CONSUMER AND STAKEHOLDER PERCEPTIONS AND ACCEPTANCE OF BUILDING TECHNOLOGIES USED IN RESIDENTIAL CONSTRUCTION

RESEARCH REPORT








NATIONAL HOME BUILDERS
NHBRC
REGISTRATION COUNCIL

TABLE OF CONTENTS

ABBREVIATIONS

CBE	Council for the Built Environment
CIDB	Construction Industry Development Board
CSIR	Council for Scientific and Industrial Research
CSOS	Community Scheme Ombud Service
DHS	Department of Human Settlements
DPW	Department of Public Works
dti	Department of Trade and Industry
EAAB	Estate Agency Affairs Board
ECSA	Engineering Council of South Africa
HDA	Housing Development Agency
IBT	Innovative Building Technology
IDT	Independent Development Trust
NHBRC	National Home Builders Registration Council
NHFC	National Housing Finance Corporation
NURCHA	National Urban Reconstruction and Housing Agency
NRCS	National Regulator for Compulsory Specifications
RHLF	Rural Housing Loan Fund
SABS	South African Bureau of Standards
SACAP	South African Council for the Architectural Profession
SACLAP	South African Council for the Landscape Architectural Profession
SACPCMP	South African Council for Project and Construction Management Professions
SACPVP	South African Council for the Property Valuers Profession
SACQSP	South African Council for the Quantity Surveying Profession
SAIA	South African Institute of Architects
SANS	South African National Standards

SHRA	Social Housing Regulatory Authority

1. INTRODUCTION & BACKGROUND

1.1 BACKGROUND

1.1.1 INNOVATIVE BUILDING TECHNOLOGY TRENDS

The availability of environmentally friendly building materials are on the rise. Environmentally conscious builders, built environment professionals and consumers have begun creating a market for alternative and innovative building products, and a proliferation of these innovative products have ensued. Changing climatic conditions are forcing the building and construction industry to change and innovate in terms of alternative and innovative building products.

In an attempt to address the rising housing backlog and various subsequent complaints and frustrations from registered beneficiaries on the ground, the Department of Human Settlements (DHS) began its drive to use Innovative Building Technologies (IBTs) in 2005 with the establishment of the Eric Molobi Housing Innovation Hub at the NHBRC's Soshanguve office.

Activities at the Hub reflect the interrelationship of functions that contribute to enhancing the quality of the standard of building work. One part comprises the houses built with innovative building technologies (IBT), while the other part consists of the Construction Testing Laboratory and Training Centre. The IBT houses allow for displaying innovation and monitoring performance. In order to assist the public and private sector to promote quality, the houses are complemented by a Training Centre, where dialogue and training can occur, as well as the Construction Testing Laboratory, where material testing and related skills development can take place.

- **NHBRC and ABSA Housing Innovation Competition**
  The objective of the Housing Innovation Competition was to identify, draw in and support innovative housing systems developed locally and internationally. The ultimate aim is to showcase a wider choice of quality, aesthetically pleasing and affordable homes to the poorest of the poor and other end users.
- **The Martha Molobi Training Centre**
  The Martha Molobi Training Centre is located in the Hub and serves as a multi-functional facility where complementary and main functions of the NHBRC are to be held. This centre provides stakeholders with first class facilities that promote the vision of enhancing the quality of the standard of building work. The centre is also utilised to:
  - Conduct and facilitate construction related training.
  - Conduct training sessions on general NHBRC product knowledge and generic training for internal staff.
  - Facilitate seminars and conferences for the NHBRC and any other interested parties.
  - Provide other training on life skills, counselling, entrepreneurship and exit opportunities in Ministerial Projects.
  - Provide administrative facilities for training staff.
- **Construction Testing Laboratory**
  The main purpose of the Construction Testing Laboratory is to provide facilities that will enable the improvement of structural quality and technical standards through the physical testing of building materials and products as well as to support the development of home builders. In the broader perspective, the laboratory is used to:

- Test suspect materials and/or products identified by NHBRC inspectors during their routine inspection of houses.
- Support Agrément Board and other relevant organisations in the approval of innovative housing systems. This includes conducting structural tests of the housing systems and other relevant tests.
- Support the training of historically disadvantaged home builders in trades including: brick and masonry laying, concrete properties, concrete mix designs, plastering etc.
- Support the development of technical standards relevant to the home building industry.
- Support provincial Departments of Human Settlements and municipalities in geotechnical investigations to facilitate quicker turnaround times in the enrolment processes.

The objective of the Eric Molobi Housing Innovation Hub project was to seek out new, affordable, quick-to-erect and aesthetically pleasing housing products that would assist in meeting the enormous housing target. Since then Cabinet adopted a stipulation in August 2014 to use IBTs to construct 60% of all new social infrastructure projects by 2017.

