this approach by public sector. Some pioneering architects and academics have developed open building in China since 1980. Recently, the China Institute of Building Standard Design and Research has initiated cooperating with local developers and product manufacturers in order to promote open building. In this regard, as Kendall (2015a) emphasised, a large number of "skeleton/infill" projects have been built in Beijing and Shanghai by considering Japanese experiences in some cases while some were planned by Chinese architects.
Nowadays, some developing countries have focused on developing the principles related to open building. The documents for ground breaking documentation related to additional housing processes has been performed in Mexico, India, South Africa and some other places. In addition, some pioneering projects have been conducted in Mexico and Chile (Kendall, 2015a).
Mirmoghtadaei, Talebi and Ershad (2007) presented the some recommendations for implementing open

building in Iran. Due to mass housing development in Iran, open building approach include many potentials to pursue quality and flexibility, especially because of housing problems and needs.

Table 1. A Number of Related Studies

Book or Article	Authors	Year	Scope
Reflections on the history and future of the open building network	Kendall	2015a	Examining the goals of open building, design methods, the study of open building in Asia and Europe and the future of the open building.
Developments in the residential open building: Analysis and reflections on two seminal case studies	Setien	2015	The study of the main elements of open building and case studies.
Diversity in Housing	Habraken	1988	The introduction of open building, the principles of design, existing samples in the world and complete investigation by the founder of open building.
The introduction of open building principles of the residential complexes for use in mass construction projects in Iran	Mirmoghtadaei, Talebi and Ershad	2007	Introducing open building, design principles, existing samples in the world and …
Open building concepts, open building implementation	Kendall	2015b	Explaining open building paradigms.
Open building manufacturing: Core concepts and industrial requirements	Kazi et al.	2007	In 16 chapters, they have fully examined all the fields of open building.
Built designs: Some case studies in residential open building	Kendall	2014	Examining case studies of open building in a comprehensive manner.
Notes on "Open Systems" in building technology	Kendall	1987	Open building systems.
Towards adaptable buildings: Pre-configuration and re-configuration; Two case studies	Gibb et al.	2007	Case studies of flexible buildings.
An open building strategy for achieving dwelling unit autonomy in multi-unit housing	Kendall	2004	Methods for open building application.
Open building: An approach to sustainable architecture	Kendall	1999	The relationship between open building and sustainable architecture.

Space puzzle in a concrete box: Finding design competence that generates the modern apartment houses in Seoul	Seo	2007	Modern methods for flexible design.
Factors affecting open building implementation in high density mass construction design in Hong Kong	Wong	2010	Suggestions for the application of open building in tall buildings.
The efforts to develop longer life housing with adaptability in Japan	Minami	2016	Suggestions for the application of open building.
Report on Free Plan Apartments in Moscow	Kendall and Kiseleva	2013	Case studies of open buildings.

THE APPLICATION OF OPEN BUILDING IN IRAN

The needs and necessities of the application of open building: The effect of the open building approach has not been considerable in designing the architecture of residential complexes in Iran. The application of this approach to design in Iran requires attention to the social, cultural, legal and technical characteristics of this country (Mirmoghtadaei, Talebi and Ershad, 2007). Making future changes in the building by the residents themselves and restoring the resilience of the past Iranian housing through designing residential complexes based on this approach are regarded as the most important features of designing with open building approach. The open building should achieve flexibility through technical principles and changing the interior space, which results in enhancing the need for shifting and modifying the residence.

In order to investigate the feasibility of this theory, it is necessary to examine a set of influential factors affecting the application of open building. These variables are expressed in terms of the following conceptual model (as shown in Figure 1). It should be noted that the design and construction topic which is the main topic of the present research, has been discussed in detail in this study. Other factors are briefly reviewed.

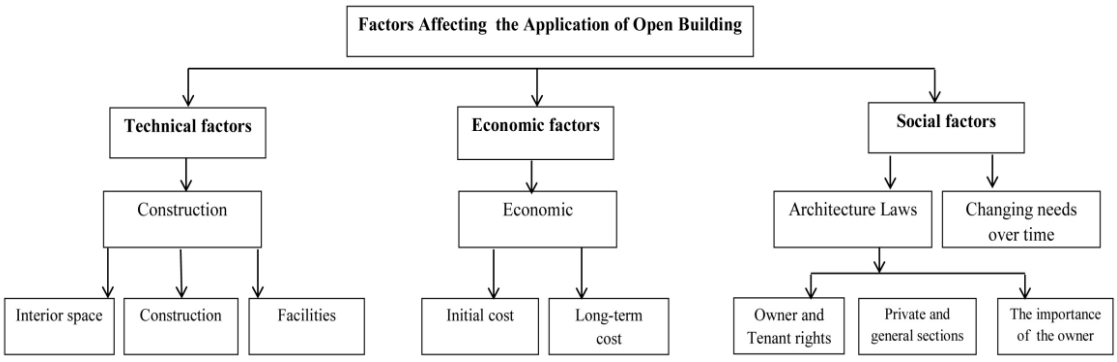


Figure1. Influential Factors Affecting the Application of Open Building

Social Factors

Social factors are one of the most important and influential factors in this approach. These categories have different aspects as follows:

1. Rights and laws of architecture in Iran: Legal issues are among the factors which play a great impact

on the application of this theory in Iran. Therefore, those laws which are relevant to making changes in residential units by current and future residents should be considered. For this purpose, public and private sectors of the apartment should be identified and reviewed. After reviewing the laws, it was evident that in some cases, there would be legal problems for using open building. Thus, the suggestions should be addressed and implemented inevitably in the area outside these cases (Mirmoghtadaei, Talebi and Ershad, 2007). Table 2 indicates a number of important issues in this area.

2. The changing needs of the family over time: Changing the pattern of life and the structure of families lead to a change in people's need for residential spaces. Housing and residence always follow the economic, social, cultural and climatic conditions of each region. Thus, the yesterday's house of a family is no longer suitable for tomorrow. The change in the basic family from the time of the formation to the end of the life of the couples is regarded as one of the factors which should be considered during the feasibility study of using open building. In general, it is possible to estimate the changing spatial needs of family members, which should be considered during the design process (Mirmoghtadaei, Talebi and Ershad, 2007).

Table 2. Legal Restrictions in the Application of Open Building in Iran

Limitations of Making Plan in Iran	Explanations
The owner's and tenant's rights	According to the Clause 493 of the Civil Rights, the tenant cannot change the design of his residential home without the consent of the landlord.
Common wall of the apartment	The flexibility of the design should be related to the internal area and cannot include the common walls of the apartment.
Building facade	The wall of the building facade is a part of the common parts and its changing requires a majority agreement of the owners.

Source: Mirmoghtadaei, Talebi and Ershad (2007) and Taqilou (2005)

Economic Factors

The reduction of potential costs is regarded as one of the main advantages of open building. In order to assess the economic value of open building projects, the following factors should be considered:

1. Initial cost: The initial cost of the building depends on its flexibility degree. The greater capacity of the plan for creating diversity leads to more costs. However, the capability of the plan to meet the diverse needs justifies an increase in the cost of construction. Such a building should be more durable and be able to meet the residential needs of several generations. Similarly, a building with a smaller diversity capacity would be simpler and less costly (Mirmoghtadaei, Talebi and Ershad, 2007).

2. Long-term cost: Open building may increase the initial costs to some extent based on the flexibility level, but will have considerable benefits over the long term. The residing families in this building can change the internal division of the residential space with respect to the changing needs of their own over the time and at different stages of their growth and expansion. Furthermore, since the electrical and mechanical installations of the building cross from certain areas, changing the layout of the internal separator walls becomes less expensive and takes less time, compared to conventional buildings (Mirmoghtadaei, Talebi and Ershad, 2007).

Technical Factors (Design and Construction)

Technical factors, as one of the major issues in the open building include the structural framework, facilities and internal separators. The open building approach is implemented with these parts in the

building. The support consists of structures such as building structural elements and façade and the related facilities while the infill is concerned with the changeable items such as portable elements and interior partitions. Their details and implementation are very effective in applying this approach.

OBJECTIVE AND METHOD

The present study aimed to investigate the feasibility of using open building approach in the housing of the study area. For this purpose, the technical factors affecting open building were examined as the main variable of the study. Technical factors were studied based on construction and implementation, as well as design factors. The main research questions are as follows:

1. To what extent, is it possible to use the open building approach with respect to materials and methods of construction in the area under study?
2. To what extent, is it possible to use open building according to the existing design?

The descriptive method was used in this study. Initially, library method and the study of documents and articles were used to recognise the theory of open building. Then, the factors affecting the application of this approach were studied and summarised in a descriptive manner in Iran. It was necessary to find out the current status of existing residential buildings in the study area (Gonbad-e Kavoos city), due to technical and designing factors. Therefore, a number of residential buildings with a popular type in the region were randomly selected and their plans were reviewed and analysed. Forty buildings, including four-storeyed urban apartments built on a pilot and one to three residential units on each floor. In the next stage, the results were obtained in technical scope by performing a half-structured interview with 20 architects and construction engineers in the region. Table 3 presents the questions discussed in the interview.

Table 3. Interview Questions

Questions	
Structure	What structure is the most commonly used structure in residential buildings in the region? What new methods are used in the building structures?
Internal space	Are prefabricated products and partitions used in the interior space? How much prefabricated products are used in the interior space and which products are used more?
Facilities	What type of facility is used in residential buildings? Which new methods are applied in residential buildings?

FINDINGS AND RESULTS

Findings of the Interviews (Construction Area)

According to the socio-economic report of Golestan province in 2011, the most construction systems used in this province were skeletal systems with metal or concrete skeleton. Based on the field study, it was observed that the most kind of materials were concrete materials and using clay blocks for walls and ceilings of the block joist with polystyrene sheets were common in these areas. Further, the stone materials, brick and clay compositions, as well as the shotcrete and cement are the most used materials in the facade materials. In recent years, new systems and materials such as three-dimensional panel walls have been widely used. Thus, in the region, the needed background for the use of modern methods such as the machinery, manpower, access to materials and the like is desirable (naturally at a higher cost)

similar to that of the many other urban areas of the country. According to the study conducted in the Modern Building Technologies in the field of open units such as separators, a wide variety of separators is usable and suitable for construction (Eram and Mirsaeedie, 2016; Building, Housing and Road Research Center, 2009). Table 4 illustrates all kinds of non-load bearing wall systems approved by the Ministry of Road and Urban Development. These systems were provided for many companies in Iran and are available in most parts of the country.

The following results were obtained based on the interviews conducted on the construction and implementation in the three areas:

1. Structure: Based on the results of the interviews and observations, the concrete and metal skeleton structures are used abundantly, although the concrete skeleton structure such as post, beam and cast is more widely used in residential usage in the region.
2. Interior space: Prefabricated productions market and its use in the field of interior separators in the region are not very active and these systems are used less in the design and implementation. Gypsum panels and other prefabricated production separators are available on the market, but rarely used and mostly used in false ceilings.
3. Facilities: In the study area, the use of vertical ducts is common and necessary. Some contractors use large-size dimension ducts which are able to travel within. It is noteworthy that using false ceilings for the passage of facilities pipes is also common and is used in many construction projects of false ceilings as a horizontal area for the distribution of ducts, pipes and other elements. Thus, there is no limitation in this field according to the applied procedures in the facility.

Table 4. Types of Non-Load Bearing Walls Approved in Iran

	Main Group	Secondary Group
Types of Non-Load Bearing Walls	Base material: AAC lightweight concrete	The constructed walls from wall blocks made by gaseous concrete. Reinforced wall panels made of AAC lightweight concrete.
	The non-load bearing walls constructed from AAC lightweight concrete.	
	Three-dimensional (3D) sandwich non-load bearing walls.	Semi-prefabricated non-load bearing walls, 3D sandwich sheets.
		BBLOCK (a block consisting of polystyrene and two layers of steel mesh around) interior non-load bearing walls.
		Metal foam non-load bearing walls.
	LFS prefabricated lightweight non-load bearing walls	
	Wall panels constructed from lightweight concrete with LECA aggregate.	
	Fibre panels	Concrete fibre panel.
		Panels made of straw and concrete (straw-concrete).
		Wall panels made of resin, wheat stem and rice.
	Base material: Lightweight concrete with polystyrene aggregates.	QPANEL (a panel consisting of light weight concrete foam and two layers of fibre cement around) non-load bearing walls.

Base material: Lightweight concrete with polystyrene aggregates.	QPANEL (a panel consisting of light weight concrete foam and two layers of fibre cement around) non-load bearing walls.
	ERCOLITH (a panel from porous lightweight concrete foam) non-load bearing wall panels.
Base material: Perlite lightweight aggregates.	Using perlite in building applications in order to light weighting and insulating.
	Rail-Wall prefabricated panels from perlite concrete type.

Note: AAC – Autoclaved Aerated Concrete block; LECA – Light Expanded Clay Aggregate blocks.

