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AN EVALUATION OF THE EFFECTS OF NON-PHYSICAL WASTES ON BUILDING PROJECTS PERFORMANCE

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ABSTRACT

Non-physical waste (NPW) is one of the challenges that is engendering low performance levels, yet an underexplored contributor to poor performance in the construction sector, particularly in developing countries, where emphasis has mainly been on material waste. Previous studies have identified NPW, limited attention has been given to how different NPW types separately influence multiple project performance measures (PM). This paper, therefore, aims to evaluate their distinct effect on six (6) PM, such as quality, cost, time, safety, satisfaction, and productivity. An extensive literature review was done to identify the NPW types and PM. A questionnaire survey method was administered to construction professionals in Abuja, Nigeria, through a purposive sampling technique. A reliability test was conducted to check the suitability of the data and the data were analysed using descriptive statistics. The study revealed that the data have good reliability with Cronbach's alpha of 0.96. More importantly, the results show that NPWs create performance-specific impacts: 'waiting' had the greatest impact on time performance (3.81); unused talent' (3.61) has the most impact on quality performance; 'defect/rework' has the greatest impact on cost (3.79) and productivity performance (3.75); and accidents related waste critically impact safety (3.47) and client satisfaction (3.54) categories. In conclusion, NPWs should not be seen as a single unit but as distinct performance-related risk factors requiring targeted management strategies. Thus, enhancing awareness, stronger supervision, improved workforce structure, and structured communication systems are recommended to minimise the high impact of NPW.

Keywords: *Building projects, Defect/rework, Impact, Non-physical wastes, Normality, Performance measures.*

INTRODUCTION

The construction process originates from clients' needs to have safe, comfortable, and valuable buildings delivered on time. Non-physical waste is any activity or operation that consumes resources without adding equivalent value to the product (Nagapan et al., 2012; Bosnich, 2019). Wastes in building construction are classified as physical (visible material wastes) and non-physical (hidden wastes from inefficient activities causing time and cost overruns) (Nagapan et al., 2012).

In many developing countries including Nigeria, the focus of practitioners and public clients has been largely on how to manage physical wastes, with little attention given to the prevalence and impact of NPWs (Ismail & Yusof, 2016; Igwe et al., 2022a).However, studies have shown that, about 10% of the total construction waste is in the form of materials, while a much larger portion of up to 90% is non-physical waste, yet are significant for the successful completion of the final product (Bosnich, 2019). These non-visible types of waste are prone to decreasing productivity, expected value, quality, and overall efficiencies of the process (Bajjou & Chafi, 2022). The economic cost is significant as construction practitioners and clients incur the cost of NPW. For example, the construction industry suffers from annual losses of $30 to 40 billion due to labour inefficiencies (Phillips, 2023). The costs of waste tend to create substantial challenges that serve as a barricade to the successful realization of improved construction process performance.

Apart from cost, time, and quality, other performance measures such as productivity, safety, and client satisfaction are also essential in evaluating project process, and its outcome and all are impacted by the persistence of NPWs (Maliha et al., 2021; Oda et al., 2022; Galjanić et al., 2023). Increase in safety issues, poor satisfaction, and low productivity are consistently associated with the constant presence of value-subtracting activities (Bosnich, 2019; Igwe et al., 2022b). These outcomes show why it is essential for NPWs' influence on various performance measures to be assessed.

Furthermore, past studies mainly focused on the identification of non-physical waste types. Also, these studies attempted to evaluate their impact on performance measures but are limited to the few well-known measures, which are cost, time, and quality (Bajjou & Chafi, 2022; Igwe et al., 2022b; Bhatta et al., 2023). Thus, there is not enough evidence on how specific types of NPW affect other project performance, such as productivity, safety, and client satisfaction. The lack of performance-specific analysis reduces the capacity of practitioners to prioritise and implement targeted non-physical waste management strategies as the visible measure is affected.

Therefore, this study aims to evaluate the effects of non-physical wastes on multiple construction project performance measures. The objectives are to: (1) identify NPWs critical to project execution through a review of relevant literature; and (2) assess how each waste type affects key project PM.

LITERATURE REVIEW

Lean construction theory

This study is underpinned by lean construction theory, which conceptualises construction as a production system where value is generated through the elimination of non-value-adding activities (waste) and the optimisation of workflow (Koskela, 2004). From this scenario, NPWs represent inefficiencies within construction processes and evolve mainly from human activities that end up truncating progress of workflow and reducing value targets in the process and the end product (Koskela et al., 2013). By linking specific NPWs to distinct performance measures, this study extends the lean construction initiative beyond general waste identification to a performance-based evaluation of waste impacts. Lean construction has some practices such as the Last Planner system, Just-in-time delivery, kaizen, 5 s, etc (Bosnich, 2019). Utilising them in a labour-intensive environment such as Nigeria will significantly improve processes; however, their implementation is still low in this type of construction environment (Horsfall & Alaribe, 2024).

Non-physical wastes (NPWs)

At the early stage of Non-Physical Waste (NPW) identification from the manufacturing sector, particularly the Toyota Production System, these wastes were originally seven, including transportation, overproduction, defects in products, available time, inventory, additional processing, and movement

(Koskela et al., 2013). The waste of not utilising talent (Liker, 2004) and making–do (starting operation when one critical input is absent) (Koskela, 2004) were other forms of NPW that were added, making the current major NPW nine. According to Koskela et al. (2013), these wastes are a widespread challenge in the construction sector. In the construction sector, NPW is also referred to as lean construction wastes (Igwe et al., 2022a), process wastes, and non-value-addingr activities (Nagapan et al., 2012; Emuze et al., 2015; Abubakar et al., 2019).

