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Full Length Research Paper

Exploring concrete materials batching behaviour of artisans in Ghana's informal construction sector

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This paper investigated construction materials-batching behaviour of artisans in the informal construction sector in Ghana. The research was conducted in three major towns across three regions namely the Volta, Greater Accra and Eastern regions of Ghana. A quantitative data collection approach was adopted as the primary methodology for gathering the data from the target population using cluster-sampling technique to select the sample population. The results showed that the informal construction sector in Ghana paid little attention to the standard practices and procedures in constructing residential buildings. This is due to inadequate levels of apprenticeship training to develop the skills and competence of artisans. Low-quality training duped apprentices into thinking that they were fully qualified when they were not. Furthermore, apprenticeship varied widely across construction trades and master artisans. Batching was eyeballed instead of being measured scientifically resulting in insufficient cement to the aggregate ratio in cement blocks, concrete and mortar works. Moreover, weak cement blocks often lead to poor construction and weak buildings with rising moisture content in walls, leaking roofs, cracks and structural failures.

Key words: Artisans, batching, concrete materials, construction industry, Ghana, informal sector.

INTRODUCTION

The construction sector in Ghana like many developing countries is made up of formal and informal sectors. Mlinga and Wells, (2002) reports that in Tanzania, there is both formal and informal sector, that collaborates strongly between enterprises in the construction sector. The findings conclude that the formal construction industry is one in which all the government regulations about construction licensing, registration, employment among others are adhered to, while in the informal construction sector, there is little or no regulatory compliance. The formal sector consists of construction organisations that employed trained professionals such as architects, civil engineers, quantity surveyors, geotechnical engineers, electrical engineers and other related skills sets. Formal construction sector organisations are regulated, monitored and taxed by the government while informal construction sector organisations are unregulated; they hardly pay taxes and

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are often managed by informally trained artisans (Wells, 2001). Moreover, unlike the formal sector, construction projects in the informal sector are implemented on an incremental basis without consideration of project duration, cost, quality and health and safety issues. Clients' financial resources and master artisan determine the completion date and project quality (Hedidor et al., 2016). Constructions projects undertaken in this sector typically include incremental housing, shops, fence walls and other institutional facilities. The informal construction sector in many developing countries is developing at a faster pace due to the high demand and desire of individual's homeownership (Bondinuba et al., 2016). This demand has resulted in many constructions works being carried out without materials and workmanship specifications, non-compliance with building planning permits and documentations. Building facilities completed without compliance with the above requirements often experienced rising moisture content in walls, leaking roofs, cracks and structural failure. Though the above challenges are on the increase in the informal construction sector in Ghana; there is little or no systematic study that unearthed the nature of construction activities and the materials batching behaviour of artisans in this sector. This paper, therefore, seeks to investigate the material batching behaviour of artisans in the informal construction industry in Ghana. The paper is structured into five sections. Section two discusses the nature, trend and training needs of the informal construction sector in Ghana. Section three and four presents the methodology and discussions on the findings whiles sections five draw conclusions from the findings.

NATURE AND TREND OF THE INFORMAL CONSTRUCTION SECTOR IN DEVELOPING COUNTRIES

The informal sector of many developing economies can be described as very relaxed and friendly due to the unregulated operational rules and regulations often adopted by operatives in the industry. Hart (1973) studied Frafra urban migrants in Ghana and describe the operatives in this sector as mainly of "unskilled and illiterate" whose activities are often affected by price inflation and inadequate wages. This has contributed significantly to the high degree of informality in the income-generating activities of the sub-proletariat. Uwakweh (2000) also examined the conceptual framework of construction workers motivation in developing countries and argued that reward or wage structures is one of the compelling forces in the informal construction sector. Chen, (2001) reviewing the size, composition and movement of women in Sub-Saharan Africa and other parts of the world, found that "virtually all of the female non-agricultural labour force are in the informal sector". This indicates that in most developing countries, there are more females in the informal sector than males. The ILO (2002b) report described the informal sector as the total of all income-earning activities outside of the legally regulated enterprises in an economy. The report further analyses factors such as legal and institutional frameworks, employment, poverty and demographic factors and the informal economy and suggest that informal sector in Sub-Saharan Africa had the largest concentration of informality in the world.

In the views of Wells (2007), the term 'informal economy' should be examine based on the conceptual whole of informality taking into consideration both production and employment relationships in the sector. The paper further suggests that the concept of informal economy is broad which emphasised on the 'unregulated' nature of economic activities where labour laws were rarely followed. In this regards, a job in this sector is considered to be informal if it falls outside the framework of labour regulations and therefore the holder does not enjoy any legal protection or entitlement to certain social benefits such as annual leave, sick leave, among others (Uwakweh, 2000; Wells, 2007). Potts (2008) also examined the attitudinal changes that are needed in the urban informal sector in the Sub-Saharan Africa and suggest that most new urban jobs in Africa were in the informal sector. This means the informal sector contributes significantly to the continent's economy. This means the informal sector in these developing economies can no longer be regarded as a temporary or residual sector. Furthermore, Meagher (2010) conducts a comparative case study of 14,000 small enterprises in Nigeria and notes that the informal economy was at the heart of contemporary issues of economic governance and restructuring where the central governments could no longer ignore the importance of the informal sector's contribution to the national economy.

Whereas Misati (2010) studied the role of the informal sector investments, Walther (2011) on the other hand reviewed various studies on the informal sector in Sub-Saharan Africa. Using system-GMM forecast techniques and informal market data created by the Heritage Foundation, Misati (2010) notes that there was a positive correlation between economic investment and the informal sector. Walther (2011) also establishes that many of the operatives working in the informal sector were informally trained and in some economies, the informal sector accounts for about 90% of all labour market activities and jobs. Furthermore, Misati (2010) argues that the informal sector in sub-Saharan Africa can be seen on the streets, sidewalks and back alleys of cities including petty traders, street vendors, small-scale artisans and shoe shiners which signifies that, the informal sector play a strong role in income and wealth generation. Walther (2011) on the above premise proposes various schemes for skill building which includes the development of apprenticeship schemes adapted to the specific context of agricultural and rural

sectors.

Nature and activities of the informal construction

Despite Rogerson (1988), assertion that the construction industry is one of the largest employers of informal sector workforce and any stagnation precipitates the expansion of the informal sector economy; the wage levels in the industry are very low. The daily wage levels at the study regions on the average ranges from Gh¢ 35.00 to Gh¢ 50.00 for an eight hours' day work. Another aspect that characterised the sector is the nature and condition of employments. In this regards, Well (2001) examines building ownership and labour management perspectives in Kenyan construction industry as well as the material purchases and capital formation among construction organisations. The findings reveal that there is a close relationship between employees and building owners in the informal sector and there is the absence of regulation regarding conditions of employment and the construction process in the country.