RESULTS AND RECOMMENDATIONS IN CONSTRUCTION AREA

1. Structure: In the area of structures, after checking the approved and licensed structural systems and the adaptation of the characteristics of open building with different structures, it was observed that there is a little structural constraint in the area of open building. However, many of the new structures have a limited use in the area, but the dominant structure is based on the adaptation, economic power and availability of a concrete structure which does not constrain the open building. To the way of adapting the structure to the design is important which is presented in the design section.

2. Facilities: The separation of facilities from other parts of the building is regarded as one of the major achievements of the open building. Thus, the repair and replacement of pipes will be easily feasible, in addition to the possibility of change and flexibility of the design. In popular Iranian buildings, the pipes are buried on the building floor and walls and since their life is less than the life of the building, they usually need to be replaced several times during the useful life of the building. In particular, in populated residential complexes, it is necessary to adopt specific policies for the deployment of facilities systems (Mirmoghtadaei, Talebi and Ershad, 2007). Recently, accessible vertical and horizontal channels are utilised for mechanical and electrical installations, by which the use open building is provided through increasing their use.

3. Walls and internal separators: The interior space of the building is regarded as the most important factor in open building, which should be made of prefabricated elements and elements that can be modified. In addition the variability should be provided easily and at an affordable cost for the residents. The products which require wet materials, making the work harder for residents, but gypsum panels and dry walls and movable separators are more suitable because of less complexity in construction. In general, the internal separators which are constructed through a dry construction can be used to replace the walls of the building. Table 5 demonstrates the types of walls, along with the type of their proposed materials.

Table 5. The Proposed Materials of Walls Based on the Obtained Results

Type of Building Wall	Proposed Materials
Interior separator wall	Dry construction, prefabricated movable separators and gypsum panels.
Fixed building walls	Common materials (bricks, types of blocks), types of prefabricated panels complying with the requirements.
The separating wall of units	Common materials (bricks, types of blocks), types of prefabricated panels complying with the requirements.

A slight limitation is available in the area of fixed building (structural framework and facilities) in order to promote the open building in the region. However, with respect to open units (separators, etc.); it is required to promote the use of prefabricated products such as separators and its types. This can be encouraged by the government and related institutions as part of a program to support the expansion of industrialisation of the building. Further, the development of the application of these systems provides a suitable working environment for manufacturers and operators of these systems, which can promote the building industry.

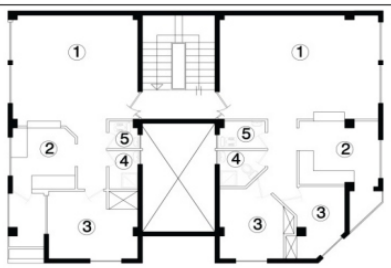
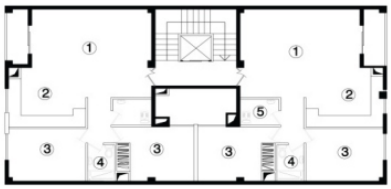
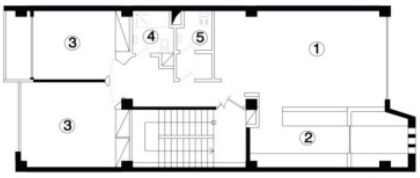
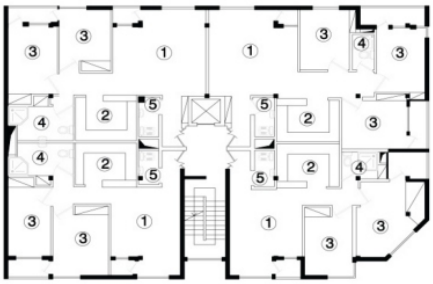
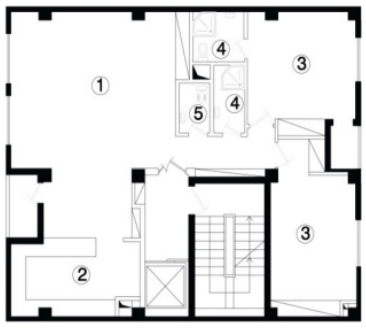
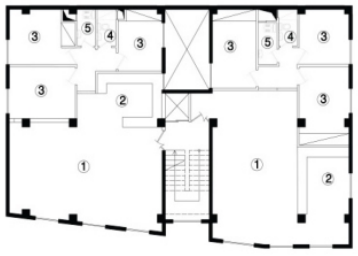
FINDINGS OF THE SAMPLE STUDY (DESIGN AREA)

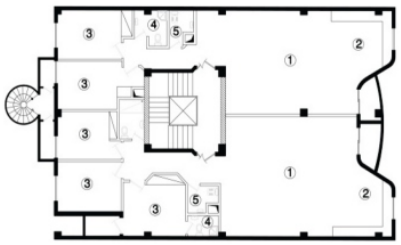
In 2007, a study was conducted on the degree of individuals' satisfaction from their home plans and their willingness to interfere in the design. The research indicated the need of residents for changes in parallel with time and the reasons for dissatisfaction with the considered space (Mirmoghtadaei, Talebi and Ershad, 2007). Based on the results, the residents tended to change spaces such as living room and dining room, kitchen and bedroom. The most important reasons for dissatisfaction with the kitchen design were its small size. Changing the kitchen mainly involves opening the wall and removing the door. Further, as higher number of rooms in the residential unit leads to more satisfaction for residents. The possibility of increasing the number of rooms, as well as integrating or separating the rooms, are among other cases which residents have demanded for more satisfaction. Furthermore, the possibility of enlarging the living and dining space was highly considered (Mirmoghtadaei, Talebi and Ershad, 2007). The possibility of integrating or separating the residential unit was regarded as another important item, which can be appropriate for the user (family of the resident) as well as the builders and sellers. The family can separate or integrate the house based on the need and over the time. As a result, the builders and vendors can also segment or integrate the building by spending less time and less cost, based on the housing market and the demand for large or small units. Any factor such as parking supply should be predicted in this regard. On the other hand, the flexibility and diversity of plans can create a variety of plans and units in a building which effectively prevents the uniformity and lack of diversity of residential units, due to the repetition of the plan in the floors, which will create better conditions for both housing buyers and sellers.

It is worth noting that wet areas such as sink, bath and at least a part of the kitchen in Iran are considered as fixed building elements and it is not possible to move or change them, due to the use of facilities and other items (Mirmoghtadaei, Talebi and Ershad, 2007).

In the present study, the popular residential buildings made by private builders were taken into consideration. These buildings usually include three or four floors on the ground and each floor has one to three residential units. In addition, the areas for each unit ranges from 70–150 sq. m. Forty residential complexes were randomly selected in the study area and their plans were modified in terms of their variability. Table 6 indicates the analysis conducted for a number of plans. By reviewing and analysing the plans, it was found that the limited patio directions, the distribution of service spaces in the plan, the inappropriate placement of public-use area and inputs and the limiting geometry of the plan were considered as the common problems in designing area. On the other hand, the possibility of increasing the living area and kitchen, the possibility of increasing and reducing the room area and the possibility of integrating the rooms were regarded as some facilities which are available in designing many units. Table 6 presents a number of the studied samples

Table 6. The Study and Analysis of Some Plan Samples

	Plan Sample	Features	Limitations	Area
1.		1. The possibility of changing 2. The dimensions of living room and kitchen	1. The impossibility of changing the size and number of rooms 2. The impossibility of integration of units	The right-hand side unit: 75 m²; The left-hand side unit: 63 m²
2.		The possibility of changing the dimensions of living room and kitchen	1. The impossibility of changing the size and number of rooms 2. The problems in integrating units	Each unit: 85 m²
3.		1. The possibility of changing the dimensions of living room and kitchen 2. The possibility of limited changing in room dimensions 3. The possibility of room integration	The impossibility of increasing the number of rooms	Around 105 m²
4.		1. The possibility of changing the dimensions of living room and kitchen 2. The possibility of limited changing in room dimensions 3. The possibility of room integration 4. The possibility of increasing the number of room and unit integration		Each unit: 120 m²
5.		1. The possibility of changing the dimensions of living room and kitchen 2. The possibility of changing in room dimensions 3. The possibility of room integration 4. The possibility of increasing the number of rooms		Around 150 m²
6.		1. The possibility of room integration 2. The possibility of increasing the number of rooms	1. The impossibility of the room integration 2. The impossibility of changing the dimensions of living room and kitchen	The right-hand side unit: 131 m²; The left-hand side unit: 137.5 m²

7.		1. The possibility of changing the dimensions of rooms 2. The possibility of room integration 3. The possibility of increasing the number of rooms	1. The impossibility of increasing the number of rooms 2. The impossibility of increasing the living room dimensions	Around 150 m²

1. Living Room
2. Kitchen
3. Bed Room
4. Bath
5. Toilet

Spaces

RESULTS AND RECOMMENDATIONS FOR DESIGN

After reviewing and analysing the plans, some potentials and constraints were available in the existing plans regarding the common requirements and various conditions of the design and building in the contemporary era. Accordingly, some suggestions were proposed based on the current situation by using and increasing the existing potentials and decreasing and eliminating the limitations. Table 7 indicates the suggestions related to the design process for adopting open building approach in different building sectors.

Table 7. Design Suggestions Based on the Open Building Approach

Design Solutions for the Possibility of Open Building	
Optimal location of fixed building (supports)	The integration of fixed building segments such as staircase and services and part of the kitchen.
	The integration of services in one range.
	The suitable location of public-use area and inputs for providing more features.
	The suitable location of ducts and the establishment of duct among the two units boundary.
	Kitchen designing in two fixed and open parts.
	The establishment of fixed building in non-patio directions.
Optimal location infill	The proximity of living room with one of the rooms.
	The proximity of most rooms with each other.
	The proximity of living room with the open section of kitchen.
The mass and space of building	The increase of patio fronts (with suitable fill and empty or using the patio).
	The increase of casement numbers in the external shell.
Structural consideration	The placement of shear walls at the adjacent edges and the staircase and in non-patio sections.
	Regular piling with large openings.
	Coordination of the structural framework with architectural spaces.

CONCLUSION AND DISCUSSION

It seems that a large part of the approaches behind open building can be implemented in Iran, due to the characteristics and the proper design of the plan and taking the structures and facilities into

consideration. During recent years, the construction industry has changed from providing public and mass housing to private construction by the related developers. To this aim, flexibility should be considered for designing these buildings although adapting to a variety of occupants is regarded as a forgotten area.

In construction area, a little limitation is available for the application of open building approach in terms of structures and facilities as supports in the study area, because of using the concrete skeleton structures in a widespread manner, which necessitates the use of vertical channels, risers and ducts to pass the elements of the facility and the extensive use of false ceilings in the area construction although it seems different for infills.

In design area, flexible design and the application of prefabricated separators play an influential role in designing and modifying the interior area. Given the fact that wide varieties of these partitions are currently available in the Iranian market and are easily accessible and implemented, it seems that the application of these elements can be very beneficial for architects and designers to achieve open building approach.

In the area of designing with open building approach, flexibility can be considered as an important and appropriate feature of housing, which is even beneficial for builders and homeowners, as well as the residents. Thus, the following recommendations are suggested:

1. Architects and designers should focus more on the building with more flexible direction from the advent of the design and pave the way for more capabilities in the process of designing, by considering open building principles, controlling and adapting the conditions and facilities related to the structures and implementing appropriate elements in the construction phase for infill units.
2. Planners and the related institutes can play a significant role in scaffolding this approach and enhancing the motivation for manufacturers and consumers of the prefabricated panels as a part of a plan to improve industrialisation.

Table 7 presents some suggestions for implementing open building approach during the process of design and construction in Iran.

In order to promote and implement open building in Iran, further studies should be conducted on the socio-economic factors as the most important factors. The investigation of barriers and legal challenges and the role of ownership in the application of open building, in addition to studying and providing a scenario for Iranian households needs over time and the like can provide the groundwork for using this approach.

REFERENCES

Building, Housing and Road Research Center (2009). New Construction Technologies [in Persian]. Tehran: Ministry of Roads and Urban Development. Available at: https://www.bhrc.ac.ir/ [Accessed on 16 July 2016].

Eram, T. and Mirsaeedie, L. (2016). Selection of optimal building system by using the analytical hierarchy process, a case study: Residential project in Gonbad-e Kavoos. Paper presented at the 3rd International Conference on Research in Science and Technology. Berlin, Germany, July.

Gibb, A., Austin, S., Dainty, A., Davison, N. and Pasquire, C. (2007). Towards adaptable buildings: Pre-configuration and re-configuration; Two case studies. In M. Sharp (ed.), Manubuild: Proceedings of the 1st International Conference, the Transformation of the Industry; Open Building Manufacturing. London: The Construction Industry Research and Information Association (CIRIA).