Furthermore, additional NPWs exist within the construction setting that are mainly behaviourally related. For instance, unsafe behaviour resulting in accidents and unnecessary discussion is considered as NPW (Sahlu & Dinku, 2021; Fateh & Sulaiman, 2021). More so, workers' deliberate slow work pace is common in Nigerian construction settings, where most work is based on daily payment, which can be seen as procrastination/effort withholding (Akinbode, 2025). This waste type is what Fredrick Taylor called soldiering, which is a situation where workers deliberately slow their pace to limit output, often because they are paid by the day or to create job security for the coming days (Taylor, 1911). This particular waste was emphasised during group discussion of the research, as a pattern that is still prevalent within the Nigerian construction process.

Impact of Non-physical waste

The impact of non-physical waste cannot be overemphasized and the need to reduce them systematically should be encouraged. According to Dupin (2014), activities that add no value to the process take up 68% of the total time expended during construction sites' operations. Workers' value-subtracting operations consumed 62% of the total time required for the work (Nassri et al., 2023). Thus, NPWs have negative influences on construction processes (Igwe et al., 2022a); yet many construction personnel do not recognise NPWs, and thus, concentrate less in this direction compared to physical wastes (Ismail et al., 2025). Also, unnecessary discussions have been pointed out as one form of NPWs that received less attention (Sahlu & Dinku, 2021; Methot et al., 2021; Nassri et al., 2023). Therefore, more awareness still needs to be raised among construction practitioners and clients.

Effect of NPWs on Project PM

Project Measures (PM) are data measures used to evaluate the success of construction operations and the quality of specific activities (Bhuinyan et al., 2019). This study focuses on time, cost, quality, productivity, safety, and client satisfaction, as recommended by recent studies (Maliha et al., 2021; Oda et al., 2022; Galjanić et al., 2023). In Nigeria, construction projects face challenges in time management (Oluyemi-Ayibiowu & Omolayo, 2022), and overall project quality depends on processes, organisational procedures, and outputs (Wawak et al., 2020). NPWs negatively affect project processes and organisational productivity (Bissenova & Hossain, 2018; Igwe et al., 2022a). Construction projects often experience cost overruns of 5–10% of the contract value (Kamaruddeen et al., 2020). Many causes of building construction wastes are hidden, leading to additional production costs (Bosnich, 2019; Nagapan et al., 2012). The industry's labour-intensive methods and lack of regulatory oversight, especially in developing countries, impair health and safety management (Boadu et al., 2020). NPWs can cause conflicts between clients and practitioners and create unsatisfactory environments, as client satisfaction is often underprioritised (Othma, 2015). Client satisfaction during and after construction is a key measure of project success.

Point of Departure

Previously, researchers in the area of construction waste management have greatly focused on managing material wastes in Nigeria (Ogunmakinde et al., 2019; Oladiran et al., 2019; Chidiobi, 2022); the area of non-material waste has been limited. Studies on NPWs have primarily examined their causes, such as non-value-adding activities (Emuze et al., 2015; Abubakar et al., 2019) and combined physical and non-physical wastes (Nagapan et al., 2012; Bajjou & Chafi, 2022). Research on the effects of NPW types on PM is limited. Only Igwe et al. (2022a) ranked NPWs by their influence on transformation, flow, and value using nine lean construction wastes, while Igwe et al. (2022b) focused on waste causes and performance measures limited to time, quality, and cost. This study identifies 12 NPW types and evaluates their impacts on multiple PM, including productivity, client satisfaction, and safety, following the recommendation of Galjanić et al. (2023). This helps raise practitioners' awareness of NPWs and supports the development of strategies to manage the most frequent and critical wastes affecting performance measures.

Conceptual framework

Figure1 presents the conceptual framework of non-physical waste effects reduction. The inner cycle entails the inefficient building process and requires attention. Based on this, the symptoms (effect) appear to be linked to the conventional time, cost, and quality measures that have been focused on overtime. However, the symptom lines extends beyond the conventional triangle to another triangular measure of satisfaction, productivity, and safety related issues, which are all surrounded by a red line of waste cycle that indicates the impact of the NPW waste causing the inefficient process. Along the line of the waste appears the measures for improvement with the application of lean theories and multiple management strategies, representing the blue line for adequate application.

