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The 5Rs for Waste Management of Abandoned Infrastructure in Nigeria

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Abstract

This paper focused on how the 5Rs concepts can be adopted to resuscitate abandoned infrastructure in Nigeria while curbing the challenges faced in the Nigerian environment. The initial concept of the R system of sustainability was 3Rs: reduce, reuse and recycle, which are alternatives for waste management that progressively gained attention in the 1970s. Nevertheless, a new concept of dealing with waste includes multiple 5Rs systems consisting of a rethink, reduce, reuse, refurbish, and regulation. These new concept attempts to promote waste management required to be done effectively. This paper illustrated how the Rs concept could sustainably address the waste generated by abandoned infrastructure in Nigeria through semi-structured interviews. Eight (8) construction professionals, including architects, Project Managers, Engineers, Quantity Surveyors and Contractors, participated in the interview. The interviews were transcribed and analysed through qualitative content analysis. The findings revealed the imperativeness of effective thinking for a change to adaptive reuse/refurbishment of existing structure while abiding by the constituted regulation. The outcome of these findings is further research into the sustainable framework to the redevelopment of abandon infrastructure. The possible implication of the findings initiated a paradigm shift in sustainable development that is not just for Nigeria only, but globally.

1.0 INTRODUCTION

Okafor et al. (2018); Woka and Miebaka (2014); and Okereke (2017) identified the country as the world's junkyard for abandoned infrastructure and failed projects. The buildings are an abode for nefarious and criminal activities, with negative impacts such as waste of useful resources, the threat to public health, and abode for pests. Despite the definition of sustainable development (SD) that emphasises meeting the present needs without compromising the needs of the generation to come, Pavlovskis et al. (2017) argued that the target of the SD is not only about developing new infrastructure; but also redeveloping abandoned infrastructure. On the other hand, the Federal Government of Nigeria acknowledges the 17 sustainable development goals (SDG) for their advancement (Federal Republic of Nigeria 2017). However, the array of abandonment of infrastructure questions their success concerning SDG goals 9 - Industry Innovation and Infrastructure (Ogunnusi et al 2021). These structures possess an adverse effect on society, the economy and the environment. The need arises to proffer a solution to this growing menace hindering the socio-economic ambience of the country. With quantitative methods, Nwanekezie & Nwanguma (2019) studied the causes of uncompleted and abandoned building projects; Doraisamy et al., (2015) reviewed the effects of abandoned construction projects, Alao et al., (2019) assessed the resuscitation strategies of abandoned projects and Ogunnusi et al., (2022) employed TOPSIS analysis for the sustainable redevelopment potential of abandoned infrastructure. However, none evaluated the research qualitatively, focusing on the 5Rs concept of a rethink, reduce, reuse, refurbish, regulation to address the waste management approach.

This paper, through semi-structured interviews, addressed the redevelopment of the abandoned infrastructure in Nigeria relative to the 5Rs concept. Prior to this, the causes and the impact of this abandonment will be discussed.

2.0 INFRASTRUCTURE ABANDONMENT IN NIGERIA

Abandoned infrastructure, as defined by Ubani & Ononuju (2013); Olalusi & Otunola (2012); Hanachor (2012), are constructing buildings that started at an earlier date and stopped for one reason or another, or structures that were initially occupied and subsequently vacated with no intention of resuming the usage. This abandonment is not peculiar to the Nigerian milieu alone. Other countries such as Spain, Russia, Saudi Arabia, the United States, and Malaysia also have the same story (Hoe, 2013). However, infrastructure abandonment in Nigeria requires broadened attention as it cluttered the entire environment of Nigeria. Some of these abandoned infrastructures include government buildings, as mentioned by some authors and identified in table 1.

