INVESTIGATING THE USE OF ALTERNATIVE BUILDING TECHNOLOGIES FOR AFFORDABLE HOUSING DELIVERY IN NAMIBIA

A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF BUSINESS ADMINISTRATION (FINANCE)

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Abstract

The huge housing backlog estimated by several studies conducted in Namibia to be over 100,000 units in 2016 and still growing is a manifestation of inadequate delivery of affordable housing. This study is inspired by this dire reality perpetuated by the low productivity of affordable housing projects that make use of conventional methods of construction. This study investigates the use of Alternative Building Technology (ABTs) as a potential solution to this problem. In pursuit of that, a convergent independent mixed methods research design was adopted where data was collected in parallel, analysed separately, and then merged at the discussion and reporting stages. The theoretical framework for the study included concepts and principles from economics, project management, psychology and lean construction. ABTs have qualities such as reduced waste in construction time, labour, and materials which make them more productive than conventional methods. Unavailability of serviced land, limited funding, conservative regulations, and poor project management are significant factors undermining the delivery of affordable housing in Namibia. Currently, use of ABTs in Namibia is very minimal but success has been observed elsewhere in Nigeria, South Africa, Kenya, and Uganda. The study is useful to policymakers recommending reforms to the delivery of affordable housing as well as property developers interested in this market segment.

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Dedication

This thesis is dedicated to my loving family, for whom without, I am nothing.

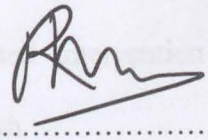
I also dedicate this to my children, they are my future, the light, and they make the path worthwhile. I know that everything I do in this world is to enrich their lives, as they have given me unconditional love and support.

To my parents and the extended family, in which so many look at me as an inspiration for their lives.

Lastly, to all my friends who believed in me and encouraged me to complete this project.

Declarations

I hereby declare that this thesis represents my work, which has been done after registration for the degree of MBA Finance at the Namibia Business School (NBS) and has not been previously included in a thesis or dissertation submitted to this or any other institution for a degree, diploma or other qualifications.



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Abbreviations and Acronyms

ABT	Alternative Building Technologies
BTP	Build Together Programme
CSF	Critical Success Factors
HRDC	Habitat Research Development Centre.
LSF	Light Steel Frame
MURD	Ministry of Urban & Rural Development
NHAG	Namibia Housing Action Group
NHE	National Housing Enterprise
NSA	Namibia Statistics Agency
PMBOK	Project Management Body of Knowledge
PMI	Project Management Institute
PPP	Private Public Partnership
SDFN	Shack Dwellers Federation of Namibia
SIP	Structural insulated panels
TIPEEG	Targeted Intervention Programme for Employment and Economic Growth
UNAM	University of Namibia

Chapter 1: Introduction

1.1 The orientation of the proposed study

The role of housing in human civilization cannot be overemphasized; it is a basic need of a human being besides food and clothing. According to Maslow's hierarchy of needs visualized as a pyramid where the basic needs sit at the bottom followed by the safety needs of which shelter is one of them. The Universal Declaration of Human Rights (UDHR) adopted by the United Nations General Assembly on 10 December 1948 at the Palais de Chaillot in Paris, France; declares housing a human right under article 25. The Namibian constitution does not seem to declare this right to housing explicitly but article 144 of the same constitution holds that international laws and agreements that are binding to Namibia are included in the laws of Namibia. Thus, by inference to the UDHR, Namibia, makes housing a right under the constitution of Namibia.

Affordable housing in Namibia is delivered mainly through housing projects by the National Housing Enterprise (NHE), the Build Together Programme (BTP), and the Shack Dwellers Federation of Namibia (SDFN). The private sector is almost non-existent in this market segment (Remmert & Ndhlovu, 2018). Affordable housing projects in Namibia mainly use conventional methods of construction (Hailulu, 2014). Al-Fakih, Mohammed, Nuruddin and Nikbakht (2017), uses the term conventional to contrast it with other methods of construction that may be traditional or alternative building technologies (ABTs). In Namibia, conventional construction uses mortar and bricks with reinforced steel for bigger projects. These methods of affordable housing

delivery have failed to meet the ever-increasing demand estimated with a backlog of over 100,000 houses by 2013 (Hailulu, 2014). The problem of inadequate affordable housing delivery in Namibia is the result of a mismatch of demand and supply instigated by several demand drivers (Randa, 2016). According to several studies carried out in Namibia and elsewhere, one of the causes is land scarcity, especially serviced land (Remmert & Ndhlovu, 2018) and its high cost (Kalili, 2014). However, this assertions about the land can be challenged and interrogated since it contradicts the observation that Namibia is a vast country of 825,615 square kilometres and a relatively small population of 2.45 million in 2018 (NSA, 2018). Kalili (2014) provides evidence that land is not the only factor to be considered when looking for a solution to the affordable housing delivery problem in Namibia. He found in his study that only 61 housing units were mortgaged in June 2014 while serviced land in the same period was enough for 920 units. If this was the trend throughout the year then there is evidence that delivery of housing lagged behind serviced land availed over the same period. Therefore, a case can be argued to investigate more productive housing delivery mechanisms that will increase the supply of affordable housing.

Innovative non-conventional methods of construction commonly referred to as alternative building technologies (ABTs) are emerging with the potential to significantly improve the delivery of affordable housing in Namibia. Construction is a process of assembling materials using labour and overheads over time into a finished product (Vidhate & Salunkhe, 2018). Nambatya (2015), Magutu (2015) and, Al-Fakih et al., (2017) in their respective studies found that some ABTs can reduce construction time with up to 50 percent, thereby savings in labour costs. If these ABTs are used it

is expected that the assembly of the finished product will be faster hence producing more in a given period. For instance, using conventional methods of construction, the NHE has only managed to deliver an average of 457 housing units instead of the envisaged 1 200 units per year housing to date (Jauch, 2015). Low productivity of housing projects such as those undertaken by the NHE may be one of the contributing factors of inadequate supply of affordable housing. Therefore, in search of solutions to alleviate the housing deficit in Namibia, it is interesting to investigate other mechanisms of affordable housing delivery.

The study makes use of theories and concepts from the following four fields of study: 1. Economics (laws of supply & demand; Cobb-Douglas Theory; Public Interest Theory), 2. Lean Construction, 3. Project Management (PMBOK) and, 4. Psychology (Cognitive Theory of Perception).

The value proposition for ABT application in affordable housing delivery projects is increased productivity. To unlock this value, articulation of factors that inhibit the use of ABT is vital. Firstly, input resources such as land and financing must be available (Fungai, Kahilu & Akintayo, 2018). Secondly, the existence of materials, labour, and technologies with the potential to reduce the cost of construction (Ajibola, 2014; Kagai, 2017). Thirdly, a positive perception of ABT technologies (Nambatya, 2015; Magutu, 2015). Fourthly, an ABT friendly regulation regime (Jauch, 2015). Lastly, it is important to incentivize the private sector to participate in the delivery of affordable housing in Namibia.

ABT housing delivery has seen some success in South Africa (Fungai et al., 2018), Nigeria (Al-Fakih et al., 2017; Adjibola, 2014), Kenya (Magutu, 2015) and

Uganda (Nambatya, 2015). These studies attribute the success of ABT application to the active involvement of the respective governments in attracting the private sector to partake in the affordable housing market segment in those countries.

1.2 Statement of the problem

Globally the issue of affordable housing has taken a focal point as different governments strive to provide shelter for their citizens. Namibia is no different, the supply of affordable housing mainly using conventional methods is inadequate failing to meet the demand (Remmert & Ndhlovu, 2018). This dire situation is exacerbated by the low productivity of affordable housing projects (Jauch, 2015). This problem cannot be neglected any longer; it is urgent and will continue to affect the quality of life of many Namibian citizens.

Using ABTs in affordable housing delivery projects shall make them more productive than the conventional delivery mechanisms currently in use. Consequently, the increased supply of affordable housing will alleviate the problem in Namibia. ABT application for affordable housing delivery has seen success in Nigeria, South Africa, Kenya and Uganda.

Successful application of ABTs for affordable housing delivery will require overcoming a lingering perception and acceptability problem as well as other challenges that may impede their application.

1.3 Research Purpose, Objectives and Questions

Purpose

The study investigated the use of ABTs in affordable housing delivery projects in Namibia.

Objectives

To investigate the application of ABTs as an affordable housing delivery mechanism in Namibia. In achieving this goal, the study addressed the following three sub-objectives:

1. To draw attention to the perception problem of using ABTs for affordable housing delivery in Namibia.
2. To appraise the qualities of ABTs that make them a more productive affordable housing delivery mechanism in the context of a country like Namibia.
3. To assess the challenges that impede the use of ABTs for affordable housing delivery in Namibia.

The main research question:

How does the use of ABTs for affordable housing delivery prove to be more productive than conventional methods currently in use in Namibia?

Sub questions:

1. Which qualities of ABTs make their application more productive as affordable housing delivery mechanism for a developing country like Namibia?
2. How does the perception problem impact the use of ABTs for affordable housing delivery in Namibia?
3. What challenges impede the use and therefore the success of ABTs for affordable housing delivery in Namibia?

1.4 Significance of the study

The study is defended on the following three grounds. Firstly, it will be an important resource to policymakers and those mandated to deliver affordable housing. Implementation of affordable housing solutions should be supported by empirical studies. Secondly, gaps in knowledge on the subject have been identified. For instance, the impact on labour and the environment is still very vague and under-researched. Also, the perception problem ought to be modelled to understand the impact on ABT application. Lastly, the study creates general awareness about ABT application to stakeholders among them, Government (ministries and local authorities), non-governmental organisations (Shack Dwellers Federation of Namibia, etc.), private sector (contractors, materials suppliers and property developers) and individuals.

1.5 Limitations of the study

It is important to take into consideration that while the findings are supported by the data collected, these findings still contain certain limitations. The researcher used a variety of data collection methods in an attempt to gather data from a variety of sources to triangulate, merge and draw conclusions. However, no data were collected from individuals therefore it's not a fully accurate representation of all the stakeholders in the affordable housing value chain.

The survey of estate agents may have skewed some of the results because they deal mainly with property developed using conventional methods; ABT application in Namibia is almost non-existent. Furthermore, the focus group was from a

government agency mandated to deliver affordable housing in Namibia. There is a likelihood that data collected was subject to bias since they did not want to be seen as failures. There are additional limitations to consider the data collected from alternative building technology companies. After extensive research, nine alternative building technology companies were found in Namibia. Of these nine, the researcher was only able to contact and conduct interviews with three. This limited the amount of direct information that the researcher was able to collect from the ABT companies. Also, there is a chance of inaccurate or exaggerated information during interviews with ABT companies because they are trying to market and promote their products.

Even though these limitations are important to consider, the researcher remains confident that the data presented in the findings provide valuable information on the application of ABT for affordable housing in Namibia. Also, the mixed-methods design with triangulation increases reliability where bias may occur (Creswell & Clark, 2007).

1.6 Definition of terms

i. *Alternative Building Technology (ABT)* in this study is defined as the housing construction techniques intending to minimize the use of costly materials and methods without affecting the quality of construction (Al-Fakih et al., 2017; Ajibola, 2014).

ii. *Alternative building materials* refer to locally available materials from which products are made that could be an input to low-cost housing construction in Namibia (Remmert and Ndhlovu, 2018).

iii. *Conventional building* methods refer to the common mortar and brick building methods, which are usually deemed to be labour intensive,

wasteful, and take a considerable amount of time to complete a project (Al-Fakih et al., 2017).

iv. *Affordability of housing* is the ability of consumers to buy a home using not more than 30% of their gross monthly income (Kalili, 2014; Randa, 2016)

v. *Low-Cost Housing* is a concept, which deals with effective budgeting and the use of techniques, which help in reducing the cost of construction (Randa, 2016; Kagai, 2017).

1.7 Conclusion

As the need for affordable housing in Namibia continues to grow, the Namibian government will need to find new solutions to alleviate the country's housing shortage. Alternative building technologies have the potential to be one of these solutions. However, their application for affordable housing will face challenges that ought to be overcome, among them, the perception and acceptability problem. Undisputedly, serviced land availability and cost of construction are the two most likely factors contributing to inadequate delivery of affordable housing in Namibia. The use of ABTs will increase the supply of affordable housing because of the accompanying efficiencies that increase the productivity of those projects in Namibia.

Chapter 2: Literature Review

2.1 Introduction

This chapter reviews the literature, the main researchers, and the contemporary discourses on the subject of affordable housing delivery. The body of the chapter starts with a discussion on the current situation of affordable housing in Namibia captured through the literature available in the form of academic studies and other sources such as regulations and policies on housing. Then the theoretical framework that draws from various fields of study is explained followed by the conceptual framework used to organise the ideas. Lastly, a summary of the chapter highlighting the key points.

2.2 Affordable housing situation in Namibia

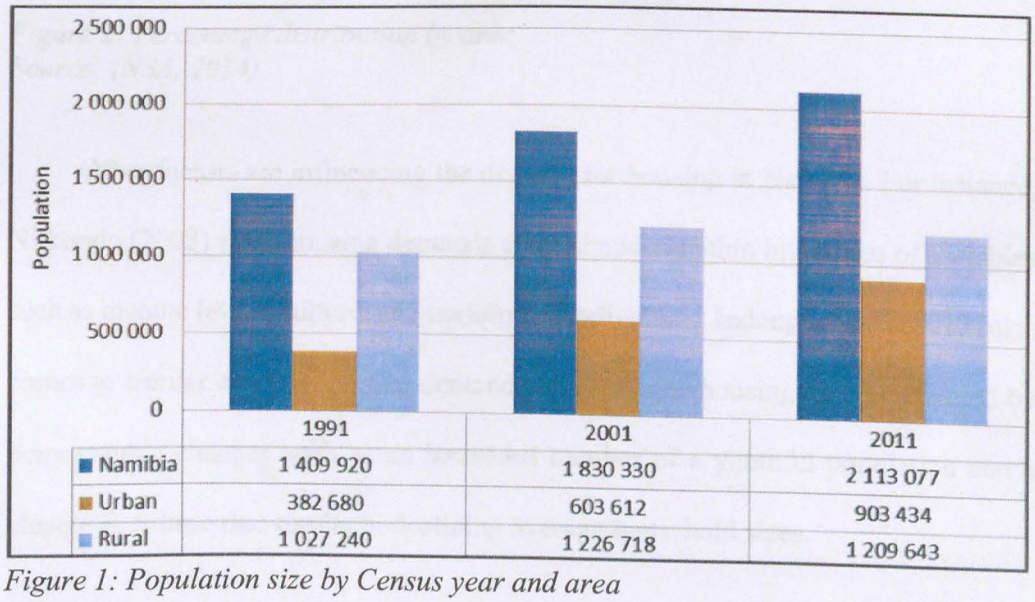
2.2.1 Stakeholders

The key stakeholders in the housing sector roughly fall into three categories: the public, private sector and civil society. Among these stakeholders, the government is the most prominent (Remmert & Ndhlovu, 2018). The public sector includes the central government, its agencies and directorates, local authorities and municipalities. They mainly regulate, provide funding, and construct affordable housing. The second is the private sector, which includes contractors, suppliers of technologies and financiers. The third one is the civil society mainly including NGOs such as Shack Dwellers Federation of Namibia (SDFN), Namibia Housing Action Group (NHAG), etcetera.

2.2.2 Demand drivers for affordable housing

There is a mismatch between the supply of affordable housing and demand for the same (Remmert & Ndhlovu, 2018). Studies on the subject conducted in Namibia (Niikondo, 2008; Indongo, Angombe, & Nickanor, 2013) identified two major reasons that instigate demand for affordable housing which are population growth and rural-urban migration. A third reason is the falling household size linked to cultural changes (FNB Namibian Housing Market report, 2016).

Population growth creates demand for housing in general and more so for affordable housing which currently surpass the supply of the same mainly driven by conventional methods. For illustration, the Namibia population is projected to increase to 3.44 million by 2041 from the current 2.5 million, or by about 40 percent (NSA, 2014). Overall, the population has grown steadily since 1921 rising from under one-quarter of a million in 1921 through to 1.8 million in 2001 and 2.1 million in 2011 (Figure 1).



	1991	2001	2011
Namibia	1 409 920	1 830 330	2 113 077
Urban	382 680	603 612	903 434
Rural	1 027 240	1 226 718	1 209 643

Figure 1: Population size by Census year and area

Source: (NSA, 2014)

Urbanisation occurred at a rapid speed after independence when the apartheid restriction of living was abolished (Niikondo, 2008). Results of a study conducted by Indongo et. al., (2013 show that people in Namibia move from the rural areas into the urban centres because of the following three reasons: employment, education, and for a better life. Plotting the percentage changes in the population distribution illustrated in Figure 2; the urban population increases while the rural population decreases.

