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Sustainable Waste Material Management: The Role of Hnd Programmes In Ghana

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***Abstract**:- Sustainable waste management is important for achieving sustainable construction. The increasing rate of deterioration of the environment coupled with the need for basic developmental needs underscore the need for sustainable construction waste materials management (SCWMM). A survey was conducted with the aim of examining knowledge requirements of Higher National Diploma (HND) programmes in relation to sustainable waste material management in construction alongside construction professional training with Tamale Polytechnic in Ghana as a case study. Questionnaires were administered to a sample of 34 continuing students, 11 graduates employed in the construction sector, and 7 teaching staff. The results demonstrate that training does not adequately address key sustainable waste material management practices such as design solutions to waste materials generation, recycling and sorting of waste materials. Also, graduates perceive this aspect of their role challenging with their training offering them little knowledge to solve practical problems bordering on issues relating to sustainable waste material management. The paper makes recommendations for implementing measures that will address the requirements of SCWMM at the HND level of polytechnic education in Ghana and other developing countries practicing similar educational system.*

***Keywords:** Construction material waste, developing countries, sustainability, education, Higher National Diploma.*

I. INTRODUCTION

Waste remains one of the greatest challenges facing humanity in the twenty first century as more attention is given to issues relating to sustainable development. Increasingly, the harmful effects of waste produced by industrial sectors on the environment have drawn the attention of policy makers and researchers in both developed and developing countries [1]. The construction industry is one in which significant amounts of waste are generated [2, 3] which have deleterious effects on the health and safety of persons as well as the environment. Bossink and Brouwers [1] report waste levels of 15-25% common in the literature pertaining to construction industry's contribution to industrial waste. Common waste generated by the construction sector include; solid waste such as concrete, brickwork, stone, metals (particularly steel), timber and glass. These wastes are generated in workshops where work is being prepared for construction sites, at construction sites and by the activities of the consumers of construction products.

Generally, waste is a by-product of industrial and consumption activities. Increasing industrialisation and urbanisation characterise developing countries [4]. Industrial waste is therefore likely to increase in parallel with the pace of industrialisation particularly in urban centres in these countries. Arguably, the quantity of construction wastes in these countries is likely to increase with their effects on the health, safety of the populace as well as the environment reaching abysmal levels if the construction sector fails to adopt sustainable construction practices. Ghana is one of the few developing countries believed to be on tract in achieving the Millennium Development Goals (MDGs) in attaining a middle income country by 2015. However, this progress can be greatly impeded if adequate measures are not taken to reverse the rate at which the construction industry generates material waste through inappropriate sustainable waste management practices. Whilst attaining a middle income status by 2015 will require huge injections of capital in the area of urban infrastructure, maximum benefits can be realised only if such development is in accord with sustainable development principles.

Education provides skilled human resource in both developing and developed countries which is required to effectively manage waste generated by human population, consumption and technology. To date the corpus of literature has highlighted the role of educational institutions in sustainable waste management [5, 6]. However, there is a paucity of literature on the extent to which sustainable waste management is incorporated in the main activities of higher learning institutions namely; teaching, learning and research particularly in developing countries. Given the impact waste has on the environment and the implications for the cost of construction, it is necessary that construction engineers and managers trained by educational institutions are equipped with the requisite know-how to face challenges relating to waste management issues in today's world.

In regard, the overarching aim of this study is to examine the role polytechnic education plays in sustainable management of waste in the construction sector with specific focus on HND Building Technology programme in Tamale Polytechnic. The specific objectives of the study are as follows:

- to examine the relevance of professional training provided by Tamale Polytechnic in relation to sustainable construction waste management; and
- to make recommendations for improving the capacity of graduates in the HND Building Technology discipline in sustainable waste material management principles.

II. BACKGROUND AND CONTEXT

The construction industry plays an important role in the provision of infrastructure in both developed and developing nations. The products of the industry range from large infrastructural projects such as; roads, bridges, dams, mass housing, waste facilities to institutional buildings, shopping malls, warehouses and single dwelling houses. The association between infrastructure and economic growth has been well documented in the literature [7]. Alongside the contribution of the industry to economic growth, it negatively impacts upon the environment through depletion of non renewable resources, land use and waste it generates. Construction waste remains the responsibility of clients, consultants, and contractors and therefore requires adequate knowledge and technical expertise on their part to effectively manage waste. In this regard construction educators have a role to play in ensuring that sustainable construction and waste management practices are adequately addressed in teaching, learning and research.