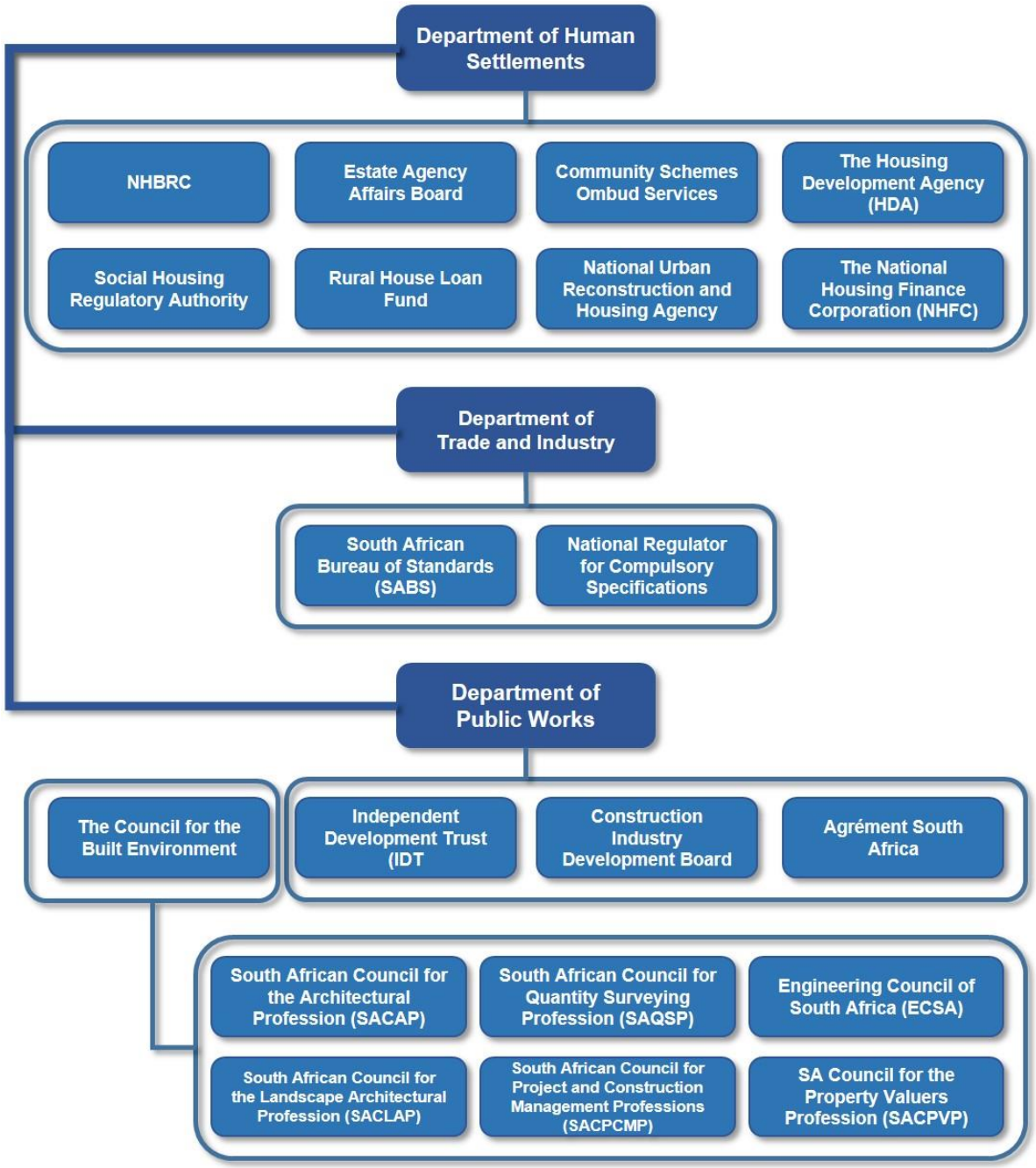
In spite of all these efforts, however, beneficiaries are reported to complain about the quality of IBTs and there is a general industry belief that consumers do not want anything other than traditional brick and mortar homes. Acceptance of new products in both the green and mainstream building markets depends on a number of factors, especially consumer demand and the builders' perceptions of consumer preferences.

1.1.2 HOUSING INDUSTRY ROLE PLAYERS

Housing is a National Government Priority, to ensure the Proper Provision of Housing and Service Delivery of Housing by the Building/Construction Industry. The Government has put into Law by promulgating under Legislation; Acts; Departments; Councils and boards to provide a holistic oversight of the entire industry and critical aspects impacting directly and indirectly on Housing. Diagram 1.1 presents an organogram of the role players within the industry, each role players is subsequently introduced and their respective roles outlined.

- **Department of Human Settlements (DHS):**
  The Constitution of the Republic of South Africa (1996) states that access to housing is a basic human right, the government has to ensure that an environment is created conducive to realising that right.
  - **National Home Builders Registration Council (NHBRC)**
    The NHBRC is a regulatory body of the home building industry in accordance with the provisions of the Housing Consumers Protection Measures Act, 1998.
  - **National Housing Finance Corporation (NHFC)**
    The NHFC was established with the principal mandate of broadening and deepening access to affordable housing finance for the low-to-middle income South African households.
  - **Housing Development Agency (HDA)**
    The HDA is a national public development agency that makes well-located land and buildings available for the development of housing and human settlements.
  - **Social Housing Regulatory Authority (SHRA)**
    The SHRA regulates and invests in delivery of affordable rental homes.

