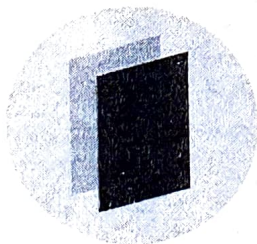


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To cite this article: W. B. Kareem *et al* 2019 *J. Phys.: Conf. Ser.* **1378** 032007

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# Evaluation of Wood and Plastic Formworks in Building Construction Industry for Sustainable Development

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## Abstract

This research work assessed wood and plastic in building construction. The study was a descriptive survey design and as such made use of questionnaire with 42 items. The Population of the study was 110 respondent which include 40 building professional and 70 non-building professional. The data were analyzed using mean and standard deviation. T-test was used to test the null hypothesis at 0.05 level of significant. The finding of the study shows that plastic work form can be used for casting slab, concrete wall among others. The finding also revealed some factors that determines the selection of form work such as climatic condition, labour efficiency and that plastic formwork saves cost as a result of long reuse period. It is therefore recommended that; plastic and wooden formwork should be integrated often in the casting of slabs, beam and columns without discrimination, proper adherence to standards and specifications for use of any type of formwork, there should be large scale production of plastic formwork to conserve forest and wood, factors to be considered in the selection of formwork should not be ignored, there should be proper weighing of the advantages and disadvantages of each type of formwork relating to the scale of construction before the choice of any formwork.

**Keywords:** Formwork, Evaluation, Plastic, Wood and Technology.

## 1. Introduction

Evaluation is an elastic word that stretches to cover judgment of many kinds which may includes: evaluation of a new programme and workers job performance. The word evaluation emphasis is based on judging merit. Patton (2008) view evaluation as a survey of features or value of an activity, programme or object of study with a view of adopting criteria to improve, enhance or apprehend them in a better way. Evaluation seeks identification of quality or value of an object or specific subject. In the context of this study evaluation is referred to as an assessment of formwork materials (wood and plastic) with a view to identify their performance both in effectiveness and durability in order to make a better choice. The result so obtained was the basis that indicates characteristics of both formwork and the reasons for the choices of formwork in relation to building construction.





Wood is the composition of the element of tissues that is fibres, vessels tracheid's and other like the hard fibrous material occurring between the pith and the bark (Kareem 2013). Timber is another term related to wood. It is called lumber in North America. It is refer to the solid wood of trees which has been sawn up that is, converted for constructional purposes. It is readily available as a material, very economical feasible. It is remarkably strong in relation to its weight, highly machine-able, and can be fabricated into all kind of shapes and-sizes to fit practically any construction need. In relation to construction, it is the most common material used for shuttering (formwork) and is almost available everywhere. Wood is cheap and it can be easily shaped. Wood forms deteriorate under the stress of heat and contact with water. It is also difficult to evaluate the true strength of timber. Thus, a logical method of design becomes difficult.

Plastic is any material consisting of any of a wide range of synthetic or semi synthetic organic compounds that are malleable and can be moulded into solid objects. Plastics are typically organic polymers of high molecular mass, but often they contain other artificial substances, they are commonly derived from petrochemicals, but are mostly partially natural. Plastics are manufactured with ease, flexible and are impervious to water. Plastic forms, which include PVC, neoprene and polyester strengthened with glass fibres are some of the plastic forms in use. They are manufactured as per required shapes, they do not rust, are easy to clean, and they do not stick with concrete when used in building construction.

A building, otherwise known as edifice is a relatively permanent structure that is enclosed with a roof and walls, such as a house or factory. Buildings come in a variety of sizes, shapes and functions (Whitney and Benjamin, 2017). Therefore, building can be viewed as a structure that is comparatively stable and permanently enclosed with roof, windows, doors and other necessary facilities. It is usually used for a wide variety of activities which include shelter, entertaining or manufacturing. Buildings are constructed for different purposes, such as agricultural, commercial, residential, medical, educational, government, industrial and military buildings. However, before a structure can be considered as a building, it must be able to provide shelter, security, safety, ease of functionality, ease of maintenance, durability and also the ability to recycle materials and components (Stephen & Christopher, 2005).