2.1 Material waste in construction

Many authors attribute material waste generation by construction and demolition activities to factors that include design, take-off/specification, delivery and site operations [8-12]. Ekanayake and Ofori [9] identified design changes as a major cause of material waste generation on construction sites in Singapore and suggest effective management of waste at the design stage as key to minimising material waste generated on construction sites. However, significant factors that contribute to material waste on construction site may vary considerably from one country to another depending on local conditions. Ironically, actual waste levels on construction sites have been found to be higher than those allowed by estimators [13]. The management of material waste generated by the construction sector needs to be done in a manner to ensure efficiency in the production process and sustainability of the scarce primary materials while minimising cost and environmental hazards. This will ensure that principles of sustainable development and for that matter, principles of sustainable construction are not compromised.

2.2 Sustainable waste management

Sustainable waste management has the goal of reducing the quantity of waste generated, reusing waste materials in construction and renovation and recycling waste by processing waste that is generated for use in construction and renovation works [14, 15]. This has often been summarised in the waste management literature as the 3Rs; Reduction, Reuse and Recycling.

Reducing material waste on construction sites requires prudent management practices. Materials have to be ordered in the right quantities and material handling should be such as to minimise waste on site. Material control procedures must be put in place and closely managed. It is essential to reduce the use of non-renewable materials and where possible they should be substituted with secondary resources such as materials reclaimed after construction or demolition activities. Emissions into the atmosphere resulting from construction and demolition activities should be reduced to tolerable levels.

Heavy reliance on the use of primary construction materials such as timber, river sand, quarry chippings etc for construction and other related activities ultimately leads to high rates of depletion of these natural resources unless appropriate measures are taken to control the rate at which they are extracted. Alternative sources which could serve as substitute to these materials involve the use of non-primary materials

Recycling in construction will involve sorting of material wastes produced on sites into their constituents and processing of the base constituents using appropriate recycling equipment. Where possible sorting of materials and processing should be done on site to facilitate re-use and minimise generation of waste and demand for primary materials.

Life cycle assessments (LCA) of methods of managing construction material waste by Craighhill and Powell [10] suggest reuse of material waste as the lowest overall environmental and social impact, followed by a combination of reuse and recycling, with landfill disposal the least desirable option. It should however be noted that only small proportion of construction materials waste is used to replace primary materials. This leaves a combination of recycling and reuse as the more practicable option of sustainable management of construction materials waste. Recycling has a disadvantage over reuse since the recycling process involves substantial amounts of energy consumption.

2.3 Construction education

Changing regulation, environmental concerns and competition are key issues in material waste management in the construction industry worldwide. These challenges make it imperative for construction engineers and project managers to continually acquire technical and managerial skills on more innovative ways of addressing these issues than their traditional training can offer. Clearly, this need calls for a re-evaluation of the technical and managerial know-how of construction professionals and re-examination of existing programmes. Edum-Fotwe and McCaffer [14] have emphasised the need for additional skills and knowledge beyond the technical requirements of basic academic training of construction professionals.

Polytechnics in Ghana play a significant role in the provision of skilled manpower needs of the country [16:43-49, 17:51-65]. To date, there are many challenges to realising the aims and objectives of polytechnic education as contained in the White Paper establishing polytechnics in Ghana. Owusu-Agyeman and Oosterkamp [17:59] have documented challenges to the Ghanaian Polytechnic educational system as including quality and relevance of curricula and argued for continuous update and evaluation of the various course contents to reflect social and technological development. Clearly, HND Building programmes run by polytechnics in Ghana suffer from lack of proper design of course contents. Arguably, the implementation for curricula are likely to have serious setbacks on the competence of graduates in the discipline vis-à-vis their ability to cope in a changing technological world.

III. METHODS

3.1 Questionnaire development

Draft questionnaires were developed and piloted among teaching staff of the school of Engineering– Tamale Polytechnic. Suggestions made were incorporated and final versions of the questionnaires were administered to lecturers, students and graduates of the Building Technology Department of Tamale Polytechnic. The final questionnaires developed and used for the three categories of respondents in the study comprised questions with fixed response categories and open-ended questions.

