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Appraisal of Recycling of Deconstructed Building Materials from Selected Renewal and Renovation Projects in Minna

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Abstract
Deconstruction involves the process employed to disassemble the existing building structures such that it can be reused or recycled. As cities develop and grow, urban renewal is often carried out which requires that existing structures be made to reflect changes in modern architecture and to meet new standards. This process is often done hurriedly and without necessary precautionary measures required to salvage building components that may still be valuable and reusable. The resultant effect is great economic loss, damage and more worryingly generation of significant waste and lots of debris to the built environment. Selected urban renewal and renovation sites were examined to find out the techniques employed in removing whole or parts of such existing structures allow for effective reuse or recycling. The study employed the case study survey and descriptive research methods. Data were collected by means of structured observation and interviews. The result showed that more emphasis was given to the economic benefits of deconstruction over its sustainable benefits. The findings further demonstrated a lack of technical know-how as well as deployment of unsuitable equipment during the construction process. The study recommended that there is need for the engagement of deconstruction experts and specialists in order to ensure proper deployment of appropriate tools in carrying out the work. The research concluded that greater partnership between construction industries and recycling factories should also be encouraged.
Keywords: Building components, deconstruction, recycle, reuse, salvage, waste

Introduction
Buildings are known to require maintenance, refurbishment or renovation to sustain their life cycle. It may also be completely demolished when it has approached its end of life. Over the years, demolition has been mostly employed to achieve this partial or complete removal of buildings. This process generates tremendous amount of waste and debris. Santos and Brito (2005) confirm that construction and demolition wastes are responsible for up to a third of all wastes dumped into landfills. The result of this includes ecological impacts, severe negative landscape, and occurrence of illegal dumps, emissions and leaks. The Boulder County (2008) adds that about 136 million tons of debris is generated annually in the United States arising directly from building related construction and demolition waste. The bulk of which comes from renovation and urban renewals. The Century Bay Builders (2016) further reiterates that the decomposition of construction and demolition waste is directly responsible for the production of methane – one of the most portent greenhouse gases. However, as more attention is continuously drawn towards sustainability, more attention is also paid to the techniques and methods that are used to take buildings apart.

The process where old buildings are dismantled carefully in such a manner as to preserve the building components for reuse or recycling is referred to as deconstruction (Sherman, 1998). Deconstruction can be seen to be the opposite of building construction as the building is dismantled in the reverse order in which it was built. Century Bay Builders (2016) and Greer (2004) also concur with the above definition that deconstruction is simply construction in reverse. Diven and Taylor (2006) put deconstruction to mean the process by which a building is dismantled from the roof down, a piece at a time. Deconstruction can similarly be seen as a green approach to the dismantling of buildings. It ensures that the waste arising as a result of the debris are minimized and the building components are recycled (Addis, 2006).The Century Bay Builders (2016) similarly defines deconstruction to be the selective dismantling of building components for recycling, reuse and efficient management of waste. Santos and Brito (2005) also describes as a process that ensures the maximization of whole building materials and components to complete the duration of their technical life cycle for social, sustainable and economic purposes by means of careful disassembly methods and techniques.

This is as opposed to demolition where the ‘wrecking ball’ or ‘bulldozer’ approach is employed to teardown a building with all of the building components crushed into debris that would typically end up in landfills or dumps (Thomsen, Schultmann, Kohler, 2011).

It can hence be deduced that deconstruction is a sustainable practice that can be harnessed to significantly reduce waste and debris arising from renovation or renewal projects. The potentials that deconstruction possesses especially when sustainability is factored is quite enormous and could potentially lead to massive energy savings and enhance the environment. This paper seeks to assess the extent to which building deconstruction is employed in building renovation and renewal projects in Minna to reuse or recycle building components and materials.

Deconstruction as a Sustainable Practice

The modern concept of deconstruction goes well beyond the economic benefits to being strongly tied to environmental sustainability (The Century Bay Builders, 2016). Beyond giving a building material a new life cycle, it helps reduce the craving for new resources and materials for building new projects. This leads to lower energy consumption and emissions that could have otherwise been emitted from the production of new building components. Deconstruction is usually carried out on a local level, it saves energy that would have been expended on transporting debris and wastes to dumps or landfills. It also grossly reduces the production of solid waste by ensuring that construction waste is either significantly minimized or not produced entirely. It further opines that since construction and demolition waste accounts for up to 20% of solid waste, this should be a big saving for better sustainability (Century Bay Builders, 2016).