Construction according to Oxford Advanced Learner's dictionary (2016) is the process or method of building or making something, especially roads, buildings, bridges, and others. It is also good to note that construction is different from manufacturing in that manufacturing typically involves mass production of similar items without a designated purchaser while construction typically takes place on location for a known client, with the term, construction site refer to an area of land on which construction work take place. Construction entails a number of works applicable to the structures of buildings, such as: architecture, plastic work, mechanical engineering, bricklaying, scaffold construction, electrical work, roof work, carpentry work, piping work, glass work, dredging work, thermal insulation, interior finishing, and lots of others.

Formwork is a part of a building construction in term of a mould used to form concrete into structural shapes (beams, column and slabs). It can be of timber, fibre glass, plastic or wood, the inside surface is coated with a bond breaker (plastic or oil) to keep the concrete from sticking to the mould. In the context of concrete construction, the formwork supports the shuttering moulds. The construction of formwork takes time and involves the expenditure of up to 20 to 25% of the cost of the structure or even more (WASE 2004). The design of these temporary structures is mostly made in accordance with economic expenditure. Formwork systems are among the key factors determining the success of a construction project in terms of speed in construction, quality, cost and safety of the works. Nowadays, most projects are required by the client to complete in the shortest time possible as a means to minimize costs along with ensuring safety.

The building and construction industry is normally seen as the industrial foundation, this is because over 50% of the Nigeria budget usually takes the forms of construction output (WASE 2004). It is noted that in building construction industry, concrete is one of fundamental materials. Formwork is not left out as the most unavoidable materials as in hardening process and concrete forming. Any effect in concrete forming results to formwork collapse during concerting placement procedure.

This kind of collapse also resulted in loos of budget, materials and life, hence an indication that formwork is notable and very important material in building construction industry. The main raw material in formwork is wood, because of it natural availability and workability until the discovery of new materials such as plastic, aluminum, steel and plywood. However wooden formwork deteriorate at use with all certainty and as such often discarded because of it repeated engagement for up to three to five times. More retained nails and chemical treatment on the surface of the wood used for the formwork makes the continuous use uneasy.

This process raise the emphasis placed on the need for environmental protection, since by the end of the day, there will be a much of wasted wood. Despite the general understanding of this, several construction industries in order to serve their own personal interests ignore all kinds of forewarnings by their unswerving and lingering use of timber, of which it has been observed by the World Nature Organization (WNO) that the speed of deforestation is far behind the progress of forestation, hence the need for diversification to other similar materials for formwork which will do well to the wasting of wood.

Industry is the entire manufacturing section of an economic. Shobowale, (2006) highlighted that industry can be interprete as a group of firm utilizing human capital and material resources in-part to produce specialized goods and services for the satisfaction (basic) social needs.

This study use a survey investigation to compare the following terms which are the; effectiveness, time and cost restrictions between wooden formwork and plastic formwork. The life cycle of the plastic formwork and wooden formwork are not the same and this tends towards the favor of plastic forms, hence this indicate that the plastic formwork has full



potential to develop and thrive as a main important and popular formwork material despite its higher costs over that of wood formwork.

Even when these materials seem to be at each of their own end of the spectrum in terms of characteristics, there are factors that are must to be considered when deciding what material should be placed in to use, and they include; strength and ability to retain the shape without deformation, other are economical in terms of the total cost of the forms, the required concrete surface finish, sufficiently resistance to leakage at the joints and others. This study aimed to evaluate use of plastic and wood formwork in building construction. The application of formwork types in building construction, the factors in making the choice of formwork and the advantages and disadvantages of both plastic and wood formwork.

## 2. Methodology

The study was a descriptive survey design because it involve the use of structured questionnaire to determine the view of the respondents. The design was successfully used for similar studies in different areas, such as Kareem (2013). The researcher assessed the effectiveness of local building materials used for building construction. This study was conducted in some selected construction site in Minna Metropolis, which includes Bosso, Gidan-Kwano, Mobil, Kpakungu and Tunga. The population for the study involves 40 building professional and 70 non-professionals. The instrument used for data collection was a structural questionnaires design by the researchers. It contains three parts A, B and C, with information obtained from the review of relevant literature to the study. Part A contains 21 items, while Part B and C contain 11 items respectively. Four points rating scale was used to adjudged the view of respondents. Any information with less than 2.5 total mean outcomes considered to be disagree while 2.5 and above considered to being agree with by the respondents.