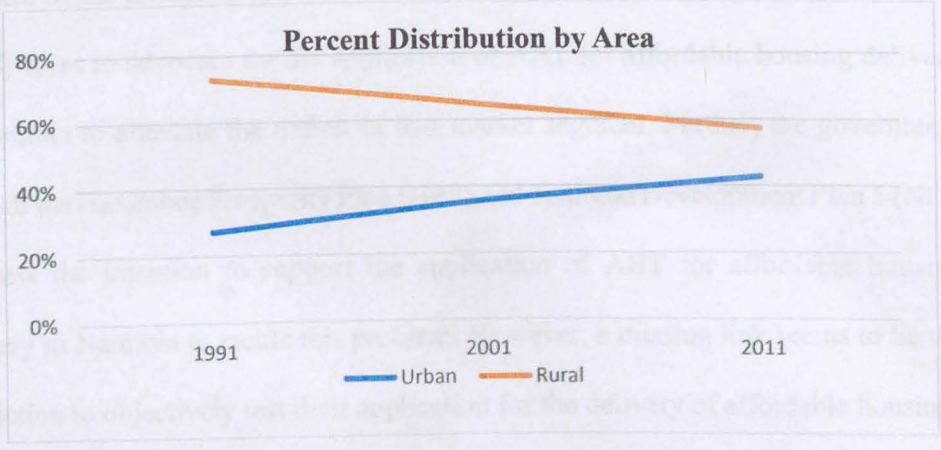


Figure 2: Percentage distribution by area
Source: (NSA, 2014)

Other factors are influencing the demand for housing in Namibia. For instance, Niikondo (2008) says, housing demands are embedded within influences of variables such as income levels, culture, and tradition of individuals. Indongo et. al., (2013) also comes to similar conclusions that demand for affordable housing may be affected by demographic changes such as an increased number of a youthful population and a change in culture that results in declining average household sizes.

2.2.3 ABT application in Namibia

Currently, the application of ABT for affordable housing delivery is almost non-existent. A pilot study by the NHE to assess the use of ABTs for affordable housing delivery did not seem convincing. Hailulu (2014) said that ABTs showed some savings in construction time but the cost savings were not significant. According to Hailulu, (2014), in contrast, conventional methods contractors are readily available, unlike ABT suppliers also, retraining the workers and the customers were generally sceptical of the technologies demonstrated. Remmert and Ndhlovu (2018) and Jauch (2015) seem to advocate for the application of ABT for affordable housing delivery in Namibia to alleviate the deficit in that market segment. Further, the government through the Harambee Prosperity Plan (HPP) and National Development Plan 5 (NDP 5) show the intention to support the application of ABT for affordable housing delivery in Namibia to tackle this problem. However, a missing link seems to be the conviction to objectively test their application for the delivery of affordable housing.

2.2.4 Materials used for construction

Most of the materials used can be broadly divided between those that are harvested with labour from local resources (grass, stick, mud and dung etc) and those that are purchased with cash (cement bricks or blocks and corrugated iron). Most households in Namibia, 41 percent reside in dwellings with walls made from cement/bricks (Tables 1). These are considered permanent/durable materials and an indicator of development. About 57% of urban households use cement/bricks for outer walls compared to 26% for rural households. There was a much higher proportion of

rural households that used wood poles/sticks or grass/reeds for walls (29.6%) than the 3.6% found in urban areas.

Table 1: Percent distribution by main materials used for outer walls

Area	Households	Cement blocks/bricks/ stones	Burnt bricks/ Face bricks	Mud/clay bricks	Corrugate d iron/zinc	Prefabricated material	Wood poles/sticks or grass/reeds	Sticks with mud/clay and/or cow dung	Tin	Other
Namibia	464 839	41.1	0.8	7.7	20.5	3.1	16.8	8.4	0.7	0.9
Urban	228 955	57.0	0.7	2.0	27.6	4.8	3.6	2.5	0.8	1.0
Rural	235 884	25.6	0.9	13.3	13.6	1.4	29.6	14.1	0.6	0.8
Caprivi	21 283	15.2	0.4	21.5	0.8	0.5	8.9	51.7	0.0	0.9
Erongo	44 116	57.6	0.4	0.5	6.8	18.8	11.2	1.5	0.9	2.3
Hardap	19 307	61.2	0.3	0.1	35.1	1.2	0.3	0.1	1.3	0.4
Karas	20 988	56.9	0.5	1.0	27.7	3.5	5.5	1.2	3.2	0.3
Kavango	36 741	16.2	0.8	14.6	6.8	1.6	26.0	33.2	0.1	0.6
Khomas	89 438	57.9	0.4	0.2	38.3	1.2	0.3	0.1	0.7	0.9
Kunene	18 495	33.9	0.5	1.6	12.2	2.7	4.3	41.7	0.4	2.8
Ohangwena	43 723	22.9	1.0	30.9	12.1	0.6	29.7	2.1	0.2	0.5
Omaheke	16 174	42.3	1.7	1.3	40.5	3.2	1.1	7.1	1.6	1.1
Omusati	46 698	28.0	0.9	9.3	9.4	0.8	47.4	3.6	0.1	0.4
Oshana	37 284	41.5	1.7	3.9	22.8	1.4	26.1	1.7	0.2	0.6
Oshikoto	37 400	30.9	1.1	9.9	17.4	0.8	36.0	3.2	0.4	0.4
Otjozondjupa	33 192	52.8	1.4	5.2	28.0	2.5	2.4	4.5	2.1	1.1

Sourced from NSA, 2014, p.74

Corrugated iron sheets were the main material used for roofing, covering more than half of all Namibian households, followed by thatch/grass (26%), Table 2. In urban areas, 78% of households live in dwellings where roofs are constructed with corrugated iron sheets, compared to 46% in rural areas.

Table 2: Percent distribution by main materials used for the roof

Area	Number of Households	Corrugated iron/zinc	Asbestos sheet	Brick tiles	Concrete	Thatch, grass	Slate	Wood covered with melthoid	Sticks with mud and cow dung	Tin	Other
Namibia	464 839	61.6	6.0	0.7	0.4	25.9	0.3	2.2	0.8	0.8	1.2
Urban	228 955	78.0	11.3	1.2	0.7	2.0	0.5	3.8	0.2	0.9	1.5
Rural	235 884	45.6	1.0	0.2	0.1	49.2	0.2	0.7	1.4	0.7	0.9
Caprivi	21 283	48.9	0.9	0.1	0.1	47.3	0.0	0.5	1.1	0.1	1.0
Erongo	44 116	23.8	44.9	2.7	0.8	0.2	1.3	18.6	0.3	1.3	6.1
Hardap	19 307	95.7	1.7	0.1	0.1	0.1	0.1	0.2	0.0	1.6	0.3
Karas	20 988	77.7	13.3	0.4	0.3	4.2	0.6	0.5	0.5	1.8	0.7
Kavango	36 741	39.1	0.6	0.4	0.1	57.9	0.1	0.3	1.1	0.2	0.2
Khomas	89 438	94.1	1.8	1.1	1.1	0.1	0.2	0.2	0.1	0.9	0.3
Kunene	18 495	72.2	1.6	0.1	0.1	11.1	0.2	0.3	10.1	0.6	3.8
Ohangwena	43 723	29.8	0.5	0.2	0.1	67.6	0.2	0.7	0.3	0.4	0.2
Omaheke	16 174	92.1	2.2	0.7	0.2	0.7	0.3	0.3	0.6	1.9	1.0
Omusati	46 698	38.9	0.7	0.1	0.1	58.3	0.2	0.5	0.5	0.2	0.6
Oshana	37 284	65.2	1.8	0.4	0.4	29.2	0.5	1.3	0.3	0.5	0.5
Oshikoto	37 400	49.8	1.4	0.3	0.2	45.9	0.2	0.9	0.4	0.4	0.5
Otjozondjupa	33 192	89.3	2.2	0.9	0.2	3.5	0.2	0.3	0.8	1.7	1.0

Sourced from NSA, 2014, p.74

Table 3 shows that exactly one third (33%) of all Namibian households have floors of sand/earth and another third (33%) have cement floors. While sand/earth is more common in rural dwellings (43% of households), cement is the main material in urban areas (35.4%) followed closely by tiles (33%). However, cement is also an important material in rural areas (31%), as well as clay and mud (23%).

Table 3: Continued percent distribution by main materials used for the floor

Area	Households	Sand/ earth	Cement	Mud/clay	Wood	Concrete	Tiles (Ceramic /wood/plastic)	Other
Namibia	464 839	33.1	33.0	13.0	0.7	2.2	17.3	0.8
Urban	228 955	23.4	35.4	3.3	0.9	3.4	32.6	1.0
Rural	235 884	42.5	30.6	22.5	0.5	1.1	2.4	0.5
Caprivi	21 283	10.0	11.4	66.9	0.3	2.2	8.9	0.4
Erongo	44 116	21.6	34.0	0.8	1.6	2.8	37.8	1.4
Hardap	19 307	23.1	54.5	0.5	0.6	1.5	19.2	0.6
Karas	20 988	18.5	52.6	0.8	2.3	2.6	21.8	1.4
Kavango	36 741	30.8	18.2	45.0	0.3	0.7	4.8	0.2
Khomas	89 438	26.2	27.9	0.4	0.7	3.7	39.6	1.5
Kunene	18 495	29.8	39.9	21.2	0.7	0.9	5.4	2.0
Ohangwena	43 723	43.1	24.1	29.6	0.3	0.3	2.6	0.1
Omaheke	16 174	29.0	58.5	2.9	0.9	2.3	5.7	0.7
Omusati	46 698	58.2	27.3	8.9	0.3	2.2	2.7	0.3
Oshana	37 284	39.1	37.2	6.8	0.8	2.9	12.6	0.5
Oshikoto	37 400	50.9	31.7	10.1	0.4	1.2	5.6	0.2
Otjozondjupa	33 192	27.6	50.5	3.0	0.6	2.5	15.5	0.4

Sourced from NSA, 2014, p.75

2.2.5 Basic housing facts

The housing situation in Namibia is encapsulated into basic housing facts. One of those facts is the changes in household composition, which has resulted in falling household sizes (Figure 3). Another one the population growth and rural-urban migration (Niikondo, 2008; Indongo, Angombe, & Nickanor, 2013). Despite effort through government initiatives such as Tipeeg, Mass housing and the Harambee prosperity plan (HPP), housing is inadequately shown in the increasing housing deficit (Figure 4). NHE, the agency government mandated to deliver affordable housing

using conventional methods is not producing enough to meet the demand or at least reduce the deficit (Figure 5). The increase in shacks as shown in Figure 6 and Figure 7 improvised structures, is indicative of the dire situation in the affordable housing segment. This situation cannot change with the current conventional methods of affordable housing delivery that have been so unproductive over the years.

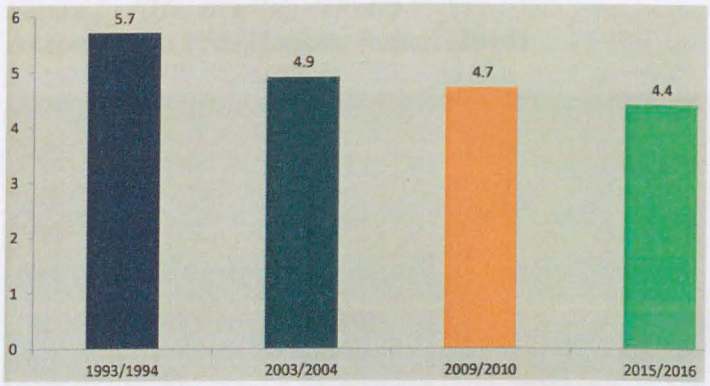


Figure 3: People per household
Adapted from FNB Housing Report (2016)

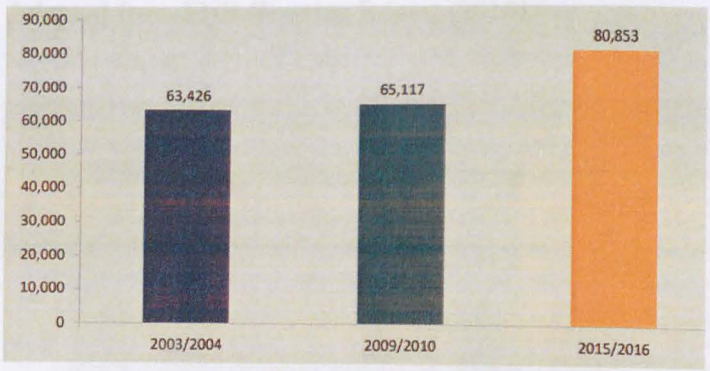


Figure 4: Housing deficit
Adapted from FNB Housing Report (2016)

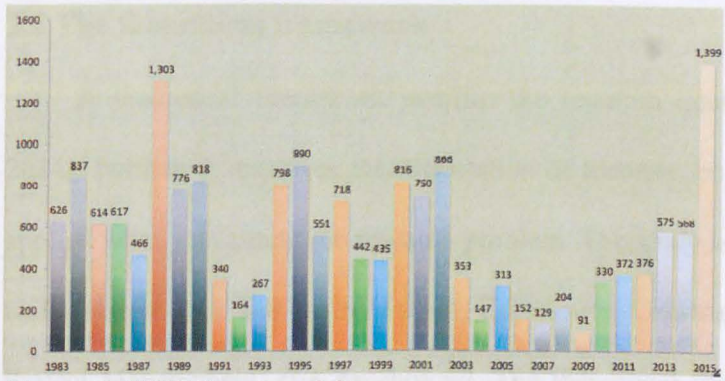


Figure 5: NHE Housing delivery
Adapted from FNB Housing Report (2016)

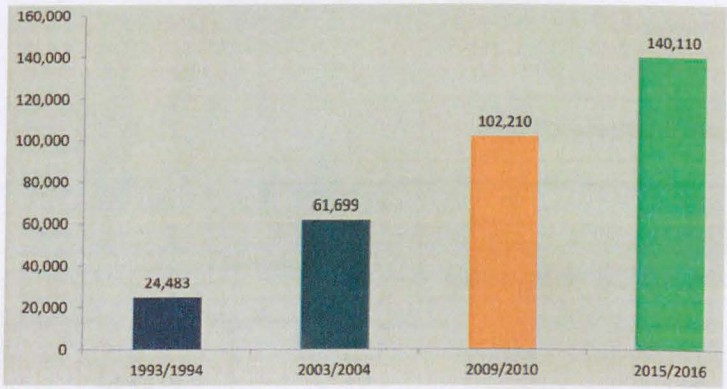


Figure 6: Shacks
Adapted from FNB Housing Report (2016)

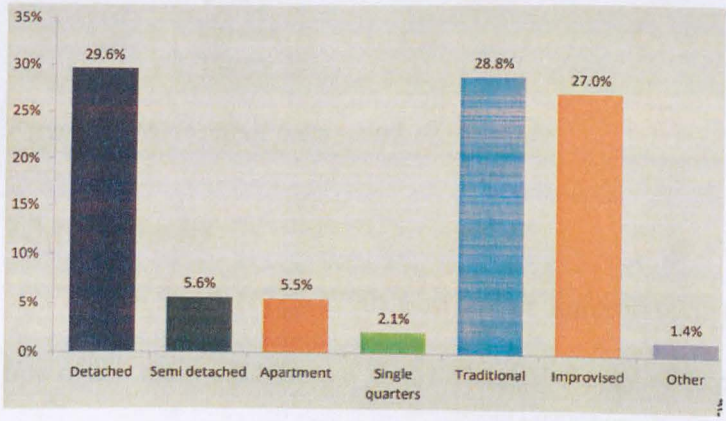


Figure 7: Type of dwelling
Adapted from FNB Housing Report (2016)

2.3 The theoretical framework

A theoretical framework justifies the research question (Grant & Osanloo, 2014). Further, it improves the articulation of theories, concepts and the reasoning applied when explaining the research problem. The study is underpinned by theories and concepts from four fields of study, Economics, Construction and Manufacturing, Project Management, and Psychology. The theoretical framework for the study is summarised in Figure 8 below.

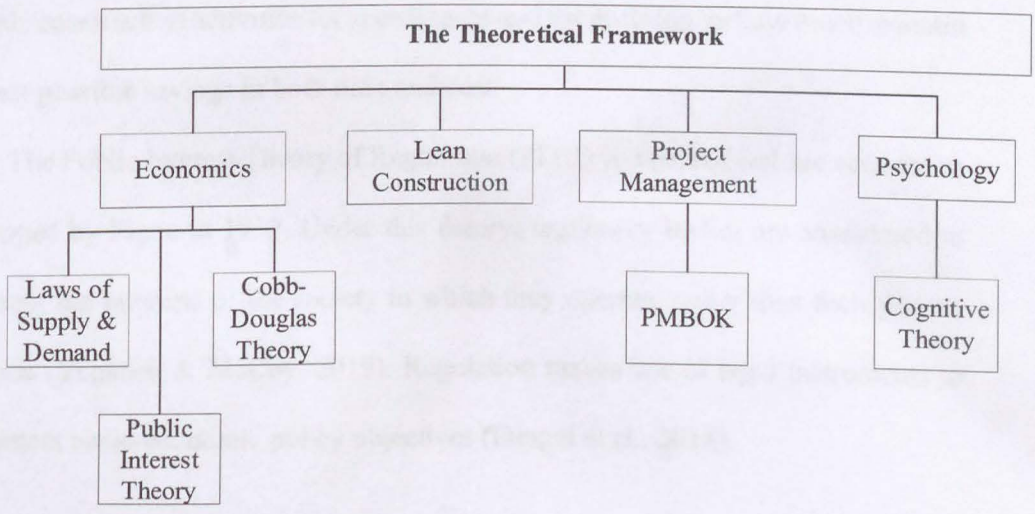


Figure 8: Theoretical framework of the study

2.3.1 Economics

Adam Smith (1723-1790), best known for promoting a free-market economy is one of the main contributors to the classical theory of Economics and the Laws of Supply and Demand. The law of supply says that at higher prices, sellers will supply more of an economic good. However, the law of demand says that at higher prices, buyers will demand less of an economic good. These two laws interact to determine

the equilibrium market price, which is the actual market prices and therefore the volume of goods that are traded on a market.