The New South Wales Department of Environment, Climate Change and Water (2010) also alludes to the fact that Deconstruction contributes immensely to sustainability and helps avoid negative environmental impacts associated with Construction and Demolition wastes. This can be achieved through the lowering of the amount of materials extracted and reducing the amount needed to be produced. Other benefits of Deconstruction to sustainability include protection of air quality, reduction of water pollution, reduction in energy use, reduction of habitat loss as well as reduction in the production of greenhouse gases.

The National Association of Home Builders [NABH] (2000) who are responsible for the construction of over 80% of homes in the United States of America further support the earlier assertions by The Century Bay Builders (2016) and New South Wales Department of Environment, Climate Change and Water (2010) that Deconstruction has important benefits to sustaining the environment by diverting valuable resources from dumps into recycled components for profitable uses.

Stages in Deconstruction

The main goal in deconstruction is to ensure that disassembled building components are either reused or recycled. However, that may not often be the case as certain building materials may not be salvageable entirely. The figure 1 further explains the process involved in the Deconstruction cycle.

Benefits of Deconstruction

There are incentives for a contractor or client to take the deconstruction option as against the generally accepted norm of the 'bulldozer' or 'wrecking ball' demolition approach. The New South Wales Department of Environment, Climate Change and Water (2010) posits that the choice between Demolition and Deconstruction lies with the factors of time, cost, site security, availability of storage space, health and safety issues, construction company/client reputation and environmental sustainability. Sherman (1998) comments that Deconstruction is increasingly becoming practical for its savings on disposal costs, reducing demolition costs, decreasing distance to dump sites, the generation of financial revenue from the sale of recycled materials, minimizing dangerous air pollutants such as asbestos, lead, dust and burning of building components on construction sites. He further states other benefits to include the enhancement of contractor/client image as being more environmentally responsible, preserving landfill spaces, while conserving energy at various stages of deconstruction and preserving raw materials.

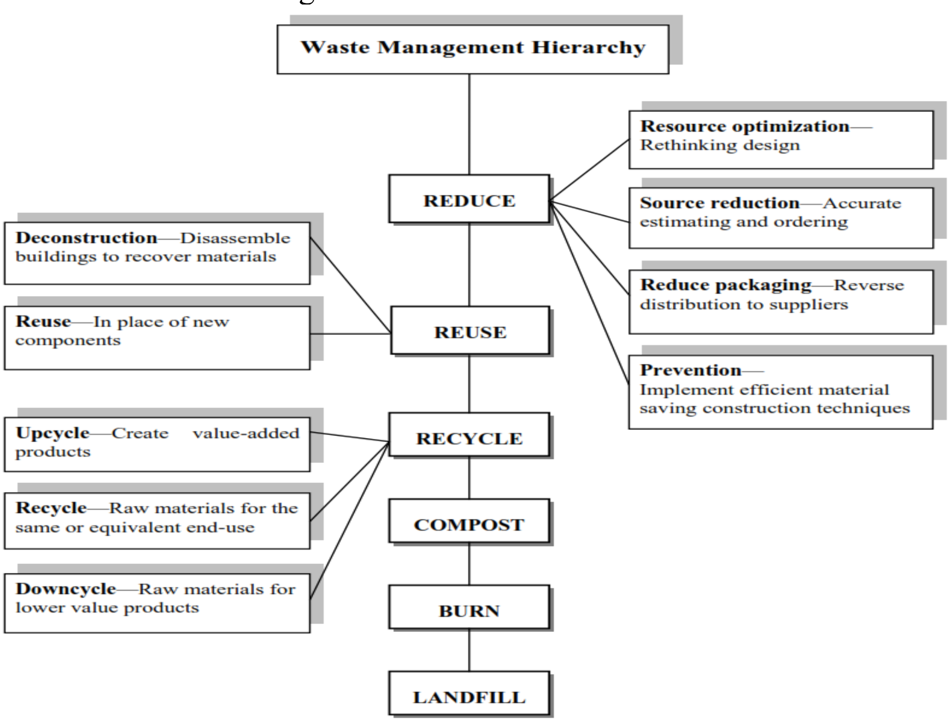

Figure 1: Stages in Deconstruction. Source: Kibert, Chini (2000).