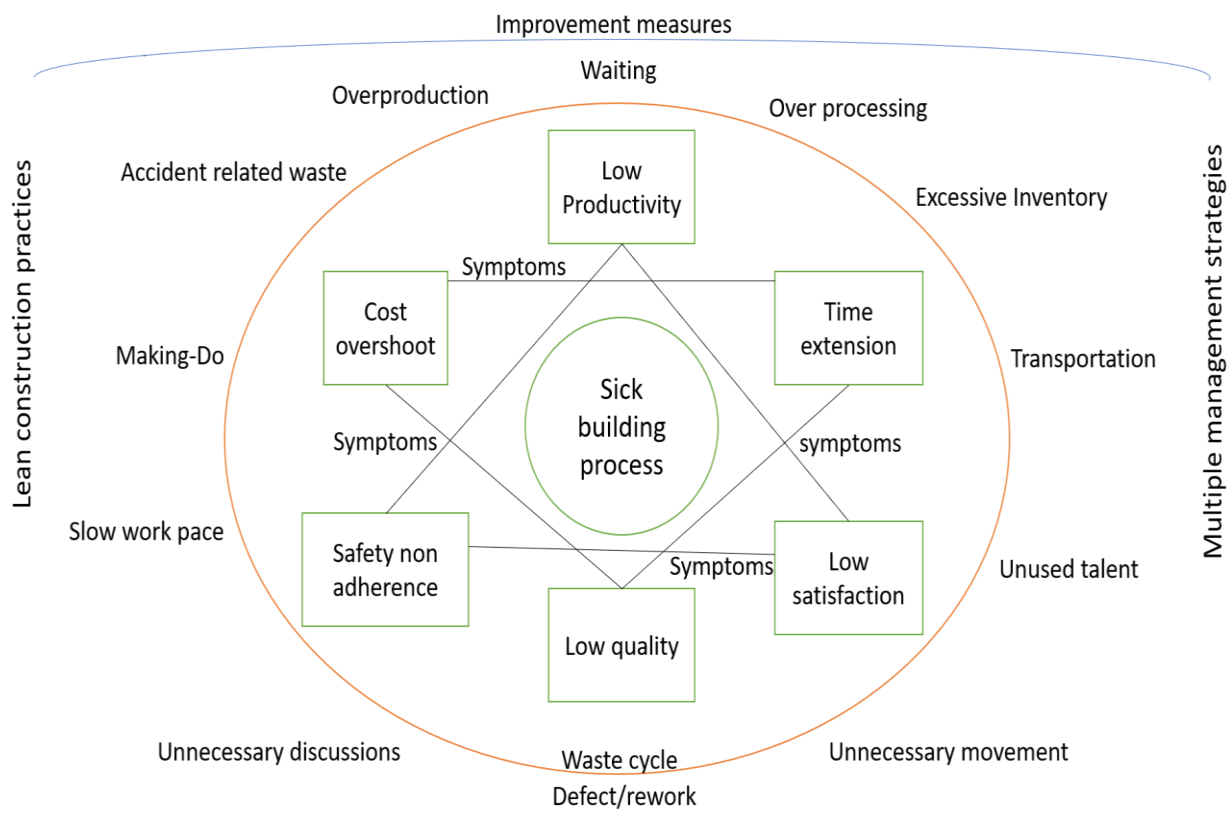

Figure 1: Conceptual framework for non-physical waste effects' reduction
Source: Author's compilation

METHODOLOGY

Sampling technique

Purposive sampling was used because the study required respondents who were knowledgeable construction professionals, and only those working on active building projects at the time of data collection were selected.

Sample Size determination

The study focused on ongoing building public projects, but since no database of such public projects exists, the population is considered unknown. Cochran's formula for an unknown population was then used to calculate the sample size, following the studies of Sweis et al. (2021) and Uakarn et al. (2021), at 95% confidence level, z = 1.96, picking choice (p)= 0.5, and confidence interval (e)= 10% were used to arrive at 96 building projects. Thus, 30% was added to account for the non-response rate common in survey data collection methods (Emuze et al., 2014; Chidiobi, 2022), resulting in 125 building projects. Then, to determine the respondent count, the key participants involved in project delivery are considered: clients, contractors, and consultants (Leo-Olagbaye et al., 2023). Accordingly, the total number of questionnaires administered was 375, calculated as 3 groups × 125 respondents each. A total of 310 questionnaires were returned over three months (October 2024–January 2025), of which 300 were valid, giving an 80% response rate. The data were analysed using SPSS version 27.

Data collection instrument

A structured questionnaire was developed based on literature to examine the occurrence of NPWs and their impact on PM. It has two sections: (A) respondents' information, (B) effects of NPWs on performance. Section B used a 5-point Likert scale (1 = not effective, 2 = fairly effective, 3 = effective, 4 = very effective, and 5 = extremely effective) to measure impact.

Method for data collection

The data was administered by hand and collected in the same way. This method was adopted to increase the response rate and to be sure the data focused on only public building projects.

Data Analysis

Reliability test for the data

A reliability test is essential when using a Likert scale. Cronbach's Alpha was used to assess internal consistency, yielding values of 0.72 for Section B and 0.96 for Section C. Based on Arof et al. (2018), these indicate acceptable and excellent reliability, respectively, confirming that the data is suitable for further analysis.

Descriptive statistics

Descriptive statistics, including mean and standard deviation, were used to evaluate the impact of 12 NPW on six PM. Previous construction management studies have employed descriptive statistics to analyse variable importance (Abubakar et al., 2019; Bajjou & Chafi, 2022). The formula for calculating the mean score used in the study is

$$MS = \frac{\sum_{i=1}^{5} ai.xi}{\sum_{i=1}^{5} xi}$$

MS represents the mean score for each item; ai is the numerical value of the ith response, with i as the response index (1–5 for a five-point Likert scale), and xi denotes the frequency of the ith response among the total responses.

RESULT AND DISCUSSION

This section presents the analysis of the nature of those that responded to the data and the evaluation of the. performance measures.

Respondents profile

Based on the data, most respondents have 6–10 years of experience (27.7%), while those with over 21 years are the least (10%). Site managers (21.7%) are the most represented job role, and "others" (such as facility managers or estate valuers/managers) are the least (11.3%). In terms of education, most hold BSc/B.Eng/B.Tech degrees (44.3%), with PhD holders being the fewest (9.7%). Regarding professional affiliations, NIOB members are the majority (22.7%) and NIA members the least (8.3%). The respondents are 56.7% private practitioners and 43.7% public clients.

Effect of NPWs on Different PM

NPWs influence project performance indicators differently. Their impact on six PM was assessed using a five-point Likert scale from 1 = not effective, 2 = fairly effective, 3 = effective, 4 = very effective, to 5 = extremely effective to identify the most impactful wastes for each indicator, as shown in Tables 1 to 6. The analysis shows that different waste types affect six PM in various ways, negatively impacting construction processes (Igwe et al., 2022a).