There is also a high percentage of construction work carried out in developing countries through informally or unconventional means (Jewell et al., 2005). For instance, in developing economies, informal construction accounted for 80% of employment. The above reviews indicate that the informal construction sector is very complex and challenging to measure although it is one of the major sectors in the developing world. Standing (2011) in trying to understand the nature of informal construction sector workforce, classified them under precariat and survivalist informal workers. Precariat workers in the construction industry are the categories of informal workers who cannot identify themselves with any skills jobs. Precariat's workers have much more to offer including qualifications, expertise and experience in the labour market than the survivalist informal workers. However, unlike the Precariat workers informal worker, the survivalist informal workers often lacked labour rights in most developing countries construction sectors.

There is also a lack of artisan training schemes and programmes in the informal construction sectors in many developing countries including Ghana. The artisanal apprenticeship systems in many DCs were formulated in the latter middle ages before it came to be supervised by craft guilds and town governments (Anosike and Oyebade, 2012). Stretton (1981) discussed the construction industry in Ethiopia, Kenya and Sri Lanka, comparing the industry in those countries with that of the Philippines and indicate that there was no formal apprenticeship system in the Philippians. Instead, independent foremen and Pakiaos (subcontractors) conducted skill training for employees for no certain duration. As the trainees were often relatives of the trainers, no fee was charged. The system was referred to as "learning by doing". With piecemeal briefings from the trainer, the trainee learned as much as the trainer knew and was willing to share during the training period. Within the period of training, the trainee remained with one master craftsman, who determined when the trainee was competent enough to graduate from any trade. Informal construction sector artisans therefore usually formed the information network that is crucial to the skill acquisition and job recruitment within the industry (Stretton, 1981). Ndua and Ng'ethe (1985) note that the common apprenticeship system in Ethiopia is one where masters in the various trades taught apprentices the way they (the masters) were taught with little or no infusion of new technology and new designs. There is the possibility of such a system of training creating virtually no new knowledge and limiting the exposure potential of the apprentices and the quality of work that they could perform.

Abban and Quarshie (1993) also expand the understanding of the technical skills of apprentices and master mechanics in the informal construction industry. Their findings show that apprenticeship training system was carried out in phases wherein the phase one, a novice was coached to perform menial tasks such as tidying up the work area or running errands. Phase two introduced tools, equipment and work materials, though the training system was effective it was limited in scope and innovation. Informal construction sector artisans also constitute the human resource development in small- and micro-enterprises in developing countries. Knowledge transfer and tuition fee structures in the construction industry were not published (Boehm, 1995). Therefore, any effective apprenticeship system should be able to offer an effective way of transferring skills or education directly to the apprentice. There is usually no agreed or established fee structure; sometimes the trainer received a fee, but at other times the apprentice worked for reduced or no wages. Schwartz (1999) investigates the working class in revolutionary France about men's occupations. The study discusses cottage industries, migrant and elite workers as well as apprenticeship practices in the country and notes that apprenticeship is one of the oldest methods of training artisans, a practice that could last from five to eight years under a "master craftsman" through an indenture agreement.

Moreover, in the case of Zambia Muya et al. (2003) discuss the construction skills requirements suggest that the "future effectiveness of the construction industry depends on the quality of the workforce it educates and trains". To be cost-effective, publicly owned and managed technical and vocational education and training (TVET) will need to develop new programmes in TVET especially nonfarm employment skills development. Apprentices learned trade-related skills such as how to handle tools and repair machines, as well as general business management skills like sourcing, pricing, and contracting, can be enhanced by trade associations which could be very instrumental in providing skills for the informal sector

under certain conditions" such as clear understanding of the interest of potential participants (Adams et al., 2013). The Joint Initiative on Priority Skills Acquisition (JIPSA, 2007) examined the accelerated and shared growth initiatives for South Africa and suggested that the continent produced only 5,000 artisans per year. The Joint Initiative is of the view that Africa needed to train at least 12,500 artisans each year to meet industry demand by 2012. Walther (2008) seminal work on the apprenticeship systems in Benin, Mali, Senegal and Togo reveals that there is a very disappointing lack of apprenticeship reforms in these countries except Mali where reforms were introduced in 1997. These reforms enable apprentices to spend 20% of their training time in the classroom and 80% in the field. Another study by Fitchett (2009) examines the skills development and job creation perspectives through small public buildings in South Africa. The study reveals that the construction sector is an important job creator. Artisan training programmes should, therefore, adapt to the realities of communities where high unemployment prevents people from engaging in lengthy periods without a wage income.

Trends of artisans training in Ghana

The informal construction industry in Ghana is pervasive throughout the rural communities, peri-urban and urban areas in the country. Small and medium size construction organisations dominate this sector, employing between 5 to 10 people on a casual basis (Bondinuba, 2012). According to the Ghana Living Standard Survey (GLSS 6), about 91% of all the young people working in the construction sector are employed by the informal construction sector. The Ghana Statistical service GSS (2014) reports that monthly wage levels of young people in the informal sector are approximate $100 per month which is less than their counterparts working in the mining sector with ($210), health and social work ($152), transport and storage ($110) and agriculture ($144). Frazer (2006) developed models for apprenticeship training in Ghana and suggest that the nature of apprenticeship training in the country was sector-specific and often product-specific; apprentices might learn how to manufacture or repair only one item at a time.

Furthermore, Haan and Serriere (2002) explores the training programs and needs of the informal sector in Ghana and found that traditional apprenticeships in these countries were often family or community centred and included 'moral upbringing' as well as the transfer of practical skills. However, in analysing the various types of training programs, the researchers identify vocational training, training for self-employment, apprenticeship training and related educational training programs as a prerequisite for the development of the informal sector in Kenya, Ghana, Tanzania, Uganda, Zambia and Zimbabwe. Besides, training programs needs of the sector, information and communication technologies (ICTs) also holds a vast potential for training for the informal sector. To this end, Akyeampong (2002) concludes that the vocationalization of the informal sector is key and efforts must be intensified by all stakeholders to improve the sector. In a similar study, Osei (2004) reviewed the vocational or pre-vocational training programs in Ghana's 1987 junior secondary school reforms. Using various types of interviews, the researcher found that teachers failed to implement proposed integrated changes, concluding that vocationalization initiatives were not successful because they were not clearly conceptualised. Botchie and Ahadzie (2004) review the various occupational skills training initiatives by interviewing managers of formal and informal programs throughout the country. They argued that apprentices lack of basic literacy and numeracy skills undermine the ability to develop core occupational competencies, concluding that the provision of training services by 'inexperienced staff" and lack of agency coordination duplicated efforts and created gaps in educational service delivery and occupational skills acquisition.