Golestan Governorship (2011). Socioeconomic Report of Golestan Province [in Persian]. Golestan,

Province [in Persian]. Golestan, Iran: Golestan Governorship. Available at https://golestanp.ir/ [Accessed on 8 September 2017].
Habraken, J. (1978). Diversity in Housing. Translated by G. Faridian and N. Yazdkhasti. Tehran: Iranian Student Book Agency.
Kazi, A., Hannus, M., Boudjabeur, S. and Malone, A. (2007). Open Building Manufacturing Core Concepts and Industrial Requirements. Espoo, Finland: Manubuild with VTT-Technical Research Centre of Finland.
Kendall, S. (2015a). Reflections on the History and Future of the Open Building Network, CIB W104 (1996–2015). Delft, The Netherlands: International Council for Research and Innovation in Building and Construction (CIB).
———. (2015b). Open Building Concepts, Open Building Implementation, CIB W104. Delft, The Netherlands: CIB.
———. (2014). Case Studies of Residential Open Building. Continuing Project of the Building Futures Institute (BFI). Muncie, Indiana: College of Architecture and Planning, Ball State University.
———. (2004). An open building strategy for achieving dwelling unit autonomy in multi-unit housing. Housing and Society, 31(1): 89–99. https://doi.org/10.1080/08882746.2004.11430500.
———. (1999). Open building: An approach to sustainable architecture. Journal of Urban Technology, 6(3): 1–16.
———. (1987). Notes on "open systems" in building technology. Building and Environment, 22(2): 93–100. https://doi.org/10.1016/0360-1323(87)90029-1.
Kendall, S. and Kiseleva, N. (2013). Report on free plan apartments in Moscow. Available at: http://drstephenkendall.com/open-building-studies-reports and-lectures/ [Accessed on 5 September 2017].
Minami, K. (2016). The efforts to develop longer life housing with adaptability in Japan. Energy Procedia, 96: 662–673. https://doi.org/10.1016/j.egypro.2016.09.124.
Mirmoghtadaei, M., Talebi, Z. and Ershad, L. (2007). Introduction to the Principles of Open Building of Residential Complexes for Use in Mass Construction Projects [in Persian]. Tehran: Building and Housing Research Center Publication.
Seo, K.W. (2007). Space puzzle in a concrete box: Finding design competence that generates the modern apartment houses in Seoul. Environment and Planning B: Planning and Design, 34: 1071–1084. https://doi.org/10.1068/b32134.
Setien, I.N. (2015). Development in the residential open building: Analysis and reflections on two seminal case studies. Perkins+Will Research Journal, 7(1): 19–35.
Taqilou, Z. (2005). Legal Issues of Apartments [in Persian]. 2nd Ed. Tehran: Partoe Khorshid Publication.
Wong, J.F. (2010). Factors affecting open building implementation in high density mass construction design in Hong Kong. Habitat International, 34(2): 174–182. https://doi.org/10.1016/j.habitatint.2009.09.001

Application of Hybrid Green Fences for Security in Public Building Designs in Nigeria: Lessons from Kigali, Rwanda and Abuja, Nigeria

***Olatunde Adedayo1,2, Manlio Michieletto1, Eunice Bamidele2 and Marie Ntigulirwa1**

ABSTRACT

The issue of security has become a burning topic and major concern for urban dwellers in many developing countries. The use of active security measures is no longer considered as adequate to forestall the security breaches in many public buildings. It is commonplace in urban areas in developing countries such as Nigeria to find that these public buildings having perimeter walls of solid walls. These practices constitute environmental challenges to the urban planners and the architects who design such buildings. In the case of Kigali, there has been a significant attempt to create a blend of the environment with security walls through the design of the perimeter fences of public buildings. The advantages of these concepts have different approaches which could be adapted for different situations. This article aims to examine the nature of the hybrid fences designs in use in public buildings in Kigali with the view of suggesting advantageous ones for application to ensure environmental sustainability in Nigeria. The research method adopted is a qualitative approach using case studies of selected public buildings in Kigali and buildings in Abuja, Nigeria. The design of these fences would be examined and the different options identified. A comparative analysis would be drawn from the two cities and the areas of applications of the solutions from Kigali would be proposed. The study would conclude that the approach of hybrid green fences in Kigali offers the best advantage of security as it allows for visual contact and serves as the passive role of environmental sustainability while ensuring aesthetic value for the buildings. The article would recommend that architects incorporate the concept of hybrid green fences in the overall design of the public buildings and not as a secondary development.

Keywords: Design, Green, Hybrid-fences, Security, Public buildings

INTRODUCTION

Fences have become an integral part of building design and construction, the purpose they are meant to serve varies amongst countries, cities and property owners. Every building, public or private, has surrounding space within the plot which is used for other activities. The premises are usually demarcated by property line on which a form of demarcation is made using fences from the line of shrubs, trees or kerbs. Land demarcation is believed to be the first activity of humans when they got organised and it was done to serve the purpose of defining the boundaries of a property, the extent of land and the shape of the land (Libecap and Lueck,2011). Property boundaries are also defined to ensure that there is no dispute between neighbours as opined by Hull et al. (2016) in explaining the benefits of property demarcation. Over the years as urban centres grew and the demand for land became pronounced, demarcation of property boundaries became more important which is usually the challenge for the Urban Development Boards in many countries.

Public buildings definition could vary depending on the context in which it is applied either in terms of ownership or use. In the case of use, it is expected that it is a building that the general population would

have access to with minimum restriction. The design of such building should not offer any form of restriction to the possible users (Oyetola et al., 2015; Anunobi et al., 2016). Research in public building access in the past has focused on access for the physically challenged (Wong, 2014). However, the narrative has changed to inclusive design that seems to ensure that no group of people are denied access to public buildings right from the design stage to its completion (HM Government, 2006; Lee, 2008). The population growth witnessed in many cities of the world has come with the challenge of security equally as many buildings (public and private) now require some form of security be it passive, active or both (Georgiou, 2006; The Protection Engineering Group, Inc., 2011; Zhang and Yu, 2013). The common type of passive security measure adopted by many architects in the design of public buildings is in the perimeter fencing of the property such that access is controlled and limited. The materials used for these types of fences are usually monolithic material of either steel, concrete or any other choice. In cases where the materials used for the fences become mixed, such fences are referred to as hybrid fences which have become a common feature in the cities mainly for aesthetic purposes.

The inclusion of some form of active security is included through the use of security guards who man the gates and the use of security cameras as surveillance. There are several forms of application these passive security elements in the design and construction of public buildings in Nigeria and Rwanda. The challenge for the architects in the 21st century is how to ensure sustainability in the built environment in terms of social and environmental requirements. In the case of Rwanda and Nigeria, it is common to find public buildings such hotels, government buildings, markets, banks, churches and security buildings fenced, however, the point of departure is usually the nature of the fences. This article seeks to examine the nature of fences designs and elements used in selected buildings in Kigali with selected buildings in Abuja with the view determining the application of hybrid green as a viable design choice for public buildings in Abuja.

Security of Public Buildings

The rate of urbanisation when left unchecked will lead to what Raeisi, Nezhad and Hafezifar (2010) and Zhang and Yu (2013) referred to as social fracture with resultant development imbalance which endangers the urban development of any society where this occurs of which security would now be a major concern for the inhabitants of the city. The growing population is of great impact on the sustainability of the city and many people find their way into the city (Mumovic and Santamouris, 2009). The major evidence of urbanisation of settlement or community is the number and nature of buildings being constructed and the level of infrastructure being provided to serve them. Public buildings are usually a common place accessible to as many people who desire to access the building which often affects the security nature of the building and the occupants. The common feature in public building designs is to find some level of segregation of the users in the name of security and privacy (Georgiou, 2006).

It is common to find active security measures being employed in the security of with little attention to passive security measures in the design aside from the regular measures employed by architects in general which should not be the case (Federal Emergency Management Agency, 2003). The general belief is that active security offers the users a sense of security while using passive security the beauty of the building could be misplaced given the design considerations that would be required to be implemented. According to Zahner Group (2017) the beauty of a building when designing a building it is good to always consider how the building could be defended passively in a sustainable manner. The use of specific security building materials was suggested by Meara (2014) which could range from doors, walls, windows and roofs. In choosing the type and nature of security to implement in a public building the nature of the activity and users of such building must be considered as stated by Dorn et al. (2014).

The common feature as observed in many buildings and its environment in terms of passive measures for security is the use of perimeter fences which could vary depending on the aim of the architects, the client and the government policy.

Fencing of Public Buildings

In many cities in the developing countries, the use of fences is usually found in the cities as a means of protecting the building from undue access and also for privacy purpose. In the rural areas or countryside, the use of fences is often none existent as neighbours are allowed to walk through each other properties. There is the belief that communities without fences are better secured as it is difficult for a person to hide his activities from the public view, this is supported by the argument of transparent architecture (Sadeghi, Sani and Wang, 2015). In many public buildings giving the nature of the users, the properties within the buildings and the time of use, it is therefore common to find that the architects usually have the building enclosed with a perimeter fence which serves the purpose of passive security and also demarcating the property line (Libecap and Lueck, 2011). The benefit of the use of the perimeter fence is that it allows for the deployment of active security in specific places such as the gate and corner points of the property. The security personnel could easily be stationed at the security gates to check the users coming in and out of the building in addition to the security cameras that would have been installed. In many public buildings, the use of fences is argued as helping to regulate undue access and also shielding the building from possible attack as access is controlled through the gate.

The nature of the fence designs and the fence construction materials vary according to the city, the architects and the image sought by the clients. The common thing that is expected to be paramount is the need for sustainability in every design and construction decision making in the construction of the buildings. According to Kim and Kwon (2018), sustainability should form the basis for securing the cities, particularly public spaces and by extension public buildings. The issue of sustainability as it affects fences relates directly to the social and environmental aspects as the fence designs and materials could either affect the environmental conditions of the city or the inclusiveness it projects as reflected in the public building design fences. Examples of fences include walled fences, picket fences,iron grill fence, wire fence and green hedged fences. It is also possible to find a combination of either of these and the ration of combination varies on several factors such as design, cost, client requirement, availability of materials and law. The need for environmental sustainability usually should play a major role in the selection of the fence type, however, this is often not the case in many developing countries and their cities. The availability of research on the hybrid fence and its application have been very minimal or non-existent however in practice this type of fences is observable. It is a common term used by companies involved in fence provision (see Capital Fence and Wire Ltd., 2017).

RESEARCH METHOD

A descriptive survey method was adopted for this study. The study areas were Abuja and Kigali cities, both capital of Nigeria and Rwanda because there is a concentration of public buildings in the cities and the cities are still growing. In undertaking the study, literature review and direct observation were used through a case study approach. The selection of public buildings was based on access granted by the authorities in charge of the building but care was taken to ensure that the categories of buildings selected were the same in the two cities. A checklist is used to determine the type and nature of the fences used in the building and then the data obtained were analysed and presented in comparative form. The use of figures in terms of sketches and picture was to provide a graphical representation what was obtained. The discussion on the finding was based on the selected fence feature and the lessons from the Kigali case study is compared with that of Abuja and relevant deductions are made to support the implementation in

Abuja case. The examination of the law governing approval for fence designs in the two cities was examined and tabulated for a quick view of the difference as possible areas of improvement in the case of Nigeria.

RESULTS AND DISCUSSIONS

In examining the findings of the study, the results are presented and discussed based on selected factors that related to the provision of fences in the overall city development and architectural design. The discussion is based on specific subsection that would show the lessons from the hybrid concept as adopted in Kigali.

Policy Regarding Fences in Kigali

In examining the policy of Rwanda regarding the use of fences around the property line, the following requirements were extracted from the available policy and law documents.
Plots may be, but do not have to be enclosed by hedges, wire fences and walls with the following requirements:

1. Impervious fences or wall fences shall be discouraged but where inevitable shall not exceed a height of 2 m.
2. Walls shall be maintained in an optically clean and structurally safe condition.
3. Wire fences shall be of plain wire mesh.
4. Greening in fencing activities shall be encouraged.
5. Broken glass, electrical wire fence, barbed wire or angled top sections of barbed wire shall not be permitted.
6. To ensure the physical security of the neighbourhood, plot boundaries shall be as transparent or semi-transparent as possible.

It is observable that the use of wall fences is being discouraged while greening in fences is encouraged, this forms the basis for the visible use of such greening in fences. The policy also goes ahead to state that to ensure security within neighbourhoods, owners of properties should ensure semi-transparent nature in their fences and this is easily achievable with the greening of the fences. This type of policy can be adopted in the case of Abuja and any other city that does not have a clear policy regarding fences. The policy should always cover the height and the materials used for the fences and what the policy seeks to achieve. There is also the need to ensure that the policy is easily accessible on the websites of the authorities saddled with the responsibility of planning the city and also approving the designs for the buildings.