Effect of non-physical wastes on time performance

Table 1 effect of non-physical wastes on time performance

Types of non-physical wastes	1	2	3	4	5	N	Sum	Mean	Std.D	Rank
Waiting waste	11	21	94	62	112	300	1143	3.81	1.125	1
Overproduction	7	46	79	126	42	300	1050	3.50	.990	7
Defect/rework	18	24	86	94	78	300	1090	3.63	1.130	3
Overprocessing	5	22	138	104	33	300	1038	3.46	.847	8
Unnecessary movement	6	33	88	121	52	300	1080	3.60	.964	4
Inventory	6	47	122	104	21	300	987	3.29	.884	11
Transportation	11	31	83	118	57	300	1079	3.60	1.025	5
Making-do	15	42	107	112	24	300	988	3.29	.975	12
Unused talent	13	30	105	114	38	300	1034	3.45	.982	9
Accident waste	7	16	90	116	71	300	1128	3.76	.952	2
Unnecessary discussion	9	24	94	146	27	300	1058	3.53	.879	6
Deliberate slow work pace	8	41	112	98	41	300	1023	3.41	.976	10

1=not effective, 2=fairly effective, 3=moderately effective, 4= high effective, 5= extremely effective. N= Number of responses, Std.D= standard deviation

Source: Field survey (2025)

Non-physical waste (NPW) was evaluated and Table 1 present the effect of NPW on time performance and waiting has the greatest effect followed by accident and defect/rework. Waiting caused by delays in completing activities or receiving information, significantly increases project time and overall costs. Based on this study, in Nigerian construction projects, waiting has the greatest impact on time performance, which is consistent with Aravindh et al. (2022), who also found waiting time and defects to most affect project outcomes. Sahlu and Dinku (2021) in Ethiopia, concluded that waiting time took the highest portion in interrupting workflow. Also, waiting waste was one of the most significant wastes in the flow and conversion process of construction (Igwe et al., 2022a). Waiting waste threatens both project profitability and client satisfaction. It arises from poor production sequencing, site layout, and communication, and can be managed through experienced planners and effective scheduling techniques, including the lean last planner system (Abdullahi & Tembo, 2023).

The effect of non-physical wastes on quality performance

Table 2 The effect of non-physical wastes on quality performance

Types of non-physical wastes	1	2	3	4	5	N	Sum	Mean	Std.D	Rank
Waiting waste	32	82	80	52	54	300	914	3.05	1.264	11
Overproduction	8	56	135	82	19	300	948	3.16	.893	8
Defect/rework	8	48	114	73	57	300	1023	3.41	1.051	3
Overprocessing	11	47	169	56	17	300	921	3.07	.845	10
Unnecessary movement	9	52	125	93	21	300	965	3.22	.916	6
Inventory	23	62	138	63	14	300	883	2.94	.954	12
Transportation	14	67	115	89	15	300	924	3.08	.950	9
Making-do	13	34	116	109	28	300	1005	3.35	.951	4
Unused talent	9	30	110	72	79	300	1082	3.61	1.072	1
Accident waste	5	32	134	75	54	300	1041	3.47	.962	2
Unnecessary discussion	6	62	127	85	20	300	951	3.17	.900	7
Deliberate slow work pace	10	57	122	71	40	300	974	3.25	1.018	5

1=not effective, 2=fairly effective, 3=effective, 4= very effective, 5= extremely effective. N= Number of responses, Std.D= standard deviation

Source: Field survey (2025)

From Table 2, which presents quality performance evaluation, shows that "Unused talent of workers" and "Accident waste" have the greatest impact on quality performance in Abuja building projects. Unused talent refers to management issues, such as misplacing workers or not utilising their skills and knowledge effectively (Brito et al., 2019). The major cause of this form of waste is not allowing workers to input their ideas into the work process, which results from inadequate supervisory working experience (Bajjou & Chafi, 2022). This form of waste is among the most dangerous non-physical wastes in lean construction literature, as it leads to low morale and low productivity. This result is similar to Igwe et al. (2022a), with unused talent as the second impactful waste on the transformation section of the construction process. The cost incurred as a result of this waste is incurred in different ways. It could be due to engaging highly skilled personnel in work that requires less skilled labour or vice versa, thus paying more. Through training in lean practices, marrying workers' skill set to available tasks, adequate supervisory commitment, and employment of some motivational techniques could improve this form of waste.

The effect of non-physical wastes on cost performance

Table 3 The effect of non-physical wastes on cost performance

Types of non-physical wastes	1	2	3	4	5	N	Sum	Mean	Std.D	Rank
waiting waste	9	46	90	79	76	300	1067	3.56	1.115	8
Overproduction	11	13	94	114	68	300	1115	3.72	.983	3
Defect/rework	7	17	80	125	71	300	1136	3.79	.947	1
Overprocessing	7	23	70	132	68	300	1131	3.77	.963	2
Unnecessary movement	48	61	87	77	27	300	874	2.91	1.207	12
Inventory	5	53	133	73	36	300	983	3.28	.957	11
Transportation	6	28	109	112	45	300	1062	3.54	.926	9
Making-do	5	43	128	105	19	300	990	3.30	.852	10
Unused talent	7	25	83	136	49	300	1095	3.65	.929	5
Accident waste	11	12	96	118	63	300	1110	3.70	.966	4
Unnecessary discussion	7	25	99	107	62	300	1092	3.64	.977	6
Deliberate slow work pace	8	26	90	125	51	300	1085	3.62	.955	7

Source: Field survey (2025)

Table 3 shows that defect/rework waste has the greatest impact on both cost and productivity performance measures. Defects result from workers' mistakes or errors, which significantly increase the overall cost of trying to fix the errors as rework (Ismail & Yusof, 2018). This agrees with the conclusion that the consequences of a defect are an increase in cost (Sravani et al., 2020).