Daven and Taylor (2008) similarly support the postulation put forward by Sherman (1998) that apart from financial benefits that would likely accrue to the client/contractor, the environmental trade-off as well as life cycle assessment of building materials with the accompanying savings on the acquisition, transportation, manufacture, installation and energy expended makes Deconstruction an interesting prospect. It continues that the use of Deconstruction can lead to less dust, less noise and reduced vibrations around sites.

The New South Wales Department of Environment, Climate Change and Water (2010) further reiterated some of the benefits of Deconstruction to include;

a. Financial gains from the sale of salvaged components.
b. Lowering of disposal costs as well as transportation of debris to dumps sites.
c. Reduction in the consumption new resources that would have been manufactured.
d. Increasing the business prospects and opportunities of contractors to environmentally savvy costumers.

The Indiana Brown Fields Program (2010) further comments that as much as 30-50% can be saved from using Deconstruction when compared to traditional labour cost.
It can be deduced that there exist quite some advantages when using Deconstruction over the traditional Demolition in addition to sustaining the environment.

Current Issues on Deconstruction

Although a lot of advantages and benefits exist for Deconstruction vis-à-vis Demolition, quite a number of issues remain unresolved and serve as potential stumbling blocks to the use of Deconstruction New South Wales Department of Environment, Climate Change and Water (2010). Some of these issues observed include;

a. Longer time taken to deconstruct
b. The labour required is more skilled and intensive.
c. Specialised tools and equipment

Jacque (2008) also opines that Deconstruction takes more time, requires more pre-planning and involvement in the process by everyone and requires more on-site storage space.

Bruening and Chini (2004) provide further insight into some of the current challenges to Deconstruction viz;

a. Existing buildings structures were neither designed nor constructed in such a manner as to allow for Deconstruction
b. Deconstruction often requires special equipment and tools and is sometimes unavailable or even non-existent.
c. Building codes and building standards very rarely adopt standards or regulations to aid Deconstruction.
d. Lack of expertise.
e. Financial and environmental benefits have not been sufficiently established.

As specialised tools and equipment for Deconstruction become more available and accessible, the intensive nature of the labour would likely reduce. This could in turn lead to lesser time required to successfully deconstruct a building. As more attention is continuously drawn to field of Deconstruction, experts and skilled technicians and artisans may likely emerge to further enhance the disassembly of building parts. This could also further provide job employment opportunities as well as make Deconstruction even more efficient in reducing waste until eventually a situation is reached where everything can be salvaged. Greer (2004) however, argues that unless there are more economic and financial benefits to Deconstruction, its potentials based on sustainability alone may be limited. This is especially because the construction industry is largely money driven and heavily influenced by financial benefits.

Types of Deconstruction

Deconstruction is basically divided into two: Table 1 summarises the types of deconstruction, its characteristics and likely Deconstructed materials.

Research Methodology

The study employed the case study and descriptive research methods, to study the problem. Both primary and secondary data were used. Primary data were obtained from direct observation and interviews. A total of 8 renovation/ urban renewal sites within Minna metropolis were studied. Sites were selected using purposive non-probability sampling based on the magnitude of renovation wok carried out and wastes generated. Public works were accorded more priority while simple residential buildings were given lesser priority. Secondary data were obtained from journals, textbooks, online sources and other publications to further corroborate findings from the field. The data was collected and analysed using descriptive statistical tools such as mean, percentages and averages in a tabular format. The data were analysed and computed using Microsoft office 2010.

Study Sample.