The questionnaires developed contained two sections (Section A and Section B). Section A solicited responses on personal particulars and personal information such as name, telephone number, experience (for the questionnaire administered to lecturers), type of sponsorship (questionnaire administered to students) and type of organisation the respondent is employed in (questionnaire administered to students and graduates). Section B asked questions on sustainable construction and demolition waste material management practices and suggestions on how teaching and learning in Ghanaian polytechnics could enhance training in sustainable construction and demolition waste material management.

3.2 Sampling

All fifteen staff teaching courses in the Building Department were supplied with the questionnaire designed for lecturers. All final year students (35) pursuing HND Building Technology were given the questionnaire designed for students. Whereas as many as 219 students have successfully completed the HND Building Technology programme run by Tamale Polytechnic, only few are known to be employed in the construction industry. The researcher contacted graduates working directly in the construction industry and those in technical departments of organisations that require the services of construction professionals in the Northern Region of Ghana. The latter organisations included Ministry of Health, Architectural and Engineering Services Limited, Public Works Department, Organisations providing consultancy services in construction and architectural services, building material suppliers, District, Municipal and Metropolitan assemblies.

3.3 Procedure for analyzing results

The data obtained was analysed using descriptive statistics. This enabled responses to be categorised and the summarised data presented in tables and a figure. Respondents' opinions on sustainable construction and demolition waste material management practices were analysed using relative importance index (RII) [18] given as

$$\text{RII} = \frac{4m_1 + 3m_2 + 2m_3 + m_4}{4(m_1 + m_2 + m_3 + m_4)}$$

Where m_1= number of respondents who rate the item (sustainable measure) as 'very important';
M_2=number of respondents who rated 'important';
M_3=number of respondents who rated 'somewhat important';
and, M_4=number of respondents who rated 'not important'.

IV. RESULTS

4.1 Respondent characteristics

Thirty-four out of a total of 35 final year HND Building Technology students completed the questionnaires and submitted. Efforts to contact the student who failed to submit the questionnaire which was given to him proved futile. Thirteen students (37%) said they were responsible for payment of their fees and living expenses while on campus while 17 (49%) said their guardians were responsible for all expenses in connection with their education. Three said their employers sponsored their education and one student indicated that apart from his guardian catering for expenses in connection with his education he also made significant contribution. When asked about their employment history, 11 said they were working with Ghana Education Service, 5 said they were working in family business, 3 indicated they were working with construction businesses, 1 worked with an NGO and the other with Ghana Prisons Service. The age distribution of the respondents is given in **Fig. 1 below.**

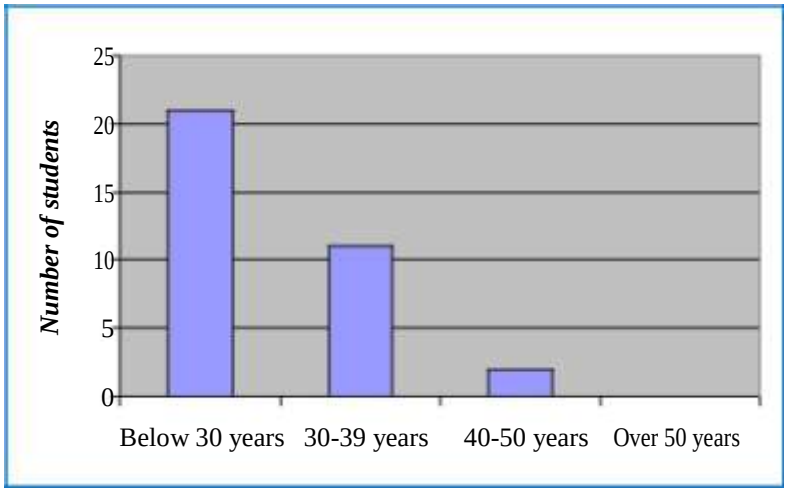

Figure 1 Age distribution of students

Twenty-one of the students said they obtained the Senior Secondary School Certificate, 9 had Construction Technician Course Certificate, 2 Ordinary Technician Diploma certificate and 1 student said he had Full Technological Certificate.