The influence of non-physical wastes on productivity performance

Table 4: The influence of non-physical wastes on productivity performance

Types of non-physical wastes	1	2	3	4	5	N	Sum	Mean	Std.D	Rank
waiting waste	14	36	87	91	72	300	1071	3.57	1.118	6
Overproduction	9	26	96	115	54	300	1079	3.60	.978	5
Defect/rework	5	31	80	103	81	300	1124	3.75	1.019	1
Overprocessing	7	20	126	120	27	300	1040	3.47	.839	8
Unnecessary movement	8	23	106	106	57	300	1081	3.60	.967	4
Inventory	7	28	119	127	19	300	1023	3.41	.835	11
Transportation	12	19	88	154	27	300	1065	3.55	.893	7
Making-do	5	39	132	95	29	300	1004	3.35	.885	12
Unused talent	14	18	72	136	60	300	1110	3.70	1.007	3
Accident waste	14	23	77	97	89	300	1124	3.75	1.104	2
Unnecessary discussion	16	30	90	135	29	300	1031	3.44	.981	10
Deliberate slow work pace	15	26	94	131	34	300	1043	3.48	.976	9

1=not effective, 2=fairly effective, 3=effective, 4= very effective, 5= extremely effective. N= Number of responses, Std.D= standard deviation

Source: Field survey (2025)

Table 4 presents the effect of NPW on productivity and defect/rework is more impactful on productivity than other NPWs. Productivity of workers is improved if the morale of workers is stable or high. This can be achieved through the application of different motivational techniques. However, if defect/rework occurs as a result of workers' errors or supervisory oversight (Rabia et al., 2020), the overall morale of workers or the team is weakened, and productivity drastically drops in all ramifications. Defects threaten a firm's reputation by requiring extra time and cost to fix, reducing productivity. Poor workmanship and weak communication are key contributors to defect/rework waste (Aftab et al., 2025). While some studies, like Igwe et al. (2022a), found defects less impactful, this may reflect methodological differences, as the negative effects of defect/rework are widely evident in construction processes.

The effect of non-physical wastes on clients' satisfaction performance

Table 5 effect of non-physical wastes on clients' satisfaction performance

Types of non-physical wastes	1	2	3	4	5	N	Sum	Mean	Std.D	Rank
Waiting waste	55	75	90	55	25	300	820	2.73	1.197	11
Overproduction	7	93	102	77	21	300	912	3.04	.970	9
Defect/rework	7	38	131	54	70	300	1042	3.47	1.055	2
Overprocessing	7	50	104	111	28	300	1003	3.34	.943	3
Unnecessary movement	49	85	97	56	13	300	799	2.66	1.090	12
Inventory	25	86	118	55	16	300	851	2.84	.997	10
Transportation	23	49	132	75	21	300	922	3.07	.999	8
Making-do	20	58	127	63	32	300	929	3.10	1.044	7
Unused talent	8	39	127	99	27	300	998	3.33	.907	4
Accident waste	8	39	97	96	60	300	1061	3.54	1.035	1
Unnecessary discussion	12	58	120	93	17	300	945	3.15	.933	6
Deliberate slow work pace	15	46	111	86	42	300	994	3.31	1.051	5

1=not effective, 2=fairly effective, 3=effective, 4= very effective, 5= extremely effective. N= Number of responses, Std.D= standard deviation

Table 5 presents the results of the evaluation of waste types on client satisfaction. The result shows that the most significant factor that affects this measure is accident waste, followed by the defect/rework. Safety performance achievement involves the behaviour and culture of workers, the knowledge and skills of supervisors, and the workplace environment. Accidents occur basically because of poor training, carelessness, apathy or recklessness, lack of knowledge, supervision or means for safely performing tasks (Mahfuth et al., 2019). For public projects, clients expect outcomes that are satisfactory and value-adding. Poor enforcement of safety laws and culture, risky workers' attitude, and site conditions may increase the accident rate (Rafindadi et al., 2023), and does not add value rather it subtracts. Availability of limited personal protection equipment and informal practices, including non-compliance with safety measures in

Nigerian construction sites (Ebekozien, 2022), makes accident waste more critical to safety performance compared to other wastes. Effective communication and regular safety inspection have been identified as means for improving safety performance in the construction process (Chan et al., 2023). Thus, safety should not be seen as a secondary issue, because at an early stage, safety hardly comes into the budgetary provisions of Nigerian clients. Therefore, protective equipment, safety audits, and regulatory bodies' safety enforcement strategies should be prioritised. All employees and workers on building and construction sites must undergo sufficient safety training to increase their level of safety awareness (Kadiri et al., 2014).