Table 2: Sampled Project Sites

S/No	Name of Project
1	Cbn Minna, Paiko Road
2	Mini Market, FUT Minna (Gidan Kwano Campus)
3	Late Idris kuta's Villa, IBB Drive, Hill Top Minna
4	City Centre Shopping Mall, Mobil Roundabout
5	No 15. Commissioners Quarters.
6	DSS Office Minna
7	Residential Estate, Behind Bomas Supermarket.
8	Kuta Road

Table 1: Types of Deconstruction

Type of Deconstruction	Definition	Characteristics	Types of Materials Salvaged
Non-structural	Non-structural deconstruction involves removal of building parts and elements whose disassembly does not affect the structural integrity of the building.	Normally light and can be salvaged with minimum safety issues. It seldom requires bracing or support to disassemble.	Floor finishes, doors and windows, wall finishes, sanitary wares, electrical fittings and installations, fire fighting fittings.
Structural	Structural deconstruction involves the removal of building parts and elements that constitutes an integral part of the building and/or contributes to the integrity of the building structure.	Typically large, rough and often more likely to be reused as building materials or recycled into other products.	Roofing sheets, roof trusses, ceilings, suspended floor systems, blocks/bricks, steel/wooden beams and columns

Source: National Association of Home Builders [NAHB] (2000).

Discussion of Results

Table 3 shows the demography of the samples studied. 37% of the sampled studied were urban renewal projects while 63% were renovation works. This implies that a lesser amount disassembling of building components is required since renovation works requires lesser amount of stripping and removal of components and materials.

Renovations are mostly carried out on non-structural components of buildings; hence the materials salvaged are mostly non-structural components. Table 3also shows 63% of the Clients public/ government institutions and 37% of were private clients. This signifies that majority of the projects studied were sufficient in scope and size as most public buildings or offices have large acreage.

Table 3: Demography of The Samples Studied

Name of Project	**Nature of Project**		**Nature of Client**	
	Renewal	**Renovation**	**Public**	**Private**
CBN Minna, Paiko Road		1	1	
Mini Market, FUT Minna (Gidan Kwano Campus)	1		1	
Late Idris kuta's Villa, IBB Drive, Hill Top Minna		1		1
City Centre Shopping Mall, Mobil Roundabout	1		1	
No 15. Commissioners Quarters.		1		1
DSS Office Minna		1	1	
Residential Estate, Behind Bomas Supermarket.		1		1
Kuta Road	1		1	
TOTAL	**3**	**5**	**5**	**3**
Percentage (%)	**37**	**63**	**63**	**37**

Table 4: Method of disassembly

Name of Project	**Labour used**			**Equipment Used**	
	Skilled	**Unskilled**	**volunteer**	**Simple**	**powered tools**
CBNMinna, paiko road	1				1
Mini market, FUTMinna (gidankwano campus)		1		1	
Late IdrisKuta's Villa, IBB Drive, Hill Top		1		1	
City centre Shopping Mall, Mobil Roundabout			1	1	
No 15. Commissioners Quarters.	1			1	
DSS Office Minna		1		1	
Residential Estate, Behind Bomas Supermarket.		1		1	
Kuta Road			1	1	
TOTAL	**2**	**4**	**2**	**7**	**1**
Percentage (%)	**25**	**50**	**25**	**87**	**13**

Table 4 shows the distribution of the various methods and skill sets employed in carrying out the task. The table indicates that 50% of the projects employed unskilled labour, 25% skilled labour and a further 25% utilised volunteers. Proper Deconstruction of building components or building structures require sufficient knowledge of the building process as deconstruction is merely construction in reverse. It then means that unskilled labour and volunteers which constitute 75% of the labour used- though cheaper and more economical – are generally unsuitable for deconstruction works. This results in more wastage and poor management of the deconstruction activity. Building materials and other components salvaged are hardly reusable immediately and end up being recycled (raw materials for the same or equivalent product) or down cycled (raw materials for lower value goods). The wasted components or materials remaining sadly end up in dumps or landfills due the use of inappropriate labour force which endanger the environment.

Table 4 further shows the equipment utilised during the Deconstruction process. 87% of projects studied utilised simple handheld tools and 13% employed the use of powered tools. This reveals that more time and effort will be required in 87% of Deconstruction works. Since powered machines require careful handling, skilled labour will be required to execute the job as is the case on the CBN Minna site shown in plate 1. Less time will also be spent in carrying out the work.