Setbacks from Road and Infill of Space

In examining the setbacks between roads and buildings one is quick to notice that these buildings usually obey the regulation both in Abuja and Kigali. It is common practice to find that landowners regardless of the type of building they seek to build often try to fence the entire property. It is therefore common to find that in certain aspects of the cities, the location of the fences could be very close to the road as is the case in residential areas. In the case of government and public buildings, it is common to find that there is an adequate setback of the fence from the road and in the case of Kigali, 6 m or above from the road as shown in Figure 1. It is observed from Figure 2 that Types A and B setbacks are usually available in areas where traffic is often high and the setback is further divided to accommodate dedicated lanes for bicycles and pedestrians. The provision of a lawn before the bicycle lane serves as a buffer zone, while the second

lawn and flower bed serves as a buffer for the fence and pedestrian. This flower bed is used to plant different types of flowers and hedges which in turn help protect the fence and reduce direct visibility into the building premises. The use of these spaces ensures that the setback is not seen as unutilised space which could be commandeered for other purposes. Type C fence setback is common in places where the traffic is low and the road is smaller. The common feature in Types A, B and C setback is that there is always the provision of lawn/flowerbed space before the fence. Type D fence is common in many roads adjoining the public buildings in Nigeria where little attention is given to the provision of lawn before the fence. The advantage of Types A, B and C is that the strip of this lawns helps improves the environmental sustainability of the areas located before the fence, it also ensures that the hybrid fence fits into the overall scheme of the city. The lawn area by the fence is also maintained by the owners of the building, the key lesson here is that the design of the fence setback is often planned along with the landscape requirements of the building. These lawns provided within the setbacks for the fence also ensures that there is a reduction in the heat gain within the city. The security of the building is also improved as people do not get to walk along the fence which could encourage a person to attempt to jump the fence, as the areas are clearly defined.

Figure 1. Indication of the Setback from Road and Facilities within the Spaces

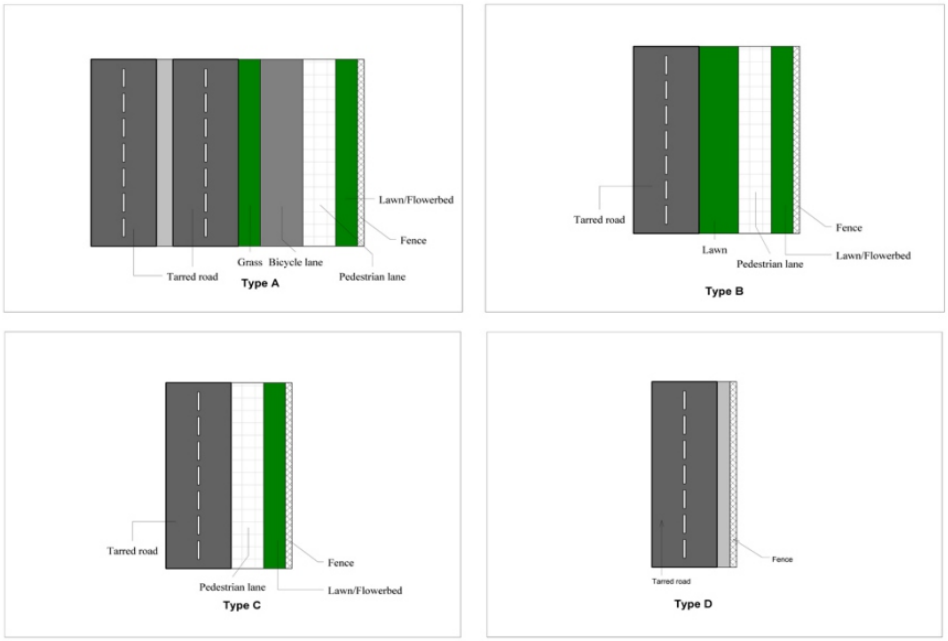


Figure 2. Examples of Different Types of Setbacks in Relation to Fences

Categories of Fences

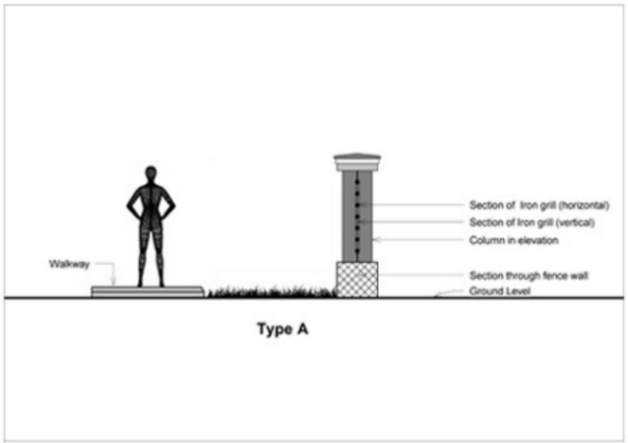
Fences are often named or grouped based on the material or height of the fence, however, this categorisation can become cumbersome. The common type of fence found in Abuja is the walled fence, usually made of either concrete or sandcrete block; the designs could vary depending on what form of beauty the architect seeks to create. There are also examples of fences with iron grill, mesh or a combination of concrete and sandcrete wall as shown in Figure 3. These types of fences usually increase the amount of heat gain and are not considered as being environmentally friendly. The claim is that these types of fences usually ensure no direct visibility to the building premises. There is also the iron grilled fence which is simply the use of iron grill or mesh inserted between concrete columns; this offers a direct view into the premises which could greatly affect the security of the building. There are the mixed iron grill and wall fence; this type usually includes a base wall of a given height which could be as high as 1.8 m and an iron grill to make up the remaining height. The green fences are usually the type that is made up of a line of hedges planted together at very close intervals, though this type can allow for pedestrians to pass through thereby not ensuring security despite being environmental good. The last category is the hybrid fence as proposed in this article, the key thing is that it incorporates some part of the wall fence at a low level, the iron grill and the green hedges or climbers. Examples of such fences are shown in Figures 3 and 4 where these fences are a common feature in the city of Kigali. These hybrid fences and its variants are considered good for security when they are fully matured as seen in Figures 3 and 4, it allows the architect latitude to design them and improve the aesthetics of the building while ensuring sustainability.

Figure 3. Examples of Fences around Some Selected Public Buildings in Kigali

Figure 4. Examples of Fences in Selected Public Buildings in Abuja

The Basic Structure of Fences

In examining the basic structure of the fences found in cities of Abuja and Kigali, it was easy to find Type C fence structure in Abuja which is made up of either solely concrete or a mixture of concrete and sandcrete block as shown in Figure 5. The coping on the fence is used to create beauty and ensure that water drains away from the building. In the case of Kigali, Types A and B are a common feature created for the climbers to find support. Concrete or bricks are used in the columns to support the iron grill. The iron grill or mesh are produced in compartments to fit the spaces between columns, this allows for easy replacement should the need arise, this ensures that the scheme is sustainable. Examples of such fences are shown in Figure 5 where it is possible to see a fence at the early stage and the one at the finished stage. The advantage of this type of fence structure is that the architect can vary the green plant and also the pattern of the climbers.



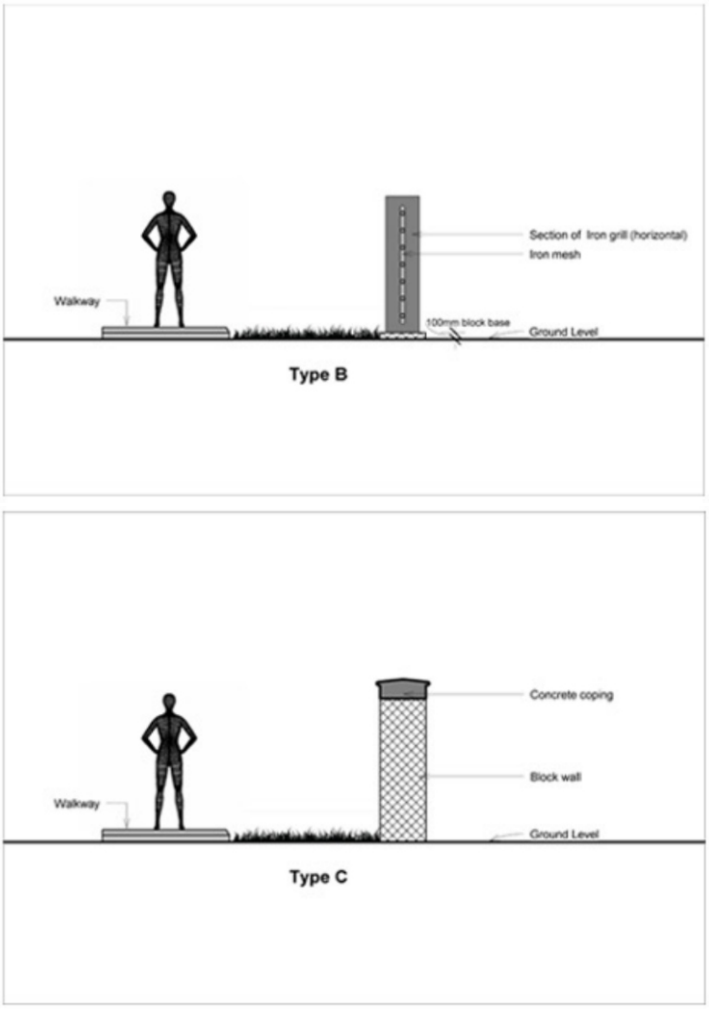


Figure 5. Structure of Common Fences

Type of Climbers on Fences

In determining the type of climbers to provide for the hybrid fences the major consideration in the amount of visibility intend for the premises and also the carrying capacity of the iron support or mesh. The other consideration is the suitability of the climbing plants to the environment, hence the advice for the use of local plants that have climbing characteristics. The climate of Rwanda plays a major role in ensuring that these plants survive well with minimum watering but the same might not be obtainable in the case of Nigeria where the weather is different, although there are local plants that can climb and survive. The process of watering the flowers in offices could also be extended to these climbers through the use of the concept of spot watering which ensures that water is not wasted. The density of the climbers can be determined with the assistance of landscape specialists, an initial dense situation could be created with the possibility of pruning down as the climbers mature and take shape thereby reducing the weight and water requirement without compromising the visibility requirement as shown in Figure 6. There are cases where the fence is embedded within rows of shrubs that are kept at the height of the fence and allowed to spread across, these shrubs are made to perform the function of climbers and they do not add any weight to the fence or the iron grill as they are self-supporting plants.

Figure 6. Example of Fences with Shrubs and Climbers

Visibility through Fences

The reasons for erecting a fence on a property vary amongst property owners or even administrators. A common function achieved with the fence is that it helps demarcate the property from others, while it is used to provide an image of the company or the owner. In terms of security, the fence is used to restrict movement and prevent unlawful incursion into the property, hence many public buildings in busy sections of the city of Abuja always try to prevent a direct view into their premises from the road through the use of wall fences. The need to ensure a lack of visibility into the premises often supersedes the need to achieve environmental sustainability and it is a common excuse given by some of the architects interviewed. They are quoted saying "If you cannot see inside the compound, it will be difficult for the building to be robbed and security camera will easily make possible to watch those loitering around; security before sustainability".

If the statement is a reflection of the architects involved in designing public buildings in Abuja, then one will understand why the city is referred to as a jungle of concrete. The security challenges in Kigali are quite different from those of Abuja and one might assume that this is the reason why the fences, usually the hybrid fences in some cases allow visibility. In Figure 7, it can be observed that there are variants of the hybrid fences that do not allow visibility into the premises from the road, these easily fit into the need stated as the basis for the choice of the walled fences while ensuring the sustainability required for the city. It is possible to make use of a combination free-standing shrubs and climbers which will increase the densification of the green part of the fence which reduces the visibility from the road.

Figure 7. Reduced Visibility Through the Fence

Sustainable Application Concept for Existing Wall Fences

Based on the changing climate and the need to ensure sustainability in the cities, the recurring question from the architects interviewed was "How do we improve the existing fences and make them environmentally sustainable and enjoy the benefits?".

In responding to this question, there is a need to ensure that waste is not created through the reconstruction of the fences. Possible suggestions that could be adapted to handle the challenge as provided in Figure 8 where Types A and B show the possibility of providing a variant of the hybrid fence.

In Types A and A+ fence suggestion, the existing fence is fitted with short iron rods drilled into the wall with a little portion of 100 mm to 150 mm protruding out that would serve as the path for the climbers. The arrangement of these sprouts should be such that they do not weaken the structural integrity of the fence. The sprouts can then be connected with a lighter weighing iron rod is used to connect the sprouts in a manner that allows for easier climbing.