The Cobb-Douglas theory of production provides an important framework for the measurement of productivity and employment of factors of production since the 1930s (Amuka, et al. 2018). The production function has been used in various fields of study in economics (Wang & Fu, 2013), manufacturing (Husain, Shaiara & Islam, 2016) and productivity (Amuka, et al. 2018). This study is fortified by the quest to understand the time-cost optimization problem, defined as a process to identify suitable construction activities for speeding up and for deciding by how much to attain the best possible savings in both time and cost.

The Public Interest Theory of Regulation (PITR) is a part of welfare economics developed by Pigou in 1932. Under this theory, regulatory bodies are considered to represent the interests of the society in which they operate, rather than their private interests (Yeganeh & McCoy, 2019). Regulation makes use of legal instruments to implement socio-economic policy objectives (Fungai et al., 2018).

2.3.2 Lean Construction

Lean construction is a philosophy by which the construction team adopts practices and technologies that reduce costs, materials, time and effort, specific to the project at hand (Hall, 2019). The principles involved in lean construction have been modified from those of the better-known managerial approach of lean production often associated with six sigma (Vidhate & Salunkhe, 2018). Lean Construction came into being when several studies found that 'Lean Production' as applied to manufacturing

did not entirely work for construction projects (Vidhate & Salunkhe, 2018). The following five principles underpin Lean Construction (Vidhate & Salunkhe, 2018):

- Value specification: Precisely specify what creates value from the client's perspective
- Value stream identification: Identify all the steps in the processes (value stream) that deliver exactly what the customer values and remove everything that does not add value to the customer.
- Flow: Take actions that ensure continuous flow in the value stream,
- Pull: This means to produce only what the customer wants just in time; and
- Perfection: Always strive for perfection by delivering what the customer wants and expects through continuous removal of waste. Through process improvement to deal with the challenges in the construction.

A process or method of construction is considered lean when it has the following characteristics (Hall, 2019):

- Shorter Construction Time
- Reduce Costs
- Accelerate Activities
- Improve Planning
- Improve Process control

2.3.3 Project Management

Increased acceptance of project management as a profession indicates that the application of its knowledge, processes, skills, tools, and techniques can have a significant impact on project success (Azozama, 2016). PMBOK is the lexicon providing a standardized set of frequently used project, program, and portfolio

management terms with clear and concise definitions to improve understanding and consistent use of terminology. PMBOK defines a project as the work activities an organization does including the operations. Project management concepts and methods will help in avoiding project failure (Azozama, 2016). According to the Project Management Institute (PMI), project management methods provide tools and techniques to benefit all aspects of planning, scheduling and monitoring the time, cost and specifications of projects.

2.3.4 Psychology

Psychology is a very broad field of study with many theories. However, for this research study, use is made of the Cognitive Theory of perception by Saks and John (2011), which identified these three components of perception:

1. The perceiver, the person who becomes aware of something and comes to a final understanding. In the context of the ABT affordable housing delivery mechanism, the perceiver is the consumer of housing. Three factors can influence his or her perceptions: experience, motivational state, and emotional state. In different motivational or emotional states, the perceiver will react to or perceive something in different ways. Therefore, there is room for changing one's perception using various stimuli.
2. The target is the object being perceived or judged. ABT is the target objective. In her study, Nambatya (2015) found that "Ambiguity or lack of information about a target leads to a greater need for interpretation and addition."
3. The situation also greatly influences perceptions because different situations may call for additional information about the target. For

instance, a financial crunch may lead to ABT being perceived as a cheaper option for affordable housing (Nambatya, 2015).

2.4 Qualities of ABTs

Al-Fakih et al. (2017), Magutu (2015), and Nambatya (2015) observed three qualities that make ABT suitable for affordable housing: shorter periods of construction, more productive use of labour and reduced waste of materials. In combinations, these qualities make ABTs more productive than conventional methods delivering more housing in a given period. Therefore, this will translate into a lower cost per unit given the economies of scale. Importantly, the technical qualities of ABTs must also render them aesthetically pleasing in appearance making them more acceptable (Nambatya, 2015).

Increased productivity of labour is the most significant value proposition of ABT application for affordable housing delivery. According to Heinrich Schroeder the inventor of the K-Brick estimates a reduction in time of construction at 40% which he attributes to increased productivity of labour in Namibia. Scholar elsewhere observed between 25 and 50 percent (Al-Fakih et al., 2017; Ajibola, 2014). Further, ABTs geometrically designed to self align required less skilled labour (Ajibola, 2014). Notably, not all scholars agree on the labour benefit. Fungai et. al., (2018) cautions that projects for affordable housing should also promote sustainable community development through employment opportunities and imparting technical skills to the unskilled and semi-skilled. The rejoinder on the issue of labour supply for ABT application comes from Ajibola, (2014), on the grounds of increased productivity resulting in more housing thus more demand for labour.

To explain the phenomenon of productivity, two techniques were found to be common in ABTs that claim to reduce the time of construction hence the cost. The first technique is a modular construction which makes use of factory-produced pre-engineered building units (Al-Fakih et al., 2017). These units are delivered to the site and assembled as large volumetric components or as substantial elements of a building. Using this technique is the Moladi system from South African also used in Mexico, Ghana, Botswana, Mozambique, Namibia, Sudan, Kenya, Zambia, Angola, and Nigeria for affordable housing delivery. The promoters of Moladi claim savings of more than 50% in time and cost. The second technique involves geometrically designing building units to be easily assembled in situ. See an example of such an ABT in Figure 9. The geometric features of the individual blocks facilitate interlocking in horizontal and/or vertical directions, which makes them self-aligning (Al-Fakih et al., 2017). This is the reason Ajibola (2014) argues that less skilled labour can be used for assembly when using such ABTs. Also, compared to conventional masonry, interlocking blocks, which may be dry assembled saves a great deal of mortar normally (Ajibola (2014). An example of such a system is the Kavango Block Brick (KBB) also known as the K-brick, a Namibian patented technology that saves 40 percent in construction time according to Heinrich Schroeder the inventor.

Figure 9: Interlocking building brick
Source: http://www.fcs.com.ph/fcsbricks/img/prod.fcs.png

Theoretically, the productivity of ABTs can be explained using the Cobb-Douglas production theory and lean construction (lean principles and TVF). The theory of production is generalised in the form of a production function (Q = f (K, L, t, etc.), for the application in production systems, where f is the function, Q is output (housing delivered), K is capital input (land, materials, etc.), L is labour input, t is 'technology or the art of production'. Isoquants or iso-product are used to demonstrate how the production functions work. An isoquant or isoproduct curve is a contour line that joins together different combinations of two factors of production that are just physically able to produce a given quantity of a particular good. The concept of isoquants is explained with the help of the data presented in Table 4.

Table 4: Labour and capital combinations

Combination of Labour & Capital	Units of Labour (L)	Units of Capital (K)	Output (houses)
A	5	9	100
B	10	6	100
C	15	4	100
D	20	3	100

Table 4 is based on the assumption that only two factors of production, namely, Labour and Capital are used to produce 100 houses with the following combinations.

- Combination A = 5L + 9K = 100 houses
- Combination B = 10L + 6K = 100 houses
- Combination C = 15L + 4K = 100 houses
- Combination D = 20L + 3K = 100 houses

The combinations A, B, C, and D show the possibility of producing 100 houses by applying various combinations of labour and capital. Thus, conceptually an isoquant schedule is a schedule of different combinations of factors of production yielding the same quantity of output. When plotted on a graph it will look like Figure 10 below.

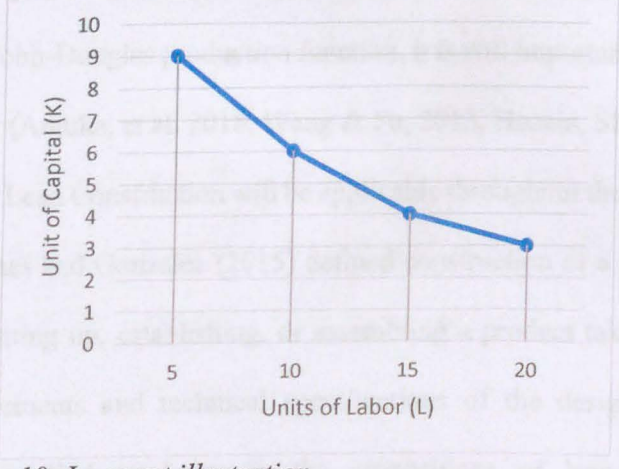


Figure 10: Isoquant illustration

Isoquants have several characteristics but the one most relevant to the study is the Marginal Rate of Technical Substitution (MRTS). MRTS shows the rate at which inputs may be substituted while the output level remains constant. Therefore MRTS is the slope of the line connecting A and B as shown in Figure 11 below.

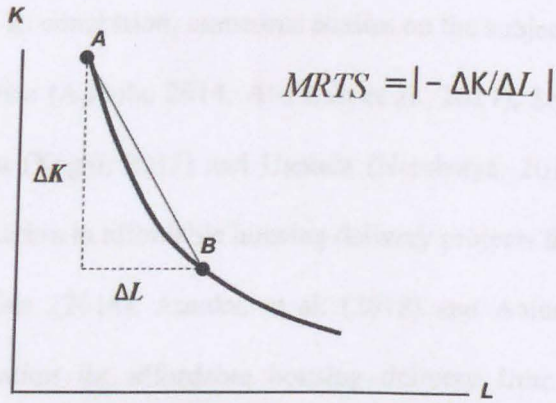


Figure 11: Marginal Rate of Technological Substitution
Source: Adopted from Amuka, et al. (2018)

The Cobb-Douglas production function (CDPF) has been criticized on two grounds. One criticism of the model is on the assumption of constant returns to scale on which the model has built its analysis (Amuka, et al. 2018). The second one is the assumption of constant technology (Feder, 2017). However, despite the criticisms of the Cobb-Douglas production function, it is still important in the theory of production today (Amuka, et al. 2018, Wang & Fu, 2013, Husain, Shaiara & Islam, 2016).

Lean Construction will be applicable throughout the entire construction process. Antunes and Gonzalez (2015) defined construction as a process of building, putting up, setting up, establishing, or assembling a product taking into account functional requirements and technical specifications of the design concept. Notably, some scholars find weakness in the propositions of lean principles as applied in construction. One such criticism comes from Vidhate and Salunkhe (2018), they did not discard the lean principles totally but, argues that construction is too complex a process to be simply modelled by production processes stemming from traditional manufacturing alone.

In conclusion, numerous studies on the subject conducted in Nigeria and South America (Ajibola, 2014; Al-Fakih et al., 2017), South Africa (Funagi et. al, 2018), Kenya (Kagai, 2017) and Uganda (Nambatya, 2015) agree on the merits of ABT application in affordable housing delivery projects from the productivity angle. Also, Wu Tao, (2014), Amuka, et al. (2018) and Antunes et al., (2015) support ABT application for affordable housing delivery from a project management angle. However, Yeganeh and McCoy (2019) contend increased productivity as the most important characteristics rather arguing for environmental sustainability as key. Jauch (2015) and Magutu (2015) both criticise the application of ABT in affordable housing delivery on the ground of cost.

There are other qualities of ABTs that are not explained technically but are equally important to the success of the ABT application for affordable housing delivery. For examples, the potential for ABT application to be scalable (Nambatya, 2015). Al-Fakih et al., (2017) credited the success of the interlocking brick system in Nigeria and South America on its application in big projects that were delivered using the technology. Another quality is the impact on the environment (Yeganeh and McCoy, 2019; Kagai, 2017).

2.5 The Perception

Peoples' perceptions of housing are largely shaped by social and cultural norms specific to different regions of the world (Nambatya, 2015). The houses' building materials and construction process are a critical part of these expectations (Magutu, 2015). Living in a house constructed from brick and mortar is a standard that many

low-income Namibians aspire to because the homes of wealthier Namibians are built with those materials. People are hesitant to live in low-income housing communities that are built from unconventional materials because they feel that alternative building technologies will brand them as poor (Magutu, 2015). Houses built using alternative technologies can look different from typical houses and as a result, do not meet peoples' expectations. This can cause resistance to housing development proposals which incorporate alternative building systems and technologies (Magutu, 2015). Funagi et al, (2018), quoting a property dealer in South Africa, "...people knock the walls, if they sound hollow then they instantly perceive the building as not solid or secure". Furthermore, some Namibians associate certain building materials with poor housing and construction quality (Remmert & Ndhlovu, 2018). For example, wood is uncommon in formal houses but in informal settlements, people regularly use the material to construct their shacks, and as a result, people in Windhoek perceive wooden houses to be of low quality (Remmert & Ndhlovu, 2018). These perceptions surrounding alternative building technologies make the government feel compelled to build low-income housing using conventional methods like brick and mortar otherwise they will be rejected.

The following are some of the reasons for the perception problem of ABTs (Kagai, 2017; Nambatya, 2015; Magutu, 2015):

- Poor workmanship
- Trying to save more than necessary on materials
- More focus on production and less on quality
- Faulty construction (incorrect building procedures)
- Lack of involvement of professional designers and engineers

A gap in knowledge of ABT application for affordable housing exists regarding the perception problem. The researcher proposes the modelling of the ABT application perception problem on the three components (perceiver, target, situation) proposed in the cognitive theory as suggested by Saks and Johns (2011). Applying the cognitive theory of perception will enable targeted messages to counter the narrative that ABTs are inferior to conventional methods if used as a delivery mechanism for affordable housing. Therefore incorporating the components of perception gives a better proposal to respond to the perception problem outlined below:

1. Promoters of ABT for affordable housing will best communicate to clients with training course content for various stakeholders (perceivers). Demonstration projects, training, and dissemination of product information should be given top priority (Magutu, 2015).
2. ABT technologies and materials are incorporated into the existing building code in Namibia (target). For instance, a study conducted in Uganda (Nambatya, 2015) finds inadequate recognition of ABT on the Government level hampered the growth of the ABT sector in that country.
3. The role of policy (situation), legislation, and government in promoting the use of ABT for affordable housing delivery. Local authorities typically use two simple tools, zoning and regulation to either restrict housing supply and inflate prices, or spur growth in affordable housing units and stabilize prices.

2.6 Challenges for ABT application

Application of ABT for affordable housing may face challenges that may impede their application. These challenges are pervasive to affordable housing delivery therefore ABTs are susceptible to them as much as the conventional methods.

Most scholars on the subject agree that land is a factor that has the potential to undermine affordable housing delivery in general. Fungai et al., (2018) underscore land as the overarching input resource on the supply side of affordable housing delivery in Namibia. Besides, the scarcity of serviced land pushes the cost upwards hence negatively impacting the affordability of housing (Jauch, 2015) in Namibia. But Kalili (2014) gives another reason for the high cost of land which is access to credit on the demand side which pushes prices upwards. Nevertheless, the gravity of the land situation in Namibia was echoed by his Worship the Mayor of Windhoek Mr Muesee Kazapua in a mayoral speech in 2018 in which he said the following:

> It is important to appreciate and understand that the issue is not about the availability of land itself, but it is about the unavailability of land that is serviced; in terms of connection to portable water, electricity, and sewer networks to make it fit for sale and subsequent development. First, you need to have municipal services on the land, before making it available for housing development.

The pressure on land availability can be relieved by using innovative policy instruments such as Pubic Private Partnership (PPP) as suggested by Harelimana (2017). Another example of such inventions is land pooling as was used in Amaravati City, Andhra Pradesh India. In that case, people in 24 villages were offered a house built on part of their land in exchange for surrendering the rest to the city for affordable housing.

Funding for affordable housing developments in Namibia is generally scarce (Jauch, 2015). According to Jauch (2015), the NHE used to be financed by the

Namibian, German and Chinese governments but this is no longer the case. Consequently, the funding pool ought to be expanded by attracting the private sector to partake in the affordable housing market segment (Remmert & Ndhlovu, 2018; Harelimana, 2017).