Palmer (2005) examined the impact of informal and formal skills development on poverty reduction in Ghana and reviewed the historical role of post-basic education and training (PBET), government poverty reduction strategies as well as the role of nongovernment providers of PBET. The study suggests that vocational and technical education were linked to labour market demands which mean that traditional apprenticeship training accounts for about 80-90% of all skills development in Ghana. This makes apprenticeship training essential building blocks of the government's poverty-reduction strategy in the country. Preddey (2005) appraised the trends in skills development in rural Ghana and profiled training providers in the country and point out that the National Vocational Training Institute mandate is to coordinate the various informal training activities including apprenticeships, standards, certification and labour-market monitoring. There is, therefore, the need to support skills development in the informal economy which is virtually non-existent. Palmer (2007) analysed skills development in Ghana's informal sector and argue that various training providers trained microenterprise operators and that skills development interventions follow a top-down strategy, with programmes having little labour market relevance. King and Palmer, (2007) reviewed the relationship between skills development and poverty reduction. After recounting the history of technical and vocational education and training (TVET), industrial and agricultural education, vocational education and training (VET) as well as poverty reduction initiatives, they found that while apprenticeships represented accessible training routes for the poor, high costs pushed essential training out of reach. They concluded that "left to the market, skills systems [tendered] to favour the non-poor".

Monk et al. (2008) suggest that apprentices are made

up of nearly 25% of working-age Ghanaians and 28% of urban residents. These percentages suggest that there is little research on apprenticeship as a form of skills training in the country. Akyeampong (2010) also notes that Ghana's educational initiatives from 1961 to 2007 are characterized by teacher shortages in TVET and learning-resource limitations which led to learner interest and quality reduction. One possible reason for the lack of TVET relevance includes inappropriate assumptions concerning the general labour market and lack of linkages between training providers and business owners (ILO, 2002a). Furthermore, though access to all levels of education has improved significantly over the years, skills training still remain one of the unsupported sectors (Akyeampong, 2010). Anokye et al. (2014) note that nearly 33% of Junior High School and 42% of Senior High School students dropped out were from the technical schools in the country. There is therefore the need for a conscious effort by all stakeholders to address the many bottlenecks to the growth and development of the apprenticeship system.

Artisans batching behaviour and its effect on construction works

Workmanship, is defined in the ISO (2000) standard as "the totality of features and characteristics of a product or service that bear its ability to satisfy stated or implied needs", was a persistent problem in the Ghana construction industry. Baiden and Tuuli (2004) investigated the impact of quality control practices in concrete blocks. They analysed construction-project defects and related activities including architectural drawings, specification, workmanship and "durability, aesthetic, performance or design". They noted that "defects and variations in construction products from standards is persistently a problem of concern in the construction industry in Ghana". They concluded that defective construction was typically due to "in compliance or lack of conformity with contract agreements. Kazaz and Birgonul (2005) studied the construction quality of mass housing projects in Turkey. Using a questionnaire survey containing 108 questions, they investigated the completed projects of the companies engaged in building public houses for low and middle income groups. They found that poor workmanship was commonplace and that "households are not completely satisfied" with the quality of workmanship of these companies.

Chong and Low (2005) investigated the defects at construction and occupancy stages of building projects in Singapore. Arguing that the limitations of construction inspections inhibit the types of defect that a building inspector could detect, the authors examined "differences among the defects that occurred during construction and 2 to 6 years after initial occupancy". They found that latent defects were almost never discovered during the construction stage. They also found that workmanship quality was influenced by the lack of incentives, concluding that most defects were due to lack of knowledge, lack of information or lack of motivation" and carelessness. Razak et al. (2010) conducted a benchmarking investigation of the status of the Malaysian construction industry. They examined the production processes used by Malaysian construction workers, key success factors, challenges, research and development, concluding that many construction projects in the country did not meet client satisfaction.

For instance, the materials for concrete and mortar production are typically stipulated in standards and specification manuals. However, Goldbeck and Gray (1968) examines the compression strength of structural and paving concrete and concludes that concrete mixture should be engineered to fit the available aggregates and the strength and durability requirements of the job. Neville and Brooks (1987) analysed concrete technology and discuss many aspects of cement technology including cement as a structural material, aggregate properties, water quality and the factors influencing the workability of fresh concrete in which it has been concluded that volume batching of materials was a bad practice.

The Concrete –Complementary British Standard to BS EN 206-1 – Part 1: Method of specifying and guidance for the specified" published by the British Standards Institution (BSI) outlined the standards and specifications for mixing concrete. Specifically, the standard described the following types of concrete: designated concretes, designed concretes, prescribed concretes, standardized-prescribed concretes and proprietarily concretes. According to BSI, the specifier of the concrete shall ensure that all the relevant requirements for concrete properties are included in the specification given to the producer. Olusola et al. (2012) discovered that the common batching practices in the Nigerian construction industry are by batching by volume. This is because most site operatives find the process easier, simpler and faster. The researchers note that batching by mass was uncommon and the compressive strength obtained from volume batching in a typical construction site in the country was almost likely to be less than the target strength stipulated in the relevant standards and specifications. Despite the above plethora of literature, the informal construction sector and the need for proper batching of construction materials in other jurisdictions none of these researchers has established the batching behaviour of construction artisans in the construction industry, particularly in Ghana.

METHODOLOGY

A quantitative data collection approach was adopted as the primary methodology for gathering data from the target population. The study population comprised construction artisans (block/bricklayers) who were directly involved in the use and batching of construction materials such as cement, fine and coarse aggregates. According

Table 1. Questionnaire distribution and response rate.

Study Zones	Frequency	%	No. of questionnaire suitable for analysis	%
Mepe/Battor	70	23.33	67	25.97
Pokuase	120	40.00	97	37.60
Nsawam	110	36.67	94	36.43
Total	**300**	**100**	**258**	**100**

Source: Fieldwork (2016).

to Neuman, (2006), questionnaire allows researchers to collect an extensive amount of information such as demographic, behavioural habits, perceptions, opinions and attitudes from a wide range of respondents, and thus the findings become applicable to a population. To complement the questionnaire survey, the relevant literature on construction and the informal construction sector published in journals, textbooks and government documents were extensively reviewed. Before the questionnaires distribution, they were pretested on five artisans in the target population and on an expert who worked with informal construction artisans. After making the corrections suggested by the validators, 300 questions were hand delivered to randomly selected artisans in the study zones as showed in Table 1. Since the target population was in a wide geographical area; cluster sampling technique was used to choose the sample population. Out of the 300 questionnaires, 70 were distributed to artisans in Mepe/Battor, 120 at Pokuse and 110 at Nsawam.