This internal consistency of the instrument was tested using pilot test, Eight (8) building professional and Eighteen (18) non-professional are involved in the pilot test. Twenty-Six (26) questionnaire were distributed out of which Twenty-three (23) representing 88.5% return rate were retrieved. The retrieved questionnaire were subjected to analysis using Statistical Package for Social Science (SPSS) Version 23. The result of crobach alpha analysis obtained was at coefficient of 0.75 which was found to be reliable according to Loius, Laurence, and Keith (2007).

Three hypothesis were formulated to guide the study and was tested at (0.05) level of significance:

- H<sub>01</sub>: There is no significance difference between the mean responses of building professionals and non-professionals on the application of formwork types in building construction
- H<sub>02</sub>: There is no significance difference between the mean responses of building professionals and non-professionals in making the choices of formwork.
- H<sub>03</sub>: There is no significance difference between the mean rating of building professional and non-professional in advantages and disadvantages of both plastic and wood formwork.

### 3. Results and Discussion

The data analyses for research questions are presented as follows:

The finding of research question one, shows that both wood and plastic formwork can be used for various application in building construction as highlighted in the table with all the 21 items. It was noted in item 19 that various application of both types of formwork, wood as a natural materials has more applications such as scaffolding, bench, table and many others after removing it from formwork application. This finding is supported by Wang and Shen (1987), the researcher highlighted that Bamboo Tree as a local material is widely used in building application such as flooring, ceiling, walls, doors, windows, fences among others. This implies that the use of wood in formwork as readily available local materials cannot be over emphasized, even though plastic as synthetic materials can be durable as compare to wood formwork because of it's use and reuse severally.

The finding of research question two, revealed that factors such as climatic condition, labour efficiency, surface finishing, potentiality in re-use of types of formwork determined the choice of any. This finding is supported by (Omzokpia 2008) who opined that the choice of types of foundation for building construction is determine by factor such as soil topography, soil types, purpose of building and types of building to be so erected among others. Onibokun (1986) recognized finance as factors that determine the erection of building such as land and building materials in term of cost implication. This implies that the re-use potentiality of plastic formwork made it a subject of good choice.

The finding of research question three, reveal advantages and disadvantages of using both types of formwork. However, it shows that even through wood is cheaper in term of cost, the expenses to be incurred in wood preservation is an issue and also limitation to the reuse of wood formwork, make plastic formwork a good choice. The finding also reveal that plastics gives a better surface finishing than wood and as sure can be reuse as many times as possible than it does with wood. This finding is supported by Kareem (2011), the researcher highlighted that use of wood in building construction needed a thoroughful preservation because of the way wood deteriorate and decomposed. This in effect will demand extra expenses to be incurred to obtain an effective preservative for wood formwork whereas a plastic formwork will not require preservation and it allow use and reuse than wood.

**Table 1:** Mean responses of professional and non-professional builders on the applications of both types of formwork in construction sites.

S/N	Items	$\bar{x}_1$	SD <sub>1</sub>	$\bar{x}_2$	SD <sub>2</sub>	$\bar{x}_t$	SD <sub>t</sub>	Remark
1.	Casting of slab can be carried out with plastic formwork	3.05	0.50	2.84	0.47	2.94	0.49	Agreed
2.	Casting of concrete wall can be done with plastic formwork	2.84	0.79	3.39	0.68	3.13	0.74	Agreed
3.	The hole in plastic formwork creates easy lighting and air conditional system during installation	3.40	0.74	3.33	0.72	3.36	0.73	Agreed
4.	Both residential and industrial buildings casting can be carried out with plastic formwork	3.27	0.44	3.26	0.69	3.27	0.57	Agreed
5.	Plastic can be preferably for large construction work	3.23	0.46	3.43	0.71	3.33	0.59	Agreed