Plate 1: Removal of Floor Finish using powered tools

Table 5 shows deconstructed building materials salvaged on the respective sites. All sanitary fittings, roofing (Plate 3), egresses and wooden trusses were salvaged in all of the samples studied. Floor finishes were sampled in 87% of sites. The remaining 13% was salvaged due to the nature of floor finish involved (cement sand screed). 63% of sample studied also made efforts to salvage power fixtures and steel bars.

Ceiling, Blocks/bricks, lighting fitting and wall finishes were only deconstructed in 13% of the sites sampled, while no site salvaged sanitary piping and concrete as also shown in Table 5. Concrete and sanitary wares were not salvaged on any of the sites sampled. Very few sites disassembled Ceiling and Lighting fitting and may not be unconnected with the low resale value of these components.

Although sanitary piping (PVC or Galvanised) and lighting fittings (tungsten) have harmful impacts on the environment, they were not salvaged. This further confirms that economic benefits are the primary motivation for deconstruction with sustainability of the environment probably being a secondary reason. Blocks were also predominantly neglected due to difficulty and expertise required in carefully disassembling as seen in plate 4. This further reiterates the assertion made from Table 4 that the use of unskilled workers will result in wastage and turning of blocks and concrete into debris. The lack of technical know-how in recycling blocks and concrete even when broken or turn to debris further contributes the neglect in deconstructing blocks and concrete.

Plate 2: Wall tiles carefully salvaged.

Table 5: Deconstructed Building Components and Materials

Name of Project	**Non-structural Components (Salvaged)**							**Structural components (salvaged)**					
	Plumbing wares	**Plumbing . .**	**Power fittings**	**Light fittings**	**Floor finishes**	**Wall finishes**	**Egresses**	**Roofing sheets**	**Ceiling**	**Wooden trusses**	**Blocks/Bricks**	**Steel Bars**	**Concrete**
CBNMinna, paiko road	1		1		1		1	1		1		1	
Mini market, futminna (gidankwano campus)	Na	Na	1				1	1		1		1	
Late IdrisKuta's Villa, IBB Drive, Hill Top	1		1		1	1	1	1		1			
City centre Shopping Mall, Mobil Roundabout	1				1		1	1		1			
No 15. Commissioners Quarters.	1				1		1	1	1	1	1	1	
DSS Office Minna	1		1		1		1	1		1		1	
Residential Estate, Behind Bomas Supermarket.	1		1	1	1		1	1		1			
Kuta Road	na	na			1		1	1		1		1	
TOTAL	**6**	**0**	**5**	**2**	**7**	**1**	**8**	**8**	**1**	**8**	**1**	**5**	**0**

Plate 3: Roofing sheets carefully salvaged.

Conclusion

A lot of waste is generated from Construction and Demolition sites. Deconstruction is one of the sustainable practices that can be employed to mitigate and substantially reduce the amount of waste and debris generated, conserve energy and protect the environment. Deconstruction was shown to be more beneficial and helpful than 'wrecking ball' or 'bulldozer' style demolitions. Deconstructed materials salvaged from buildings can be reused, up cycled, recycled, down cycled, compost, and burn or landfilled in the order of preference. The study also shows that more preference is given to the economic benefits of deconstruction to its sustainability.

Recommendations

- Tax breaks or relief or other reward systems can be offered to companies and contractors who choose deconstruction over demolition as practiced in Australia, US and the EU.
- Efficient deconstruction requires specialisation and expertise. Companies that specialise in Deconstruction should be subsidized and encouraged.
- The Leadership in Energy and Environmental Design (LEED) rating system should be incorporated into the National Building Code to encourage industry professionals to adopt sustainable deconstruction practices.
- Architects should design buildings to allow for Deconstruction.
- More modular, demountable and prefabricated construction should be

encouraged as it allows for easy disassembly.

- Recycle plants and Processing facilities for concrete, blocks and cement related waste is highly required to eliminate cement waste as it constitutes the bulk of the debris that end in landfills and dumps.
- Surveys need to be carried out prior to Deconstruction to determine the required tools, equipment and technicality to be used.

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