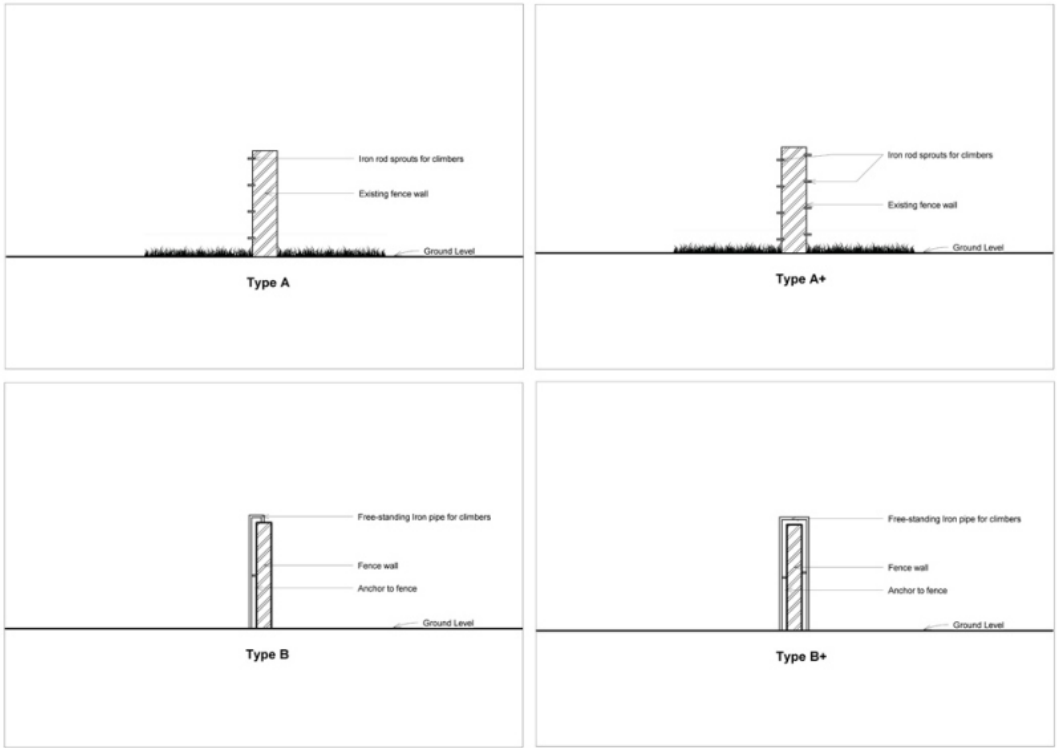


Figure 8. Concepts of Hybrid Fence for Existing Wall Fences

In Types B and B+ fence, the concept is slightly different as it requires freestanding iron grills or meshes fixed to the ground at a distance of 100 mm to 150 mm from the walled fence, at certain selected points the iron grill or mesh is anchored to the fence. The advantage of this Type B fence is that it offers the opportunity to use hollow pipes for the production of the iron mesh or grill and it is free standing hence reducing the load on the initial wall fence.
The use of either of the options will ensure that the initial walled fence forms the inner core of the fence and does not allow the concrete or sandcrete part to make contact with the sun hence reducing the heat gain. This new fence developed from either of the options will ensure that some form of environmental sustainability is achieved. The idea can be replicated on the other side of the fence to ensure complete compliance with the environment.

Benefits of Hybrid Fence

The benefits that could be derived from the use of hybrid fences in public buildings are quite numerous when compared to the problems associated with disuse. In the interview conducted amongst selected architects, they claimed that apart from the easily noticeable sustainability benefit, the ability to adapt the hybrid concept to existing wall fences is a good concept. A participant is quoted saying that "the fact that one does not need to destroy the existing fence will make it easier to convince the client to key into the scheme and this will ensure the need perception of security".

The issue of placement of security cameras in positions where are not easily visible to the pedestrian makes the concept interesting and acceptable based on "the fact that there are spaces behind the mesh for the climbers ensures that cameras can be placed at strategic points without a direct view to people".Every architect is always interested in ensuring that his buildings are quite interesting and appreciated by all while the first point of appreciation is the fence of the property. The possibility of getting flowers that are colourfully incorporated in the hybrid fence makes this concept valuable because:

The use of iron rods as a basis for the design of the mesh for support of the climbers and also the opportunity to select different flower types means that the fences could be given a whole new appearance which would attract attention or take attention away from the premises.

In examining the benefits of the variants of the hybrid fence, it is clear from the opinions of the architects that this type of fences would be of beneficial effects to the owners of the properties as they can choose the type of greenery to adopt in the fence. It was a unanimous opinion that the use of the hybrid fences would not affect nor compromise the security sought for by the clients, they equally agreed that it should be a part of the design requirements particularly in cities where it is not the case. A summary of the findings between the two cities as shown in Table 1 supports the argument for improvements and application of highbred fences.

Table 1. Summary of Comparison of Findings between Kigali and Abuja

	Variable	Kigali	Abuja	Observation
1.	Policy issues	Clear documented statements on the use on nature of fences including the type of materials for use.	The policy is neither clear nor available. Interviews show that the nature of the fence is not specified.	The policy on fences in Kigali can be modified and adopted in Abuja.
2.	Setbacks from road and infill of space	The setbacks are well defined from the road to the fence. The spaces are filled with lawns, flowers and walkways.	Undefined setbacks from roads which are often left unused.	There is a landscaping opportunity for the aesthetic value which could restrict movements close to the fences.
3.	Categories of fences	There are several variants of fences, however there the inclusion of green elements ensured that the fences appeared sustainable and improved the environment.	Many cases of monolithic material fences. In the case where hybrid fences occurred, it did not have any green element.	Sustainability could be improved using green elements on the fences and also improvement of security.
	Variable	**Kigali**	**Abuja**	**Observation**
4.	The basic structure of fences	The structure of the fences is made of low walls and iron grill for the climbers.	High wall fences with little options for climbers.	The basic fence structure in use in Kigali can be adapted for general use.
5.	Type of climbers on fences	The use of local plants allows for survival of the plants based on adaptation to climate.	The climbers are not available as this is not a common feature in the fences.	The use of hybrid fences should allow for local plants to be applied.
6.	Visibility through fences	The close-fitted nature of the climbers and plants reduces and eliminate direct view through the fences.	The use of concrete wall eliminates views through the fence.	The hybrid options as applied in Kigali offers better advantages.

CONCLUSION AND RECOMMENDATION

The clear definition of the laws in design and construction of fences in Rwanda shows that careful attention has been paid to details of how they would want their city to appear, the same cannot be said of Nigeria and several reasons could be adjudged for with. The key issue as observed in this article is that the architects practising in Kigali are aware of the rules governing the use of fences and they have been able to ensure that their clients follow through and there are always regular checks by the authority. This regular check is important in the case of Abuja where an examination of the fences provided did not connote the clear understanding or application of the law. The hybrid fence as proposed in the article

would ensure that in implementing the law the existing fences are not destroyed and that within a period the city can become green.

The willingness shown by the architects and the benefits stated shows that cities with existing walled fences could be made greener while adopting other variants for new fences. The article recommends that there is a need for a clear policy or law on the remodelling of existing wall fences and new fences in cities where none exist as in the case of Abuja. Architects should be encouraged to seek other opportunities of improving the environmental sustainability of the buildings they design and with the view of determining areas of increasing the greenery.

REFERENCES

Anunobi, A.I., Adedayo, O.F., Ayuba, P., Oyetola, S.A. and Otijele, G.O. (2016). An assessment of ramp designs as barrier-free accesses in public buildings in Abuja, Nigeria. Centre for Human Settlements and Urban Development Journal, 6(1): 119–131.

Capital Fence and Wire Ltd. (2017). Hybrid privacy. Available at: http://capitalfence.ca/hybrid-privacy-300040004500-series/.

Dorn, M., Atlas, R., Schneider, T., Dorn, C., Nguyen, P., Satterly, S., Bentley, R. and Ellis, R. Goble, C., Bellaire, U., Wilson, R. and Billinger, M. (2014). Seven Important Building Design Features to Enhance School Safety and Security. Macon, GA: Safe Havens International Inc. Available at: https://safehavensinternational.org/wp-content/uploads/2014/12/Seven_Important_Building_Design_Featur es_to_Enhance_School_Safety_and_Security-ISSSA_2014.pdf.Federal Emergency Management Agency (FEMA) (2003). Site and layout design guidance. In Reference Manual to Mitigate Potential Terrorist

Attacks against Buildings: Providing Protection to People and Buildings.

Washington DC: FEMA. Available at: https://www.fema.gov/media-library data/20130726-1455-20490-7805/fema426_ch2.pdf.

Georgiou, M. (2006). Architectural privacy a topological approach to relational design problems. MSc diss., University College London.

HM Government (2006). Better Public Building. London: Commission for Architecture and the Built Environment and the Department for Culture, Media and Sport.

Hull, S., Sehume, T., Sibiya, S., Sothafile, L. and Whittal J. (2016). Land allocation, boundary demarcation and tenure security in tribal areas of South Africa.

South African Journal of Geomatics, 5(1): 68–81. https://doi.org/10.4314/sajg.v5i1.5.

Kim, S. and Kwon, H. (2018). Urban sustainability through public architecture. Sustainability, 10(1249): 1–21. https://doi.org/10.3390/su10041249.

Lee, Y. (2008). "Designing with users, how?": Investigate users' involvement tactics for effective inclusive design processes. Paper presented at the International DMI Education Conference on Design Thinking: New Challenges for Designers, Managers and Organizations. Cergy-Pointoise, France, 14–15 April.

Libecap, G.D. and Lueck, D. (2011). The demarcation of land and the role of coordinating property institutions. Journal of Political Economy, 119(3): 426–467. https://doi.org/10.1086/660842.

Meara, S.P.O. (2014). School security design: Planning to mitigate risk and avoid liability. The Construction Lawyer, 34(1): 1–9.

Mumovic, D. and Santamouris, M. (2009). A Handbook of Sustainable Building Design and Engineering: An Integrated Approach to Energy, Health and Operational Performance. London: Earthscan.

Oyetola, S.A., Adedayo, O.F., Anunobi, A.I., Adebisi, G.O. and Eri, P.O. (2015). Should public buildings

be exclusive? A study of selected institutional buildings in Minna, Niger State. American Journal of Engineering Research (AJER), 4(3): 81–87.
Raeisi, I., Nezhad, A.K. and Hafezifar, M. (2010). Architectural design principles of public spaces based on social sustainability approach: A case study in Ardabil, Iran. Design Principles and Practices: An International Journal, 4(5): 99–113. https://doi.org/10.18848/1833-1874/CGP/v04i05/37968.
Sadeghi, G., Sani, R.M. and Wang, R. (2015). Symbolic meaning of transparency in contemporary architecture: An evaluation of recent public buildings in Famagusta. Current Urban Studies, 3(4): 385–401. https://doi.org/10.4236/cus.2015.34030.
The Protection Engineering Group, Inc. (2011). Security Master Plan: Physical Security Design Criteria. Chantilly, VA: The Protection Engineering Group, Inc. Available at: https://docplayer.net/818255-Security-master-plan-physicalsecurity-design-criteria.html.
Wong, H. (2014). Architecture without barriers: Designing inclusive environments accessible to all. MSc diss., Ryerson University, Toronto.
Zahner Group (2017). Passive Security in Architecture: Designing for Security without Sacrificing Beauty. Kansas City, MO: A. Zahner Company. Available at: https://www.azahner.com/blog/passive-security-in-architecture.
Zhang, Y. and Yu, J. (2013). A study on the building of urban public security management network platform. Procedia Engineering, 52: 613–617. https://doi.org/10.1016/j.proeng.2013.02.194.

Framework for Evaluating Quality Performances of Subcontractors: Case of Turkish Contractors

***Befrin Neval Bingol1 and *Gul Polat2**

ABSTRACT

Success of a construction project mainly depends on the performances of the subcontractors. Thus, general contractors should be very careful when selecting their subcontractors. Turkish contractors are active in international markets, where competition is fierce. This study aims to provide general contractors, who predominantly operate in international markets, with a practical and user-friendly subcontractor quality performance measurement framework. The methodology of this study has two main phases, pre-survey and survey stages. The pre-survey stage aims to identify the most important key performance indicators (KPIs), which can be used to develop a framework for measuring the quality performances of candidate subcontractors. For this purpose, an extensive literature review and a questionnaire survey among 40 large scale Turkish contractors were conducted. In the survey stage, the performance measurement framework was developed using the group decision on the weights of the most important KPIs obtained from the analytic hierarchy process (AHP) calculations. Face-to-face interviews were conducted with the target users of the proposed performance measurement framework to construct the comparison matrices and thereby determine the weights of these KPIs. The proposed framework can be used by Turkish contractors to measure the quality performances of subcontractor candidates in an objective, systematic and structured manner.

Keywords: AHP, Group decision making, KPI, Subcontractor selection, Quality performance measurement

Introduction

Globalisation and scarcity of construction projects in domestic markets compel general contractors to expand into new markets. Turkey is a developing country and both the economic crisis and shortage of projects have induced Turkish contractors to seek new opportunities in foreign countries since 1972. Turkish contractors have done business in 120 countries and undertaken more than 9,300 international projects, most of which were large or mega-scale projects, since then. As a result of the success of these projects, Turkish contractors ranked second in the Engineering News-Record (ENR) "Top 250 International Contractors" list in 2016 (Turkish Contractors Association [TCA], 2018).