The influence of non-physical wastes on safety performance

Table 6 influence of non-physical wastes on safety performance

Types of non-physical wastes	1	2	3	4	5	N	Sum	Mean	Std.D	Rank
Waiting waste	62	97	94	39	8	300	734	2.45	1.041	12
Overproduction	23	103	112	49	13	300	826	2.75	.964	11
Defect/rework	12	49	136	73	30	300	960	3.20	.964	6
Overprocessing	13	70	134	64	19	300	906	3.02	.936	8
Unnecessary movement	8	37	136	79	40	300	1006	3.35	.951	4
Inventory	25	55	148	63	9	300	876	2.92	.918	10
Transportation	16	35	112	96	41	300	1011	3.37	1.031	3
Making-do	26	48	122	89	15	300	919	3.06	1.001	7
Unused talent	2	50	126	80	42	300	1010	3.37	.943	2
Accident waste	18	38	99	74	71	300	1042	3.47	1.158	1
Unnecessary discussion	15	49	118	90	28	300	967	3.22	.995	5
Deliberate slow work pace	19	68	122	73	18	300	903	3.01	.983	9

1=not effective, 2=fairly effective, 3= effective, 4= very effective, 5= extremely effective. N= Number of responses, Std.D= standard deviation

Source: Field survey (2025)

Table 6 presents the analysis of NPWs on safety and accident-related waste has the most influence on safety performance followed by unused talent. Unused worker talent, caused by misplacing or underutilising workers, lowers focus and morale, leading to unsafe behaviour. Misplaced skilled workers are more likely to make errors and overlook best practices, increasing the risk of hazards and negatively affecting safety performance. In Nigeria, labourers are mostly engaged based on availability rather than the actual skill match to the activity that needs to be done (Oni et al., 2024). Opportunities for training, workshops, and self-development are not in abundance; thus, skilled workers are less than the available jobs, resulting in the engagement of mismatched skills or using workers with less capacity than required. When this occurs, workers may not be comfortable and create unsafe behaviour and an unsafe environment, which increases the likelihood of accidents and affects safety performance (Li et al., 2021). Addressing skill mismatch, training, and adequate knowledge empowerment could indirectly reduce unsafe practices and accident occurrence. Training and licensing of workers, particularly those working in areas prone to high-risk, should be made compulsory and enforced by the Nigerian building regulatory bodies. The issue of accidents should be analysed and traced back to issues of mismanagement of human capabilities and untapped skills. This study suggests that NPWs are not all about productivity but are also tied to the safety performance of the construction sector. Unused talent skill waste as the second most influential on safety highlights the crucial nature of managing people and optimising their skill usage. Therefore, efforts to maximise workers' and supervisors' capabilities must be integrated with strategies for preventing site accidents, if safety performance in construction projects is to be greatly enhanced.

CONCLUSION AND RECOMMENDATIONS

Conclusion

This study investigated the performance r amifications of NPWs in construction pro jects in Abuja, Nigeria. The study focused on addressing the limited attention previously given to these impactful inefficiencies that are hidden within project processes. The outcome of the study reveals that NPWs exert different scales of effects across performance measures rather than a uniform impact on the project end-product. More insight is gained in how specific wastes affect particular performance metrics. In such a way that waiting predominantly slows project execution, unused talent corrupts quality, defect/rework drives both cost escalation and productivity loss, and accident-related waste significantly compromises safety and client satisfaction.

This finding suggests that NPWs should not be perceived and treated as a uniform group of wastes that can be managed in the same way. Instead, they should be viewed as performance-specific risk factors that require targeted control strategies, depending on which aspect of project performance is most affected at a given stage of the ongoing project. Thus, this study extends current knowledge of NPW by connecting separate waste types to specific performance metrics, thus progressing beyond the conventional focus on time, cost, and quality to include productivity, safety, and client satisfaction.

Limitation of the Study

Generalizability of the findings of this study is limited by its exclusive use of quantitative methods. The study acknowledges that Including open-ended questions could have allowed participants to provide additional insights and made the findings more comprehensive. However, the findings presented here provide good basis for further exploratory researches.

Recommendations

In practice, these results show that constr uction managers need to focus on behavio ural, managerial, and process-related changes. These include stronger supervision, stronger workforce structure, and structured communication systems in order to minimise the high impact of NPW. Also, enhancing awareness and integrating lean-based management practices such as the Last Planner System (LPS) and Just-in-time delivery (JIT) into project execution can significantly improve overall project performance.

Future studies can as well examine the causes of non-physical wastes across the various stages of building project delivery, as NPWs occur throughout multiple phases. Ultimately, addressing NPWs offers a critical pathway for improving efficiency and value delivery in Nigeria's construction sector, particularly in environments where resource constraints and managerial inefficiencies are prevalent.

REFERENCES

Abdullahi, C. M., & Tembo, M. (2023). Improving the efficiency and effectiveness of construction project planning and scheduling using lean principle. *International Journal of Construction Engineering and Management, 12*, 75–80. DOI: 10.5923/j.ijcem.20231203.01

Abubakar, M. M. M., Ganiyu, B. O., & Jibril, A. M. (2019). Examination of non-value adding activities in public building construction projects in Niger State, Nigeria. *International Journal of Strategic Research in Education, Technology and Humanities, 1*(6), 73–85. https://www.semanticscholar.org/paper/

Aftab, U., Aslam, M., Ulhaq, A., Jaleel, F., Malik, S., & Zahoor, H. (2025). Deconstructing construction wastes: Exploring waste generation causes and their impact on project performances. *PLoS ONE, 20*(5), e0322295. https://doi.org/10.1371/journal.pone.0322295

Akinbode, G. A. (2025). Psychological contract violation and effort withholding: Mediating role of work conditions among SMEs in Lagos. *African Journal of Social and Behavioural Sciences, 15*(1). https://scholar.google.com/scholar?cluster=6535505056146999978&hl=en&oi=scholarr

Aravindh, M. D., Nakkeeran, G., Krishnaraj, L., & Arivusudar, N. (2022). Evaluation and optimization of lean waste in construction industry. *Asian Journal of Civil Engineering, 23*(5), 741–752. https://doi.org/10.1007/s42107-022-00453-9

Arof, K. Z. M., Ismail, S., & Saleh, A. L. (2018). Contractor's performance appraisal system in the Malaysian construction industry: Current practice, perception and understanding. *International Journal of Engineering & Technology, 7*(3.9), 46–51. DOI 10.14419/ijet.v7i3.9.15272