Diagram 1.1: Housing Industry Role players



- **National Urban Reconstruction and Housing Agency (NURCHA)**
  NURCHA is an innovative development finance company that provides bridging finance and construction support services to contractors and developers. It finances and supports the construction of Subsidy and Affordable Housing, Infrastructure and Community Facilities. It also provides account Administration, Project and Programme Management services to Local and Provincial Authorities.
- **Rural Housing Loan Fund (RHLF)**
  The RHLF was set up as a wholesale development finance institution with the mandate of enabling low income earners to access small loans that they could afford to repay. Borrowers use these loans to improve their housing conditions.

- **Estate Agency Affairs Board (EAAB)**
  The EAAB was established in 1976 in terms of the Estate Agency Affairs Act 112 of 1976 (the "Act"), with the mandate to regulate and control certain activities of estate agents in the public interest. The EAAB regulates the estate agency profession through ensuring that all persons carrying out the activities of an estate agents as a service to the public are registered with the EAAB. A Fidelity Fund Certificate, which is to be renewed each year is issued as evidence of such registration and confirmation that such person is legally entitled to carry out the activities of an estate agent.
- **Community Schemes Ombud Service (CSOS)**
  The CSOS was established in terms of the Community Schemes Ombud Service Act, 2001 to regulate the conduct of parties within community schemes and to ensure their good governance.

- **Department of Trade and Industry (the dti)**
  In terms of the building industry, the dti oversees The South African Bureau of Standards (SABS), which provides a range of standards covering the demands of the Building and Construction Industry, from quality management systems to test methods for specific materials or parts. These help organisations to enhance customer satisfaction, meet regulatory, safety and reliability requirement, and ensure consistency of quality throughout the supply chain. The SANS 10400 series are the most referenced regulations by architects and contractors.
  The dti also oversees the National Regulator for Compulsory Specifications (NRCS), which administers compulsory specifications and other technical regulations with the view to protect human health, safety, the environment and ensure fair trade in accordance with government policies and guidelines.
  - **South African Bureau of Standards (SABS)**
    SABS is a statutory body that was established in terms of the Standards Act, 1945 (Act No 24 of 1945). As the national standardisation institution in South Africa, it is mandates to: (1) develop, promote and maintain South African National Standards (SANS); (2) promote quality in connection with commodities, products and services; and (3) render conformity assessment services and assist in matters connected therewith. SABS provides a range of standards covering the demands of the Building and Construction Industry, from quality management systems to test methods for specific material or parts.
  - **National Regulator for Compulsory Specifications (NRCS)**
    The NRCS is an entity of the dti established to administer compulsory specifications and other technical regulations with the view to protect human health, safety, the environment and ensure fair trade in accordance with government policies and guidelines. The legislative framework under which the NRCS performs its tasks on behalf of the dti are as follows: (1) The National Regulator for Compulsory Specifications Act (Act No 5 of 2008); (2) Legal Metrology Act (Act 9 of 2014); and (3) National Building Regulations and Building Standards Act (Act No 103 of 1977).
- **Department of Public Works (DPW)**
  The Department's mandate is to be the custodian and manager of all national government's fixed assets, for which other legislation does not make another department or institution responsible. This includes the determination of

accommodation requirements, rendering expert built environment services to client departments, the acquisition, maintenance and disposal of such assets.

- **Construction Industry Development Board (CIDB)**
  The CIDB was established to lead construction industry stakeholders in construction development.
- **Agrément South Africa**
  Agrément South Africa's core function is assessment and certification of innovative, non-standardised construction products, systems, materials, components and processes, which are not fully covered by a South African Bureau of Standards' Standard.
- **Independent Development Trust (IDT)**
  The IDT undertakes development programme management on behalf of the government. The programmes cut across a number of sectors, but are largely within the social infrastructure domain. The development agency's portfolio is broadly characterised into social infrastructure programmes and social development programmes which include schools, Early Childhood Development Centres (ECDC), clinics hospitals, courts, community halls, potable water and sanitation infrastructure, etc.
- **Council for the Built Environment (CBE)**
  The CBE is an overarching body that coordinates six Professional Councils:
  - **South African Council for the Architectural Profession (SACAP)**
    SACAP's mandate is to guide, facilitate and promote a high standard of competency and responsibility in the architectural profession and to increase public awareness of the range of architectural services offered. To ensure the profession fulfils its total role in the development of South Africa.
  - **Engineering Council of South Africa (ECSA)**
    The ECSA's primary role is the regulation of the engineering profession. Its core functions are the accreditation of engineering programmes, registration of persons as professionals in specified categories, and the regulation of the practice of registered persons.
  - **South Africa Council for the Property Valuers Profession (SACPVP)**
    SACPVP's mandate is to promote a high level of education and training of practitioners in the Property Valuers Profession so as to facilitate full recognition of professionalism in the valuers profession.
  - **South Africa Council for Landscape Architectural Profession (SACLAP)**
    SACLAP strives to establish, direct, sustain and ensure a high level of professional responsibilities and ethical conduct within the art and science of landscape architecture with honesty, dignity, and integrity in the broad interest of public health, safety and welfare of the community.
  - **South African Council for the Quantity Surveying Profession (SACQSP)**
    SACQSP handles the registration of professionals, candidates and specified categories in the quantity surveying profession.