Large or mega-scale construction projects involve a great number of activities and general contractors may not be capable of carrying out all these activities by themselves. In those cases, they may prefer to divide their projects into smaller components and assign subcontractors to them based on their speciality areas. In construction projects where large portions of the activities are outsourced, numerous subcontractors are obliged to work together, which in turn makes construction sites chaotic and complicated. In such projects, coordinating and controlling the works of these subcontractors is not an easy task for general contractors. Since most of the construction activities are carried out by subcontractors and the success of the entire project, which is mostly assessed in terms of time, cost and quality, is determined by their performances, working with ineligible subcontractors may bring about failures such as delays, cost overruns, quality problems, disputes, etc. Therefore, general contractors should be very careful during the subcontractor selection process and select the right subcontractor for

the right job to achieve business continuity in such a highly competitive market.

In practice, general contractors tend to select the subcontractor who offers the lowest bid price (Tserng and Lin, 2002; Arslan et al., 2008; Mbachu, 2008; Hartmann, Ling and Tan, 2009) or is known from previous projects (Tserng and Lin, 2002; Arslan et al., 2008; Ulubeyli, Manisali and Kazaz, 2010; Choudhry et al., 2012). However, both practices may lead to severe problems in either meeting quality requirements or controlling the cost. It is obvious that there is a need for a sound and systematic approach for measuring/evaluating the performances of candidate subcontractors and selecting the most appropriate one in order to fulfil the contract requirements and ensure business continuity.

General contractors may take into account several tangible and intangible criteria during the subcontractor evaluation and selection process. While some of these criteria such as time and cost can be assessed easily as they can be numerically expressed, the remaining criteria such as safety and quality performances of the candidate subcontractors cannot be easily assessed as they are highly subjective. The quality of construction works is defined as "to be fit for use as intended" (Trinkūnienė et al., 2017) and it is very difficult to estimate and evaluate the quality performance of a subcontractor at the beginning of a construction project. Moreover, even though subcontractors perform the large portions of the construction works, general contractors are liable for the quality of the accomplished works (Enshassi et al., 2008). Therefore, there is a need for an approach, which enables general contractors to measure the quality performances of the candidate subcontractors in an objective, systematic and structured manner, in order to improve the subcontractor selection process.

The main objective of this study is to provide general contractors, especially the ones who predominantly operate in international markets, with a practical and user-friendly performance measurement framework, which assists them in estimating quality performances of candidate subcontractors. The proposed framework is based on the most commonly used KPIs. The proposed framework also aims to enable general contractors: (1) To predict the overall quality performance of the project, (2) To achieve quality requirements specified in the contract and (3) To minimise risks resulting from quality problems. c

PREVIOUS STUDIES ON PERFORMANCE MEASUREMENT AND SUBCONTRACTOR SELECTION IN THE CONSTRUCTION INDUSTRY

The construction sector is criticised by many researchers for its poor performance (Lee, Cooper and Aouad, 2000; Kagioglou, Cooper and Aouad, 2001). Performance measurement in the construction sector has scholarly attracted attention with the increasing complexity of construction projects and developments in construction management and technology (Lin and Shen, 2007; Yang et al., 2010) with studies often focusing on metrics of duration, cost and quality objectives (Ward, Curtis and Chapman, 1991; Kagioglou, Cooper and Aouad, 2001). Recently, new performance indicators such as customer satisfaction, business performance, safety and environment have gained importance (Yu et al., 2007; Yang et al., 2010). Performance measurement has been assessed in three levels: project, organisation and stakeholder.

European Foundation for Quality Management (EFQM), balanced scorecard (BSC) model and key performance indicator (KPI) model are three of the most commonly used frameworks for performance measurement in the construction industry (Yang et al., 2010). EFQM and BSC models are more suitable for strategiclevel performance measurement and company-specific measurement. KPI model, however, is more flexible and can be easily generalised and allows measuring performance at different levels. In this study, the KPI model is selected to construct a framework for measuring quality performances of subcontractor candidates at two different levels, namely project and organisation.

In construction management literature, many studies focused on the subcontractor selection process.

METHODOLOGY

The methodology of this study has two phases: (1) a pre-survey and (2) a survey stage (as shown in Figure 1).

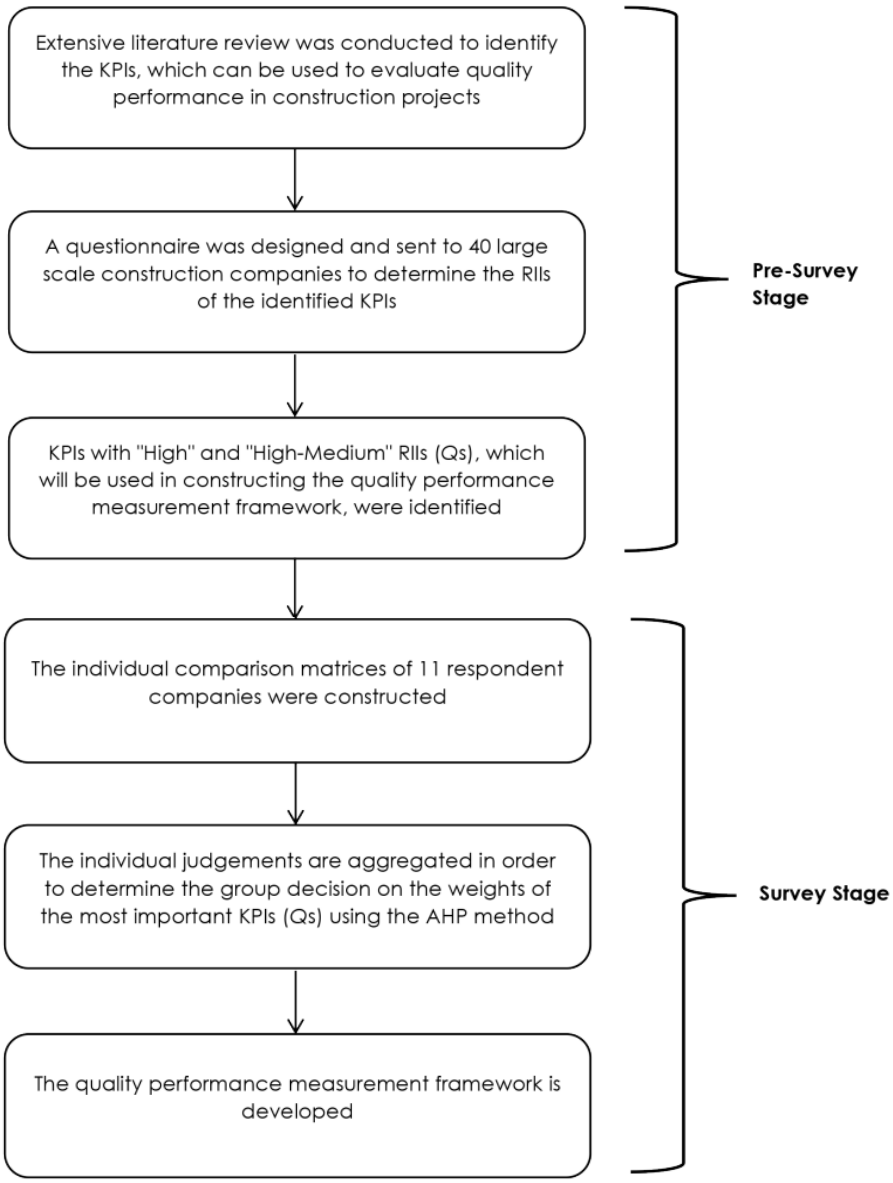


Figure 1. Steps of the Proposed Methodology

In the pre-survey stage, firstly, 12 KPIs, which can be used to measure quality performance in construction projects, were identified in the light of an extensive literature review (as shown in Table 1). Then, a questionnaire survey among 40 large scale Turkish contractors, most of which are members of TCA and predominantly act as general contractors, was conducted to determine the relative importance of these KPIs. According to the official figures issued by the Ministry of Labour and Social Security, there are 494 large scale construction companies, which employ more than 250 labourers, in Turkey. From these 494 companies, 100 of them were selected using the purposive sampling method and were contacted. Of the 100 mailed questionnaires, 40 were returned duly filled out, which corresponds to a response rate of 40%. In the questionnaire, the respondent companies were asked to rate the relative importance levels of 12 KPIs using typical five-level Likert scale, where 1 represents the "Least

Importance" and 5 represents the "Highest Importance".
Having collected the responses, reliability (i.e. Cronbach's alpha) and ranking (i.e. RII) analyses were carried out in order to test the internal consistency of the scale used in questionnaire for measuring the perceptions of the respondents and to compute the relative importance of the KPIs, respectively.
Cronbach's alpha value was found to be 0.939, which indicates that the internal consistency of the scale used is excellent (Field, 2017). RII is calculated by dividing the arithmetic mean of the responses given for each KPI to the highest importance, which is 5 in this study (Chen, Okudan and Riley, 2010). Based on the findings of the ranking analysis, out of 12 KPIs, six have "High", three have "HighMedium" and three have "Medium" RII. As this study aims to construct an efficient and practical quality performance measurement framework, three KPIs with "Medium" RII, namely availability of quality assurance certificate and date of certificate (KPI#2), subcontractors' management ability of quality assurance and certificate programs (KPI#3) and the establishment of quality assurance system and cost for managing it (KPI#4) were eliminated. The most important nine KPIs with "High" and "High-Medium" RIIs were used when constructing the quality performance measurement framework, namely adequacy of quality assurance policy (Q1), application-level of the quality management system in projects (Q2), the audit of the quality management system in project level (Q3), construction quality (conformance to the specification) (Q4), the quality of workmanship (Q5), the cost of poor quality resulting from the low standard production (Q6), number of reworks (Q7), percentage of reworks (%) (Q8) and severity of defect at construction phase (Q9). The findings of the pre-survey phase were extensively reported in Bingol and Polat (2016).
In the survey stage, the main objective was to calculate the group decision on the weights of the most important nine KPIs (Qs) used in the quality performance measurement framework on the subcontractor selection process. In order to achieve this objective, the AHP method was employed. The target users of the proposed evaluation framework were the large scale Turkish general contractors, who predominantly operate in international markets, are listed in "ENR Top 250 International Contractors" list, are the members of the TCA and had management system certificates (i.e., ISO 9001:2008, ISO 14001:2004, OHSAS 18001:2007). There are 27 Turkish contractors, who fulfilled all these criteria. Therefore, the target population of this research was 27 and all of these companies were contacted. Out of these 27 Turkish contractors, 11 were accepted to contribute to the research. Face-to face interviews were conducted to construct pairwise comparison matrices. The individual judgements of these target users were aggregated to reach a group decision.

Table 1. Identified KPIs and Their RIIs

KPI#	Q#	Description	References	RII
KPI#1	Q_1	Adequacy of quality assurance policy	Enshassi, Mohamed and Abushaban (2009); Yasamis-Speroni, Lee and Arditi (2012)	H-M
KPI#2	–	Availability of quality assurance certificate and date of the certificate	Hatush and Skitmore (2010)	M
KPI#3	–	Subcontractors' management ability of quality assurance and certificate programs	Marzouk, El Kherbawy and Khalifa (2013)	M
KPI#4	–	The establishment of a quality assurance system and cost for managing it	Luu, Kim and Huynh (2008)	M
KPI#5	Q_2	Application-level of the quality management system in	Luu, Kim and Huynh (2008)	H-M

KPI#6	Q_3	The audit of the quality management system in project level	Luu, Kim and Huynh (2008)	H-M
KPI#7	Q_4	Construction quality (conformance to the specification)	Mahdi et al. (2002); Chan and Chan (2004); Luu, Kim and Huynh (2008); Arslan et al. (2008); El-Mashaleh (2009); Enshassi, Mohamed and Abushaban (2009)	H
KPI#8	Q_5	The quality of workmanship	Hatush and Skitmore (1997); Arslan et al. (2008); El-Mashaleh (2009)	H
KPI#9	Q_6	The cost of poor quality resulting from the low standard production	Marzouk, El Kherbawy and Khalifa (2013)	H
KPI#10	Q_7	Number of reworks	Ali, Al-Sulaihi and Al-Gahtani (2013)	H
KPI#11	Q_8	Percentage of reworks (%)	Ng and Skitmore (2014)	H
KPI#12	Q_9	The severity of defect at the construction phase	Enshassi, Mohamed and Abushaban (2009)	H

Notes:RII = L: Low (RII < 0.2); M-L: Medium-Low (0.2 ≤ RII < 0.4), M: Medium (0.4 ≤ RII < 0.6), H-M: High-Medium (0.6 ≤ RII < 0.8), H: High (RII ≥ 0.8) Source: Chen, Okudan and Riley (2010)

AHP was developed by Saaty (1980). It is a basic approach that deals with both the rational and the intuitive decisions to select the most appropriate option from several alternatives with respect to several criteria (Saaty and Vargas, 2012). Fundamentally, the AHP method is based on mathematics and psychology and is the application of an Eigenvalue approach to the pairwise comparisons (Vaidya and Kumar, 2006). The simplest form of AHP is composed of a hierarchy consisting of three levels: (1) The goal of the decision is at the top level, (2) Criteria of the goal are in the second level and (3) Alternatives are located in the third level (Saaty and Vargas, 2012).