Responses from 12 graduates were obtained out of which 11 were useable. In all 17 graduates were reached indicating a response rate of 65%. Key graduates in the Tamale Metropolis and in municipalities and District capitals co-ordinated the data gathering process thus enabling the response rate of 65% to be achieved. However, there is no certainty that the 17 graduates contacted are the only graduates of the Building Technology Department of Tamale Polytechnic employed in the relevant organisations covered in the study. The age of the respondents ranged from 30 to 39 with the mean number of years of working experience of 6. Majority of the respondents (8) were working at construction sites as site supervisors and the rest (3) working in the estates departments in the organisations they were employed. The highest level of educational qualifications attained was HND although three were enrolled for a bachelors degree programme through distance education mode.

Seven teaching staff completed the questionnaires and submitted. Efforts to get the rest to complete and submit the questionnaires they were given was unsuccessful. Two of them gave reasons of tight schedule as the reason for failure to complete and submit the questionnaire within the deadline for submission. The rest (6) did not advance any reasons for their failure to submit. The length of experience ranged from 5 to 14 years with majority aged between 40 to 49 years. The courses taught at the HND level by the respondents include the following:

- site organisation procedures;
- building maintenance;
- Building services;
- Project planning and control;
- Technical report writing;
- Construction technology;
- Strength of materials
- Building materials;
- Building management; and
- Environmental impact of construction activities.

Given the experience of this category of respondents the responses to questions could therefore be considered as true and accurate reflections of teaching and learning relating to sustainable construction and demolition waste material management.

4.2 Training in construction and demolition waste materials management

All the graduates agreed that their training does not address waste materials management at the design phase with some indicating that aspects relating to recycling and sorting of waste materials are not adequately addressed by their training (Table 1). The most widely adopted waste management practice is reuse (10) and disposal at landfill (8). Four said they ensure strict supervision on site to minimise waste materials generated on site and 2 said they dispose off waste materials by incineration. However, these responses should be treated with caution as there can be a tendency for respondents to project a positive image about their employers.

Table 1. Graduates' perceptions of the extent to which their training addresses key waste management issues.

Key waste management issues	Does not address it	Addresses it
Effects of construction and demolition waste materials on the environment.	0	**11**
Causes of construction and demolition wastes materials on project sites.	0	**11**
Cost of construction and demolition waste material on construction sites.	0	**11**
Reuse of waste materials arising from construction and demolition activities.	0	**11**
Recycling of waste materials arising from construction and demolition works.	2	**9**
Sorting of waste materials arising from construction and demolition works.	3	**8**
Minimising waste materials arising from construction and demolition works.	0	**11**
Addressing waste materials arising from construction and demolition works at the design stage.	11	**0**
Handling of waste materials arising from construction and demolition works.	0	**11**
Disposal of waste materials arising from construction and demolition works.	**0**	**11**

The third year students' responses on the extent to which their training address waste management issues are summarised in Table 2. Clearly, many of them regard their training as not addressing the same issues named by the graduates namely; design solutions to waste material generation, recycling and sorting of waste materials. This rather surprising result may be due to a considerable revision and adoption of the course content of the HND Building Technology syllabus in the year 2000. Another plausible explanation is changes in the level of expertise of academic staff in the years following 2000.

The introduction of Polytechnic education resulted in tremendous efforts in staff development many of which had completed their courses of study and returned to post after the year 2000. This, clearly resulted in a significant change in quality of academic staffing and consequently had an impact on teaching and learning. In parallel with academic staff development, the same period witnessed serious efforts in improvements in management of Polytechnics in Ghana through external funding by the Netherlands Government. While the influence of such an intervention may be difficult to assess, it could yet be another reason that could account for differences in responses of the two categories of respondents.

Table 2. Students' perceptions of the extent to which their training address key waste management issues.