6.	Use of nails and wires as consumable materials decreases when Plastic formwork is employ	2.77	0.50	3.42	0.83	3.09	0.67	Agreed
7.	Plastic formwork are used for parapet	2.95	0.98	3.42	0.92	3.22	0.95	Agreed
8.	Plastic formwork are used for casting pillars	3.57	0.40	3.50	0.37	3.22	0.39	Agreed
9.	Plastic formwork permit sanitary fittings into walls	2.62	0.41	3.14	0.39	3.35	0.40	Agreed
10.	Plastic formwork are possibly the formwork of the future	3.25	0.47	3.16	0.38	2.89	0.43	Agreed
11.	Wood formwork can be used for casting of slabs	3.55	0.50	3.66	0.48	3.45	0.49	Agreed
12.	Wood formwork can be used for casting concrete walls	3.45	0.83	3.60	0.61	3.52	0.72	Agreed
13.	The spacing in wood formworks easily allow for the installation of lighting and air conditioning systems	3.17	0.82	3.53	0.55	3.35	0.68	Agreed
14.	Wood form is best applied for small construction work	3.42	0.77	3.67	0.73	3.55	3.29	Agreed
15.	Wood formwork increases the use of consumables (nails, wire, etc.)	3.15	0.68	3.58	0.65	3.36	3.48	Agreed
16.	Wood formwork are used for casting pillars	3.42	1.06	3.70	1.02	3.56	3.06	Agreed
17.	Wood formwork can be used for parapet	3.00	1.16	2.93	1.06	2.96	2.58	Agreed
18.	wood formwork are the are the most common formwork for use	3.40	0.70	3.21	0.69	3.30	3.16	Agreed
19.	Wood formwork after use can be broken down and its pieces used for other important work, e.g. scaffolding, bench, table for cutting which is not the same for plastic	3.30	0.80	3.64	0.78	3.47	3.22	Agreed
20.	Wood formwork can be used for any type of buildings	3.70	0.60	3.79	0.61	3.74	2.86	Agreed
21.	Wood formwork do not easily permit sanitary fittings (pipes for wires and drainage) into walls	3.30	0.68	3.33	0.63	3.31	3.23	Agreed

Table one reveals that all the items are above 2.5. This means that respondent agreed with entire listed items as various applications of wood and plastic formwork.

**Table 2:** Mean responses of building professional and non-building professional on the factor that determine the selection of formwork.

S/N	Items	$\bar{x}$	SD <sub>1</sub>	$\bar{x}_2$	SD <sub>2</sub>	$\bar{x}_t$	SD <sub>t</sub>	Remark
1	Climatic condition of the environment	3.37	0.4	3.60	1.06	3.48	0.93	Agree
2	Labour efficiency	3.27	0.5	3.15	0.65	3.21	0.83	Agree
3	Access for containing concrete	3.02	0.8	3.62	0.14	3.32	0.87	Agree
4	Required surface finish	3.25	0.6	3.49	0.61	3.37	0.91	Agree
5	Reuse potential	3.02	0.68	3.04	0.54	3.03	0.95	Agree
6	Resistant to leakage	3.03	0.67	3.70	0.59	3.36	0.97	Agree
10	Easy and quick shuttering and de-shuttering	3.22	0.58	3.84	0.66	3.59	0.91	Agree
8	Strength	3.15	0.64	3.80	0.45	3.47	0.87	Agree
11	Ease of handling	3.10	0.45	3.73	0.78	3.43	0.84	Agree
7	Low storage costs with is maintainers	3.22	0.22	3.33	1.45	3.28	0.95	Agree
9	Economize cost	3.03	0.54	3.86	0.65	3.44	0.89	Agree

Table two reveals that the mean responses of the items are above 2.5. That implies that the respondents agree that all listed factors determine the selection of formwork.

**Table 3:** The mean score of the respondents on the advantages and disadvantages of both types of formwork

S/N	Items	$\bar{x}_1$	SD <sub>1</sub>	$\bar{x}_2$	SD <sub>2</sub>	$\bar{x}_t$	SD <sub>t</sub>	Remarks
1	Wood formwork are initially cheaper than plastic formwork	3.60	0.67	3.86	0.63	3.70	0.65	Agree