- **South Africa Council for Project and Construction Management Professions (SACPCMP)**
  The SACPCMP provides for the registration of professionals, candidates and specified categories in the project and construction management professions and for the regulation of the relationship between the SACPCMP and the CBE. The SACPCMP was established to regulate Construction Management and Construction Project Management Professionals to protect the Public
- **Council for Scientific and Industrial Research (CSIR)**
  The CSIR is one of the leading scientific and technology research, development and implementation organisations in Africa. The CSIR undertakes directed and multidisciplinary research, technological innovation as well as industrial and scientific development to improve the quality of the life of the country's people.

1.1.3 UNDERSTANDING THE MANDATE AND ROLE OF THE NHBRC

The Housing Consumers Protection Measures Act of 1998 (Act No 95 of 1998) requires the NHBRC to establish a fund for the purpose of providing assistance to housing consumers where a home builder fails to rectify major structural defects or a roof leak attributed to workmanship, design or materials which has manifested itself within 5 years or 12 months from the date of occupation, respectively.

The NHBRC is a regulatory body of the home building industry in accordance with the provisions of the Housing Consumers Protection Measures Act, 1998. The role of the NHBRC is to **represent the interests of housing consumers by providing warranty protection against defects in new homes**; **regulate the home building industry; provide protection to housing consumers in respect of the failure of Home Builders to comply with their obligations in terms of the Act; establish and promote ethical and technical standards in the home building industry; improve structural quality in the interests of housing consumers and the home building industry; promote housing consumer rights and to provide housing consumer information; communicate with and to assist Home Builders to register in terms of the Act; assist Home Builders, through training, monitoring and inspection to achieve and to maintain satisfactory technical standards of home building**.

The **Vision** of the NHBRC is to be a world class builder's warranty organisation that ensures the delivery of sustainable, quality housing.

The **Mission** of the NHBRC is to protect the housing consumer and regulate the home building industry by promoting innovative building standards and improving capabilities of Home Builders.

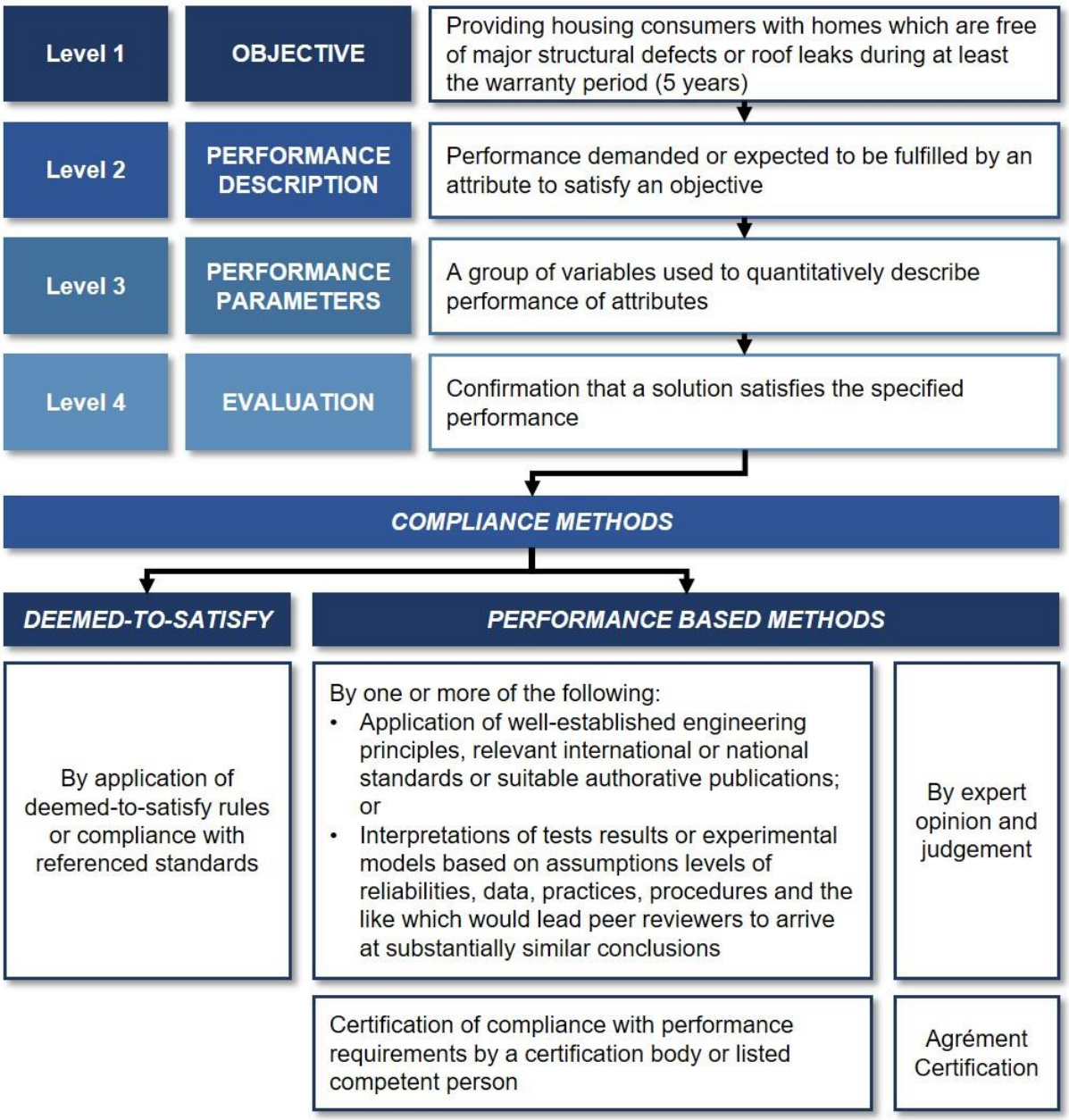
A home is one of the largest investments anyone makes in their lifetime. It is vital to safeguard these investments by ensuring that homes are safely and correctly built. The NHBRC Regulations warrant that the residential industry is held to a standard. This means that Home Builders are given the technical information required to build correctly, sustainably and ethically. All homes, no matter the cost, are held to the same building standard.