Table 1: Abandoned Public Infrastructure in Nigeria

No	Description	Authors
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1	4000 abandoned and uncompleted Federal Government projects in Nigeria at an estimated cost of about N300billion (about 6.3M Pounds).	(Okafor, Osadebe and Sylvester, 2018)
2	Over 60 buildings belonging to the Federal Government are abandoned and subsequently become dilapidated due to the relocation of the seat of the Government from Lagos to the Federal Capital Territory in Abuja.	(Ubani and Ononuju, 2013)
3	Federal Ministries of Works and Housing, The National Stadium complex, Federal Secretariat Complex, National Assembly Complex, Ministry of Defence and Ministry of Education buildings.	(Muzenda, 2018)
4	Over N3 trillion (about 5.1 billion pounds) worth of abandoned infrastructure projects are also attributed to 10 states of the nation since 2012 and are yet to be accounted for by the sitting government.	(Alao <i>et al.</i> , 2019)
5	10-lane Abeokuta Sagamu interchange road projects, 27 General hospitals across Imo state, N20 Million (about 34,000pounds) two units blocks of three classrooms in Kano states, abandoned public tertiary education institution building in Osun State.	(Odutola, A. and Adeniran, 2017)

In addition to the relocation of the seat of government, other factors that contributed to abandonment in Nigeria as studied by Ogunnusi et al., (2021) include the inefficient procurement process, recurrent change in government and political power, and deficiency in technological capacity, amongst others. The Federal Government can adopt the Rs concept to address these imperil situations.

3.0 MULTIPLE R - SYSTEM

The traditional concept of the R system, which progressively gained attention in the US and Europe in the 1970s, comprises only the three Rs" reduce, reuse and recycle (Reike et al., 2018; Abdul-Rahman, 2014; Goyal et al., 2018). Nevertheless, there is a new concept that encompasses multiple R systems that include rethinking, reducing, reusing, refurbishing, and regulation (figure 1) as part of the study conducted by Govani et al. (2021); Kirchherr et al. (2017). Different explanations of all these concepts are being viewed from products and waste. Authors such as David et al. (2019) listed waste production from glasses, electronics, papers, foods, and plastic manufacturing, excluding buildings, while Lei et al. (2020) considered waste generated from wood, concrete, and asphalt shingles, steels and bricks. Quite a few Scholars, such as Boo & Kwon (2018); Cascone & Sciuto (2018), related the concept of "Reuse" to existing abandoned buildings, hence the strong preference for linking the 5Rs concepts to abandoned infrastructure redevelopment in Nigeria.

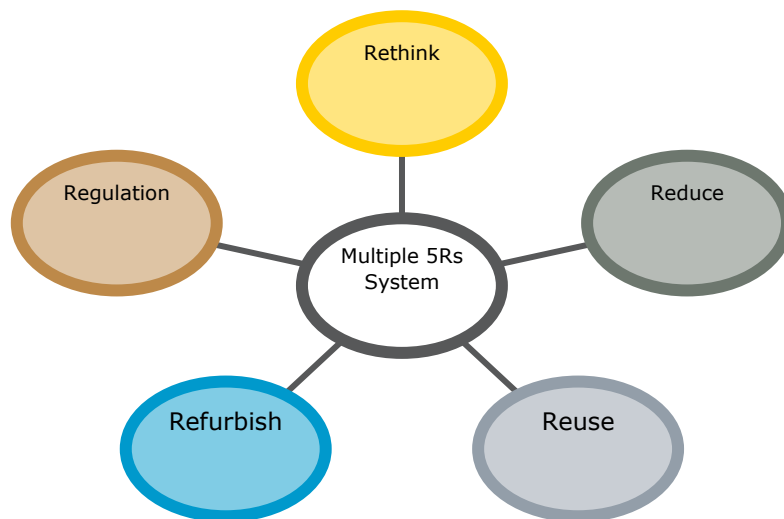


Figure 1: Multiple 5Rs Systems

3.1 Rethink

Rethink is the first on the multiple R systems identified by Govani et al. (2021). Rethink is the initial process required before using products that will be a waste once used. Rethinking is to prevent procuring needless materials for decorative or luxury purposes. To rethink is to select a wiser option for a sustainable product as a substitute for one-time use and subsequent abandonment. For instance, in regenerating lively spaces out of abandoned industrial wastelands, Arup (2014) emphasised the need for drastic rethinking of solutions to be implemented in the city. Rethinking is a huge responsibility for leaders, as Dinika (2022) concluded.

3.2 Reduce

To reduce is to lessen product consumption however and wherever possible. Not promoting or procuring single-use products and needless products can reduce the amount of waste generated. Maintaining things, using and handling them can enhance waste reduction (Govani et al., 2021).