2	Plastic formwork due to their long reuse period save costs and are overall cheaper than wood	3.04	0.88	3.77	0.50	3.40	0.69	Agree
3	Wood formwork are more flexible for designs than plastic	3.15	0.67	3.43	0.53	3.29	0.60	Agree
4	Plastic gives better surface finish than wood	3.45	0.73	3.80	0.62	3.62	0.68	Agree
5	Wood formwork has good thermal insulation which makes it more useful in colder regions	3.12	0.76	3.07	0.78	3.10	0.77	Agree
6	Plastic formwork can be easily pre-fabricated into any shape or size	3.15	0.71	3.23	0.65	3.17	0.68	Agree
7	Wood formwork with too low or high moisture content affect the concrete	3.27	0.41	3.82	0.73	3.54	0.57	Agree
8	Wood formwork are easier to erect than plastic formwork	3.02	0.75	3.41	0.65	3.21	0.7	Agree
9	Plastic formwork are lighter than wood formwork	3.15	0.63	3.14	0.66	3.13	0.65	Agree
10	Wood formwork are stronger than plastic formwork	3.37	0.81	3.66	0.78	3.52	1.79	Agree
11	Plastic formwork do not require rather too special environments in which to be stored	3.01	0.67	3.73	0.56	3.37	1.87	Agree

Table three discloses that the mean responses of the analyzed items are above 2.5. This means that these are the advantages and the disadvantages of using both wood and plastic formwork by respondents.

### Hypothesis 1

**Table 4:** *t*-test analysis of professional and non-professional builders on the applications of both types of formwork in construction sites.  $N_1=40$ ,  $N_2=70$

S/N	Items	S.D <sub>1</sub>	S.D <sub>2</sub>	t-test	Decision
1.	Casting of slab can be carried out with plastic formwork	0.50	0.47	0.14	NS
2.	Casting of concrete wall can be done with plastic formwork	0.79	0.68	1.35	NS
3.	The hole in plastic formwork creates easy lighting and air conditional system during installation	0.74	0.72	0.7	NS
4.	Both residential and industrial buildings casting can be carried out with plastic formwork	0.44	0.69	0.15	NS
5.	Plastic can be preferably for large construction work	0.46	0.71	0.9	NS
6.	Use of nails and wires as consumable materials decreases when Plastic formwork is employ	0.50	0.83	0.56	NS
7.	Plastic formwork are used for parapet	0.98	0.92	0.53	NS
8.	Plastic formwork are used for casting pillars	0.40	0.37	0.07	NS
9.	Plastic formwork permit sanitary fittings into walls	0.41	0.39	0.47	NS
10.	Plastic formwork are possibly the formwork of the future	0.47	0.38	0.56	NS
11.	Wood formwork can be used for casting of slabs	0.50	0.48	0.48	NS
12.	Wood formwork can be used for casting concrete walls	0.83	0.61	0.53	NS
13.	The spacing in wood formworks easily allow for the installation of lighting and air conditioning systems	0.82	0.55	0.17	NS
14.	Wood form is best applied for small construction work	0.77	0.73	0.18	NS
15.	Wood formwork increases the use of consumables (nails, wire, etc.)	0.68	0.65	0.78	NS
16.	Wood formwork are used for casting pillars	1.06	1.02	0.36	NS
17.	Wood formwork can be used for parapet	1.16	1.06	0.33	NS
18.	wood formwork are the are the most common formwork for use	0.70	0.69	0.16	NS



19.	Wood formwork after use can be broken down and its pieces used for other important work, e.g. scaffolding, bench, table for cutting which is not the same for plastic	0.80	0.78	0.7	NS
20.	Wood formwork can be used for any type of buildings	0.60	0.61	0.67	NS
21.	Wood formwork do not easily permit sanitary fittings (pipes for wires and drainage) into walls	0.68	0.63	0.9	NS

Key:  $N_1$ - Number of building professional,  $N_2$ - Number of Non-building professional,  $SD_1$ - Standard Deviation of Professional,  $SD_2$ - Standard Deviation of Non- Professional, NS - Not Significant

The t-test in table 4 show that there is no significant difference in the mean response of Building Professional and Non-building professional on the application of formwork. All items were accepted because the falling rate of t-test is above 0.05 level of significant.