The NHBRC regulations offer a functional guide for Home Builders to assist in ensuring they build to the South African National Standards (SANS). The benefits of the regulations to the

building industry is that every builder is given the opportunity to build within the SANS and that homeowners are protected.

The National Building Regulations do not purport, and were never intended, to be a handbook on good building practice. They set out, in the simplest and shortest way possible, requirements to ensure that buildings will be designed and built in such a way that persons can live and work in a healthy and safe environment. The National Building Regulations are based on the 4-level performance framework (refer to Diagram 1.2) set out in the Bill of Rights of the Constitution of South Africa and the National Building Regulation and Building Standards Act of 1977.

Diagram 1.2: Four level performance based regulatory system for the National Building Regulations



Application for approval of building plans must be made to local authority which applies the National Building Regulations (NBRs) when considering such applications. Compliance with the NBRs may be demonstrated by:

- meeting the relevant deemed-to-satisfy rules of the current South Africa National Standards (SANS) Code of Practice 10400: The Application of the National Building Regulations, when using a conventional method of construction, or
- a valid Agrément certificate when using a non-standardised or innovative building system
- a rational design by a competent person.

There are two independent organisations in South Africa that are concerned with technical approvals- the SABS and Agrément South Africa. While the SABS operates in a wide range of areas, Agrément South Africa confines its activities to the building and construction industries. The activities of the two organisations are largely complementary: the SABS deals with standard and code of practice which relate to conventional products, and cooperates with international organisations for standardisation, while Agrément South Africa assesses innovative, non-standardised construction materials, products and systems and maintains links with the World Federation of Technical Assessment Organisations (WFTAO), the Union of European Agrément (UEAtc) and other Agrément-type organisations. The Council for Scientific and Industrial Research (CSIR) also provides the staff of the Technical Agency which serves the Board of Agrément South Africa.

1.2 STUDY RATIONALE AND OBJECTIVES

As indicated earlier, in spite of all the efforts by government to seek out new, affordable, quick-to-erect, aesthetically pleasing housing products that would assist in meeting the enormous housing target, beneficiaries continue to complain about quality and there is a general industry belief that consumers do not want anything other than traditional brick and mortar homes. Acceptance of new products in both the green and mainstream building markets depends on a number of factors, especially consumer demand and the builders perceptions of consumer preferences. The NHBRC therefore commissioned a consumer research study to determine general housing consumer perceptions and acceptance of IBTs.

The study was commissioned to:

- Determine the perceptions and acceptance levels of consumers and stakeholders regarding IBTs used in residential construction
- Assess consumer awareness levels of IBTs
- Identify and unearth any potential cultural, behavioural or perceptual barriers
- Understand the costs related to constructing an IBT home versus a conventional home through the completion of a Cost-Benefit Analysis
- Deliver a scientific report with findings and recommendations on how to improve awareness, acceptance and promotion of IBTs within the residential construction sector (particularly amongst government subsidy housing stock)

1.3 RESEARCH DESIGN

As emphasised by the background information and study rationale, there is a general belief that consumers are opposed to the use of Innovative Building Technology in residential construction due to negative perceptions related to the quality and strength of the products.