The questionnaire comprised of six sections. Section A consisted of five closed-ended questions and one open-ended question about the respondent's skills set. Section B consisted of seven open-ended questions about project type undertaken by those surveyed, while Section C consisted of six open-ended questions about building materials and tools used on construction projects. Section D consisted of another eight open-ended and four close-ended questions about material batching. Section E consisted of five close-ended questions about building defects resulting from poor material batching skills of artisans while the last part F consisted of five open-ended and two close-ended questions about respondent's background. To facilitate follow-up and boost return rate, contact cellphone numbers of the respondents were collected. Regular contact between the researchers and respondents was made until the completed questionnaires were returned. The responses were analyzed using simple percentages, and frequency tables and charts.

RESULTS ANALYSIS AND DISCUSSION

The issues discussed here were respondents' background, respondents' skills training and types of building project undertaken by those surveyed. Other issues discussed were building materials and tools used on the selected building projects, batching techniques used in measuring building materials on site, and defects noticed during post-construction audits. The questionnaire response rate was high. Out of the 300 questionnaires, two hundred and fifty-eight (258) completed questionnaires were collected, yielding a response rate of 86%. Of these, forty-two (42) representing 14% contained no information or were incomplete and were not included in the results analysis. The following narrative highlighted the key findings.

Respondents' information

Here, the respondents' background to help generate confidence in the reliability of data collected and eventually in the results of the study is briefly discussed. Adinyira and Anokye (2013) opined that "it is always important to have a fair idea of the respondents to situate the responses within context". Consequently, the relevant socio-demographic variables of respondents that this research covered included age, sex, the level of education and trade expertise (occupational status). The survey found that males dominated the construction sector in Mepe/Battor, Pokuase and Nsawam thus the sample was composed entirely of men, 100% n (258). The results agree with the findings of (Eisenberg et al., 1998). A survey of major employers by Mackenzie et al. (2000) also revealed a high level of scepticism about the recruitment of women in the construction industry and Mitullah and Wachira (2003) found in a similar study that males dominated the construction sector. They further reported that women's role on construction sites was limited to selling affordable food to workers. On the contrary, there was a significant percentage of women in the Indian construction sector. To ensure human capacity building in the construction industry, artisans needed to be continuously trained. The labor-intensive nature of construction work meant that the trainees required to be millennials if trainers were to be productive. Accordingly, the respondents were asked to indicate their age. The age of the respondents was categorised in ten years intervals to isolate the age range that produced most of the respondents. The respondents' ages ranged from 18 to 65 years with the majority being in the 26 year's brackets 26.36%. Out of the above, 5.04% were in the age bracket of up to 20, 25.19% of them were between 18 and 26 years, while 20.16% were between 32 to 44 years. Moreover, almost 10.85% of the respondents were over 60 years of age as showed in Table 2.

Experience plays important roles in an artisan's construction operational excellence. Without well trained and experienced artisans, it would be difficult to produce quality workmanship. Mojahed and Aghazadeh (2008) reported that the skill level and experience of the

Table 2. Respondents biographical data.

Response	Frequency	%
Age (years)		
Up to 20 years	13	5.04
20-30 years	68	26.36
30-40 years	65	25.19
40-50 years	52	20.16
50-60 years	32	12.40
60+ years	28	10.85
Total	258	100
Respondents' experience		
Up to 10 years	104	40.31
10 - 20 years	76	29.46
20 – 40 years	41	15.89
40 – 50 years	28	10.85
50+ years	9	3.49

Source: Fieldwork (2016).

workforce on site was the most important indicator of site productivity in the construction industry. Consequently, the respondents were asked to indicate their work experience as artisans since graduating from apprenticeship training. The results show that 40.31% had up to 10 years' experience, 29.46% had between 10 to 20 years' experience and 15.89% had between 20 to 40 years' experience, 10.85% of the respondents had 40 to 50 years' experience while 3.49% had 50 plus years' experience (Table 2). The above numbers showed that there were experienced artisans in the Ghana informal construction industry. This finding agrees with that of Offei–Nyako et al. (2014) who report that the modal year range of experienced artisans in the construction industry was between 6 to 10 years based on a frequency of 29 and representing 58% of the total number of respondents. Sherif et al. (2014) reported that skill gaps in knowledge influenced productivity levels of workers; eventually contributing to poor workmanships due to in-experience.

The results showed that the labour force in Ghana's informal construction sector at the time of the study was ageing; the respondents in the up-to-20-year group formed only 5.04% n(13). The difference between those in the 20 to 30 and 30 to 40 range was only 1.17% (3). This result could be attributed to the lack of interest in the building trades by the country's rapidly increasing youthful population who were more interested in white-collar jobs than physical labour. Mitullah and Wachira (2003), study already cited, the youngest construction worker was twenty-one years old while the eldest was 63. In general, the sector accommodated a relatively young workforce; the majority of the labour force was 45 years of age in Kenya. The respondents were also asked to state their educational accomplishments. The results showed that 14.34% of the respondents had only primary education while 39.92% completed junior high and middle schools. About 32.56% attained vocational and technical education while 13.18% completed senior high school. In a similar study, Offei–Nyako et al. (2014) reported that 68% of artisans in the Ghana construction industry had formal education up to junior high school as showed in Figure 1.

In another study, Ndua and Ng'ethe (1985) suggest that workers within the informal economy were mainly individuals with comparatively low levels of education. However, the trend in both informal employment and low-paying manual jobs changed since the beginning of the 1990s. This change perhaps could be attributed to the effect of Ghana's Free Compulsory, and Universal Basic Education Programme (FCUBE) launched in 2005, aimed at making it mandatory for every Ghanaian to attain at least basic education. On the contrary, Wahab (2010) reported that 58.10% of artisans in the Nigeria construction industry were not educated; they passed through Trade Test Programme. The respondents were also asked to describe their skill sets. The results from Figure 2 showed that 43.41% of the respondents were skilled 36.05% of the respondents said they were semi-skilled while 20.54% stated that they were unskilled.