The AHP methodology relies on pairwise comparison of either criteria or alternatives. Decision-makers compare criteria/alternative using actual measurements or a fundamental scale to reflect the relative strength of their preferences and feelings. In the pairwise comparison matrices, the question of "How many times the one criterion/alternative is more important or dominant over the other criterion/alternative with respect to the goal/criterion?" should be expressed on a scale of 1 to 9 (as shown in Table 2) (Saaty, 2008).

Table 2. Saaty's Rating Scale

Intensity of Importance	Definition	Explanation
1	Equal importance	Two factors contribute equally to the objective
3	Somewhat more important	Experience and judgement slightly favour one over the other
5	Much more important	Experience and judgement strongly favour one over the other
7	Very much more important	Experience and judgement very strongly favour one over the other
9	Absolutely more important	The evidence favouring one over the other is one of the highest possible validity
2–4–6–8	Intermediate values	When compromise is needed
Reciprocal of above nonzero numbers		If the activity *i* has one of the above nonzero numbers assigned to it when compared with activity *j*, then *j* has the reciprocal value when compared to *i*

Source: Saaty (2008)

The constructed pairwise comparison matrices are positive and reciprocal (i.e. [ ] aij1 = aji) (as shown in Equation 1).

$$A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ 1/a_{12} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \cdots & \vdots \\ 1/a_{n1} & 1/a_{n2} & \cdots & a_{nm} \end{bmatrix} \quad \text{(Eq. 1)}$$

Saaty (1980) proposed to check the inconsistency of judgements with a measure called the Consistency Index (CI). CI is calculated with the following Equation 2:

$$CI = \frac{(\lambda_{max} - n)}{(n-1)} \quad \text{(Eq. 2)}$$

where max is the principal eigenvalue of the judgement matrix and n refers to the number of criteria in this matrix. The consistencies of decision-makers' evaluation are checked with the consistency ratio (CR). The following equation is used to determine this ratio (as shown in Equation 3).

$$CI = \frac{(\lambda_{max} - n)}{(n-1)} \quad \text{(Eq. 3)}$$

CR depends on both the CI and the random index. The random index values determined based on different numbers are provided in Table 3.

Table 3. Random Index

Number of Items	Random Index	Number of Items	Random Index
1	0	6	1.24
2	0	7	1.32
3	0.58	8	1.41
4	0.90	9	1.45
5	1.41	10	1.49

Source: Timor (2011)

The value of CR for comparison matrices should be less than 0.1 to provide consistency of the decision-maker. If not, the results of the pairwise comparison need to be re-evaluated to improve consistency.

In most real-life decision-making problems, decisions are made by several decision makers. AHP is a convenient method to be used in group decision making. There are two different approaches for combining individual judgements, which include: (1) aggregating individual judgements and (2) aggregating individual priorities (Escobar, Aguarón and Moreno-Jiménez, 2004). The weighted geometric mean and the row geometric mean methods are used for combining group decision (Escobar, Aguarón and Moreno-Jiménez, 2004). According to Saaty (2008), taking the geometric mean of individual judgements is the best way to convert individual preferences into a group decision. Usage of 1 to 9 rating scale for individual judgements mainly result in preferring the geometric mean to reach a group decision (Timor, 2011; Onder and Onder, 2014).

When the individual judgements of the decision-makers are combined with the weighted geometric mean method, the final priority is computed via Equation 4.

$$w_{ij}^{G} = \prod_{k=1}^{m} \left(w_{ij}^{(d)}\right)^{\lambda k} \qquad \text{(Eq. 4)}$$

where *wGji* represents group decision computed with the weighted geometric mean, m represent the number of decision-makers, represents the decision matrix of the decision-maker and λk represents the weight of decision-maker.

ANALYSIS AND FINDINGS

Characteristics of the Interviewed Companies

Out of 27 Turkish contractors, 11 accepted to participate in face-to-face interviews, corresponding to a response rate of 40.74%. Interviews were conducted with 11 civil engineers, who were in charge of subcontractor evaluation and selection process. In these interviews, seven questions were asked to reveal the general characteristics of the interviewed companies. The findings of the general characteristics of the companies were summarised in Table 4.

Table 4. Demographic Characteristics of 11 Contractors

Demographic Characteristics		N	Valid %
Experience in the industry	1 to 5 years	–	–
	6 to 10 years	–	–
	11 to 15 years	–	–
	16 to 20 years	2	18.2
	21 to 25 years	3	27.3
	26 to 30 years	–	–
	> 30 years	6	54.5
	Total	11	100
Membership of TCA	Member	11	100
	Not a Member	0	0
	Total	11	100
Roles of respondent companies	General contractor	11	100
	Subcontractor	1	9.1
	Partner of the consortium	1	9.1
	Member of a joint venture	3	27.3
	Consultant companies	–	–
	Others	–	–
The markets that the respondent companies operate predominantly	National (Domestic)	–	–
	International	8	72.7
	Equally on national and international markets	3	27.3

Demographic Characteristics		N	Valid %
Expertise areas	Commercial buildings	7	63.6
	Industrial buildings	7	63.6
	Residential buildings	5	45.5
	Infrastructure and transportation structures	7	63.6
	Others	2	18.2
Percentages of work capacity transferred to subcontractors	1% to 25%	1	9.1
	26% to 50%	4	36.4
	51% to 75%	5	45.5
	76% to 100%	1	9.1
	Total	11	100
Experience of the respondents in the interviewed companies	1 to 4 years	1	9.09
	5 to 9 years	2	18.18
	10 to 14 years	–	–
	15 to 19 years	2	18.18
	20 to 24 years	3	27.27
	25 to 29 years	2	18.18
	30 to 34 years	–	–
	> 34 years	1	9.09
	Total	11	100

According to the data obtained in the interviews, out of the 11 contractors, 54.54% have 16 to 20 years of experience in the sector while 27.27% have six to 10 years and 18.18% have one to five years of experience. It is observed that 100% of the respondent companies are general contractors where 9.1% of them are subcontractors, 27.3% of them are a member of joint ventures and 9.1% are consultant companies in the undertaken projects. On the other hand, among 11 companies, eight (72.7%) were operating only in international markets and three (27.3%) were operating in both national and international markets. Based on the responses received from the companies, 63.6% of them are specialised in commercial buildings, industrial buildings and infrastructure-transport structures while 45.5% of them are specialised in residential buildings and 18.2% of them are specialised in other types of projects. Findings revealed that 45.5% of the companies sublet 51% to 75% of the total work capacity to the subcontractor companies, 36.4% of them sublet 26% to 50% of the total work capacity, 9.1% of them sublet 1% to 25% of the total work capacity and 76% to 100% of the work capacity to the subcontractor companies.

Group Decision on the Weights of the Most Important KPIs (Qs)

Respondents are strategically competitors and the individual preferences of these 11 companies have been taken one by one and then were combined to reach a group decision for the proposed framework. The AHP method was applied to determine the weights of the nine KPIs in the quality performance measurement framework. In the interviews, Saaty's (2008) rating scale was used to calculate the relative importance of these nine KPIs.

In this step, first 11 pairwise comparison matrices were built to understand the individual judgements of each company, the weights of nine KPIs in each company were calculated and the consistency index of each comparison matrix was checked (as shown in Table 5).

Then the individual matrices were aggregated using the weighted geometric mean method into a single matrix to reach a group decision (using Equation 4) and the consistency index of the aggregated pairwise comparison matrix was checked. The aggregated individual priorities are presented in Table 6 and the aggregated weights of nine KPIs are shown in the last column of Table 5.

According to the findings displayed in Table 5, "Construction quality (conformance to the specification)" (Q4) is the most effective indicator with the weight of 0.24009 in the developed framework. This indicator is followed by "The quality of workmanship" (Q5) with the weight of 0.17890, "Application-level of the quality management system in projects" (Q2) with the weight of 0.11874 and "The audit of the quality management system in project-level" (Q3) with the weight of 0.09979. On the other hand, the least effective indicator in the framework is "Number of reworks" (Q7) with the weight of 0.05634

Development of the Quality Performance Measurement Framework

The proposed quality performance measurement framework consists of three steps, which are: (1) inputs, (2) process and (3) output (as shown in Figure 2).

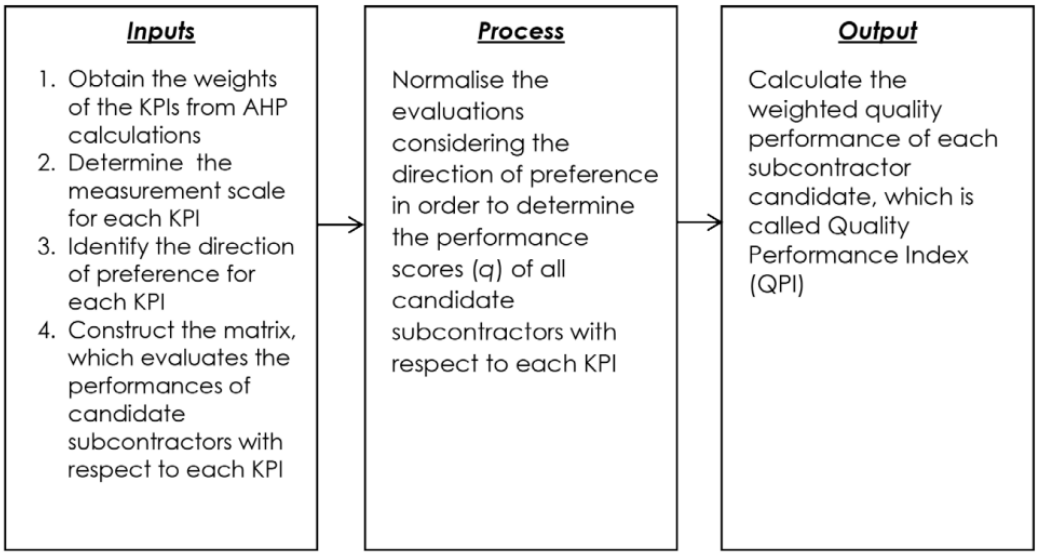


Figure 2. Framework for Measuring Quality Performance of Subcontractors

Table 5. Individual Priorities of Nine KPIs According to the 11 Turkish General Contractor Companies

	w_{QC1}	w_{QC2}	w_{QC3}	w_{QC4}	w_{QC5}	w_{QC6}	w_{QC7}	w_{QC8}	w_{QC9}	w_{QC10}	w_{QC11}	$w^{G}_{Q_i}$
Q_1	0.10252	0.10673	0.07935	0.10000	0.27167	0.10605	0.05593	0.08900	0.04907	0.04901	0.02712	0.08881
Q_2	0.10252	0.22065	0.10146	0.10000	0.08751	0.10605	0.05593	0.08900	0.15056	0.04901	0.25479	0.11880
Q_3	0.10252	0.15801	0.14647	0.10000	0.08751	0.10605	0.09904	0.06572	0.15056	0.04901	0.02712	0.09960
Q_4	0.18472	0.15801	0.28382	0.20000	0.27168	0.19915	0.37413	0.13802	0.22251	0.26073	0.17534	0.24070
Q_5	0.18472	0.07485	0.22584	0.20000	0.16496	0.10605	0.28481	0.13802	0.15056	0.26073	0.10653	0.17886
Q_6	0.10252	0.10673	0.05088	0.10000	0.02917	0.10605	0.03254	0.18842	0.02096	0.09416	0.02654	0.06956
Q_7	0.10252	0.05009	0.02669	0.10000	0.02917	0.05853	0.03254	0.01617	0.08525	0.04901	0.10361	0.05623
Q_8	0.06700	0.05009	0.05088	0.05000	0.02917	0.10605	0.03254	0.08724	0.08525	0.09416	0.17534	0.07377
Q_9	0.05096	0.07485	0.03462	0.05000	0.02917	0.10605	0.03254	0.18842	0.08525	0.09416	0.10361	0.07368
CR	0.00890	0.01700	0.01290	0.00000	0.00110	0.00370	0.00900	0.01850	0.00770	0.00090	0.00600	

Table 6. An Aggregated Pairwise Comparison Matrix of 11 Turkish Contractors

	Q_1	Q_2	Q_3	Q_4	Q_5	Q_6	Q_7	Q_8	Q_9
Q_1	1	0.722	0.8816	0.3537	0.4907	1.3493	1.5881	1.2535	1.2211
Q_2	1.3851	1	1.2211	0.4847	0.6216	1.7152	2.0433	1.6733	1.6301
Q_3	1.1343	0.8189	1	0.4012	0.5357	1.5121	1.808	1.3493	1.3851
Q_4	2.827	2.063	2.4922	1	1.5544	3.3114	3.8971	3.076	3.0142
Q_5	2.0381	1.6086	1.8669	0.6433	1	2.5126	3.3271	2.4922	2.3504
Q_6	0.7411	0.583	0.6613	0.302	0.398	1	1.2211	0.9638	1
Q_7	0.6297	0.4894	0.5531	0.2566	0.3006	0.8189	1	0.7616	0.722
Q_8	0.7978	0.5976	0.7411	0.3251	0.4012	1.0375	1.313	1	1.065
Q_9	0.8189	0.6134	0.722	0.3318	0.4255	1	1.3851	0.9389	1

Inputs of the framework include group decision on the weights of the most important KPIs (Qs), which are obtained from AHP calculations, measurement scales for each KPI, the direction of preference of each KPI (minimum is the most favourable or maximum is the most favourable) and the evaluations of

all candidate subcontractors with respect to each KPI.
Having determined the inputs' values, in the process step, the performance scores (q) of all candidate subcontractors are calculated by normalising the evaluations concerning each KPI considering the direction of preference. If the direction of preference is maximum, the quantitative equivalence of the evaluation of a subcontractor candidate for any KPI is divided by the sum of the evaluations of all subcontractors to the KPI in question. On the other hand, if the direction of preference is minimum, the reciprocals of the quantitative equivalences of the evaluations are normalised. By this way, the subcontractor candidate with the minimum value becomes more favourable.
In the output step, the overall quality performance index (QPI) of each subcontractor candidate can be calculated using Equation 5.

$$QPI_{SCm} = \sum_{i=1}^{9} w_i^G \times q_{im} \qquad \text{(Eq. 5)}$$

Where QPI_{SCm} represents the overall QPI of the mth subcontractor, w_{Gi} represents the aggregated weight of the ith KPI (Q_i) based on group decision and q_{im} represents the performance score of the mth subcontractor candidate for the ith KPI (Q_i).