Regulation impedes the delivery of affordable housing in Namibia. According to Fungai et al., (2018) and Remmert and Ndhlovu (2018), land delivery in Namibia is hugely undermined by cumbersome and bureaucratic red tape which Jauch (2015) calls outdated and irresponsive practices. Theoretically, regulatory bodies are considered to represent the interests of the society in which they operate, rather than their private interests (Yeganeh & McCoy, 2019). Regulations make use of legal instruments to implement socio-economic policy objectives (Fungai et al., 2018). For instance, in South Africa, the Social Housing Regulatory Authority (SHRA) was established to facilitate national social housing programmes (Social Housing Act, No 16 of 2008). In the UK, a Social Housing Regulatory Framework was published in 2015 followed by the Welfare Reform and Work Act of 2016, which was enacted to regulate access to affordable housing. The Working Paper (OECD Economics Department Working Papers No. 1170) presented studies of ways to stimulate the private rental sector (PRS) of the housing market by comparing experiences with regulations, policies, and reforms in Germany, the Netherlands, Finland, and the Czech Republic. The important conclusion from these four case studies is that both 'over-regulation' and 'under-regulation' are not conducive. Therefore, regulation should strike the right balance between the benefiting public and the regulators (Yeganeh & McCoy, 2019). However, two scholars criticise and claim to expose

weaknesses in the Public Interest Theory of Regulation as proposed by Pigou in 1932. Despite being a strong proponent of Pigou's theory, Yeganeh and McCoy (2019) conclude that the meaning of public interest is less important than the question of who gets to participate in the process of defining it and through what means. Similarly, Fungai et al., (2018) seem to contest the existence of the public interest theory altogether because of its ambiguity and inability to determine when and if public interest has progressed.

Project management is intimately linked to project productivity (Wu Tao, 2014; Amuka, et al. 2018; Antunes et al., 2015). Affordable housing delivery mechanisms mainly utilising conventional methods have not been adequately productive to meet the demand. Jauch (2015) provides evidence of low productivity in conventional affordable housing projects in Namibia. He cites the case of NHE which was established and mandated to produce an average of 1200 units per year. However, he found that NHE delivered only 457 houses on average yearly since its inception in 1993 less than half of what was planned. Therefore, it is reasonable to conclude that project management could be one of the contributing factors for the low productivity of the conventional methods of affordable housing delivery mechanisms in Namibia.

2.7 Impact of ABT application on affordability

The laws of supply and demand can be used to demonstrate the impact of increased productivity on affordable housing delivery projects using ABTs. An increase in the supply of a product is conceptualised to cause a shift in the supply curve to the right (Levin & Pryce, 2009) as illustrated in Figure 12 below. P_0 is the

equilibrium price when the quantity supplied is Q_0, which is assumed to be the status quo using conventional methods. When quantity supplied increases to Q_1 due to application of ABT, an external shock the price will fall to P_1.

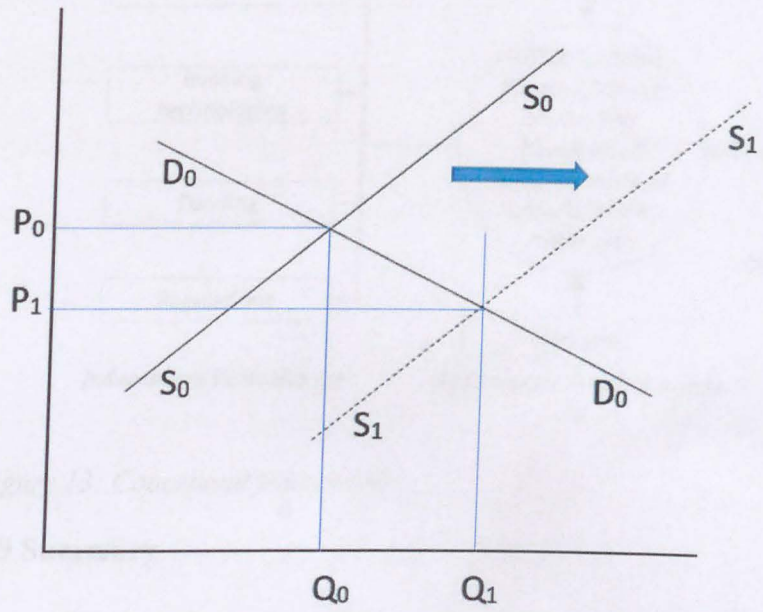


Figure 12: Movement of the supply curve
Source: Adapted from Levin and Pryce (2009)

However, the supply and pricing of affordable housing should not be left to market forces as theorized in economics because it is a basic human need (Jauch, 2015).

2.8 The Conceptual Framework

Organization of ideas for the research are depicted in a conceptual framework (Figure 13) which is the researcher's understanding of how particular variables in the study connect (Grant & Osanloo, 2014) and bring out affordable housing. The

elements that interact to deliver affordable housing are grouped into inputs, processes and outcomes making it easy to identify the independent variable (x), and the dependent variable (y).

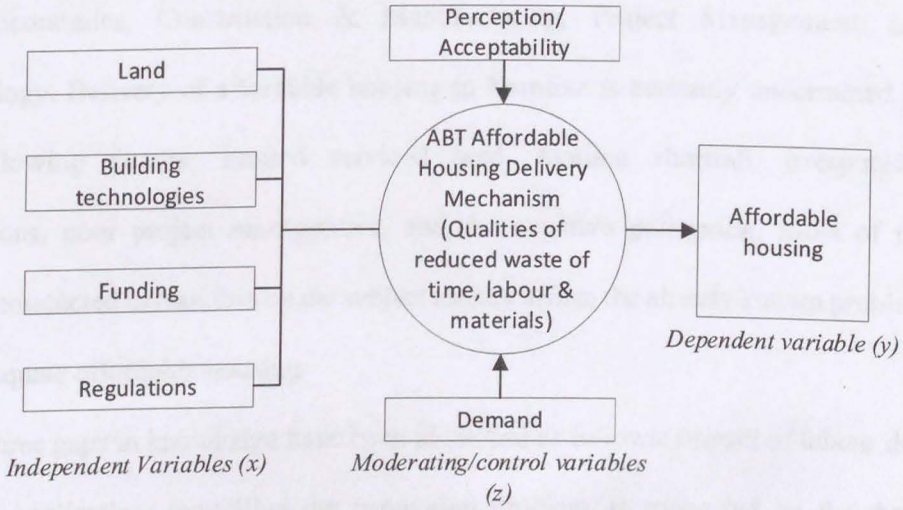


Figure 13: Conceptual framework

2.9 Summary

ABT technologies sound like an engineering topic while affordable housing can be a topic in economics, social sciences or even humanities. Many scholars in various disciplines have examined the merits of ABT but none combines the physical variables (land, labour, funding, regulations) and non-physical variables (perceptions, demand). Affordable housing delivery projects are excellent examples of multi-disciplinary projects. The overarching deficiency in the literature review on the subject is the lack of multi-disciplinary concepts and principles combining to generate knowledge on the subject. Consequently, the application of ABTs for affordable housing delivery ought to be researched in a 360-degree approach, for instance, the perception problem of ABTs as a psychological one in tandem with the technical and

economic propositions of ABTs. Therefore, the literature reviewed for this study drew from several fields of studies to get an insight into the research problem.

The theoretical framework used for the study is based on theories and concepts from Economics, Construction & Manufacturing, Project Management, and Psychology. Delivery of affordable housing in Namibia is currently undermined by the following factors: limited serviced land, funding shortfall, irresponsive regulations, poor project management, and the negative perception. Most of the studies conducted in Namibia on the subject mainly affirm the already known problem of inadequate affordable housing.

Three gaps in knowledge have been identified as follows: impact of labour due to ABT application; modelling the perception problem as suggested on the three perspectives (perceiver, target, situation) as suggested by Saks and Johns (2011) and lastly; the effect of poor project management on affordable housing projects' productivity in Namibia.

Chapter 3: Research Methodology

3.1 Introduction

The purpose of this chapter is to set out the research design used and methodology followed in the research. Grant and Osanloo (2014) describe the research design as an architectural design or blueprint of a research project and the execution of the design, the research process or methodology as the construction process using methods and tools. Firstly, the overall strategy of the study is explained. Thereafter, the description of the research design, population and sampling, data collection and instrumentation, data analysis, ethical considerations and a summary to the chapter.

3.2 Research Strategy

A pragmatist research paradigm underpins this study. Pragmatism allows and guides mixed methods researchers to use a variety of approaches to answer research questions that cannot be addressed using a singular method (Doyle, Brady & Byrne, 2009). When used concurrently or sequentially mixed-method designs add to the exploration of complex or technical aspects of the research problem (Doyle et al., 2009). The choice of the research strategy for the study is defended because the research problem included technical and social aspects, for instance in construction, that could not be adequately investigated using one research method.

3.3 Research Approach and Design

For this study, a mixed-methods approach was used because one method alone was deemed not sufficient to meet the research objectives. Mixed methods may be defined as 'research in which the investigator collects and analyses data, integrates the findings and draws inferences using both qualitative and quantitative approaches or methods in a single study' (Creswell et al., 2007). In this study, the researcher appraised ABTs to understand why their application for affordable housing delivery could be more productive compared to the use of conventional methods. Furthermore, methodological triangulation increased the credibility and validity of the research findings (Creswell et al., 2007). Central to triangulation is the notion that methods leading to the same results give more confidence in the research findings (Creswell et al., 2007).

This pragmatic approach allows and guides mixed methods researchers to use a variety of approaches to answer research questions that cannot be addressed using a singular method (Doyle et al., 2009). Qualitative and quantitative data were collected in parallel (concurrently), analysed separately and then merged at the discussion, interpretation and reporting stages as illustrated in Figure 14.

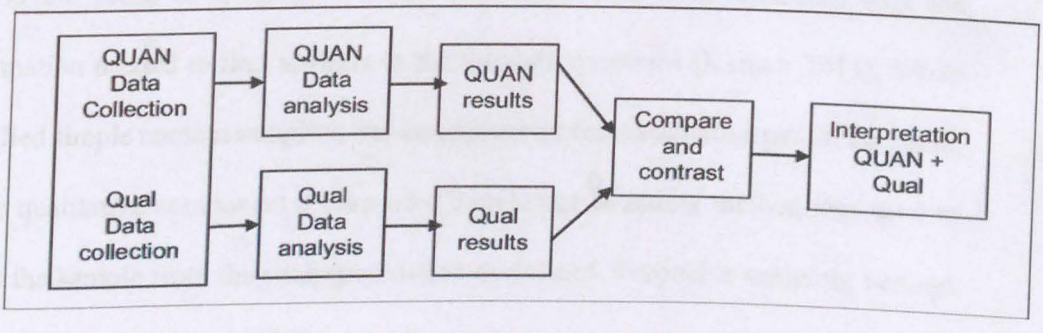


Figure 14: Mixed methods convergence
Source: (Creswell et al., 2007).

The convergence of qualitative and quantitative results occurred during the discussions, interpretation and reporting stage (i.e., the results and analytical points of integration). A simultaneous bidirectional approach was used for convergence where analytics of both the quantitative and qualitative strands were used to frame merging as proposed in Moseholm and Fetters (2017) and illustrated in Figure 15.

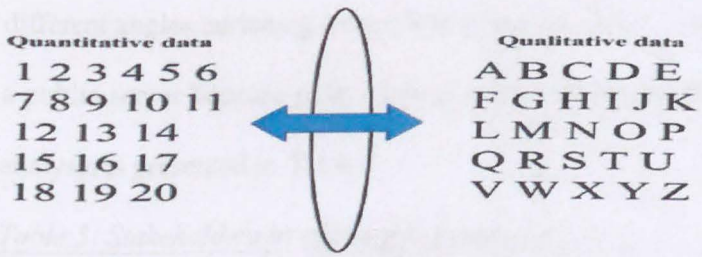


Figure 15: Simultaneous bidirectional framework
Adapted from (Moseholm & Fetters, 2017).

This methodology is considered the most suitable approach as it attempts to discover the connection of ABT qualities and the increase in productivity but also taking into account subjective factors (perception, demand) and physical factors (land, funding, regulations etc.).

3.4 Population and Sampling

A research population is generally a large collection of individuals or objects that is the focus of a study. A study population constitutes elements with the information needed to find answers to the research questions (Kumar, 2011). While stratified simple random sampling was conducted for the quantitative part of the study, in the qualitative component a purposive convenient sampling method was used to select the sample from the study population as defined. Purposive sampling belongs to the category of non-probability sampling techniques; sample members are selected

based on their knowledge, relationships, and expertise regarding the research subject (Freedman et al., 2007).

The study population consisted of all stakeholders involved in the delivery of affordable housing in Namibia segmented into the public sector and the private sector. Population segmentation can provide detailed insights into a research problem from different angles enriching triangulation (Kumar, 2011). The NGOs were classified as a public sector because most of them rely on government subsidies. The population analysis is presented in Table 5.

Table 5: Stakeholders in affordable housing delivery

Sector	Stakeholders
Public sector & NGO's	NHE, City of Windhoek, 13 regional councils, MURD, Lands Ministry), NGOs (8)
Private Sector	9 ABT suppliers, Estate Agents (255), Contractors (213)

Therefore a convenient sample was purposively selected from the stakeholders to include subjects from both the public and private sectors. Kothari (2014) defines a sample as elements selected to find out something about the total population from which they are taken. A convenient sample consists of subjects included in the study because they happen to be in the right place at the right time (Kumar, 2011). Subjects included in the sample were selected to meet the following criteria:

1. Know and be a player in the housing market in Namibia
2. Be a developer or provider of affordable housing in Namibia
3. Be a supplier of ABT technologies in Namibia
4. Have a valid email address to participate in the survey

3.5 Data collection methods and instruments

Three data collection methods were used for the study. One, in-depth interviews. The choice of this method is the flexibility in terms of the flow of the interview leaving room to generate conclusions that were not initially meant to be derived regarding a research subject. However, in-depth interviews require great skill on the part of the interviewer and at the same time involve considerable time (Kumar, 2011). The researcher is an auditor and has good interviewing skills. The research made use of a guide that was compiled with reference from the literature review. The meetings were held during July of 2019 with the technical managers to explain the purpose of the intended interviews. The discussions took place at their offices and lasted approximately 60 to 90 minutes, which was more time than anticipated but valuable in terms of information collected. Two, survey making use of a self-administered questionnaire via email. This instrument is cost-effectiveness, fast transmission, and response turnaround. Considerable thought was given to the type of email questionnaire with the main concern being the number of questions hence the time required to complete the survey. Research conducted puts emphasis on the relationship between the length of a questionnaire and the response time (Michaelidou & Dibb, 2006). Expectedly, shorter questionnaires tend to attract more responses than longer ones. The questionnaire was designed to take between 10 to 15 minutes to complete. The structured questions were designed based on the outcome of the review of works of literature. Three, a virtual focus group. The discussions were held using zoom an online virtual meeting platform. Online focus groups are beneficial in overcoming temporal and spatial barriers to qualitative research data collection

(Williams et al., 2012). The researcher was the moderator of the focus group. A focus group should not be so big and also not so small the recommended number of participants six to ten (Kumar, 2011). A Focus Group allows the researcher to gather more information in a shorter period, generally under two hours. Focus groups are suitable to provide insight into complicated topics where opinions or attitudes are conditional or where the area of concern relates to multifaceted behaviour or motivation (Kumar, 2011).

3.6 Validity and Reliability

Validity is concerned with whether our research is believable and true and whether it is evaluating what it is supposed or purports to evaluate. In this regard, Burns (1999) stresses that "validity is an essential criterion for evaluating the quality and acceptability of research." For the study, the instruments were based on information gathered during the literature review to ensure that they captured data that is relevant to the research objectives. There are four procedures to validate the instruments and the data based on content validity, internal validity, utility criterion and external validity. The study findings are not intended for generalisation beyond the sample used hence external validity and utility criterion were not required (Burns, 1999). Therefore, for this study validity was ensured using only content validity and internal validity.

Firstly, content Validity, which refers to the extent to which an instrument represents the factors under study. To ensure content validity, the research instruments were reviewed by the experts in the field of research. Based on the reviewers"

comments the unclear and obscure questions were revised and the complex items reworded. Also, ineffective and non-functioning questions were discarded altogether. Secondly, internal validity, concerned with the congruence of the research findings with reality. Also, it deals with the degree to which the researcher observes and measures what is supposed to be measured. To ensure internal validity of the research data and instruments, the researcher might apply the following six methods recommended by Merriam (1998): triangulation, member checks, long-term observation at the research site, peer examination, participatory or collaborative modes of research and researcher's bias. Triangulation was the method used to ensure internal validity. The researcher collected data through several sources: questionnaire, in-depth interviews and a focus group. Therefore, if we obtain the same results, we can become sure that the data are valid. Certainly, through triangulation, we can gain qualitative and quantitative data to corroborate the findings (Burns, 1999).

A research process should generate reliable data and findings. Reliability deals with the consistency, dependability and replicability of "the results obtained from a piece of research", (Merriam, 1998). Given the mixed methods design of the study, the purpose was not to attain the same results rather agree that based on the data collection processes the findings and results are consistent and dependable (Merriam (1998). In general Burns (1999) and Merriam (1998) suggest that the dependability of the results can be ensured through the use of three techniques: the investigator's position, triangulation and audit trial. Reliability of a research study can be external or internal. External reliability is concerned with the replication of the study while

internal reliability deals with the consistency of collecting, analysing and interpreting the data.