Francis, cited by Reike et al. (2018), described "reduce" generically as it is all about eliminating the production of waste rather than the disposal of waste itself after it has been created. David et al. (2019) further supported reducing raw material consumption for new products. In other words, the most effective approach to reduce negativity from the environment is to enhance the design of products for waste prevention.

3.3 Reuse / Resell

One of the essential strategies of the multiple R system is reuse. Reusing effects help to make absolute use of produced materials while preventing waste generation. For instance, used tyres could be used as an alternative fuel in some industries and recreational purposes. The material can be reused continuously until it exhausts its potential to be used in the same shape (Govani et al. 2021). With the end-stage of every product, some parts can be

improved for reuse purposes (David et al 2019). Reike et al. (2018) claimed that the concept of 'reuse' or 'resell' are compactly linked, expressing the double side of the market transaction required to bring back the product into the economy after previous use. Reuse practices should not be limited to some rural environments, as noted by Mihai et al. (2022).

3.4 Refurbish

Damaged and old materials are not always useless or turn to waste. Rather, they can be refurbished innovatively. Refurbishment can enhance waste reduction by adding used and old stuff value. For instance, ancient structures are refurbished into buildings with a modern touch (Govani *et al.* 2021).

Reike et al. (2018) state that refurbishment seems to be most suitable in situations where the entire structure of a "large multi-component product" remains complete while several components are repaired or replaced, leading to a total upgrade of the product. The concept of refurbishment is also recognised from shared language within an overhaul.

3.5 Regulation

Govani et al. (2021) state that robust implementation of regulations by the government of any country impacts processing and minimising waste. Reike et al. (2018) also pointed out that developing countries with weak regulations encounter illicit and illegal importation of waste from Europe. Complexities and variations in regulations highlighted by Goyal et al. (2016) can increase the gap between limited resources and increasing demand. In other words, the psychological behaviour and challenges to change from a "*use and throw mindset*" can be regulated.

The benefit of applying the new 5Rs concept is not only to enhance the waste management of abandoned infrastructure but also to encourage the practice and application of other waste management strategies such as the circular economy.

4.0 RESEARCH METHODOLOGY

This section provides the framework for this research. The semi-structured interviews by Bryman cited by Watts (2021) described constructivism as a contingent ontological standpoint that implies the social interpretation of reality as agreed upon between or amongst the key players. Such agreement may differ among the players leading to the subjective and diverse viewpoints of the same occurrences (Watts, 2021). In this study, it is the understanding, opinions and interpretation of 5Rs concepts to abandonment and redevelopment of infrastructure that is explored. Creswell (2013) states that such exploration is best conducted through an inquiry into subjective knowledge. This approach results in qualitative data collection. This data collection method tries to explore the intelligence that cannot be expressed easily in figures and numbers with a higher emphasis on profound meaning. The semi-structured interview permits applicable and interesting possibilities of information appearing during the interview to be trailed in addition to the core topic of discussion (Bryman 2016). The semi-structured interview was conducted via zoom due to the COVID 19 pandemic restrictions.

This interview was carried out to explore the participants' experience with abandoned infrastructure in Nigeria and possible solutions to be adopted. The participants were permitted to express their views and interact freely with the interviewer, which provided an opportunity for generating vital and additional information (Trumbull cited by Hamma-Adama et al., 2018). Eight (8) construction professionals participated in the interview. The interviewees who participated were selected based on their profession, years of experience and sector. The invite for the interview was sent to the participants through email, highlighting the aims and the objectives of the research. Acceptance for the interview with a completed consent form was received as a response via email. The interviews lasted between 27 minutes to 55 minutes. The interviews were transcribed and analysed through qualitative content analysis.

5.0 QUALITATIVE FINDINGS

The data generated from the semi-structured interviews with construction industry professionals were analysed. Twelve construction industry professionals were Architects, Project Managers, Quantity Surveyors, Contractors and Builders. However, eight interviews were analysed, selecting from the participants who mentioned or related to at least two of the 5Rs during the discussion. The transcribed response was analysed using content analysis to ascertain the pattern of the participant's responses. Table 2 highlights the demography of the interviewees.