An Illustrative Example of the Application of the Proposed Quality Performance Measurement Framework

An illustrative example has been presented to demonstrate how the proposed framework can be used by a Turkish general contractor, who intends to evaluate the quality performances of the subcontractor candidates under consideration for an international construction project.
In the illustrative example (as shown in Table 7), there are five subcontractor candidates. First, the general contractor determines the measurement scales for each KPI, identifies the direction of preference of each KPI and evaluates all candidate subcontractors for each KPI based on the identified measurement scale. The weights of the KPIs are obtained from the AHP calculations presented in the last column of Table 5. Second, the general contractor calculates the performance scores (q) of all candidate subcontractors. And finally, the general contractor computes the overall QPI of all candidate subcontractors. In the illustrative example, the overall quality performance of the fourth subcontractor candidate (SC_4) is higher than the other candidates.

Table 7. An Illustrative Example of the Application of the Proposed Framewor

Q#	Q Definition	Measurement Scales	Direction of Preferences	Weights	Evaluations of Subcontractor Candidates					Quality Scores of Subcontractor Candidates				
					SC_1	SC_2	SC_3	SC_4	SC_5	q_1	q_2	q_3	q_4	q_5
Q_1	Adequacy of quality assurance policy	VB–VG[3]	Max.	0.08881	G	VG	M	G	VG	0.190	0.238	0.143	0.190	0.238
Q_2	The application level of the quality management system in projects	VB–VG	Max.	0.11880	G	M	M	M	G	0.235	0.176	0.176	0.176	0.235
Q_3	The audit of the quality management system in project level	VB–VG	Max.	0.09960	M	G	G	VG	M	0.158	0.211	0.211	0.263	0.158
Q_4	Construction quality (conformance to the specification)	VB–VG	Max.	0.24070	G	VG	G	M	G	0.200	0.250	0.200	0.150	0.200
Q_5	The quality of workmanship	VB–VG	Max.	0.17886	VG	M	VG	G	M	0.250	0.150	0.250	0.200	0.150
Q_6	The cost of poor quality resulting from the low standard production	%	Min.	0.08956	1.2	2.9	2.1	1	1.1	0.234	0.097	0.134	0.281	0.255
Q_7	Number of reworks	Number	Min.	0.05623	14	9	8	4	11	0.110	0.171	0.193	0.386	0.140
Q_8	Percentage of reworks (%)	%	Min.	0.07377	3.2	4.4	4.1	1.8	3.3	0.190	0.138	0.149	0.338	0.185
Q_9	The severity of defect at the construction phase	VL–VH[4]	Min.	0.07368	M	H	M	VH	H	0.244	0.183	0.244	0.146	0.183
QPI					0.208	0.190	0.197	0.213	0.193					

CONCLUSION

Since most of the international construction projects are highly complex in nature, they require the involvement of multiple subcontractors; therefore, the selection of the most appropriate subcontractor becomes crucial for the overall project success. The subcontractor selection process is mostly affected by several compromising and conflicting, tangible and intangible criteria. While the criteria like cost and time can be numerically measured, the criteria like safety and quality cannot be easily measured. This study aimed to solve this issue by developing a framework for measuring the quality performances of subcontractor candidates more systematically and rationally way. To use the proposed framework, subcontractor candidates should be assessed based on the identified nine KPIs. After these assessments, the quality performance of the candidates can be determined using the proposed framework. The measurement framework includes indicators that can be measured quantitatively and qualitatively.

The limitations of this study are related to the developed framework relying on the individual preferences of the 11 Turkish companies that are also the target users. This potential limitation can be overcome by increasing the sample size. Moreover, the performance of the proposed framework should be tested with real cases.

REFERENCES

Ali, H.A.E.M., Al-Sulaihi, I.A. and Al-Gahtani, K.S. (2013). Indicators for measuring performance of building construction companies in Kingdom of Saudi Arabia. Journal of King Saud University – Engineering Sciences, 25(2): 125–134. https://doi.org/10.1016/j.jksues.2012.03.002.

Arslan, G., Kivrak, S., Birgonul, M.T. and Dikmen, I. (2008). Improving sub-contractor selection process in construction projects: Web-based sub-contractor evaluation system (WEBSES). Automation in Construction, 17(4): 480–488. https://doi.org/10.1016/j.autcon.2007.08.004.

Bingol, B.N. and Polat, G. (2016). Measuring quality performances of subcontractors using key performance indicators (KPIs) model. Paper presented at the 12th International Congress on Advances in Civil Engineering. Istanbul, Turkey, 21–23 September.

Chan, A.P.C. and Chan, A.P.L. (2004). Key performance indicators for measuring construction success. Benchmarking: An International Journal, 11(2): 203–221. https://doi.org/10.1108/14635770410532624.
Chen, Y., Okudan, G.E. and Riley, D.R. (2010). Sustainable performance criteria for construction method selection in concrete buildings. Automation in Construction, 19(2): 235–244. https://doi.org/10.1016/j.autcon.2009.10.004.
Choudhry, R.M., Hinze, J.W., Arshad, M. and Gabriel, H.F. (2012). Subcontracting practices in the construction industry of Pakistan. Journal of Construction Engineering and Management, 138(12): 1353–1359. https://doi.org/10.1061/(ASCE)CO.1943-7862.0000562.
El-Mashaleh, M.S. (2009). A construction subcontractor selection model. Jordan Journal of Civil Engineering, 3(4): 375–383.
Enshassi, A., Choudhry, R.M., Mayer, P.E. and Shoman, Y. (2008). Safety performance of subcontractors in the Palestinian construction industry. Journal of Construction in Developing Countries, 13(1): 51–62
Enshassi, A., Mohamed, S. and Abushaban, S. (2009). Factors affecting the performance of construction projects in the Gaza strip. Journal of Civil
Engineering and Management, 15(3): 269–280. https://doi.org/10.3846/1392-3730.2009.15.269-280.
Escobar, M.T., Aguarón, J. and Moreno-Jiménez, J.M. (2004). A note on AHP group consistency for the row geometric mean priorization procedure. European Journal of Operational Research, 153(2): 318–322. https://doi.org/10.1016/S0377-2217(03)00154-1.
Field, A. (2017). Discovering Statistics Using IBM SPSS Statistics: North American Edition. Thousand Oaks, CA: SAGE.
Hartmann, A., Ling, F.Y.Y. and Tan, J.S. (2009). Relative importance of subcontractor selection criteria: Evidence from Singapore. Journal of Construction Engineering and Management, 135(9): 826–832. https://doi.org/10.1061/(ASCE)0733-9364(2009)135:9(826).
Hatush, Z. and Skitmore, M. (1997). Criteria for contractor selection. Construction Management and Economics, 15(1): 19–38. https://doi.org/10.1080/014461997373088.
Kagioglou, M., Cooper, R. and Aouad, G. (2001). Performance management in construction: A conceptual framework. Construction Management and Economics, 19(1): 85–95. https://doi.org/10.1080/01446190010003425.
Lee, A., Cooper, R. and Aouad, G. (2000). A methodology for designing performance measures for the UK construction industry. Paper presented at the Bizarre Fruit 2000 Postgraduate Research Conference on the Built and Human Environment. University of Salford, Salford, UK, 9–10 March.
Lin, G. and Shen, Q. (2007). Measuring the performance of value management studies in construction: Critical review. Journal of Management in Engineering, 23(1): 2–9. https://doi.org/10.1061/(ASCE)0742-597X(2007)23:1(2).
Luu, V.T., Kim, S.-Y. and Huynh, T.-A. (2008). Improving project management performance of large contractors using benchmarking approach. International Journal of Project Management, 26(7): 758–769. https://doi.org/10.1016/j.ijproman.2007.10.002.
Mahdi, I.M., Riley, M.J., Fereig, S.M. and Alex, A.P. (2002). A multi-criteria approach to contractor selection. Engineering Construction and Architectural Management, 9(1): 29–37. https://doi.org/10.1108/eb021204.
Marzouk, M.M., El Kherbawy, A.A. and Khalifa, M. (2013). Factors influencing sub contractors selection in construction projects. HBRC Journal, 9(2): 150–158. https://doi.org/10.1016/j.hbrcj.2013.05.001.
Mbachu, J. (2008). Conceptual framework for the assessment of subcontractors' eligibility and performance in the construction industry. Construction Management and Economics, 26(5): 471–484. https://doi.org/10.1080/01446190801918730.
Ng, S.T. and Skitmore, M. (2014). Developing a framework for subcontractor appraisal using a

balanced scorecard. Journal of Civil Engineering and Management, 20(2): 149–158. https://doi.org/10.3846/13923730.2013.802705.
Onder, G. and Onder, E. (2014). AHS. In E. Önder and B.F. Yildirim (eds.), Çok Kriterli Karar Verme. Istanbul: Dora Yayincilik, 21–64.
Saaty, T. (1980). The Analytic Process: Planning, Priority Setting, Resources Allocation. London: McGraw-Hill.
Saaty, T.L. (2008). Decision making with the analytic hierarchy process. International Journal of Services Sciences, 1(1): 83–98. https://doi.org/10.1504/IJSSCI.2008.017590.
Saaty, T.L. and Vargas, L.G. (2012). Models, Methods, Concepts and Applications of the Analytic Hierarchy Process. Berlin/Heidelberg: Springer Science and Business Media, 175.
Timor, M. (2011). Analitik Hiyerarsi Prosesi. Istanbul: Turkmen Kitabevi.
Trinkūnienė, E., Podvezko, V., Zavadskas, E.K., Jokšienė, I., Vinogradova, I. and Trinkūnas, V. (2017). Evaluation of quality assurance in contractor contracts by multi-attribute decision-making methods. Economic Research – Ekonomska
Istraživanja, 30(1): 1152–1180. https://doi.org/10.1080/1331677X.2017.1325616.
Tserng, H.P. and Lin, P.H. (2002). An accelerated subcontracting and procuring model for construction projects. Automation in Construction, 11(1): 105–125. https://doi.org/10.1016/S0926-5805(01)00056-5.
Turkish Contractors Association (TCA) (2018). Turkish Contractors Association Sector Report. Ankara: TCA.
Ulubeyli, S., Manisali, E. and Kazaz, A. (2010). Subcontractor selection practices in international construction projects. Journal of Civil Engineering and Management, 16(1): 47–56. https://doi.org/10.3846/jcem.2010.04.
Vaidya, O.S. and Kumar, S. (2006). Analytic hierarchy process: An overview of applications. European Journal of Operational Research, 169(1): 1–29. https://doi.org/10.1016/j.ejor.2004.04.028.
Ward, S., Curtis, B. and Chapman, C. (1991). Objectives and performance in construction projects. Construction Management and Economics, 9(4): 343–353. https://doi.org/10.1080/01446199100000027.
Yang, H., Yeung, J.F., Chan, A.P., Chiang, Y. and Chan, D.W. (2010). A critical review of performance measurement in construction. Journal of Facilities Management, 8(4): 269–284. https://doi.org/10.1108/14725961011078981.
Yasamis-Speroni, F., Lee, D.-E. and Arditi, D. (2012). Evaluating the quality performance of pavement contractors. Journal of Construction Engineering and Management, 138(10): 1114–1124. https://doi.org/10.1061/(ASCE)CO.1943-7862.0000539.
Yu, I., Kim, K., Jung, Y. and Chin, S. (2007). Comparable performance measurement system for construction companies. Journal of Management in Engineering, 23(3): 131–139. https://doi.org/10.1061/(ASCE)0742-597X(2007)23:3(131)

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