The belief is substantiated through protests against the use of IBTs. In the Western Cape for instance, a subsidised housing project was severely delayed and disrupted when communities protested and resisted the use of IBTs in their area – to the extent that the Department of Human Settlements had to revise their method of housing delivery for the specific project.

Due to increasing housing needs and an ever-growing housing backlog, it is imperative that the government finds new and innovative ways to provide housing as a basic human right. However, negative consumer perceptions and resistance to the use of IBTs can severely impact the success of service delivery in the regard. It is therefore necessary to understand consumers and stakeholders perceptions, whether these perceptions can be substantiated, and how, if possible, these perceptions can be changed towards a positive feel and ultimate accepting of IBTs for residential construction.

The key research questions that needs to be asked:

- How does the consumer and stakeholder view IBTs? And do they feel that it is acceptable to use IBTs for residential construction?
- Can perceptions be substantiated by facts?
- How can perceptions be influenced?

1.4 STUDY APPROACH

Based on the descriptive nature of the research design and key research questions, a hybrid research methodology was employed – using both **qualitative and quantitative** research methods. This approach enables the researcher to "triangulate" – i.e. to back up one set of finding from one method of data collection underpinned by one methodology, with another very different method underpinned by another methodology. In the case of this research study, quantitative research were conducted by means of consumers surveys using open and close-ended questionnaires to gather statistical data about responses, and this was backed-up through qualitative research by means of more in-depth structured interviews with a selection of key stakeholders/role players in the residential home building industry.

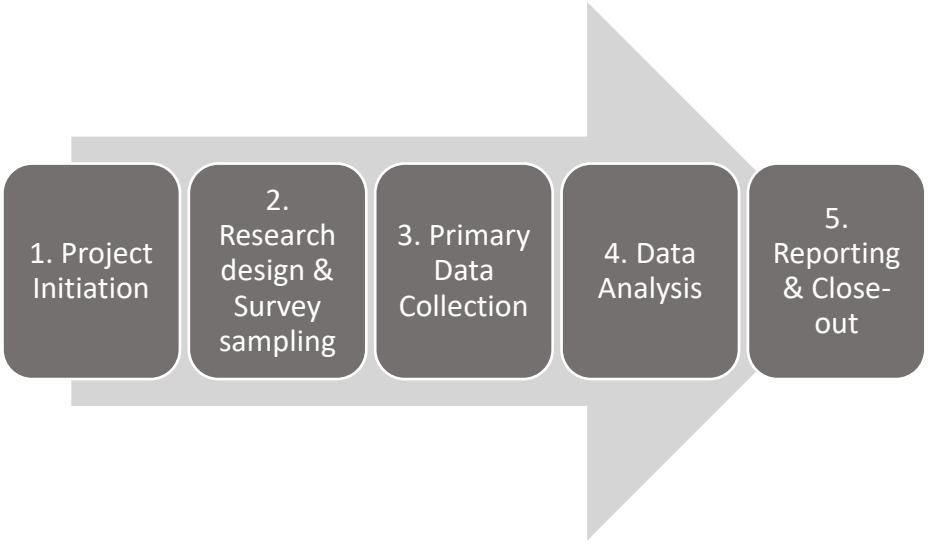
The Consumer and Stakeholder Research study was conducted through a phased approach, consisting of five key steps (as depicted in Diagram 1.3).

Step 1: Project Initiation entailed the refinement of the project brief, timeframe and deliverables, during an Inception Meeting with the NHBRC on the 15th of January 2019. All relevant an existing information was obtained and a work plan was formulated.

Step 2: Research Design and Survey Sampling entailed undertaking the necessary preparations before primary data collection commenced and developing an analysis plan. This included developing and finalising a survey questionnaire in conjunction with the client, encompassing both quantitative and qualitative research questions.

Step 3: Primary Data Collection entailed data collection through stakeholder and consumer interviews (both telephonic and personal) to collect on the ground evidence of consumer and stakeholder perceptions of IBTs. The data collection process was entirely dependent on information from the NHBRC regarding project details, project location and beneficiary details, as this information is not available in the public domain.

Diagram 1.3: Study Approach



Step 4: Data capturing and analysis entailed collating, cleaning and analysing information obtained through the primary data collection as well as the verification and cross-tabulation of data. This step also included a Literature Review to provide some perspective on consumer preferences and acceptance and current trends regarding IBTs, which included a Cost-Benefit Analysis to obtain an understanding of the costs related to IBTs versus conventional building materials.

Step 5: Report finalisation and Project Close-out entailed the interpretation of captured and analysed data, and the development of strategic finding and recommendations to enable the client to gauge the views and perceptions of consumers and stakeholders regarding IBTs used in residential construction.