It is evident from the results that there are more skilled artisans in the informal construction industry than semi-skilled and unskilled artisans. The finding coincides with that of Mitullah and Wachira (2003) who notes that about 74% of construction workers surveyed in Kenya were skilled and 21% semi-skilled. Although the sample was biased towards skilled workers, the majority of the skilled tradesmen were masons, painters, plumbers or carpenter-

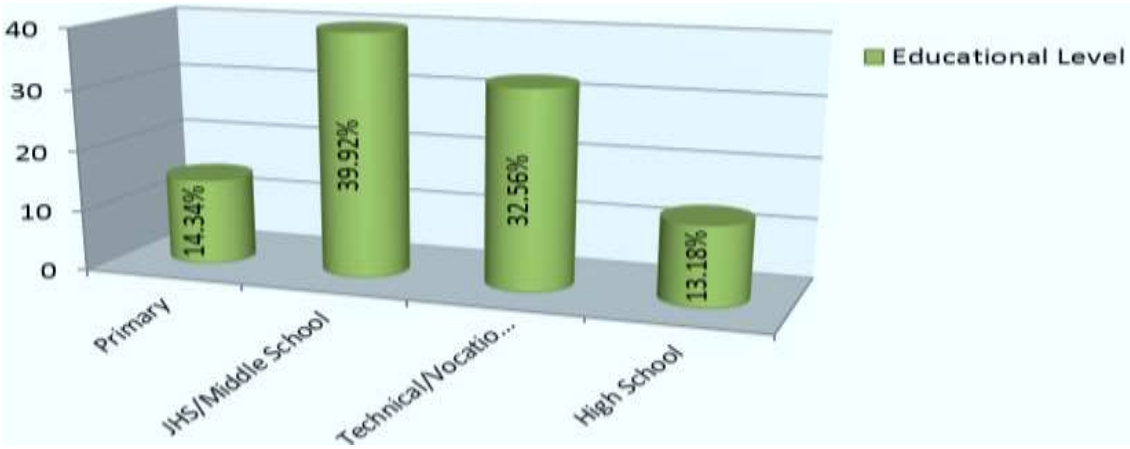

Figure 1. Artisans' educational background. Source: Fieldwork (2016).

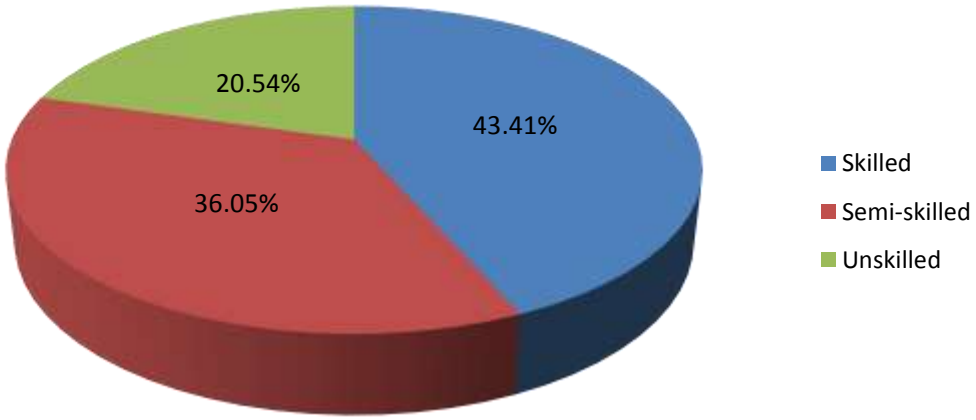

Figure 2. Skills types in the informal construction sector**.** Source: Fieldwork, 2016.

Grade 2. Regarding the occupational specialisations of artisans, about 37% of the respondents indicate they were block/brick layers. Plasterers constituted 28% with about 15% being blocked manufacturers while others who were block/brick layers, either plasterers or block manufacturers constitute 20%. This means that the informal construction sector is dominated by more block/brick layers than any other specialities (Figure 3).

The modes of artisanal training are through informal apprenticeship, vocational/technical training and on-the-job training as indicated in Table 3. The results show that about 63% of the respondents had their artisanal/ craftsmanship training through informal apprenticeship, 18% through formal apprenticeship while 17% is through on-the-job training. The remaining 2% had their training through other unknown methods. The results show that the most popular apprenticeship training in Ghana is through informal training system. In an apprenticeship training, a master (trainer) transferred his knowledge informally to an apprentice (trainee). Thus informal knowledge acquisition is widespread and shared among the informal labour force in the country. This is because the informal labour force is easily influenced by individual homebuilders/owners who want cheap labour and are willing to sidestep building codes and planning regulations. Without properly structured, accredited and regulated apprenticeship training, provision of buildings and other infrastructure development would continue with little regard to design requirements and specifications. The results support (Lerman, 2013) claim that countries that placed particular emphasis on technical training only end up with weaker human capital than those with a mixed strategy of technical and apprenticeships programmes.

Another aspect is the determination of how long artisans spent in training to gain adequate proficiency to practice as an artisan. The results in Table 3 indicates that about 40% spent three years in training, 20% spent four years, and 13% spent five years while others 27% spent more than five years in their training. The result

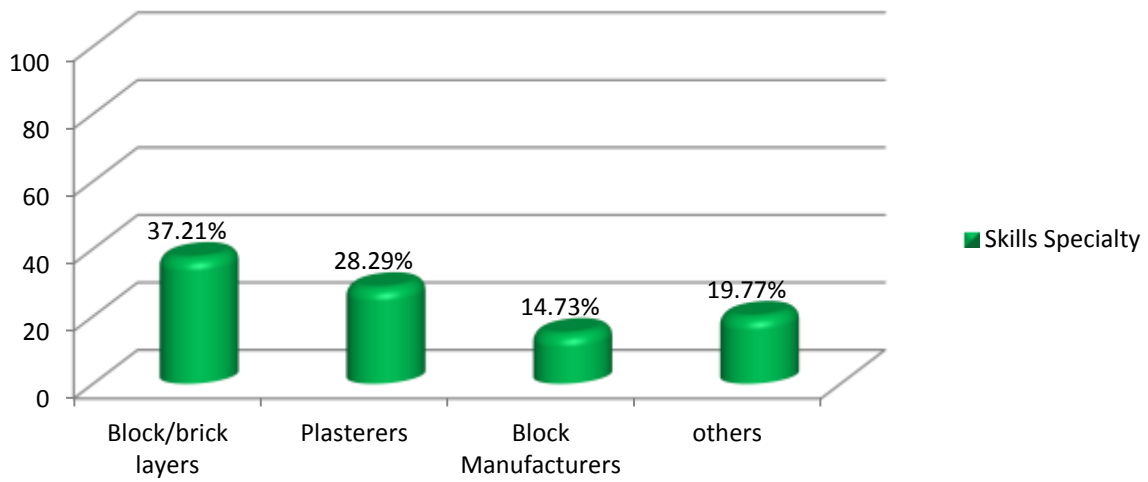

Figure 3. Artisans' skills speciality. Source: Fieldwork (2016).

Table 3. Means of skills acquisition.