3.7 Data analysis

3.7.1 Qualitative analysis

Data from the in-depth interviews and the focus group taken through brief notes and voice notes were first transcribed. To ensure a rigorous analysis of qualitative data, three levels of coding in vivo coding method ought to be used (Saldana, 2009). In this respect, keywords and phrases that were common amongst the participants were identified, coded, categorized, and then compared to one another. The *memo-code* derived from the first-level analysis is the distinct concepts and categories in the data, which will form the basic units of your analysis. *Pattern coding* was the second-level of analysis that grouped the memo-codes from the first level into themes or meta-codes (derived from literature). The third level turned these codes and categories into the final narrative to meet the research objectives.

Excel was used as the data analysis tool as followings:

1. A spreadsheet was created to easily compile the data.
2. Then, columns were used to structure important variables of the data analysis using codes as tools for reference.
3. A separate tab was created for the front of the document that contains a coding table. It is a glossary containing important codes used in the segmentation process.

Consideration was also given to non-verbal analysis (Table 6). When there is a right mix of verbal and non-verbal communication, understanding of the message gets better (Saldana, 2009).

Table 6: Non-verbal communication cues

Type of Non-verbal	Cues or signals
Kinesics (often involuntary):	Blinking the eyes, clearing the throat, and facial flushing are innate
Proxemic (the use of personal space and conversational distance in the communication)	Seating posture, proximity to the screen
Paralinguistics (Body language)	gestures, facial expressions, tone and pitch of voice
Chronemics (use of time)	Period of silence

Sourced: (Saldana, 2009)

3.7.2 Quantitative analysis

Survey data were analysed using descriptive statistics (mean, median, mode, rank, percentage, frequency and range). Excel was used as the analytical software to assist with data analysis using the following steps:

1. Preparing and checking the data. The input of data into the computer.
2. Selecting the most appropriate tables and diagrams to use according to your research objectives.
3. Selecting the most appropriate statistics to describe the data.
4. Selecting the most appropriate statistics to examine relationships and trends in the data.

3.8 Ethical considerations

The conducting of research requires not only expertise and diligence but also honesty and integrity. This is done to recognise and protect the rights of human subjects. To render the study ethical, the rights to self-determination, anonymity,

confidentiality, and informed consent were observed. Written permission to conduct the research study was obtained from the UNAM postgraduate committee as well as the Academic and Administration. Verbal permission was also obtained from the management of NHE and the ABT suppliers. Subjects were informed about the purpose of the study, the procedures that would be used to collect the data, and assured that there were no potential risks or costs involved. Anonymity and confidentiality were maintained throughout the study. Smith (2003) defines anonymity as when subjects cannot be linked, even by the researcher, with his or her responses. When subjects are promised confidentiality it means that the information they provide will not be publicly reported in a way that identifies them (Smith, 2003). In this study, confidentiality was maintained by keeping the collected data confidential and not revealing the subjects' identities when reporting or publishing the study (Smith, 2003). To ensure all risks are captured, use was made of a self-assessment checklist (Appendix D) to flag any areas of potential risks to the participants, the researcher, and the University. Lastly, all work that was not original was appropriately cited using the APA referencing style.

3.9 Summary

This chapter has presented the details of the method and procedures for this research study. The use of content analysis, a survey questionnaire, in-depth interviews and a focus group in sequence within a mixed methods research design addressed the purpose of the research: to investigate the application of ABT for affordable housing delivery.

Chapter 4: Results & Discussion

4.1 Introduction

This study aimed to investigate the application of ABT for affordable housing delivery, the perceptions and challenges to their application to affordable housing. In pursuit of achieving this research goal, the aim was broken down into three research objectives. The first one; to identify the qualities of ABT, the second one; to explore the perception and acceptability concerns and, lastly; to identify challenges that may impede their application for affordable housing delivery. It also covers the analysis of data obtained from both primary and secondary data sources. The analysis of results is organised and presented in tables, narratives and graphically as applicable. Then discussions converging and triangulating the results to facilitate validation of data through cross verification from the different sources. Lastly, is a summary giving the highlights of the chapter.

4.2 The Population and Sample

The segmented sample included 187 estate agents who had a valid email address drawn from a total of 255 registered agents; 1 public sector affordable housing developer (NHE) drawn from 22 stakeholders and 3 private sector ABT suppliers from 9 ABT companies. Estate agents operate in the property market, thus their inclusion provided an opportunity to collect data on the affordable housing market segment. The NHE was included because they are mandated to deliver affordable housing and they account for more than 90% of this market segment. ABT suppliers were included to give insight into the qualities of their technologies.

4.3 Data Collection Instruments

The structure of the instruments used for the study is explained with the tests of their validity and reliability.

4.3.1 The survey

A questionnaire was the data collection instrument. It was organized into two sections. Section 1 contained four questions to collect demographic data of the participants (gender, age, nationality and experience). Section 2 consisted of 15 closed-ended multiple-choice questions and one open-ended question. The instrument was tested to assess the face and content validity. The validity of an instrument is the degree to which an instrument measures what it is intended to measure (Kumar, 2011). Content validity refers to the extent to which an instrument represents the factors under study. For face validity, the questionnaire was sent to a sample of 23 individuals from the database of the Namibia Estates Agents Board (NEAB) soliciting for comments. The respondents were requested to give a score from 1 to 10, 10 being the highest score to the question. The lowest score given was 7 and the highest 10 the average was 9. To achieve content validity, the questionnaire was given to three professionals that included a contracting civil engineer, an architect and a quantity surveyor. Few changes were recommended mainly replacing engineering terms with more common language terms.

The number of the questionnaire sent was 187 with a response rate of 58% or 107 received back. Although the response rate seemed low, for the study, however taking into account the intended audience, this rate was deemed acceptable.

4.3.2 In-depth interview

Three in-depth interviews were conducted each lasting between 60 to 90 minutes. The interviews were conducted at the premises of the ABT Company. The researcher created a guide to be used during the interview (Appendix B). The guide starts by explaining the purpose of the interview and an ethical declaration informing the participants of their volition to be part of the interview. After salutations and introductions, the participants are given the background of the research problem and collection of demographic and employment data is conducted (i.e., gender, citizenship, age, skills). Fourteen guiding questions covering three research themes mapped to the research objectives were used. The instrument was tested using two pre-test interviews to assess instrumentation rigour and formulate measures to address identified limitations.

4.3.3 Focus group

A virtual focus group meeting was conducted on Zoom (an online virtual meeting platform). Online focus groups are beneficial in overcoming temporal and spatial barriers to qualitative research data collection (Williams et al., 2012). The researcher created a facilitation guide with three parts (Appendix C). The first part is to welcome the participants, seek their consent and give the background to the study and collect demographic data of the participants. The second part focused on group logistics and ground rules. The third part contained facilitation questions that guided the discussion. The instrument was tested in three ways as follows:

1. Technology testing which included creating a zoom account and inviting participants. The video and audio features were tested.

2. Due to the COVID 19 pandemic, most of the organizations were doing meeting virtually. However, each participant was contacted to test their audio and video settings before the meeting.
3. Three of the members were requested to participate in the discussion on one theme. The results of the test were used to allocate time and the format of the poll questions to be used.

4.4 Qualitative Data Analysis

4.4.1 The process

The initial raw data taken through brief notes collected by the researcher was initially coded using a *structural approach*. The structural approach to coding was the first level of analysis, which started with and involved organizing data around a particular research objective (Saldana, 2009). In this respect, keywords and phrases that were common amongst interviewees and the focus group discussions were identified, coded, categorized, and then compared to one another. The *memo-code* derived from the first-level coding are the various attributes that manifest the value of proposition of ABT. *Pattern coding* was the second-level analysis. During this process, the researcher grouped the memo-codes from the first level into categories or themes, which were developed into meta-codes. The meta-codes were derived from pattern codes Al-Fakih et al., (2017) and Ajibola (2014).

4.4.2 The participants

All the three respondents of the in-depth interviews were males but this was mitigated by having more females in the focus group. Half of the participants were in the age group of 41-50 years, 30% in the 51-60 age group and 20% in the in 31 to 40

age group. In terms of experience, 10% had less than 5 years, 50% had between 6 to 10 years and the remaining 40% had more than 10 years. The details of the participants are presented in Tables 7 and 8 below.

Table 7: Participants in in-depth interviews

Respondent	Gender	Age bracket	Citizenship	Position	Profession	Years of experience
R1	Male	41 - 50	Namibian	Technical Manager	Civil Engineer	6 years
R2	Male	51 - 60	Namibian	Senior Architect	Architect	14 years
R3	Male	41 - 50	Namibian	Project Manager	Structural Engineer	8 years

Source: In-depth interviews

Table 8: Participants in the focus group

Participants	Gender	Age bracket	Citizenship	Position	Profession	Years of experience
P1	Female	41 - 50	Namibian	Finance Manager	Accountant	12 years
P2	Male	51 - 60	Namibian	Business Development	MBA Strategy	14 years
P3	Female	41 - 50	Namibian	Regional Manager	Administration	10 years
P4	Female	31 - 40	Namibian	Regional Manager	Administration	6 years
P5	Female	51 - 60	Namibian	Architect	Architect	10 years
P6	Male	41 - 50	Namibian	Projects	Engineer & Project Manager	11 years
P7	Female	31 - 40	Namibian	Corporate & Marketing	Communication & Marketing	4 years

Source: Focus group

4.4.3 Research objective 1: Qualities of ABT

The initial labels extracted in the first round of in vivo analysis of the merged data from the in-depth interviews and the focus group were: time, materials, waste,

labour, design, environment, scalable, appearance, perception, availability, durability, and project management (Table 9).

Table 9: First round in vivo analysis memo codes

Labels	Context (Keywords)
Time	Duration of construction projects
Materials	Usage of materials, source of materials
Waste	Waste handling
Labour	Usage of labour hours, skills levels
Design	Design techniques
Environment	Impact, preservation
Scalable	The extent of use, small projects or large
Appearance	Physical characteristics
Perception	Feelings and attitudes
Availability	sourced locally of imported
Durability	Level of maintenance required
Project Management	Management of the construction process

The second round analysis relied on literature, which identified three themes (used as meta-codes in the study) around which an ABT can be evaluated (Al-Fakih et al., 2017; Ajibola, 2014) listed as follows:

1. Cost drivers such as time and labour;
2. Acceptability in terms of appearance, durability, perception, location
3. Sustainability on the grounds of the environment, materials, and scalability.

The output of the second level analysis resulted in the grouping of labels (memo-codes) from the first round into the themes (meta-code) derived from literature on the subject presented in Table 10.

Table 10: Memo-code and Meta-codes of ABT attributes

	Themes (key characteristics of ABT)		
	Cost	**Acceptability**	**Suitability**
Labels	• time, • design, • materials, • labour, • waste and • project management	• appearance, • durability, • perceptions • location	• environment, • availability a • scalability

Source: Integrating literature review and in-depth interviews

The third level created narratives from the findings ready for triangulation with quantitative findings demonstrating the relevance of the data to the study phenomena and will be part of the discussion.

Cost

On the cost, attributes encapsulate the following: time of construction, use of labour and reduction in waste. Results from the in-depth interviews and the focus group are summarised in Tables 11 and 12 respectively and the merged narratives follow.

Table 11: Cost of construction- In-depth interviews

Respondent	Time-saving	Design concept	Materials	Labour (Quantity & skills)	Waste reduction	Project Management tools
R1	50%	Modular	Cement boards	Reduced	Yes	No
R2	30%	Modular	Light Steel Frames (LSF)	Reduced	Yes	No
R3	50%	Integrated (modular	Structural insulated	Reduced	Yes	Yes

		and interlocking	panels (SIPs)			

Source: In-depth interviews

Table 12: Cost of construction- Focus group

Type of data			**Comments/Expressions**
Content Data	Verbal		Insignificant time-saving, we have standard designs, waste of materials is a factor of management, Our labour is easily available. For project management, we use schedules, Gantt charts, ABT village in Windhoek's Goreagab Dam suburb by the NHE
	Non-verbal	**Kinesics**	none
		Proxemic	Nodding to agree with no significant time saving
		Paralinguistic	none
		Chronemic	Silence on designs and use of labour
Interaction Data	**Verbal**		
	Non-verbal	**Kinesics**	none
		Proxemic	Nodding to agree with no significant time-saving.
		Paralinguistic	none
		chronemic	none

Source: Focus group

The impact on labour is contentious. ABT application has an impact on employment by eliminating the need for specialised skills thus increasing possibilities of increasing employment of unskilled labourers.

The summary of the merged results:

1. There is potential for cost reduction of between 30 to 50 percent
2. ABT use pre-engineered designs
3. Materials used by ABT can be sourced locally or imported
4. The utilisation of labour is subjective and the impact on employment
5. Waste reduction can be attributed to management
6. Project management tools are the same as conventional methods

Acceptability

This aspect overlaps with perception but as a quality of ABT, the results are presented in Tables 13 and 14 for in-depth interviews and the focus group respectively.

Table 13: Aspects of Acceptability of ABT – In-depth interviews

Respondent	Aesthetics	Durability	Demo structures
R1	No architect	Up to 40 years	Yes
R2	Architect	Up to 40 years	Yes
R3	No architect	Up to 40 years	Yes

Source: In-depth interviews

Table 14: Aspects of Acceptability of ABT – Focus

Type of data			**Comments/Expressions**
Content Data	Verbal		good finishing will determine the appearance, base material determines durability e.g. steel, blocks. We have an ABT village in Otjumuise, Windhoek.
	Non-verbal	**Kinesics**	none
		Proxemic	none
		Paralinguistic	none
		Chronemic	Prolonged silence indicating little knowledge
Interaction Data	**Verbal**		

	Non-verbal	**Kinesics**	none
		Proxemic	none
		Paralinguistic	none
		chronemic	none

Source: Focus group

The summary of the merged results:

1. Aesthetics will depend on the finishing of the building
2. Base materials such as concrete, bricks, blocks or steel will determine the durability of the structure
3. Demo structures and a demo village are used to give clients a look and feel of the dwellings.

Sustainability

On the question of the environment, all three respondents in the in-depth interviews said that their technologies had a lower carbon footprint hence greener than conventional building methods, but no details to support that assertion were provided. Two of the respondents said they imported some materials from neighbouring South Africa and one from Germany. The focus group did not have much to say about the environment other than the requirement for an environmental impact assessment for projects outside proclaimed areas.

4.4.4 Research objective 2: Perception and acceptability of ABT

The first round of analysis involved summarizing the in-depth interviews and focus group transcript data into thematic statements to be analysed in the second round

meta-codes. The meta codes are components of perceptions as suggested by Saks and Johns (2011). The combination of the two is summarised in Table 15 below.

Table 15: Results of the analysis of perceptions

Perceiver (the housing beneficiary)
Poor workmanship of ABT affordable housing projects
They focus more on production and less on quality
Maintenance and service of ABT housing is high
Professional designers and engineers are not involved in ABT affordable housing projects
Target (the house or dwelling)
Location
Faulty construction (incorrect building procedures)
Policies of the finance industry to finance ABT affordable housing projects
Situation and circumstances
The economic environment forces saving more than necessary on materials
Insufficient industry investment in ABT affordable housing research
Lack of awareness/training around ABT application for affordable housing delivery

4.4.5 Research objective 3: Challenges for ABT application

The analysis of in-depth interviews yielded only two comments on this matter. One was; "...for banks to finance homeowners, the technology ought to have certification from a recognised standards bodies". Two was; the perception problem which seems intertwined with the low levels of ABT awareness. The focus group on the other hand was very lively on this topic of discussion. Verbal and non-verbal communication yielded some interesting insights into the challenges of affordable housing delivery summarised in Table 16 below.

Table 16: Results of the analysis of the challenges of affordable housing

Type of data		**Comments/Expressions**
Content Data	Verbal	'un-serviced' land, serviced land, project funding, the role of government, regulations and policies,

			awareness, incentives, Location, huge waiting list, project productivity is low
	Non-verbal	**Kinesics**	Leaning towards the camera when talking which is indicative of authenticity.
		Proxemic	Getting closer to the screen when speaking to emphasise a point on land and funding
		Paralinguistic	Tempo rose when discussing land and project funding.
		Chronemic	none
Interaction Data	**Verbal**		Comments to support land unavailability,
	Non-verbal	**Kinesics**	Nodding to agree serviced land scarcity, or disagree Clapping
		Proxemic	none
		Paralinguistic	Interjecting loudly to contend or offer clues on something
		chronemic	none

Summary of the results.

1. Unavailability of serviced land is the number one factors followed by inadequate funding.
2. Government is the best vehicle to deliver affordable housing
3. Land cost is estimated at 30-40 percent of housing cost
4. Banks are willing to mortgage ABT houses
5. The regulations are not harmonised between the NHE and the local authorities regarding the issues of availing land
6. The government should be fully involved in the delivery of affordable housing
7. Huge waiting list with over 85,000 of applicants; a manifestation of huge demand

8. Less than 500 units of affordable housing are delivered per year (350 from NHE)
9. No explicit incentives from the government to use ABT
10. Population growth and rural to urban migration are the major demand drivers for affordable housing.

4.5 Quantitative Data Analysis

4.5.1 The process

Data from the survey was quantitatively analysed using the Data Analysis Tool which is an add-on in MS-Excel with features for descriptive and inferential statistics. The first part of the questionnaire contained questions intended to capture the demographic and general data of the estate agents participating in the survey. The second part of the survey asked questions related to the research problem under investigation. The data from the survey were analysed using the following descriptive statistics:

- Measures of Frequency i.e., Count, Percentage, Frequency.
- Measures of Central Tendency i.e., Mean, Median, and Mode.
- Measures of Dispersion or Variation i.e., Standard Deviation.
- Measures of Position i.e., Rank.