1.5 RESTRICTIONS AND LIMITATIONS TO THE STUDY

The following challenges were experienced during the study and places limitations on the study process:

- Sampling limitations:
  - A detailed database with beneficiaries of IBT houses were not readily available. The Research Service Provider was provided with the contact details of system owners, however, in most instances these contractors were not contactable or unwilling/unable to provide beneficiary details.
- Beneficiary accessibility and availability:
  - In an effort to address the sampling challenge, The Research Service Provider randomly selected projects (where more than one house was built according to the NHBRC list) and deployed fieldworkers in those areas. This route was also less successful in certain areas, mostly due to beneficiaries being unaware of whether they occupied IBT houses or not, and therefore not being willing to participate.
  - It was a general occurrence that the occupants of some of the IBT houses were not the registered beneficiaries, but tenants, and were thus not able to answer the survey questions. It was stated by various sources that beneficiaries tend to sublet their houses as a source of additional income.

  - The Research Service Provider was dependent on the contractor or project managers to identify the location of IBTs as it was difficult to ascertain which houses were built using IBTs based on purely the exterior appearance of the house.
- System Owner Cooperation and Information Availability:
  - The Research Service Provider was dependent on the cooperation of the System Owners because a detailed list of beneficiaries does not exist. This was a time-consuming process as System Owners firstly wanted to approve the questionnaire, obtain approval from the local communities and then had to identify the location of the project/IBT houses to The Research Service Provider.
  - System Owners were generally reluctant to participate in the process. A detailed discussion with a particular system owner revealed that they felt they were being interrogated and their work being questioned.
- External processes and time delays
  - External processes (from the Stakeholder/System Owners end) led to major time delays.
  - From the date of providing Mr Kistnasamy (Everite) with the letter from NHBRC in July in took approximately 2 months before The Research Service Provider was able to convince him to cooperate and participate. The Research Service Provider was at the time instructed by Mr Kistnasamy to wait as he first had to obtain acceptance from the Project Manager, who in turns had to obtain approval from the local community. These approvals were given subject to certain conditions such as the use of local fieldworkers which led to a further delay. Ultimately from the day on which was agreed to participate to when The Research Service Provider was allowed to commence with surveying nearly 6 weeks had passed. Survey work was completed within 2 weeks and data capturing within a week.
  - From the date of initial contact with the Western Cape Department of Human Settlements, months passed before they provided The Research Service Provider with a list of beneficiaries in the Delft area. The Department advised The Research Service Provider to go through the local structures. The Research Service Provider subsequently made contact with the Ward Councillor for the area, who was unresponsive. After numerous attempts to engage with the Ward Councillor, The Research Service Provider was forced to bypass the Ward Councillor, and engaged instead with local religious organisations in an effort to identify and source local fieldworkers. The Cape Flats are notoriously volatile and The Research Service Provider therefore had to proceed with the utmost caution as fieldworker safety was a vital consideration. From the date on which The Research Service Provider received the list from the Department of Human Settlements to the date on which surveying could commence, nearly 4 weeks had passed. Surveying was completed within 2 weeks and data capturing within 1 week.

1.6 ASSUMPTIONS

The following assumptions were made during the research:

- Sample surveyed is a true representation of the consumers occupying subsidised residential units built using IBTs.
- Information and findings gathered in the sampled provinces will remain true and valid for the rest of South Africa.
- Innovation literature obtained will be deemed to be the latest applicable due to the very limited construction innovation literature available.

1.7 REPORT OUTLINE

The remainder of the report comprises the following chapters:

- Section 2: Literature Review
- Section 3: Stakeholder and Key Informant Perceptions
- Section 4: Consumer Perception Survey Results
- Section 5: Analysis and Recommendations
- Section 6: Conclusion

2. LITERATURE REVIEW

2.1 INTRODUCTION

This section is based on secondary research using research conducted on the topic of Innovative Building Technology (or Modern Methods of Construction as it is termed in some other countries) produced in the last 10/15 years.

The main aim of the secondary research is to better understand the factors that influence consumer satisfaction, dissatisfaction and acceptance, the trends globally and locally in terms of IBTs and how it is perceived by communities and stakeholders, and ultimately also to obtain an understanding of how government promotes and implements IBT as part of their housing delivery strategies.

The Literature Review will be dealt with on the following topics:

1. Key influences of Construction Innovation – *to obtain an understanding of what drives the construction industry to become more innovative as these factors can be used as part of a Promotion and Stimulating Usage Strategy*
2. The Concept of Consumer Satisfaction and Dissatisfaction and the Acceptance Theory – *to obtain a better understanding of what influences consumer satisfaction or dissatisfaction. To ultimately convince a consumer to accept a new and unknown it is important to focus on the aspects that influence the consumer's satisfaction levels and to understand user acceptance of new technology.*
3. Case Studies – *investigating the current situation and usage of IBTs in residential construction within other countries, and the measures implemented by the respective governments to promote and stimulate the use of IBTs.*
4. Situational Analysis of Low Income Houses in South Africa – *to obtain an understanding of the current situation with regards to housing delivery in South Africa and the role of IBTs in addressing the challenges experienced*
5. Conclusion – *provides conclusive remarks and findings based on the current situation in South Africa, how consumers rate satisfaction levels and acceptance and given the lessons learned from other countries on how IBTs are being implemented and promoted.*