Response	Frequency	Percentage
Means of Skills Acquisition		
Informal apprenticeship	163	63.18
Formal apprenticeship	46	17.83
On-the-job training	43	16.67
Others	6	2.32
Duration of Training		
3 years	102	39.53
4 years	52	20.16
5 years	34	13.18
Others	70	27.13
Training of apprentice		
Yes	163	63.18
No	95	36.82
Number of Apprentices		
0-4	94	36.43
5-8	61	23.64
9-12	44	17.05
Others	59	22.87

Source: Fieldwork (2016).

showed that most of the artisans who trained for three years were in the informal construction sector; indicating that perhaps three years was not long enough to gain professional level competence as an artisan. Those who reported that they trained between five to six or more years indicated that they learned practical skills for four years in addition to working one or two free years for their masters as *thanksgiving*. They added that the *thanksgiving* years helped them to gain deeper knowledge from their masters. Consequently, these artisans could read blueprints and transfer ideas accurately onto the ground. Apprenticeship is one of the oldest methods of training artisans in construction skills. Schwartz (1999) noted that in earlier centuries, informal apprentice training involved eight years of learning under a master artisan through an indenture agreement. He argued that the industrial revolution and the economic burden on low-income families reduce the popularity of long periods of

Table 4. The types of projects and clients.

Response	Frequency	Percentage
Types of Project Undertaken		
Residential–incremental buildings	172	66.67
Institutional buildings	24	9.30
Commercial buildings	19	7.36
Others	43	16.67
Current Projects		
Residential –incremental buildings	181	70.16
Institutional buildings	17	6.59
Commercial buildings	33	12.79
Others	27	10.47
Jobs undertaken in the Projects		
Block/brick laying	139	53.88
Rendering/plastering	17	6.59
Block Manufacturing	56	21.71
Others	46	17.82
Type of Employer or Clients		
Private individuals	179	69.38
Company	36	13.95
NGO	21	8.14
Government	5	1.94
Others	17	6.59

Source: Fieldwork (2016).

apprenticeship. Per him, the common practice in the informal sector in the 21st century is an abridged form of on-site training of artisans; the mode of operation, duration and intensity varied from place to place.

The respondents were also asked to indicate whether they were training any apprentices at the time of the survey. The results from Table 3 showed that 63% of the respondents were training apprentices, while 37% reported no apprentice-in-training. This result prompted further investigation. What kind of training did these apprentices receive since 63% of the trainers received their training through informal apprenticeship and 40% trained for only three years? Since the master artisans did not receive adequate training, they were likely to transfer the wrong skills to their apprentices, resulting in a bad workmanship in the industry. Per Ogbeifun (2011) the informal sector adopted fragmented training depending on the relationship between trainees and independent supervisors, regular team members or subcontractors. Abdul-Aziz (2001) reports that the quality of training was compromised especially if the trainee was not a close relation of the trainer.

The respondents were also asked to indicate the number of apprentices they have in training. The results from Table 3 showed that 36% of the respondents had four apprentices and 24% had 5 to 8 apprentices under training respectively. 17% of the respondents had apprentices while 23% other respondents had apprentices undergoing training. The result indicated that "half-cooked" construction artisans were churned out through the informal apprenticeship training system. Kaoma and Muya (2016) report that, artisans without proper training backgrounds were the main reasons for the high frequency of poor construction workmanship in Zambia. They observed the majority of artisans hired in Zambia were those with no formal qualifications, which required close supervision to achieve intended results on construction sites; noting that the level of supervision needed to manage these types of the workforce was very demanding.

Project types usually undertaken by informal construction artisans

Here, the type of projects respondents typically worked on is discussed. The results showed that 67% of the respondents worked on incremental residential buildings, 9% on institutional buildings, and 7% on commercial buildings while 17% worked on mixed projects as showed in Table 4. The results revealed that most informal construction sector artisans worked mainly on residential

Table 5. Means of obtaining project information detail.

Response	Frequency	Percentage
Sources of Project Drawings		
Architects/Civil Engineer	61	23.64
Draughtsman	87	33.72
Self-sketch	75	29.07
Others	35	13.57
Detail Project Drawings		
Yes	96	37.21
No	162	62.79
Means of obtaining Project Information Detail		
Through experience	130	50.39
From old project drawings	87	33.72
Others	41	15.89

Source: Fieldwork (2016).

incremental construction projects. The respondents were also asked to indicate the type of projects they were currently working on. The result showed that 70% of the respondents were working on incremental residential building projects 7% on institutional buildings, 13% of commercial building projects while 11% were working on mixed building projects. The results suggested that at the time of the study, there were more opportunities for artisans in the informal residential construction sector of Ghana's housing industry Table 4. The respondents were asked to indicate the specific services they performed in the projects they executed. The results showed that 54% of the respondents performed only block/bricklaying services, 7% performed rendering and plastering service, 22% performed block-moulding services, 8% performed carpentry service while 10% of the respondents performed multiple services as shown in Table 4.

The respondents were asked to indicate their sources of obtaining construction jobs Table 4. The results demonstrated that individual homeowners engaged 69% of the respondents, 14% obtained jobs from construction companies, 8% from NGOs. Furthermore about 2% from government agencies while 7% obtained jobs from various sources including private individuals. In Ghana, informal construction sector, employers did not typically demand company registration documents before making job offers; jobs offers were based on the recommendation of past employers. This situation was different in the formal construction sector where various documents were required including company registration certificates from the Registrar General's Department and construction classification certificate from Ministry of Water Resources, Works and Housing. This red tape coupled with cumbersome tendering processes accounted for the small number of respondents obtaining jobs from government agencies. Harvey (2003) also reported that most informal artisans often worked for building owners and private contractors as opposed to government agencies.

Source of construction project information

The respondents were asked to indicate the source of obtaining project drawings. The results from Table 5 showed that 24% of the respondents obtained project drawings from architects/civil engineers, 34% obtained project drawings from draughtsman, and 29% used self-sketched drawings while 14% used drawings from mixed sources. The low patronage of the services of architects/civil engineers could be attributed to the high cost of architectural services; sketched drawings cost nothing.

Detailed construction project drawings serve as a reference, a guide and a communication tool for both technical and non-technical artisans on a construction site. The results from Table 5 show that only 37% of the respondents report that they had detail project drawings whiles an overwhelming majority, 63% did not. Detailed project drawings typically underpinned effective and efficient project delivery. Wang et al. (2014) reported in their study of energy efficient buildings in the USA that detailed construction design largely impacted heat resistance and air leakage properties of the building envelope. The results further indicate that 50% of the respondents reported that they obtained project details from experience on previous projects, 34% from old project drawings while 16% obtained their project information detail from mixed sources as illustrated in Table 5.

Table 6. Types and source of materials for mixing concrete and mortar.