4.5.2 The participants

Both genders were equally represented; of the 107 survey participants, 51% were males and 49% females. Most participants were in the age groups of 31-40 years and 41-50 years with 29% respondents in each group making up an overall representation of 58%. Those in the 20-30 age group had a 27% representation with

those over 50 years making up the remaining 15%. Details of the participants are presented in Table 17.

Table 17: Survey respondents' information

Gender	Frequency	%
Male	55	51%
Female	52	49%
	107	100%
Age	**Frequency**	**%**
20-30	29	27%
31-40	31	29%
41-50	31	29%
<50	16	15%
	107	100%
Citizenship	**Frequency**	**%**
Namibian	81	76%
Other	26	24%
	107	100%
Experience	**Frequency**	**%**
1-5	29	27%
6-10	48	45%
<10	30	28%
	107	100%

Source: Survey

4.5.3 Research objective 1: Qualities of ABT

Question 1; What value proposition of ABT is most attractive to you? (Select only one)

The following were the choices and only one was selected

1. Reducing the cost of construction
2. Reducing the quantity of skilled labour required
3. Reducing the time of construction
4. Environmentally friendly

The results tabulated in Table 18 show that reducing the cost of construction is the most attractive value proposition for ABT. Reduced delivery time was second, followed by reduced labour burden and last was the environment.

Table 18: Ranked propositions of ABT

Proposition	Frequency	
	#	%
Reducing the cost of construction	49	46%
Reducing delivery time	25	23%
Reducing labour burden	21	20%
Environmentally friendly	12	11%
Total respondents	**107**	**100%**

4.5.4 Research objective 2: Perception and acceptability of ABT

Respondents answered five questions on this research objective.

Question 1: What is your general perception of the quality of houses built using alternative building technologies? Use Likert type quality scale: excellent, above average, average, below average, extremely poor, don't know.

No comment and average were the most common responses with 36% of the respondents choosing each. The full summarised results (Table 19).

Table 19: Response of the perception of the quality of ABTs

Response	Frequency	Percentage (%)
No comment	39	36%
Average	38	36%
Below average	15	14%
Above average	11	10%
Excellent	4	4%
Extremely poor	0	0%
Total	**107**	100%

Question 2: How often do you hear information about alternative building technologies in Namibia? The choices were: Always, Very frequently, Occasionally Rarely, Very rarely, Never.

Analysis of the data is presented in Table 20; 49% of the respondents never get information on ABT and 41% very rarely do, together making up 90%. The remaining 10% include rarely, occasionally, very rarely, never get information on ABT. No respondent got ABT information always.

Table 20: Frequency table for the response to ABT awareness question

Response	Frequency	Percentage (%)
Never	52	49%
Very rarely	44	41%
Rarely	6	6%
Occasionally	2	2%
Very frequently	2	2%
Always	0	0%
Total	**107**	**100%**

Question 3: Are you familiar with any alternative technologies used in Namibia or elsewhere? If yes which one?

The results depicted in Figure 16 below reveal that 67% are not familiar with any ABT thus 33% are familiar with some ABT.

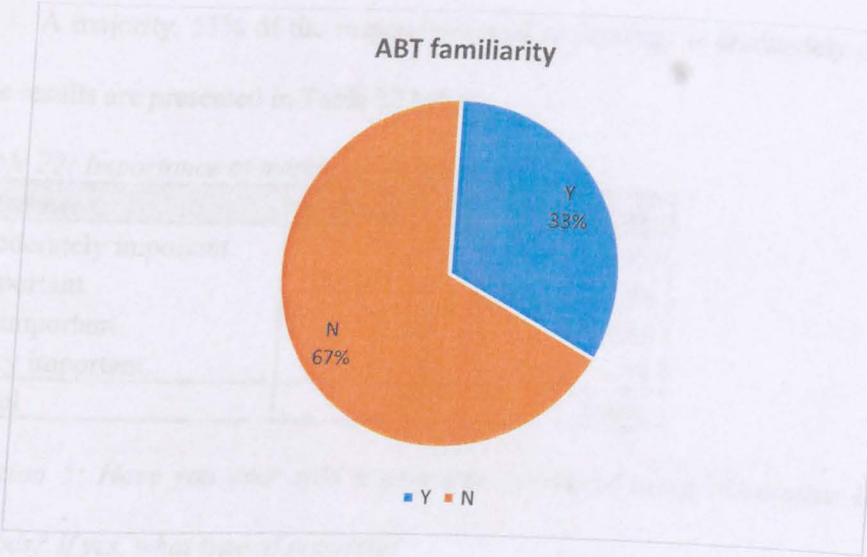


Figure 16: Response to ABT familiarity

Some ABT are used or at least known by some respondents and the results are presented in Table 21 below; Moladi from South Africa was the most popular and known by respondents or 12 (34%), followed by the rest as follows: Hydraform also from South Africa 11 (31%), Kavango from Namibia with 5 (14%), those not sure 4 (11%) and Vela, also from South Africa 3 (9%).

Table 21: Specific ABT in Namibia or elsewhere

Technology	Number	Percentage (%)
Moladi	12	34%
Hydraform	11	31%
Kavango	5	14%
Not sure	4	11%
Vela	3	9%
Total	**35**	**100%**

Question 4: How important to a potential home-owner is the technology or method of building used? The choices were: very important, important, moderately important, and unimportant.

A majority, 51% of the respondents said technology is moderately important. The results are presented in Table 22 below;

Table 22: Importance of method of construction

Response	Frequency	Percentage (%)
Moderately important	55	51%
Important	24	22%
Unimportant	20	19%
Very important	8	7%
Total	**107**	**100%**

Question 5: Have you ever sold a property developed using alternative building methods? If yes, what type of property?

A big percentage, 86% of respondents have never sold a property developed using ABT. Those who have; 9% dealt with commercial property and 5% with a residential one. Analysed results are presented in Table 23 below.

Table 23: Property developed using ABT in Namibia

Type of property	Total	%	
Y	**15**	**14%**	
Residential	5	5%	36%
Commercial	10	9%	64%
Both	0	0%	0%
N	**92**	**86%**	
Residential	0	0%	
Commercial	0	0%	
Total	**107**	**100%**	

4.5.5 Research objective 3: Challenges for ABT application

Respondents answered ten questions on this research objective.

Question 1: How serious is the problem of housing in Namibia, especially in the affordable or low-cost category?

The question was closed-ended with the following four choices: not a problem, small problem, moderate problem, and a very severe problem. It served the purpose of establishing the gravity of the situation of inadequate supply of affordable housing in Namibia.

Majority of the respondent, 87 percent say that housing is a very serious problem in Namibia. Results are summarised in Table 24.

Table 24: Extent of the problem

Response	Frequency	Percentage(%)
Not a problem	1	1%
Small problem	3	3%
Moderate	10	9%
Very severe	93	87%
Total	**107**	100%

Question 2: In what range is the average number of new affordable housing units produced annually in Namibia? The question was closed-ended with ranges from which respondents were to select. The range choices were: 1-300, 301-600, 601-900, 901-1200, and more than 1200.

The question attempted to quantify the delivery of affordable housing in a given year. The results are presented in Table 25 below. It was found that on average 542 units of affordable housing were delivered annually. Considering the standard deviation of 191 units. The lower and upper bounds rounded to the nearest 100 units is 300 units and 600 units. The median of the data is 618 units and the mode 611 units.

Table 25: Frequency table for housing units per annum

Units	Lower	Upper	f	x	fx	Cf	$\bar{x}$	$x-\bar{x}$	$(x-\bar{x})^2$	$f(x-\bar{x})^2$
100 - 299	100	299	15	200	2993	15	542	-342	117015	1755227
300 - 499	300	499	20	400	7990	35	542	-142	20185	403705
500 - 699	500	699	57	600	34172	92	542	58	3355	191254
700 - 899	700	899	11	800	8795	103	542	258	66525	731780
900 - 1100	900	1100	4	1000	4000	107	542	458	210154	840615
			107		57949					3922580

$$Std\ deviation = \sqrt{\frac{\Sigma f(x-\bar{x})^2}{n-1}} \qquad Median = L_m + \left(\frac{\frac{n}{2} - F}{f_m}\right) i$$

$$Mean\ (\overline{x}) = \frac{\Sigma fx}{\Sigma f} \qquad Mode = L_{mo} + \left(\frac{\Delta_1}{\Delta_1 + \Delta_2}\right) i$$

Figure 17: Statistical formulas

Where: n = the **total frequency,** F = the **cumulative frequency *before*** class median, f_m = frequency of class median, i = the class width, L_m = the **lower boundary** of the class median.

Question 3: What percentage of the cost of a new unit is attributed to the cost of the erven (stand)? The choices were: 10%, 20%, 30%, 40%, 50% and >50%

The purpose was to quantify the ratio of the cost of land to the overall housing. The analysis shows that on average the cost of land is 30 percent of the overall cost of housing. Data analysis is presented in Table 26. The median and the mode of the data are also 30%.

Table 26: Frequency table for percentage of stand cost

% Cost (x)	f	fx	$\bar{x}$	$x-\bar{x}$	$(x-\bar{x})^2$	$f(x-\bar{x})^2$	Cf
0.10	8	0.80	0.30	(0.20)	0.04	0.31	8
0.20	16	3.20	0.30	(0.10)	0.01	0.15	24
0.30	64	19.20	0.30	0.00	0.00	0.00	88
0.40	12	4.80	0.30	0.10	0.01	0.13	100
0.50	4	2.00	0.30	0.20	0.04	0.16	104
0.60	3	1.80	0.30	0.30	0.09	0.28	107
	107	31.80				1.03	

Question 4: Rank the following factors in terms of their importance to solving the housing problem in Namibia; availability of alternative building technologies, project management, funding, availability of land, and regulations; a 5-point scale Likert scale was used where 1 = most serious and 5 = least serious.

The purpose was to identify the most significant factors that may undermine the delivery of affordable housing in Namibia. Analysed results are presented Table 27 below giving the frequency as the number of respondents, the percentage and the overall ranking. Availability of land is ranked the number one factor, followed by funding, regulations, project management, and availability of ABT in that order.

Table 27: Frequency table of constraint ranked by respondents

Constraints on housing	R1		R2		R3		R4		Rank
	#	%	#	%	#	%	#	%	
Availability of land	62	58%	27	25%	11	10%	6	6%	1
Funding	33	31%	41	38%	21	20%	9	8%	2
Regulation	12	11%	36	34%	32	30%	19	18%	3
Project management	0	0%	3	3%	25	23%	35	33%	4
Alternative building technologies	0	0%	0	0%	18	17%	38	36%	5

Question 5: Do you agree with the statement that 'Government should only play a facilitating role in the delivery of housing in Namibia?

The aim was to establish the perceived role of government in the delivery of affordable housing in Namibia. Those that lean towards government facilitating only make up 47 percent (26%+21%). Those that say the government should play on both sides are 40 percent (21% and 19%). The undecided are 13 percent. The results are presented in Table 28 below.

Table 28: The role of government

Response	Frequency	Percentage (%)
Agree	28	26%
Strongly agree	23	21%
Strongly disagree	22	21%
Disagree	20	19%
Undecided	14	13%
Total	**107**	100%

Question 6: Are banks willing to finance homes built using alternative building technologies? The choices were: Very likely, Don't know, Likely, Not likely.

The analysis of the data is presented in Table 29 below.

Table 29: The likelihood for Banks to Finance ABT housing

Response	Frequency	Percentage (%)
Very likely	32	30%
Don't know	32	30%
Likely	24	22%
Not likely	19	18%
Total	**107**	100%

Question 7: Rank the following factors in terms of their importance in tackling the housing problem in Namibia: incentives to us ABT, Increase Awareness of ABT, cost,

land, location, regulations; using the 6-point Likert scale: 1 = most import and 6 = least important.

The aim was to identify the most significant factors that influence the delivery of affordable housing in Namibia. Land availability was ranked the most important factor to ensure the success of the ABT application, the following is the cost and the rest follows as presented in Table 30.

Table 30: Rank of the critical success factors for ABT application

Factors	Rank 1		Rank 2		Rank 3		Rank 4		Rank 5		Rank 6		Rank
	#	%	#	%	#	%	#	%	#	%	#	%	
Land	23	21%	41	38%	24	22%	9	8%	6	6%	4	4%	1
Cost	36	34%	17	16%	13	12%	10	9%	16	15%	15	14%	2
Regulations	29	27%	7	7%	13	12%	27	25%	18	17%	13	12%	3
Awareness	10	9%	25	23%	26	24%	21	20%	8	7%	17	16%	4
Incentives	4	4%	7	7%	17	16%	24	22%	33	31%	22	21%	5
Location	5	5%	10	9%	14	13%	16	15%	26	24%	36	34%	6
	107	100%	107	100%	107	100%	107	100%	107	100%	107	100%	

Question 8: In your opinion which factor has the greatest impact on the demand for affordable housing in Namibia?

Rural-urban migration was selected by 57 percent as the factor having the greatest impact on affordable housing demand. The results are presented in Table 31.

Table 31: Demand driver for affordable housing in Namibia

Phenomena	Frequency	Percentage (%)
Other reasons	4	4%
Population growth	42	39%
Rural to urban migration	61	57%
Total	**107**	**100%**

Question 9: In your opinion, which action will best reduce the movement of people into urban areas?

The question was closed-ended with the following choices:

1. Provide social amenities (schools, hospital, etc.) in the rural areas
2. Create employment opportunities in rural areas
3. Build low-cost housing in rural areas
4. Nothing, people will always move into towns

The purpose of this question was to understand the mitigating factors that will reduce the pressure on affordable housing delivery. The analysis of the results summarised in Table 32 below shows that 67 percent of the respondents chose the creation of employment opportunities in rural areas. 21 percent chose to provide social amenities such as schools and hospitals, 9 percent chose the provision of affordable housing in rural areas. Only 3% chose, nothing can be done about the problem.

Table 32: Frequency table: Interventions for rural to urban migration

Intervention	Frequency	Percentage (%)
Create employment opportunities in the rural (%)	71	67%
Provide social amenities (schools, hospital, etc.) in the rural (%)	23	21%
Build low-cost housing in rural areas (%)	10	9%
Nothing, people will always move into towns (%)	3	3%
Total	**107**	**100%**

Question 10: Which of the following reasons best explains rural to urban migration.

The question was closed-ended with the following three choices, education, employment, better life and drought & forces of nature. To rank the choices, respondents were given a Likert scale with 1 = significant and 4 = least significant. The question intended to establish the most significant cause for people to move from rural areas into urban areas.

Looking for work is ranked the number one reason for rural to urban migration. The rest were ranked in the order of their significance as follows: better life, education, and other social amenities, and lastly, drought and other forces of nature (Table 33).

Table 33: Frequency table of reasons for rural to urban migration

Reasons	Frequency		Rank
	#	%	
Employment	62	58%	1
Better life	34	32%	2
Education	6	6%	3
Drought and other forces of nature	5	5%	4

4.6 Discussion

This study aimed to investigate the application of ABT for affordable housing delivery. In pursuits of that aim, three research objectives were used. The first one was to appraise the qualities of ABTs that inherently make them a more productive affordable housing delivery mechanism compared to the current conventional methods. The second one was to draw attention to the perception problem, which impacts their acceptability as an affordable housing delivery mechanism. The third one was to identify the challenges that may impede their application as an affordable housing delivery mechanism.

4.6.1 Convergence and Merging of Results

Convergence involved merging the results; descriptive statistics and qualitative themes were compared simultaneously in a back-and-forth process framed by the research variables and constructs (Moseholm et al., 2017). Joint display analysis was used to integrate the two types of data by constructing and restructuring them to

achieve a fuller understanding of both (Moseholm et al., 2017). The intention for merging data from the different methods considered at the instrument design level (Moseholm et al., 2017), is shown as a mapping in Table 34.

Table 34: Data collection instrument mapping for convergence

Type of Data source	Data collection method	Research Objective		
		ABT attributes	Perceptions	Challenges
Primary sources	Quantitative (Questionnaire) Appendix A	Q1,	Q2, Q3, Q4, Q5, Q6	Q7, Q9,10, Q11, Q12, Q13, Q14, Q15, Q16, Q8
	Qualitative (In-depth Interviews questions) Appendix B	Q1, Q2, Q3, Q4 Q5	Q6, Q7, Q8	Q9, Q10, Q11 Q12, Q13, Q14
	Qualitative (focus group and discussion questions) Appendix C	Q1, Q2, Q3	Q4	Q5, Q6, Q7, Q8
Secondary sources	books published, academic research papers, government documents, statistical databases, and historical records, and the internet	Triangulate qualitative and quantitative data		

Triangulation and convergence as prescribed by the research design resulted in the following four outcomes during the discussion of the results. Firstly, *corroboration*, the results derived from both qualitative and quantitative methods were compared for similarity. Secondly, *elaboration*, results of qualitative data analysis was used to explain how quantitative results can be applied or vice versa. Thirdly, *complementary*, this is where qualitative and quantitative data results may differ but when put together they can generate coherent insights into the research problem.