Key waste management issue	Does not address it	Addresses it
Effects of construction and demolition waste materials on the environment.	2	**29**
Causes of construction and demolition wastes materials on project sites.	1	**31**
Cost of construction and demolition waste material on construction sites.	0	**34**
Reuse of waste materials arising from construction and demolition activities.	1	**32**
Recycling of waste materials arising from construction and demolition works.	23	**9**
Sorting of waste materials arising from construction and demolition works.	22	**11**
Minimising waste materials arising from construction and demolition works.	1	**32**
Addressing waste materials arising from construction and demolition works at the design stage.	21	**8**
Handling of waste materials arising from construction and demolition works.	5	**29**
Disposal of waste materials arising from construction and demolition works.	**0**	**34**

4.3 Importance of measures to address waste materials arising from construction and demolition works

Views of graduates and teaching staff on the importance of measures in addressing waste materials arising from construction and demolition works indicate that regulation and enforcement activity are very important measures in the effective management of materials waste on construction sites. While graduates rank regulation and enforcement activity as first and second respectively, teaching staff rank these as first and third respectively (Table 3). Measures relating to design and project team efforts are equally important as can be seen from the ranking of the graduates and teachers. This is an interesting result given that both students' and graduates' responses suggest that their training does not adequately address issues relating to design solutions to material waste on construction sites.

Storing and transporting materials properly within the site and ordering the right quality and quantity of materials are ranked low as measures to address material waste. With the exception of a few measures to address waste materials on construction sites there appears to be high degree of concordance in the two set of rankings. Significant differences in rankings relate to measures on assessing the level of waste generated during construction and demolition works with a view to finding remedial measures and using principles of modular coordination and prefabrication where the rankings differ significantly.

Table 3. Importance of measures in addressing waste materials arising from construction and demolition works

Measure	Graduates		Teaching staff	
	Index	Rank	Index	**Rank**
Regulations on management of waste materials arising from demolition and construction works.	0.82	1	0.86	**1**
Implementing quality control measures for materials and construction site practices.	0.77	3	0.82	**2**
Strict enforcement of laws governing generation, management and disposal of waste materials.	0.80	2	0.79	**3**
Assessing the level of waste generated during construction and demolition works with a view to finding remedial measures.	0.66	8	0.69	**6**

Project team efforts at effectively managing waste materials generated on construction and demolition sites.	0.75	4	0.75	**4**
Minimising design changes during the construction of facility.	0.73	5	0.71	**5**
Minimising design errors at the design phase of a construction project.	0.73	5	0.64	**7**
Using principles of modular coordination and prefabrication.	0.70	6	0.75	**4**
Ordering the right quality and quantity of materials for use on a project.	0.68	7	0.61	**8**
Storing and transporting materials properly within the site.	**0.64**	**9**	**0.57**	**9**

4.4 Suggestions for enhancing training in sustainable construction and demolition waste material management

Suggestions on how teaching and learning in polytechnics could enhance training in sustainable construction and demolition waste material management are categorised into two; one set relating to practical training and the other course content. Suggestions bordering on practical training include; allocating more time to practical periods particularly during long breaks at the end of second semester, effective supervision and ensuring industrial attachment with the right organisations. The second set of suggestions for enhancing training in sustainable waste materials management relate to reviewing the course content for the HND to bring it in line with modern construction practices vis-à-vis principles of sustainable construction and demolition waste materials management. For instance, the syllabus could be reviewed to address specific waste management issues, modes of lecture delivery such as audio visual means most amenable to presenting case studies on sustainable waste materials management. Also, lecturers need to pursue continuing education and professional development to attain the requisite level of skills and competence in handling sustainable construction and demolition waste materials management and related courses.

V. DISCUSSION

The results presented suggest that the scope and depth of training provided at the HND level needs to be improved to equip graduates with the requisite skills and technical know-how to find solutions to waste materials management when working in industry. Also, the results suggest key measures that should be implemented for effective sustainable construction and demolition waste materials management. These issues are discussed in the sections that follow.

5.1 Regulatory and institutional framework

The results suggest regulations on materials waste management and functioning institutional arrangements for enforcing regulations as measures required for effectively managing waste materials generated by the construction industry. Sadly, in Ghana there are no specific regulations to address waste materials generated on construction and demolition sites in the country. However, the Environmental Sanitation Policy of the country contains broad guidelines on waste management. While this law, is of relevance to the management of construction and demolition waste, is does not address specific issues relating to recycling, reuse and minimisation of construction and demolition materials waste. The main institutions responsible for waste management in Ghana are the Ministry of Local Government and Rural Development and departments under it (metropolitan, municipal and district assemblies). Regulatory authority is vested in Environmental Protection Agency under the Ministry of Environment Science and Technology. However, these institutions are constrained by inadequate funding and lack of logistics to carry out enforcement activity and to effectively manage waste in general.