Response	Frequency	Percentage
Type of cement		
Ghacem Cement	98	37.98
Diamond Cement	142	55.04
Pozzolana cement	3	1.16
Others	15	5.81
Sources of water for mixing concrete and mortar		
River water	71	27.52
Pipe borne water	41	15.89
Borehole water	57	22.09
Others	89	34.50
Source of coarse aggregate		
Quarry	104	40.31
Hand broke from rock areas	98	37.98
From construction waste	Nil	Nil
Oyster shells	56	21.71
Material Supplier		
Client	113	43.80
Foreman	81	31.39
Materials supplier	50	19.38
Others	14	5.43
Equipment normally used on site		
Concrete mixer	15	5.81
Vibrator	10	3.88
Gauge box	5	1.94
Wheelbarrow	170	65.89
Others	58	22.48

Source: Fieldwork (2016).

Building materials and tools

Here discusses the materials and tools used by artisans on most informal construction sites. These materials and tools typically influenced the outcome of construction projects regarding quality and duration. Consequently, the results in Table 6 show that 38% of the respondents used Ghacem Cement, 55% used diamond cement, and 2% used pozzolana cement while 6% of respondents used other brands of cement. The above numbers showed that diamond cement brand was popular among the respondents. This might not necessary be due to its strength but rather the prices since informal construction artisan does not conduct any form of test on their products. This can also be attributed to the price difference between diamond cement Gh¢ 27.50 and other brands Gh¢ 28.50 and Gh¢ 30.50 as most informal clients prefer cheaper materials.

The artisans were also asked about where they obtained sand for mixing concrete and mortar. The results from Table 6 showed that 26% of the respondents used river sand, 57% used sand from pits, and 3% used sand obtained from quarry site while 15% used sand from mixed sources. The high preference for sand obtained from borrowed pits is because of lack of fast flowing rivers, which have the capacity deposit soil along their banks as compared to the respondents who lived near the Volta River, which has large deposits of high-quality sand. In Ghana, quarry sand was commonly used by sandcrete block manufacturers. Observations from the majority of the sites visited in Pokuase and Nsawam showed hips of sand mixed with tree roots and grasses as illustrated in Figure 4. A closer visual inspection revealed that there was a high presence of clay content in the sand, suggesting that concrete produced with the sand was unlikely to meet the essential structural

Figure 4. Samples of both river and pit sand from Mepe/Battor and Pokuase/Nsawam. Source: Fieldwork (2016).

standards. Ngugi et al. (2014) conducted an experimental study on the effects of sand quality on compressive strength of concrete in Nairobi County and its environs in Kenya. They observed that the proper minimum level of silt and clay content and organic impurities in the sand being supplied in Nairobi and its environs are 4.8% and 0.106 ohms respectively. They concluded that beyond these limits then the resultant concrete will fail to meet the expected strength at 28 days' age. It is therefore found that the presence of impurities in sand significantly contributed to a reduction in compressive strength of concrete strengths which may lead to the collapse of buildings if not addressed in the concrete design mix.

Regarding the source of water for mixing concrete and mortar, the results showed that 28% of the respondents used river water. 16% used pipe borne water, 22% used borehole water while 35% used water from mixed as shown in Table 6. Water quality impacts on concrete and mortar mixing and their malleability. Chudley and Greeno (2006) also indicate that water for concrete production should be clean and free from impurities. Water with impurities adversely affected concrete quality or strength. This assertion meant that most concrete and mortar works on informal construction sites visited used water from river sources, which may not be suitable for concrete works. About 40% of the respondents obtained coarse aggregate from quarry site, 38% from hand broken suppliers; while 22% used oyster shells as the source of coarse aggregate used in mixing concrete for their construction projects. The above numbers showed that the use of construction waste aggregate was not common practice among informal construction sector workers. The use of oyster-shell aggregates was popular among the respondents from Mepe/Battor due to their location along the Volta River. Oyster-shell aggregates were popular because they were superabundant in these localities and therefore are very affordable for low-income groups in their incremental building process.

Furthermore, in the informal construction sector, individual homebuilder/clients often buy the materials for their workers as a preferred method of materials supply. The results showed that 44% of the artisans had materials provided by individual homebuilder/clients, 31% of supervisors and 19% from material suppliers while the remaining 5% obtained materials from commercial suppliers. This aspect of the finding also coincided with Mitullah and Wachira (2003) who found that invariably 80% of building owners supplied materials for construction in other jurisdictions. Construction work is typically executed using machinery and physical labour. Consequently, the response indicate that 6% used at least a concrete mixer, 4% used poker vibrators, 2% used gauge box technique 66% used wheelbarrows while 23% used multiple tools in most of the work they have executed. All the respondents used pans, spades/ shovels, spirit levels, tape measures, builders' square, block hammer, lines and pins. It was important to ascertain the range and types of equipment used by informal sector construction workers and how it impacts on work performance and quality. Many informal sector construction workers were unable to afford poker vibrators and concrete mixers which were typically rented by clients for specific tasks.

Batching of materials

Here we discussed the batching methods used by informal construction artisans in measuring materials on site. Consequently, the respondents indicate the batching methods they typically used on site as shown in Table 7. The results revealed that most respondents 78% used the volume-batching technique, 18% batched materials by weighing while 4% used multiple methods. Neville and Brooks (1987) assert that volume batching of concrete materials is a bad practice. However, Olusola et al. (2012)

Table 7. Batching methods usually used on site.

Response	Frequency	Percentage
Batching by volume	201	77.90
Batching by weight	47	18.22
Others	10	3.88
Tools used for Batching		
Gauge box	19	7.36
Head pans	52	20.16
Wheelbarrow	108	41.86
Others	79	30.62
Concreting mix ratios		
1:1:2	Nil	Nil
1:2:4	16	6.20
1:3:6	153	59.30
Others	89	34.50
Mortar mixing ratio		
1:2	Nil	Nil
1:3	Nil	Nil
1:4	107	41.47
Others	151	58.53
Source of information for mensuration		
From specification document	Nil	Nil
From experience	158	61.24
By client's instruction	78	30.23
Others	22	8.53

Source: Fieldwork (2016).

report that volume batching is a common practice in Nigeria construction sites due to its easy, simpler and faster as compare to batching by weight. The effect of batching methods on the compressive strength of concrete with mix proportion of 1:1:2, batched by weight are always higher than concrete batched by volume at all water-cement (w/c) ratios and for curing ages 7 to 28 days.

Batching tools are crucial in concrete and mortar works as concrete and mortar production are specified in ratios, it is important for fine and coarse aggregate-part measurements to correspond with their cement volume. Consequently, the results show that only 7% of the respondents used gauge box in batching fine and coarse aggregates, 20% used head pans, 42% used wheel-barrows while 31% used multiple tools. The above results further show that aggregate batching using wheelbarrows is popular among informal construction sector artisans. This could be as a result of lack of large batching machinery or measuring equipment in these localities. Many sandcrete manufacturers, for example, typically used to eyeball the quantity of sand used for making blocks indicating that there could be over batching with its attendant implications for uneven block strength and bearing capacity (Figure 5).