### Hypothesis 2

**Table 5:** t-test analyses of the mean responses of building professionals and non-professionals in making the choices of formwork.  $N_1=40$ ,  $N_2=70$

S/N	Items	S.D <sub>1</sub>	S.D <sub>2</sub>	t-test	Decision
1	Climatic condition of the environment	0.4	1.06	0.7	NS
2	Labour efficiency	0.5	0.65	0.08	NS
3	Access for containing concrete	0.8	0.14	1.55	NS
4	Required surface finish	0.6	0.61	0.37	NS
5	Reuse potential	0.68	0.54	0.15	NS
6	Resistant to leakage	0.67	0.59	0.14	NS
10	Easy and quick shuttering and de-shuttering	0.58	0.66	0.16	NS
8	Strength	0.64	0.45	0.89	NS
11	Ease of handling	0.45	0.78	0.36	NS
7	Low storage costs with is maintainers	0.22	1.45	0.47	NS
9	Economize cost	0.54	0.65	0.36	NS

Key:  $N_1$ - Number of building professional,  $N_2$ - Number of Non-building professional,  $SD_1$ - Standard Deviation of Professional,  $SD_2$ - Standard Deviation of Non- Professional, NS - Not Significant

The t-test in table 5 show that there is no significant difference in the mean response of Building Professional and Non-building professional in making the choice of formwork. All items were accepted because the falling rate of t-test is above 0.05 level of significant.

### Hypothesis 3

**Table 6:** t-test analyses mean of the mean reasons of building professional and non-professional in advantages and disadvantages of both plastic and wood formwork.  $N_1=40$ ,  $N_2=70$

S/N	Items	S.D <sub>1</sub>	S.D <sub>2</sub>	t-test	Decision
1	Wood formwork are initially cheaper than plastic formwork	0.67	0.63	0.53	NS
2	Plastic formwork due to their long reuse period save costs and are overall cheaper than wood	0.88	0.50	0.07	NS
3	Wood formwork are more flexible for designs than plastic	0.67	0.53	0.47	NS
4	Plastic gives better surface finish than wood	0.73	0.62	0.56	NS
5	Wood formwork has good thermal insulation which makes it more useful in colder regions	0.76	0.78	0.48	NS
6	Plastic formwork can be easily pre-fabricated into any shape or size	0.71	0.65	0.23	NS
7	Wood formwork with too low or high moisture content affect the concrete	0.41	0.73	0.18	NS
8	Wood formwork are easier to erect than plastic formwork	0.75	0.65	0.19	NS

9	Plastic formwork are lighter than wood formwork	0.63	0.66	0.78	NS
10	Wood formwork are stronger than plastic formwork	0.81	0.78	0.36	NS
11	Plastic formwork do not require rather too special environments in which to be stored	0.67	0.56	0.34	NS

Key:  $N_1$ - Number of building professional,  $N_2$ - Number of Non-building professional,  $SD_1$ - Standard Deviation of Professional,  $SD_2$ - Standard Deviation of Non- Professional, NS - Not Significant

The t-test in table 5 show that there is no significant difference in the mean response of Building Professional and Non-building professional in making the choice of formwork. All items were accepted because the falling rate of t-test is above 0.05 level of significant.

## Conclusion and Recommendation

The evidence obtained from this study on the evaluation of the use of wood and plastic formwork in construction sites is based on the data analyzed for findings, it was concluded that there is need for government and society to go for the integration of plastic formwork into use for its building projects which is of the bid to minimize the use of timber (wood formwork) and also in the long run save costs since reinforced plastic formwork is more durable than wood formwork and furthermore capable of meeting other standards of formwork requirements.

Although, these conclusions are true, it should however be noted that for small construction work, wood formwork is better since they are cheaper and readily available and therefore would be a waste of resources to purchase or make use of plastic formwork for a small piece of construction work bearing in mind all other advantages of utilizing wood formwork.

From the findings of this study, it is recommended that; plastic and wooden formwork should be integrated often in the casting of slabs, beam and columns without discrimination, proper adherence to standards and specifications for use of any type of formwork, there should be large scale production of plastic formwork to conserve forest and wood, factors to be considered in the selection of formwork should not be ignored, there should be proper weighing of the advantages and disadvantages of each type of formwork relating to the scale of construction before the choice.

## Acknowledgements

The authors wish to acknowledge the financial support offered by Federal University of Technology, Minna in actualization of this research work for publication.

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