The importance of regulatory framework in bringing about desirable changes in waste materials management must be treated with caution as extant research relating to the importance of the same on the much broader field of sustainable construction does not support the supposition of regulation as a remedy to implementation of sustainable construction. For instance, Bon and Hutchison [19] examined ways of positively influencing economic systems to lessen their counter effect on sustainable construction arguing that market oriented policies have favourable effects on sustainable construction over legal regulations and impositions. In line with this thought, economic measures particularly economic incentives, taxes and tradeable permits have long been seen as ways of supporting sustainable construction when compared with punitive measures for noncompliance with regulations [20]. The aforementioned studies place emphasis on economic incentives as a

possible measure in promoting sustainable construct and this by extension of the argument, may impact positively on sustainable waste materials management.

5.2 Implementing quality control measures for materials and construction practices

The results provide evidence to support the need for quality control measures to control the amount of material waste generated by construction and demolition. This result accords with past research findings on the causes of material waste [13, 15, 21]. For instance, Masood [15] suggests that implementing quality control could significantly reduce the amount of waste produced in operations involving concrete. Additionally, many authors of quality management systems argue that their implementation in construction will result in efficiency [22, 23].

5.3 Design changes and project management team

Adequate planning at the design phase of a project alongside detailed specifications will aid in the ordering of materials and use of quality materials in the right quantities during the construction and demolition phases. Clearly, this will avert possible rework during site operations and thus reduce the consumption of materials and other inputs thereby reducing materials waste on site. Frequent design changes are the result of poor planning and could lead to increased cost and large quantities of waste materials on a site. The project team has a role to play in ensuring that the quality of the finished project is acceptable and the client gets value for money invested.

Waste management plans and accurate records on waste materials should be considered at the early phases of a project. Unreliable records results in inaccurate percentage allowance for waste during estimating which invariable is below actual waste levels reported on construction sites [13]. Project team members need to aware of their responsibilities regarding the management waste materials generated on site. Also, principles of sustainability (the 3Rs) need to be embodied in the design of the project.

5.4 Suggestions for improving teaching and learning in materials waste management

The results suggest some gaps in the training of construction professionals at the HND building technology level. These gaps are partly as a result of the many challenges facing polytechnic education in Ghana as highlighted in the literature [17] and continual change involving varying technologies, working conditions and coordination of different interdependent trades that characterise the construction industry [24]. To address these gaps the following suggestions based on the study's findings are presented:

- reinforce student training by regularly updating the present HND Building Technology Syllabus to make it relevant to sustainable waste management and related issues;
- encouraging practical training on construction sites and monitoring students on practical training;
- promoting lecturers' and instructors' participation in continuing education and professional development courses;
- teaching methods should involve the use of media technologies that will reinforce student learning such as use of audio-visual technologies during lectures to emphasis case studies relating to construction waste material management; and,
- promoting research on cutting-edge issues relating to sustainable construction and waste materials management.

VI. CONCLUSION

The scope of competencies provided by academic training in the Polytechnic studied for students pursuing HND Building Technology do not address all the relevant issues bordering sustainable construction materials management. In order for students to develop the necessary skill level required to address waste management problems encountered on most construction sites teaching and learning needs to take into consideration the recommendations made. Additionally, academic staff involved in teaching courses need to extend their breadth of vision regarding competencies required by HND Building Technology graduates. The findings of the study have important implications for making policy decisions on course contents by regulatory bodies namely in Ghana and other developing countries practicing similar systems of education.

REFERENCES

[1]. B.A.G. Bossink, and H.J.H. Brouwers, Construction waste: quantification and source evaluation. Journal of Construction Engineering and Management, 122(1), 1996, 55-60.

[2]. C.T. Formoso, L. Sobelman, C.D. Cesarem and E.L. Isatto, Material waste in building industry: main causes and prevention. Journal of Civil Engineering and Management, 128(4), 2002, 316-325.