Lastly, a *contradiction* in the case when qualitative data and quantitative findings conflict.

4.6.2 The participants

Ultimately the study had a good gender balance. Forty-six percent of the participates were in the age group of 41-50 years presenting 46%. Despite the national statistics showing 21% employment in this group (2018 Namibia Employment Survey), the study required persons with experience and the assumption is, the older the more experienced. Therefore, the age bias in the study was justifiable and beneficial.

4.6.3 Qualities of ABTs

The study found that cost is the number one attraction to the adoption of ABT ahead of two other attributes of acceptability and sustainability. The reduction of construction time underpins the cost dimension of ABT compared to the conventional methods. In support of these propositions, several scholars have explained three ways of how this can theoretically be achieved. Firstly, the use of lean principles for lean construction (Vidhate & Salunkhe, 2018; Hall, 2019). Secondly, reducing waste of materials, time, and labour (Hall, 2019). Thirdly, effective project management (Azozama, 2016; PMI). Researchers with experience in the use of ABT (Kagai, 2017; Nambatya, 2015, Magutu, 2015; Al-Fakih et al., 2017) found that ABT reduces the time of construction with the effect of reducing the cost between 25 percent on the lower side and up to 50% on the higher side. The observation is supported by the use of two techniques of ABTs: modular construction and geometrically designed

building units (Al-Fakih et al., 2017; Ajibola, 2014). Quantitatively results seem to support results ranked, depicting reducing the cost of construction as the number one value proposition for using ABT for affordable housing delivery which gives credence to the findings. Not all ABTs interventions are cost-effective. For instance, if ABTs aspire to be green they are likely to be more expensive which makes their attraction even more remote. Further, in developing countries such as Namibia, using ABTs that require less labour will draw the wrath of the government whose intention is to create as much employment as possible. Despite the merits of several studies, the researcher leans more on the inconclusive outcome on the ABTs cost reduction proposition. Therefore, this gap of the marginal returns on ABT application is subject to further studies. Literature is blissful on ABT application especially on the use of labour. For instance, Ajibola (2014) argues that some ABT like those that are geometrically designed to self align required less skilled labour. But Fungai et. al., (2018), cautions that projects for affordable housing should also promote sustainable community development through employment opportunities and impart technical skills to the unskilled and semi-skilled. Al-Fakih et al., (2017) continues to suggest a rejoinder on the issue of labour supply for ABT application; increased productivity means more housing hence more demand for labour. Nonetheless, its an assumption, there is a gap in knowledge on the impact of ABT on labour, hence more investigations are required to validate the propositions based on those grounds.

4.6.4 The Perception Problem

The findings and results suggest a strong relationship between perception and awareness consequently impacting the acceptability of ABT application for affordable housing delivery. This conclusion seems to be supported by results that show 50 percent of the survey respondents approved the quality of ABT and 92 percent said they do not get any information on ABTs. The focus group was very apprehensive on the quality of ABTs as observed from their ABT demo village in Windhoek. Non-verbal communication from the focus group revealed that knowledge of ABTs is very low. Prolonged moments of silence and nodding of the heads were observed. Their contention of ABT application was on their maintainability and aesthetic appearances that were not so appealing. Further analysis shows that, of the 8 percent that had any knowledge of ABTs, only 30 percent of them have dealt with an ABT property. In contrast, Al-Fakih et al., (2017), in their study of acceptability of interlocking bricks in Nigeria, found that 85% of the respondents were receptive to that technology. Acceptability will increase with a beautiful facade and the right location for the housing developments (Al-Fakih et al., 2017). Al-Fakih et al., (2017) and Nambatya (2015), in their studies in Nigeria and Uganda respectively, identified awareness of ABT as one way to ensure successful adoption of ABT.

Perceptions are grounded in people's feelings such as attitudes and emotions as suggested by Saks and John (2011) and occur in five stages of stimulation, organization, interpretation-evaluation, memory, and recall (Nambatya, 2015). This subjective nature of human behaviour poses a challenge in relying only on empirical studies therefore theory is used to complement and supplement empirical evidence.

Theoretically, perception ought to be examined from three perspectives. That of the perceiver or consumer of affordable housing, that of the target of ABT technology and the situation or circumstance that influences perception.

A comment from one of the interviewees suggests a need for change in the regulatory framework to change the perception; "... it is my observation as an architect that the current building regulations in Namibia do not favour the use of new or alternative building technologies". While in South Africa the 'Agrément' is used to regulate the use of ABT. Remmert and Ndhlovu (2018), Fungai et al., (2017) and Jauch (2015), concluded that regulations in Namibia are very old and not responsive to the current challenges of housing. Building regulations and policies must be supportive of ABT application for affordable housing.

4.6.5 Challenges of ABT application

Survey results ranked the availability of land as the number one factor that generally undermines the delivery of affordable housing in Namibia. The other factors ranked were access to funding, nonresponsive regulations, poor project management, and lack of ABT awareness, in that order. The focus group findings gave more insight on land by qualifying that, the land is there, but it is not serviced. Remmert and Ndhlovu (2018), in their study, came to a similar conclusion on land being the most significant enabling factor. However, they confined it to the availability of serviced land just as the focus group had suggested. Surprisingly, Kalili (2014), contends land as the main factor serviced or not. He argues from his study that by June 2014 there was enough serviced land for 920 houses but only 61 houses were built. Therefore,

there are other reasons to consider. Elsewhere, Kagai (2017) in Kenya, Nambatya (2015) in Uganda and Fungai et. al., (2018) in South Africa, in their respective studies, similarly found land to be the most critical input in the delivery of affordable housing.

Banks in Namibia are willing to finance ABT projects. From the survey, 52 percent of the respondents believe that banks in Namibia are willing to finance ABT developments. The focus group discussions support the survey results. However, this is not an imposing majority, besides, according to Randa (2016), 93 percent of the population earns less than N $7,000 a month making a mortgage housing facility as an option not available to the vast majority of Namibians. But, Harelimana (2017) suggests more creative funding sources such as international lenders, specialized Development Finance Institutions (DFIs), and other International Organizations as possible solutions to the funding problem.

The role government should play in the delivery of affordable housing is blurred. From the survey results, 47 percent of the respondents favour a single role for government, that of facilitation only. Another 30 percent support a dual role that includes the delivery as well as facilitation, which is the current status. The discussion group favoured the dual role of government. It seems bias is the reason for this position because the focus group was from a government agency. A study by Jauch (2015) suggests the government playing a single role of facilitation while supporting market demand rather than directly providing housing. Theoretically, the Public Interest Theory of Regulation as proposed by Pigou in 1932 separates the government's roles of regulation and services provision. The motivation for this is, for public interest to prevail; regulatory bodies should not act in their interest (Fungai et al., 2018). In

Namibia, the dual role of government to facilitate and deliver may be one of the reasons none of the roles is being effectively discharged (Jauch, 2015; Remmert & Ndhlovu, 2018).

Sustainable application of ABT requires materials to be available locally. All respondents interviewed imported some raw materials with the lowest importing 30% and the highest importing as much as 80%. Nambatya (2015) found that 100 percent of local sourcing of materials was key to the success of the stabilised soil block in Uganda. Sustainability can be qualified on three grounds (Nambatya, 2015; Magutu, 2015). The first one is an uninterrupted source of raw materials. The second aspect is the impact on the environment. Participants in the interviews and focus group indicated that the environment is never an issue when selling their technologies; non-verbal communication cues such as prolonged silence showed that the environment is not critical. Literature seems to support this unfortunate view, Magutu (2015) found that the impact on the environment is relegated to the rear of priorities. The third aspect of sustainability is the potential for scaled-up deployment. No evidence suggests the scalability of the technologies offered by the respondents interviewed, however, the focus group concluded that ABT can be applied for large projects. Al-Fakih et al., (2017) credit the success of the interlocking brick systems in Africa and South America to their application in big low-cost housing.

Between 350 and 650 units (500 mid-point) of affordable housing units are delivered annually according to the survey. The focus group estimated an average of 350 units produced in 2019, which seems to be within the range from the survey. But, this output is far below the 10,000 units required annually to reduce the housing deficit

(Remmert, & Ndhlovu, 2018). To put it in perspective, the delivery of affordable housing as per the study ought to increase twenty-fold to reduce the deficit. There is a case to argue for low project productivity. Evidence of this deficiency presented by Jauch (2015) arguing that the NHE has only managed to deliver on average 457 units instead of the envisaged 1200 units of affordable housing. Theoretically, project management is intimately linked to productivity enhancement as found in the studies of Wu Tao, (2014) and others. The survey ranked project management very low as a reason for low project productivity, similarly, in-depth interviews showed that project management is not so prominent. For instance, none of the interviewees had any formal project management training or membership of PMI or a similar professional body by themselves or in their project teams. However, findings from the focus group gave a different picture where project management seems to be highly valued.

The problem of affordable housing in Namibia is very severe as confirmed by 87% of the survey respondents. From the focus group, the NHE has a huge waiting list of over 85,000 applicants, which is indicative of the high demand for affordable housing. The study identified rural-urban migration and population growth as the two major factors putting pressure on affordable housing in Namibia. Randa (2016) and Niikondo (2014) also came to the same conclusion on urban migration being a catalyst for housing demand in Namibia. The manifestation of the acute demand for affordable housing can be seen in shacks or informal settlements sprawling around urban centres (Indongo et. al., 2013). Niikondo, (2014) and Indongo et. al.,(2013) both found in their studies that the quest for employment was the number one reason for people to move into urban centres. The respondents in the study also ranked the same reason as the

number one most likely to explain the phenomenon. Employment creation in rural areas was identified by 67% of the respondents as the best intervention to reduce the influx of people in urban centres. Niikondo (2014) had the same view on employment creation as a major mitigating factor. However, Indongo et. al., (2013) argue that employment alone is very limited because of the poor infrastructure in rural areas, instead opting for a more integrated solution to the problem. Indongo et. al., (2013) corroborates other reasons for the migration such as the search for a better life in the city, education and the push by natural forces like draught and others.

4.6.6 State of ABTs found in Namibia

This study will be in futility if no ABT is applicable for affordable housing delivery in Namibia. Therefore, ABTs that came up in the study are discussed to give more insight on potential ABTs for application in the delivery of affordable housing delivery in Namibia. This is not an endorsement of these ABTs; further studies ought to be undertaken to assess their applicability in Namibia.

The Moladi building system makes use of re-usable plastic moulds to create a structural form of a house that is filled with concrete and after some days the plastic moulds are removed and the concrete structure remains. The building technology comprises four steps: Erecting the formwork or basic casting, reinforcing, pouring the mortar into the casting, and removing the formwork panels. The reinforcements, plumbing pipes, electrical installations, doors, and window openings are cast before the concrete is cast into the walls. It takes approximately 4 hours to set up the plastic moulding and about two hours to fill it with a special blend of concrete. The walls are

left to dry overnight (15 hours) and the formwork then removed. The formwork can be used up to 50 times and can then be recycled for other components. The technology is suitable for houses between 52 and 80 square metres and it takes approximately 14 days to complete from the laying of the foundation according to the promoters. As an alternative to traditional building methods, Moladi technology is 50% cheaper than ordinary brick wall methods. The Moladi system is used in Mexico, Ghana, Botswana, Mozambique, Namibia, Sudan, Kenya, Zambia, Angola, and Nigeria.

Namibia has its brand of an interlocking brick system, the K-brick (KBB). The building system is an example of an interlocking building system also referred to as "mortar-less" or dry construction methods. These methods make use of special bricks geometrically designed to have a female and male joint which interlock horizontally, vertically or both. ABTs that use interlocking brick systems have inherent advantages of reducing the time of construction because of ease of assembly; they use less mortar and eliminates the over-reliance on workmanship because of their self-aligning feature (Al-Fakih et al., 2017). The KBB system comprises of thirteen different moulds that include starter blocks, main blocks, corner blocks, and lintel blocks. In 2007, the company constructed two show houses at the Habitat Research and Development Centre in Windhoek's Katutura Township. Heinrich Schroeder the inventor of KBB System says he had cost reduction in mind when designing the system. He puts the estimate of the reduction in time of construction at 40%. The KBB system seems to have the credibility to be seriously considered as a potential technology of interest in the context of ABT. To this date, the system has received three awards at the 2009 International Innovative Housing and Sustainable Energy Efficiency Competition

hosted by South Africa according to the promoters. Apart from some limited application in Namibia, there is no evidence of the system being used anywhere else in the region or world.

Vela is another South African supplier of ABT with a presence in Namibia. Vela's Modular Building System (MBS) is based on a solid-walled rapid building system comprising panels that can easily be transported to the site. The system uses Structural Insulated Panels (SIPs) which are high-performance building panels used in floors, walls, and roofs for residential and light commercial buildings. The panels are made by sandwiching a core of rigid foam plastic insulation between two structural facings, such as Oriented Strand Board (OSB). Other skin materials can be used for specific purposes. SIPs are manufactured under factory controlled conditions and can be custom designed for each home. The result is a building system that is extremely strong, energy-efficient, and cost-effective. Building with SIPs will save you time, money, and labour. According to the promoters, the Vela building system can deliver a completed house in three days with a staff complement of only five. The Vela building system is also used in Angola and recently introduced in Nigeria.

Hydraform is yet another South African company that has developed and sells soil cement block brick making machines and has done so for the last 25 years. The hydraform building system is also an interlocking building system where the bricks are designed to be self-aligning. Information from their website (http://www.hydraform.com) states that the blocks are laid three times faster than conventional blocks and 70% of the structure does not require mortar therefore walls are erected quickly. There is also a claim of significant cost saving mainly because

less cement and concrete are needed. Additionally, hydraform walls do not require plastering resulting in a further save on costs and time.

4.6.7 Summary

This chapter began with an overview of the data analysis procedures and a description of the demographic characteristics of the study subjects. Then, the data collection instruments (questionnaire, in-depth interviews & focus) were described. Thereafter, the responses addressing each of the three research objectives: qualities of ABT, stakeholder perceptions and acceptability and the challenges to ABT application; these were analysed qualitatively (using in vivo) and quantitatively (descriptive statistics: frequencies, means, and standard deviations). Lastly, a culmination discussion of the results to deduce facts and knowledge about the research problem. The conclusions of the research with recommendations are discussed in chapter 5.

Chapter 5: Summary, conclusions and recommendations

5.1 Introduction

This chapter presents a summary of the findings, conclusions, recommendations and implications based on the data analysed in the previous chapter. Some limitations that may affect the usability of the research have been identified. The application of ABT for affordable housing delivery was researched by examining the qualities that make them suitable, stakeholder perceptions and acceptability attached to them, and the challenges their application may face.

5.2 Summary of findings

Qualities of ABT

The following are the qualities for successfully ABT application:

1. Reduce the cost of construction by shrinking the time of construction, use labour more productively, and reduce waste to the minimum.
2. Have an aesthetic appearance that is appealing, usable, and enhance functionality with attractive layouts and designs.
3. Sustainably usable; locally sourced materials as much as possible; the possibility of scaled-up application in large projects; be 'green' as much as possible.

Perceptions of ABT

Perception affects the acceptability of ABT which in turn will affect their applicability for affordable housing delivery.

1. ABT awareness was very low among the participants in the study which may explain why the perception of ABT is not favourable.

2. Perceptions are developed through a process, therefore continuous messaging targeting the three aspects of perception (perceiver, target, and situation) will help increase awareness hence acceptability of ABT application.
3. The perceiver will require continuous effort to be educated and informed to dispel the lingering narrative of ABT inferiority.
4. The perception target (the house) and the perceived situations can be greatly assisted with the use of building regulations that are ABT friendly.

Challenges of ABT application

ABT application is likely to face the following challenges which are common in the delivery of affordable housing:

1. Limited availability of serviced land for affordable housing is the major impediment to the delivery of affordable housing in Namibia.
2. Banks are willing to finance ABT projects so long as there are standards to control their quality.
3. Policies and regulations such as tendering requirements that favour conventional methods impede the application of ABT.

5.3 Conclusions

The conclusions of the findings for the three research objectives on the application of ABT for affordable housing delivery are based on the findings: ABT qualities, perceptions and acceptability and challenges to ABT application.

ABT qualities

It is difficult to compare the price of a house built from ABTs and one built from conventional building methods because there no standard way of measuring price. Some ABT suppliers use the price per square meter of the house while others use the price per square meter of walling. Further ABT suppliers lack information on how much it would cost to build in scale and could only give the estimated price of construction based on the assumption it was a single, stand-alone, home. Therefore, it was found that homes built from ABTs were more expensive. This shows how economies of scale are important in understanding the cost of an ABT housing project. If you build more houses, you can buy more materials in bulk, thus lowering the price of each unit.

Alternative building technologies primarily impact labour in two ways. Firstly, they reduce labour requirements. ABT suppliers advertise their products as requiring less labour than conventional building methods. Even though the validity of these claims was never verified, it highlights that reducing labour is at the forefront of the ABT industry. These labour-saving qualities conflict with the country's goal of utilising labour-intensive construction methods to increase employment. Secondly, many ABTs eliminate the need for specialized tradesmen by simplifying the construction process and create employment opportunities for unskilled labourers. Since affordable housing projects are built in communities with a large unskilled labour pool, implementing ABTs will create more employment opportunities for the people in the local communities. This is advantageous for the country because it means more of the project's funds will go into the local economy.