Bajjou, M. S., & Chafi, A. (2022). Exploring the critical waste factors affecting construction projects. *Engineering, Construction and Architectural Management, 29*(6), 2268–2299. DOI:10.1108/ECAM-12-2020-1097

Bhuinyan, S., Gadekar, P., Agrawal, N., Basak, S., & Raut, Y. S. (2019). Measuring project performance and success factors of construction sites. *International Journal of Innovative Technology, 5*(11), 2349–6002. DOI:10.13140/RG.2.2.33975.14248

Bhatta, M., Dhital, M. R., & Karmacharya, P. K. (December, 2023). Identifying the causes and effects of waste due to non-value adding activities on road construction projects in Nepal. *Proceedings of 14th IOE Graduate*

Conference. *https://conference.ioe.edu.np/publications/ioegc14/IOEGC-14-235-PS3-040-817.pdf*

Bissenova, A., & Hossain, M. A. (2018, November). Investigation of wasteful activities to improve construction productivity: In perspective of construction in Astana, Kazakhstan. In *7th Brunei International Conference on Engineering and Technology 2018 (BICET 2018)* (pp. 1–4). IET. DOI:10.1049/cp.2018.1552

Boadu, E. F., Wang, C. C., & Sunindijo, R. Y. (2020). Characteristics of the construction industry in developing countries and its implications for health and safety: An exploratory study in Ghana. *International Journal of Environmental Research and Public Health, 17*(11), 4110. https://doi.org/10.3390/ijerph17114110.

Bosnich, T. (2019). *Applying lean construction principles to waste management and identifying minimization opportunities to inform the industry*. https://toiohomai.ac.nz/sites/default/files/inline-files/ accessed 2/4/2026

Brito, M., Ramos, A. L., Carneiro, P., & Gonçalves, M. A. (2019). The eighth waste: Non-utilized talent. In *Lean manufacturing: Implementation, opportunities and challenges* (pp. 151–163). https://www.researchgate.net/publication/340978747_

Chan, A. P., Guan, J., Choi, T. N., Yang, Y., Wu, G., & Lam, E. (2023). Improving safety performance of construction workers through learning from incidents. *International Journal of Environmental Research and Public Health, 20*(5), 4570. https://doi.org/10.3390/ijerph20054570

Chidiobi, C. C. (2022). *Development of frameworks for the management of materials procurement and construction waste for Nigerian contractors* (Doctoral dissertation, University of the West of England, Bristol). https://uwe-repository.worktribe.com/preview/9886938/.

Dupin, P. (2014). *Le lean appliqué à la construction: Comment optimiser la gestion de projet et réduire coûts et délais dans le bâtiment*. Groupe Eyrolles. https://www.eyrolles.com/BTP/Livre/le-lean-applique-a-la-construction-9782212138320/

Ebekozien, A. (2022). Construction companies' compliance to personal protective equipment on junior staff in Nigeria: Issues and solutions. *International Journal of Building Pathology and Adaptation, 40*(4), 481–498. https://doi.org/10.1108/IJBPA-08-2020-0067

Emuze, F., Smallwood, J., & Han, S. (2014). Factors contributing to non-value adding activities in South African construction. *Journal of Engineering, Design and Technology, 12*(2), 223–243. https://doi.org/10.1108/JEDT-07-2011-0048

Fateh, M. A. M., & Sulaiman, N. A. (2021). Preliminary study on awareness of the lean concept from the non-physical waste perspective. *Malaysian Construction Research Journal, 14*(3), 12–26.

https://www.researchgate.net/publication/357538355

Galjanić, K., Marović, I., & Hanak, T. (2023). Performance measurement framework for prediction and management of construction investments. *Sustainability, 15*(18), 13617. https://doi.org/10.3390/su151813617

Horsfall, L., & Alaribe, B. M. (2024). Lean construction: The role of a project manager. *International Journal of Project Management, 6*(3), 52–68. https://ideas.repec.org/a/bfy/ojijpm/v6y2024i3p52-68id2197.html

Igwe, C., Hammad, A., & Nasiri, F. (2022a). Influence of lean construction wastes on the transformation-flow-value process of construction. *International Journal of Construction Management, 22*(3), 2598–2604. https://doi.org/10.1080/15623599.2020.1812153

Igwe, C., Nasiri, F., & Hammad, A. (2022b). An empirical study on non-physical waste factors in the construction industry. *Engineering, Construction and Architectural Management, 29*(10), 4088–4106. https://doi.org/10.1108/ECAM-02-2021-0145

Ismail, H., & Yusof, Z. M. (2016). Perceptions towards non-value-adding activities during the construction process. In *MATEC Web of Conferences* (Vol. 66, p. 00015). EDP Sciences. https://doi.org/10.1051/matecconf/20166600015

Ismail, H. B., & Yusof, Z. B. M. (2018). Understanding defects during the construction process. *Advanced Science Letters, 24*(6), 4227–4231. https://doi.org/10.1166/asl.2018.11577

Ismail, H., Mamat, N. A., & Mohd Shaupil, W. (2025). Understanding the effect of non-value-adding activities on construction project cost: Main effects and causal relations. *Journal of Sustainable Civil Engineering & Technology, 4*(2), 28–38. https://doi.org/10.24191/jscet.v4i2.JSCET_ICoSCID2025_007

Kadiri, Z. O., Nden, T., Avre, G. K., Oladipo, T. O., Edom, A., Samuel, P. O., & Ananso, G. N. (2014). Causes and effects of accidents on construction sites. *IOSR Journal of Mechanical and Civil Engineering, 11*(5), 66–72. http://www.iosrjournals.org/