Table 2: Interviewees' Demography

S/N	Profession	Acronym	Years of Exp.	Sector (Public/Private/Both)
1	Project Manager	PM 1	47	Both
2	Quantity Surveyor	QS 1	35	Private
3	Contractor	CON 1	34	Both
4	Civil Engineer	CE 1	30	Private
5	Architect	ARC 1	8	Both
6	Construction Manager	CM 1	22	Both
7	Builder	BU 1	27	Both
8	Project Manager	PM 2	16	Both

The participants were able to share their experience and awareness of abandoned infrastructure. 75% of these professionals are in both public and private sectors which enriched the level of their knowledge and exposure to the issue being studied. The interview was successful, with the transcript captured as the primary data. The data were subsequently coded based on the identified themes from the interview. Table 3 showcases the organised themes of the 5Rs concepts identified from the participants' responses during the interview. To achieve the aim of this study Schmidt and Hunter's (2015) analytical method for conducting qualitative content analysis was adopted as presented below:

- 1- Identification of individual aspects related to the analysis by categorisation of the materials
- 2- Compilation of categories into themes for research questions or objectives
- 3- Breaking down of themes into smaller codes or nodes which contain comprehensive information relative to the research questions or objectives
- 4- The linking of coded information into cases and the interpretation of cases to provide meaning to the study.

6.0 5Rs CONCEPT FINDINGS FROM INTERVIEW

The study findings and discussion are presented in the 5Rs concept themes, which articulate the aim of this study as linking to the issue of infrastructure abandonment. It is worth noting that about 70% referred to abandoned infrastructure as a "waste". This section pointed out the attributes of these concepts (rethink, reduce, reuse / resell, refurbish, regulation) from the interviewees' responses in table 3. Despite the non-theme specific of the interview, analysis was thematically coded to obtain the participants' thinking around the topics.

Table 3 – Organised themes of the 5Rs concepts from the interview

No	5Rs	Participants
R1	Rethink	PM1, CE1, ARC1, CM1, BU1,
R2	Reduce	CE1, ARC1, CM1, PM2
R3	Reuse	PM1, QS1, CON1, ARC1, BU1, PM2,
R4	Refurbish	QS1, CON1, ARC1,
R5	Regulation	CE1, CON1

6.1 Reasoning for a change

The most sustainable manner of redeveloping the abandoned infrastructure is to rethink the action taken by the government and individual professionals in the public sector. Almost all the interviewees mentioned or related to the need to rethink. This can further be regarded as thinking, rethinking or thinking through every effort to redevelopment of abandoned infrastructure. BU1 stated that *"at a desperate hour like this, we need critical thinkers in government"*. This require the decision and the policy makers to be engaged in cognitive exercise in providing critical solutions to the issue. The notion raised by BU1 was supported by PM1, who questioned, *"....could the country afford the colossal loss? So the first thing is to think things through..."*. ARC 1 further pointed that there is a need to *"start thinking about how you can re-strategise the buildings...."* There are possible options available in restrategising the structure for use. For instance, CE1 ruminates on *"how many accommodations that would provide, if we converted it to living quarters"*, while CM1 provided a solution during the interview to resuscitating abandoned infrastructure through *"PPP...., that is what I think"*. These interviewees have taken up the responsibility to think about the situation experienced by this abandonment and also call on the leaders to follow suit, as concluded by Dinika (2022).

6.2 Reduction of new built for existing structure to achieve economic gain

Reducing is an action in the next stage after rethinking. It is essential to reduce the development of new infrastructure that is not necessary, as argued by Pavlovskis, Antucheviciene and Migilinskas (2017) while focusing on readdressing the abandoned ones. With this in mind, CM1 affirmed that *"the economic loss will be reduced.... the level of abandonments ease-out"*. PM2 also noted that balancing the development of new infrastructure with the existing abandoned *"can reduce the impact of reptiles, of animals around all those environments"*, especially around the vicinity of the abandoned structures. ARC 1 supported this that *"once functionality plays into the role of the existing structure, it reduces your finances."* The negative effect of abandoned infrastructure is the waste of financial resources. CE1 opined that economic growth could be enhanced by illustrating how one of the major infrastructures in Nigeria can be redeveloped, for example, using *"the first two or three floors as parking and then the rest as just liveable. Just reduce, find a way to change the functionality"*.