It also emerged from the results that none of the respondents used a concrete mix ratio of 1:1:2. However, 6% used 1:2:4 mix ratio, 59% used 1:3:6 mix ratio while 35% used various ratios in mixing concrete. However, upon site visits, it was revealed that the utilisation of a formula known as 5-for-2 or five wheelbarrows of sand per two bags of cement with no specific measurement for the quantity of coarse aggregates was in place. Construction materials are therefore specified and measured in ratios depending on the section or type of construction work being undertaken. The ideal mixed ration for mortar is 1:2 and 1:3 ratios. However, the results in Table 7 show that 42% used 1:4 ratios while the majority 59% used self-determined ratios. The 5-for-2 formula is usually used for sand obtained from quarries and 4-for-2 from borrowed pit sand. This is because borrowed pit sand has high clay content while quarry

Figure 5. Eyeball batching as against volume batching using wheelbarrow by artisans on site. Source: Fieldwork (2016).

Figure 6. Some tools used by artisans on site. Source: Fieldwork (2016).

sand contained no clay. These ratios are used for both block laying and plastering works and due to varying mix ratios being used the resultant mortar are likely to be more prone to rapid degradation. This was the case with many completed buildings in the areas surveyed. Informal construction artisans also use both hand and machine moulds but do not usually follow any specific mixing ratios for block moulding (Figure 6). Typically in a regulated block factory, one bag of cement is used to produce between thirty-five and forty-five blocks irrespective of the block size in these jurisdictions. It is also evidenced that hand moulders use one bag of cement to produce about twenty-five to thirty blocks depending on the client request.

In the determination of ratios for mixing concrete and mortar, moulding and laying of sandcrete blocks, the results show that 61% determine batching ratios from experience, 30% follow clients' instruction, while the rest 9% used either experience or followed clients' instruction. This is because most of them are not trained to work with published industry guidelines and specifications. Inadequate training often led to both structural defects such as cracks and dampness in buildings. In this regards, Goldbeck and Gray (1968) recommend the application of appropriate mix proportion or a specified characteristic strength to ensure the structural integrity of

Table 8. Building defects due to poor mensuration.

Response	Frequency	Percentage
Defects due to poor material measurement/batching		
Cracked walls/floors	104	40.31
Dampness of walls/floors	91	35.27
Flaking plasters	51	19.77
Others	12	4.65
Artisan's further training		
Yes	60	23.26
No	198	76.74

Source: Fieldwork (2016).

buildings. Structural integrity largely depends on the design and the correct proportion of materials coupled with artisans batching knowledge and expertise. The results showed that only 29% knew the impact of batching on completed projects while 71% had no idea. This could be attributed to their informal training background that usually excludes training in materials properties and among others.

On the effect of poor materials batching behaviour on the structural integrity of the building in the area, the results show that 40% of the respondents report cracked walls/floors, 35% report dampness in walls/floors, 20%, and report plaster flakes while 5% report of other related types of defects. The result confirmed that most structural defects could be traced to poor material proportioning or batching. Inaccurate batching of materials on the quality of construction is another dimension that the study explored. The results indicates that about 32% of the respondents report that poor or inaccurate batching of materials led to poor concrete strength, mortar or blocks, 22% believe poor or inaccurate batching of materials may result in delay in construction time, 40% report of lots of waste while 6% indicate that such materials need the expertise of experienced artisans. Given the above, many wastes report on construction sites are often due to poor materials batching resulting in poor concrete/block strength. Regarding challenges in applying standard prescribed batching techniques, the results show that about 64% of the respondents anticipate difficulties while 35% did not anticipate any future challenges with the work they have done. Batching by weight could be identified as the most challenging though most artisans did not own batching equipment. Respondents also indicated the sources of their information use for mensuration or batching of construction materials. The results show that 40% report of working without mensuration or batching criteria while 61% did not. Working without mensuration or batching techniques emerged because local building artisans do have little understanding of the importance of mensuration or batching. This phenomenon is common practice among hand block moulders in the small-scale block manufacturing industry.

Building defects

Here we discussed the impact of informal artisans' batching behaviour on completed building projects. The results in Table 8 show that 36% of the respondents conduct post-construction audit while 64% did not. Post construction audit or inspection is necessary to the construction industry. It helps identify construction defects due to multiple factors such as poor workmanship or poor materials proportioning. Besides, post construction inspection is a standard practice in many jurisdictions such as Hong Kong. Post construction audit is an independent technical investigation of specific processes and activities carried out with the aim of ascertaining whether the activities and processes and their consequential outcomes conform to set some standards. In this regard, Sichombo et al. (2009) and Bondinuba et al. (2017) all affirm the importance of post-construction and technical audits by emphasising the need for it to be an ongoing process during and after construction in both the Zambian and Ghanaian construction industry.

The results further indicate that 36% of the respondents discover defects during the post-construction inspection, 35% identify various forms of defects while 65% did not. Respondents who conduct post-construction inspection indicate that the audit was to increase their operational excellence. To facilitate post-construction audits, Garrand (2001) outlined a general guideline for defect detection, classification into various categories including defects in the foundation and ground floor structures, external walls, roofs, internal walls and floors, above ground services, below ground drainage, and external works. Furthermore, about 47%% of the respondents report having knowledge concerning the causes of defects noticed while majority of them 53%% are not having any knowledge of the causes of defects on their completed works. On further training since graduating from their apprenticeship

training, 23% do receive further training while 77% did not. Those in the first category were artisans who went through Technical/Vocational schools before practising as a master artisan. Chan *et al*. (2006) stress that further training of local artisan in the construction will enhance the quality of construction and increase local labour capacity and capabilities.

Conclusion

The findings of the paper show that artisans in the informal construction sector in Ghana pay little attention to conventional standard construction practices and procedures in constructing residential buildings. Some of the reasons attributed to the above phenomenon include low levels of apprenticeship training to increase the skills and competence of artisans. Although traditional technical and other training institutions programmes offer flexible routes to build the capacity of their competencies and knowledge, apprenticeship programs provided by master craftsmen dominate the technical training services market in the country. Another reason is the economic burden on low-income families which ahs resulted in the reduction in the apprenticeship training period to enable apprentice graduate and earn some living. It emerged from this paper that besides the short training periods many master artisans are themselves ill-equipped to provide world-class, cutting-edge training. Notwithstanding apprenticeship training also varied widely across the various construction trades and master artisans in the country. The recommend that the Ghana Standards Authority and the Ministry of Water Resources, Works and Housing should establish regional and district offices to monitor and regulate the quality standards of construction materials and artisans training and practices in the country. There is the need to give the informal construction sector a second look in order to harness the importance of the sector.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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