Kamaruddeen, A. M., Sung, C. F., & Wahi, W. (2020). A study on factors causing cost overrun of construction projects in Sarawak, Malaysia. *Labour (Human), 2*(7), 13. https://doi.org/10.13189/cea.2020.080301

Koskela, L. (2004). Making-do – The eighth category of waste. In *Proceedings of the 12th Annual Conference of the International Group for Lean Construction (IGLC-12)*. https://iglc.net/Papers/Details/312

Koskela, L., Bølviken, T., & Rooke, J. (2013). Which are the wastes of construction? *Eprints.hud.ac.uk*

Leo-Olagbaye, F., Odeyinka, H., & Rathnasiri, P. (2023). Stakeholders' roles in the delivery of sustainable housing projects in Lagos State, Nigeria. *Sustainability, 15*(15), 11709.

https://doi.org/10.3390/su151511709

Li, Z., Bao, X., Sheng, Y., & Xia, Y. (2021). Research on unsafe behavior of construction workers. *Frontiers in Psychology, 12*, 794394. https://doi.org/10.3389/fpsyg.2021.794394?

Liker, J. K. (2004). *The Toyota way: 14 management principles from the world's greatest manufacturer*. McGraw-Hill. https://www.accessengineeringlibrary.com/content/book/9780071392310

Mahfuth, K., Loulizi, A., Al Hallaq, K., & Tayeh, B. A. (2019). Implementation phase safety system for minimising construction project waste. *Buildings, 9*(1), 25. https://www.mdpi.com/2075-5309/9/1/25

Maliha, M. N., Abu Aisheh, Y. I., Tayeh, B. A., & Almalki, A. (2021). Safety barriers identification and classification. *Sustainability, 13*(6), 3316. https://doi.org/10.3390/su13063316

Nassri, S., Talebi, S., Elghaish, F., Koohestani, K., McIlwaine, S., Hosseini, M. R., & Kagioglou, M. (2023). Labor waste in housing construction projects. *Smart and Sustainable Built Environment, 12*(2), 325–340. https://doi.org/10.1108/SASBE-07-2021-0108

Oda, M. M. A., Tayeh, B. A., Alhammadi, S. A., & Aisheh, Y. I. A. (2022). Key indicators for evaluating construction company performance. *Results in Engineering, 15*, 100596. https://doi.org/10.1016/j.rineng.2022.100596

Ogunmakinde, O. E., Sher, W., & Maund, K. (2019). Assessment of material waste disposal methods. *Recycling, 4*(1), 13. https://doi.org/10.3390/recycling4010013

Oladiran, O. J., Ogunsanmi, O. E., & Dada, M. O. (2019). Frameworks for material waste minimization. *Journal of Construction Business and Management, 3*(1), 45–61. https://doi.org/10.15641/jcbm.3.1.593

Oluyemi-Ayibiowu, B. D., & Omolayo, J. O. (2022). Critical factors responsible for time overruns. *International Journal of Mechanical and Civil Engineering, 4*(1), 22–33. https://doi.org/10.52589/IJMCE-IQYK7V9W

Oni, O., Ogunbayo, B., Ogundipe, K., Aigbavboa, C., & Akinbile, B. (2024). Construction skilled labor adequacy. In *International Conference on Construction in the 21st Century*. https://www.researchgate.net/publication/389097691

Othman, A. A. E. (2015). An international index for customer satisfaction. *International Journal of Construction Management, 15*(1), 33–58. https://doi.org/10.1080/15623599.2015.1012140

Phillips, Z. (2023). Construction lost as much as $40B on poor productivity in 2022. https://www.constructiondive.com/news/construction-wastes-billions-labor-lean-planning/696421/

Rabia, A., Bzizi, M., Al-Kbisbeh, M., Ali, T., & Almajiri, E. (2020). Factors affecting labor productivity in the construction industry. *American Journal of Environmental Science and Engineering, 4*(2), 24–30. https://doi.org/10.11648/j.ajese.20200402.13

Rafindadi, A. D. U., Shafiq, N., Othman, I., Ibrahim, A., Aliyu, M. M., Mikić, M., & Alarifi, H. (2023). Data mining of fatal construction accidents. *Heliyon, 9*(2). https://doi.org/10.1016/j.heliyon.2023.e13389

Sahlu, A., & Dinku, A. (2021). Construction site wastes categorization. *Zede Journal, 39*(1), 31–43. https://www.researchgate.net/publication/358248628

Sravani, T. D. S., Chandgude, Y. S., ST, D., & SK, S. (2020). Assessment of construction defects. *Journal of Critical Reviews, 7*(18), 4239–4245. https://doi.org/10.31838/jcr.07.18.521

Sweis, G. J., Hiari, A., Thneibat, M., Hiyassat, M., Abu-Khader, W. S., & Sweis, R. J. (2021). Causes of material wastage in construction. *Jordan Journal of Civil Engineering, 15*(2). https://www.researchgate.net/publication/350605048

Taylor, F. W. (1911). *The principles of scientific management*. Harper & Brothers. https://resources.saylor.org/wwwresources/archived/site/wp-content/

Uakarn, C., Chaokromthong, K., & Sintao, N. (2021). Sample size estimation methods. *Apheit International Journal, 10*(2), 76–88. https://so04.tci-thaijo.org/index.php/ATI/article/view/254253

Wawak, S., Ljevo, Ž., & Vukomanović, M. (2020). Understanding key quality factors. *Sustainability, 12*(24), 10376. https://doi.org/10.3390/su122410376