[3]. C.S. Poon, A.T.W. Yu, S.C. See and E. Cheung, Minimizing demolition wastes in Hong Kong Public housing projects. Construction Management and Economics, 22(8), 2004, 799-805.

[4]. P. Hämäläinen, J. Takala, and K.L. Saarela, Global estimates of occupational accidents. Safety Science, 44, 2006, 137-156.

[5]. J.M.C. Teiveira, Construction site environmental impact in civil engineering education. European Journal of Engineering Education, 30(1), 2005, 51-58.

[6]. C. Du Plessis, A strategic framework for sustainable construction in developing countries. Construction Management and Economics, 25(1), 2007, 67-76.

[7]. K.A. Anaman, and C. Osei-Amponsah, 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(7-9), 2007, 951-961.

[8]. E.Z. Kpamma, and T. Adjei-Kumi, Management of waste in the building design process: The Ghanaian consultants' perspective. Architectural Engineering and Design, 7(2), 2011, 102-112.

[9]. L.L. Ekanayake, and G. Ofori, Construction material waste: source evaluation, Proceedings of Strategies for a Sustainable Built Environment, Pretoria, 2000, 119-220.

[10]. A. Craighill, and J.C. Powell, A lifecycle assessment and evaluation of construction and demolition waste (London, Centre for Social and Economic Research on the Global Environment (CSERGE), 2003).

[11]. B. Cooke, and P. Williams, Construction planning, programming and Control (2nd Ed., Oxford, Blackwell Publishing, 2004).

[12]. J.R. Illingworth, Construction Methods and Planning (2nd Ed., London, Spon Press, 2000).

[13]. P. Olomolaiye, Materials management practoce and waste on Nigerian building sites. Building Research & Information, 1991. 19(1): p. 38-42.

[14]. F.T. Edum-Fotwe, and R. McCaffer. Developing next-generation engineering and technology professionals: the maintenance and renovation context, 11th International Conference on Inspection, Appraisal and Maintenance of Structures, North Cyprus, Building Science Research Centre, 2007, 111-121.

[15]. A. Masood, A. Arif, and F. Mahdi, Waste management strategies for concrete. Environmental Engineering Policy, 3, 2002, 15-18.

[16]. N. Aidoo-Tailor, Developing advanced technical and vocational skills through Polytechnic education: historical perspective, In G.W. Kouwenhoven, G.K.T. Oduro, and K. Nsiah-Gyabaah, (Eds), Trends in Polytechnic Education in Ghana, (Amsterdam, VU University, 2009).

[17]. Y. Owusu-Agyeman, and M.V.D. Oosterkamp, Challenges facing Polytechnic education in Ghana, in Trends in Polytechnic Education in Ghana, In G.W. Kouwenhoven, G.K.T. Oduro, and K. Nsiah-Gyabaah, (Eds), (Amsterdam, VU University, 2009).

[18]. P.F. Kaming, P.O. Olomolaiye, G.D. Holt, S.T. Kometa and F.C. Harris, Project managers' perception of production problems-an Indonesian case study. Building Research & Information, 24, 1996, 302-310.

[19]. R. Bon, and K. Hutchinson, Sustainable construction: some economic challenges Building Research & Information,. 28(5-6), 2000, 310-314.

[20]. F. Cairncross, Costing the Earth: What Governments Must Do, What Consumers Need to Know, and How Businesses Can Profit (London, The Economist Books, 1991).

[21]. A. Al-Hajj, and K. Hamani, Material waste in the UAE construction industry: main causes and minimization practices. Architectural Engineering and Design, 7(4), 2011, 221-235.

[22]. A.G.F. Gibb, and A.I. Ayoade. Integration of quality, safety and environmental systems. in Implementation of safety and health on construction sites CIB Conference, Proceedings of the First International Conference of CIB Working Commission, Rotterdam, Brookfield, Lisbon, Portugal, 1996, 456-471.

[23]. F. Harris, and R. McCaffer, Modern Construction Management (Oxford, Blackwell Publishing, 2006).

[24]. T. Laukkanen, Construction work and education: Occupational health and safety reviewed. Construction Management and Economics, 17, 1999, 53-62.