6.3 Adaptive reuse of existing infrastructure for economic sustainability

It is important to consider reuse not only for products but also for structures, especially the abandoned ones. Most of the interviewees mentioned different abandoned buildings that they are aware of and advocated for reuse or outright sale to private investors. PM1 saddened, *"look at the NEPA station at Iddo in Lagos, then find that is just there. It is not reused"*. CON 1 also emphasised the need *"to put the building back to use. The second thing is that you are conserving resources if you restore the building and put them back into use. Preservation and conservation of these buildings relate to the effort to "make good use of these buildings since it is not being used for this purpose..."* as noted by ARC1. Conversion of these structures through adaptive reuse is supported by Petković-Grozdanovića *et al.* (2016) and QS1, stating that *"...if you can convert the structure to what you plan to use it for, definitely, you will rather convert..."*. To ensure effective reuse of these buildings, BU1 called on the Lagos State government to *"forge a relationship with a Federal Government and see how those properties could be put to use"*, while PM2 believes that Federal Government should *"Sell them off, a new investor will come and buy it and you use it for something that befits the entire environment"*.

6.4 Regeneration of abandoned infrastructure

Vizzarri (2020) identified the refurbishment of abandoned places as a response to the conception of a sustainable city. In embarking on this process, ARC 1 states that *"there are guidelines for professional inputs in refurbishing or renovating a structure"*. While elucidating why buildings are vacated and abandoned by the Government, QS1 advised that *"projects that have been abandoned"* can be refurbished by engaging the service of developers. In the interview, CON1 affirmed direct involvement in projects that *"burnt out, but they have degraded to the extent that they had to completely refurbish"* them. Refurbishment will not only provide additional public resources to the citizenry, but will also align with the sustainable development goals.

6.5 Effective adherence to constituted regulation

It is one thing to set the rules and regulations, and it is another thing to stick by them, as CE1 states that "*... it is not really that there was no regulation that I referenced, because nothing was regulating*". CM1 advised that "*.....we must look at the regulations...*". There is a need for government to adhere to the regulation. The systems experience duplications or gaps in regulation resulting in Fadason et al. (2017) calling on the Federal Government to see the effectual adherence to the regulations to avoid abandonment.

7.0 IMPLICATION OF FINDINGS FOR FURTHER RESEARCH

The qualitative content analysis in this study was steered to proffer an overview of how the R-concept can be considered in addressing the abandonment of infrastructure in Nigeria. The outcome of these findings is a further research into the sustainable framework of redeveloping abandonment infrastructure. The followings titles can be considered for further studies.

- Implication of cognitive exertion to redevelopment of abandoned infrastructure
- Conceptualization of abandoned building into livable spaces
- Importance of levels of government collaboration for successful redevelopment of abandoned building to attain economic sustainability.
- Positive impact of Refurbishment for sustainable development
- Regulatory Framework for sustainable redevelopment of abandoned infrastructure
- Effect of resuscitation strategies for abandoned buildings.

Considering the redundancy, and the need for effective usage of these structures, there is a need to further study the efficiency of diverse resuscitation strategy for abandoned infrastructure.

8.0 CONCLUSION

This paper explores infrastructure abandonment in Nigeria and the implication for the society, economy and environment. The buildings are an abode for nefarious and criminal activities, with negative impacts such as waste of useful resources, a threat to public health, and an abode for pests. The 5Rs concepts, which include rethinking, reducing, reuse, refurbishing and regulation as an alternative for waste management were adopted to resuscitate the challenges encountered in Nigeria due to this menace.

Sustainable development is not only about developing new infrastructure but also redeveloping abandoned infrastructure. The Federal Government has to explore this concept by rethinking how best these structures can be used, reducing the development of excess infrastructure, salvaging projects by reusing and refurbishing them where necessary and finally adhering to established regulations to avoid future abandonment. A framework is a result of this required to ensure the implementation of these recommendations, which will align with the sustainable development goals.

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