The Perception Problem

The successful application of ABTs in the delivery of affordable housing will ultimately be determined by whether the stakeholders (on the supply side) accept ABTs as a viable and quality product. Negative perceptions of ABTs stem from the poor understanding of what they are, but people's perceptions can improve with increased exposure. Even though this data only concerns perceptions by the subjects of the study, interviews conducted with ABT suppliers support the finding that people become more accepting of ABTs once they physically experience them. People are distrustful of non-conventional building materials because they have been primarily exposed to one type of housing (brick and mortar) and as a result are unaware of how ABTs can be used to construct quality housing.

Challenges for ABT application

The one unique challenge to ABT application is the current tendering processes that favour conventional building materials and make it difficult for organisations like the NHE to use ABTs in affordable housing developments. It was found that the current tendering process emphasizes three areas: supply chain, prior implementation of the proposed building technology, and cost of each housing unit. In all three of these categories, conventional building materials have an edge over the available alternatives, often causing the organizations to award tenders to bidders who use conventional building methods. In housing construction, the supply chain consists of a manufacturer, who supplies the materials, the contractor, who uses the materials to build the house, and the customer, the individual who buys the finished product, in

this case, the house. The study concludes that ABT companies have difficulty tendering for projects because they lack a complete supply chain.

5.4 Recommendations

1. Improving perceptions will be crucial for the successful application of ABTs for affordable housing delivery. It is recommended that the government through the stakeholders such as NHE, BTP, SDFN etc, engage in multiple and continuous outreach efforts to improve the perceptions of ABTs among property developers and individuals.
2. It is recommended that affordable housing projects' tendering process be reformed on the national level to de-emphasize the importance of cost and give greater credence to other important factors essential to building, a development that will best serve beneficiaries. The scoring index used by the Bid Evaluation Committee should consider the quality, sustainability, and unique design advantages of every bidders' proposed building method.

Alternative building technologies could be used to upgrade housing conditions in informal settlements or make temporary housing for people displaced by fires or natural disasters. With a commitment to implementing alternative building technologies in the affordable housing market segment, the government can be at the forefront of transforming lives through innovative building solutions.

5.5 Implications for practice

To policymakers and those mandated to deliver affordable housing:

1. The adoption of housing delivery models often gains momentum and excitement if accompanied by promises of increased delivery of affordable housing. This was seen in initiatives such as TIPEEG of 2007

and the Mass Housing Plan of 2013. Many citizens desire the chance to own a house. However, too often these housing delivery mechanisms are implemented without being supported by empirical studies.

2. Choosing one housing delivery mechanism over another might not be the proper way to address the affordable housing problem in Namibia. The researcher suggests that government and local authorities need to utilize theory and data-driven research results before adopting a strategy to deliver affordable housing. Demand for housing will always be there and will continue to grow, however affordable housing initiatives should utilise empirical studies to assess their effectiveness before full implementation.
3. Taking care of the environment has become an implied obligation of all of us. The impact on the environment or being 'green' did not come out as a strong quality of ABT application, there is a need to investigate ways of changing this unfortunate reality.

To researchers and scholars

1. This study was not conclusive on the value proposition of ABT application for affordable housing especially the cost. Further, the perception of the general public was not captured in this study. This is a gap that can be plugged by a study utilising a broader sample that includes individuals from the public, government and local authority officials, and other professionals such as architects, engineers etc.
2. The use of fewer labour conflicts with the requirement of using labour-intensive methods of construction to create employment. Therefore, further investigations are required to assess the impact of ABT application on employment creation.
3. The utilisation of land as part of an integrated approach to solving the unavailability of land for affordable housing ought to be the focus of a study. We can learn from the case of Amaravati City, India where

villagers gave part of their land to the city in exchange for a house from the projects.

5.6 Limitations of the Study

In addition to the limitations presented in Chapter 1 of this study, the researcher acknowledges several limitations that could make vulnerable the internal and external validity of this study. For instance, the study was limited to estate agents and a few individuals extensively knowledgeable on the subject but they form a very small sample. Expectedly, the study is inherently subjective and relative, based on the knowledge and experience of the participants. Therefore, caution is advised when making generalizations based on these research findings.

5.7 Summary of the chapter

The current mechanisms to deliver affordable housing in Namibia are not productive enough to improve the supply of affordable housing with the impact of reducing the deficit. The findings are that ABT can be applied for affordable housing delivery but challenges will be there on their application. On top of the list of these challenges, is serviced land followed by funding, regulation, and others. The Achilles heel must be the perception problem linked intimately to ABT acceptability and thus applicability. Dissemination of information on ABT to increase awareness and counter the lingering perception problem is the ultimate antidote to the perception malady. Recommendations have been for research gaps identified. The chapter ends with the limitations and caution when using the findings.

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Appendix A: Survey questionnaire

This survey is voluntary and anonymous requiring only a couple of minutes to complete.

Namibia has a huge backlog of housing especially in the low-cost bracket estimated to be in the region of 100,000 units. The main reason is the inadequate delivery of affordable housing. This study aims to understand the aspects of using alternative building technologies (ABTs) successfully to alleviate the housing deficit. This questionnaire will take you around 10 minutes. This study is intended for educational purposes only, and not for any commercial purposes. This questionnaire is randomly distributed among stakeholders in the provision of housing. It will be completely anonymous.

Section 1: Demographic and participants data

Please kindly answer the following questions:

1. What is your gender?

Male	Female
☐	☐

2. What is your age bracket

20 - 30	31- 40	41 - 50	>50
☐	☐	☐	☐

3. What is your Nationality?

Namibian	Other
☐	☐

4. How many years of experience in property sales and management?

1 - 5	6 - 10	>10
☐	☐	

Section 2: Characteristics of Alternative building methods

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1. What value proposition of ABT is most attractive to you? *(Select only one)*

☐	Reducing the cost of construction
☐	Reducing the quantity of skilled labour required
☐	Reducing the time of construction
☐	Environmentally friendly

2. What is your general perception of the quality of houses built using alternative building technologies? *(Select only one)*

Very Poor	Below Average	Average	Above Average	Excellent	Don't know
☐	☐	☐	☐	☐	☐

3. How often do you hear information about alternative building technologies in Namibia? *(Select only one)*

Always	Frequent	Occasionally	Rarely	Very rarely	Never
☐	☐	☐	☐	☐	☐

4. Are you familiar with any alternative technologies used in Namibia or elsewhere? *(If yes, which one?)*

N ☐	Y ☐
	1._____
	2._____
	3._____

5. How important to a potential homeowner is the technology or method used for building?

Very Important	Important	Moderately Important	Not Important
☐	☐	☐	☐

6. Have you ever sold a property developed using alternative building methods? (*If yes what type of property?)*

N ☐	Y ☐
	☐ Residential
	☐ Commercial

7. What is your estimate of the number of affordable housing units produced annually in Namibia? *(Select only one)*

100-299	300-499	500-699	700-899	900-1200

☐	☐	☐	☐	☐

8. What percentage of the cost of a new unit is attributed to the cost of the erven (stand)? *(Select only one)*

10%	20%	30%	40%	50%	>50%
☐	☐	☐	☐	☐	☐

9. Rank the following five factors that influence the delivery of housing in Namibia. Using a scale of 1 to 5 where 1 is the most important and 5 least important. *(Use each rank only once)*

☐	Perception
☐	Project management
☐	Funding
☐	Land
☐	Regulations

10. Do you agree with the statement that 'Government should only play a facilitating role in the delivery of housing in Namibia? *(Select only one)*

☐	Strongly Agree
☐	Agree
☐	Undecided
☐	Disagree

☐	Strongly Disagree

11. Are banks willing to finance alternative technology houses? (Select only one)

Very Likely	Likely	Not Likely	Don't Know
☐	☐	☐	☐

12. Rank the following factors in terms of their importance in solving the housing problem in Namibia. *(Use each rank only once)*

☐	Incentives to use ABTs
☐	Awareness of ABTs
☐	Cost of the housing units
☐	Availability of land
☐	Marketability of location
☐	Regulations and policies

13. How serious is the problem of housing in Namibia especially in the low-cost category? *(Select only one)*

Not a problem	Small problem	Moderate	Very severe
☐	☐	☐	☐

14. In your opinion which factor has the greatest impact on housing demand? *(Select only one)*

☐	Population growth

☐	Rural-urban migration
☐	Other reasons

4.

15. Which of the following reasons best explains rural to urban migration: education, employment, better life and drought and forces of nature. Use a 4-point Likert-type scale: 1 = significant and 4 = least significant: *(Use each rank only once)*

Education	Employment	Better life	Drought
☐	☐	☐	☐

16. Which intervention will reduce the movement of people into urban areas? *(Select only one)*

☐	Provide social amenities (schools, hospital, etc.) in the rural
☐	Create employment opportunities in the rural
☐	Build low-cost housing in rural areas
☐	Nothing, people will always move into towns

Appendix B: Interview guide

This guide assists the interviewer to ask and discuss pertinent information to answer the research question. It starts with salutation and appreciation of the participants' willingness to partake in the study. Then a brief introduction and the aim of the study to set the tone of the interview. Then the interviewee is asked for his demographic and work information. Lastly, the guiding or probing questions of the interview are presented. It may so happen that some questions may lead to others that may not be explicitly in the guide. If this is the case the questions can be added as deemed fit.

Ethical declaration: Participation in the study is voluntary and completely anonymous. Although you have told me your name, it will not appear anywhere in the thesis. Therefore, your permission is sought once again to continue with the interview. The study is for educational purposes only, and not for any commercial use.

Salutation: Thank you for accepting to participate in this study. I will start by giving you a brief introduction and the aim of the study to give you the context of the interview.

Introduction: The problem of inadequate housing afflicts many developing countries and Namibia is no different. We see informal settlement sprawling, especially in the Northern part of Windhoek, and the same is observed in other urban centres. Government efforts such as TIPEEG and mass housing do not seem to have helped alleviate the housing problem. The current backlog is estimated at 100,000 units on the lower side to as much as 150,000 units and still growing at more than 3000 units per year, according to Mr Vincent Hailulu, the former CEO of NHE.

The aim of the study: It is indisputable that the delivery of housing using conventional methods is inadequate. This study aims to investigate alternative building technologies that have the characteristics of reducing the cost and time of construction to improve house delivery in Namibia.

This study is intended for educational purposes only, and not for any commercial purposes.

Section 1: Demographic and work information

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1. Gender_____
2. What is your citizenship? _____
3. How old are you? _____
4. What position do you occupy here? _____
5. How long have you been working here? _____

Section 2: The use of ABT as a delivery mechanism for affordable housing.

(We have some guiding questions but they will not limit our deliberations if you want to share any other information please feel free to do so)

Research Objective 1: Qualities of ABT	
Q1	Can you perhaps tell me why your company started dealing with this technology of construction?
Q2	What are the selling points of your technology compared to the traditional building technologies?
Q3	Can you classify your technology as 'green' or being environmentally friendly?
Q4	How do you ensure that your projects succeed?

Q5	When a new customer comes along, to what extent do you get involved in ensuring that your technology is used as designed?
Research Objective 2: Perceptions and acceptability	
Q6	What is the common comment that comes from your customers about your technology?
Q7	Can you describe any particularly difficult or challenges you face when selling your technology?
Q8	What, if anything, would you change about your technology?
Research Objective 3: Challenges for ABT application	
Q9	Have you approached the Municipalities and/or local authorities for approval of your technology?
Q10	Have you ever served a client who was getting bank financing?
Q11	Are you or anyone in your company a member of the Project Management Institute and are you familiar with PMBOK?
Q12	Do you have any formal or informal training programs for those interested in adopting it for building their houses?
Q13	Is the bulk of the base materials used in your technology locally sourced or do you get it from somewhere else?
Q14	If you import some materials what is the estimated percentage that makes up the imported materials.

5.

Appendix C: Focus group facilitation guide

This guide assists the interviewer to ask and discuss pertinent information to answer the research question. It starts with salutation and appreciation of the participants' willingness to partake in the study. Then a brief introduction and the aim of the study to set the tone of the interview. Then the interviewee is asked for his demographic and work information. Lastly, the guiding or probing questions of the interview are presented. It may so happen that some questions may lead to others that may not be explicitly in the guide. If this is the case the questions can be added as deemed fit.

The ground rules

Ground rules help the facilitator establish what behaviours are expected of the focus group participants. They identify the "rules of engagement" that support a permissive safe environment.

The following are the virtual meeting ground rules:

1. Everyone should participate and only one person talks at a time. If you want to contribute put up your hand then the facilitator will assist you.
2. 30 minutes before the meeting participants were contacted to ensure they access the meeting on time.
3. Poll questions will be used periodically to engage the audience and keep them focused build consensus where required
4. There are no right or wrong answers to questions, it's a discussion; just ideas, experiences and opinions, which are all valuable.
5. The session will be audio recorded to help us gather more detailed information about your responses than the handwritten notes that will be taken, and it will allow us to double-check our data for accuracy (if the

session is audio recorded, which is depending on consent from the participants). The University of Namibia (UNAM) has clear guidelines on confidentiality of data collected during the research.

6. Mute your microphone: to help keep background noise to a minimum, make sure you mute your microphone when you are not speaking.
7. Be mindful of background noise: when your microphone is not muted, avoid activities that could create additional noise, such as shuffling papers.
8. Position your camera properly: If you choose to use a web camera, be sure it is in a stable position and focused at eye level, if possible.
9. Limit distractions: you can make it easier to focus on the meeting by turning off notifications, closing or minimizing running apps, and muting your smartphone.
10. Avoid multi-tasking: you'll retain the discussion better if you refrain from replying to emails or text messages during the meeting.
11. Prepare materials in advance: if you will be sharing content during the meeting, make sure you have the files and/or links ready to go before the meeting begins.

Ethical declaration: Participation in the study is voluntary and confidentiality will be maintained. The recorded voice notes will be destroyed after the contents have been anonymously transcribed. Although you have told me your name, it will not appear anywhere in the thesis. Therefore, your permission is sought once again to continue with your participation in the group discussion. The study is for educational purposes only, and not for any commercial use.

Salutation: Thank you for accepting to participate in this study. I will start by giving you a brief introduction and the aim of the study to give you the context of the discussion and then I will open the floor for discussions. Please don't take too much time because our time is limited.

Introduction: The problem of inadequate housing afflicts many developing countries and Namibia is no different. We see informal settlement sprawling, especially in the Northern part of Windhoek, and the same is observed in other urban centres. Government efforts such as TIPEEG and mass housing do not seem to have helped alleviate the housing problem. The current backlog is estimated at 100,000 units on the lower side to as much as 150,000 units and still growing at more than 3000 units per year, according to Mr Vincent Hailulu, the former CEO of NHE.

The aim of the study: It is indisputable that the delivery of housing using conventional methods is inadequate. This study aims to investigate the applicability of non-conventional building methods with characteristics of reducing the cost and time of construction with the effect of improving affordable housing delivery in Namibia. Also, to explore the perceptions problem and other challenges associated with affordable housing delivery.

This study is intended for educational purposes only, and not for any commercial purposes.

Section 1: Demographic and work information

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1. Gender_____
2. What is your citizenship? _____
3. How old are you? _____
4. What position do you occupy here? _____
5. How long have you been working here? _____

Section 2: The use of ABT as a delivery mechanism for affordable housing.

(Facilitation guiding questions)

Research Objective 1: ABT qualities (20 minutes)	
Q1	The characteristics of the construction methods we use for affordable housing
Q2	How did you feel about using ABT for construction of affordable housing
Q3	Are there any ABT technology being used in Namibia
Research Objective 2: Perceptions and acceptability (20 minutes)	
Q4	Do the clients care about the methods used to build or other factors are more important
Research Objective 3: Challenges for ABT application (20 minutes)	
Q5	What will make us deliver more housing
Q6	Are banks willing to finance houses built using non-conventional methods
Q7	What can you say about regulations
Q8	What role should government play in the delivery of affordable housing
Wrap up of the discussion (30 minutes) 1. Poll questions to get a group consensus 2. Any other issues	

Appendix D: Self-Assessment Checklist

Question	Y/N	Action
Will the research project involve human participants, with or without their knowledge or consent at the time? (This includes yourself if you are the main subject of the research).	Yes	Explicit consent was sought from all participants before the commencements of the study.
Will the research project involve animals?	No	None
Is the research project likely to expose any person, whether or not a participant, to physical or psychological harm?	No	However, the impact of the study was clearly explained to the participants.
Will you have access to personal information and/ or data that allows you to identify individuals or to confidential corporate or company information?	Yes	An attempt was made to conceal data for instance, instead of asking the age, the age group was used No names were used in data collection and transcription participants and respondents were only identified as P1, P1, or R1, R2, .etc. The researcher did not share the recorded zoom meeting. After transcription, the recording was destroyed as was the condition for consent.
Does the research project present a significant risk to the environment or society?	No	None
Are there any ethical issues raised by this research project that require further ethical review?	No	None