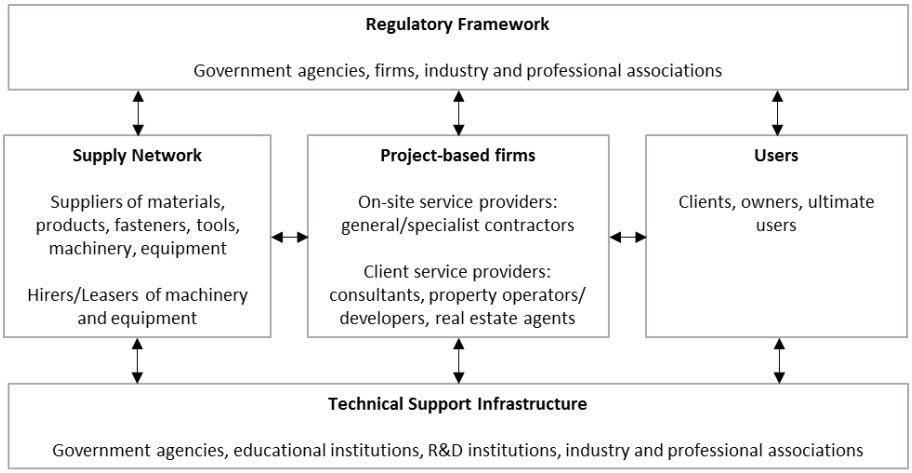
2.2 KEY INFLUENCES OF CONSTRUCTION INNOVATION

The higher the levels of innovation in the construction industry, the greater the likelihood that it will increase its contribution to economic growth. Unfortunately, in most countries, there is a perception that the industry is not generally innovative, and that there is much room for improvement (Blayse and Manley, 2004).

Innovation in the construction industry can take many forms. Slaughter (1998) characterizes such innovation according to whether it is 'incremental' (small, and based on existing experience and knowledge), 'radical' (a breakthrough in science or technology), 'modular' (a change in concept within a component only), 'architectural' (a change in links to other components or systems), or 'system' (multiple, integrated innovations). Blayse and Manley (2004) describes innovation as being either 'technical' or 'organizational'. Technical innovation involves either 'product' or 'process' innovation, whereas organizational innovation includes

changes to organizational structure, introduction of advanced management techniques, and implementation of new corporate strategic orientations (Anderson and Manseau, 1999).

Figure 2.1: Participants in the building and construction project system **(based on Gann and Salter, 1998)**



2.2.1 CLIENTS AND MANUFACTURING FIRMS

Clients and manufacturing firms are key industry participants in terms of driving innovation. Clients are commonly considered to have enormous capacity to exert influence on firms and individuals involved in construction in a way that fosters innovation (Barlow, 2000; Gann and Salter, 2000; Kumaraswamy and Dulaimi, 2001; Nam and Tatum, 1997; Seaden and Manseau, 2001). Clients are able to enhance innovation in construction in a number of ways.

They can identify specific novel requirements to be supplied by developers, building product suppliers, contractors, and operators (Seaden and Manseau, 2001); exert pressure on project participants to improve buildings' lifecycle performance, overall characteristics, and project flexibility to cope with unforeseen changes (Gann and Salter, 2000); and generally demand higher standards of work (Barlow, 2000). ***The more 'demanding' and experienced the client, the more likely it is to stimulate innovation in projects it commissions*** (Barlow, 2000).

2.2.2 STRUCTURE OF PRODUCTION

One of the features of production said to be most difficult is the temporary or once-off nature of construction projects. This is associated with discontinuities in knowledge development and in transfer of knowledge within and between organizations, and restraints on the development of an 'organizational memory' (Dubois and Gadde, 2002). The once-off nature of most building projects limits the degree to which a given innovation will be applicable to other situations, reducing the benefits of innovation and therefore incentives to innovate.

It also tends to have the effect that different solutions to similar or identical client requirements are developed time after time, meaning that organizational learning is hindered (Barlow, 2000). Traditional approaches to the management of construction projects have also been criticized as tending to dampen conditions for innovation. For example, Koskela and Vrijhoef (2001) call for a complete revision of the theory of construction management, which they see as currently deficient.

A number of researchers have elaborated on the problems caused by traditional management approaches. For example, Winch (2000) has suggested that the allocation of hierarchical roles has important consequences for innovation.

2.2.3 INDUSTRY RELATIONSHIPS

Industry relationships have an extremely significant influence on construction innovation (Anderson and Manseau, 1999). The importance of relationships lies in their capacity to facilitate knowledge flows through interactions and transactions between individuals and firms. These interactions and transactions can include processes related to product integration (between manufacturers and assemblers and installers of construction products), processes related to project organization and coordination, diffusion of technologies and practices, flow of labour, and information flow from various sources (Anderson and Manseau, 1999).

In a complex systems industry such as construction, firms must rely on the capabilities of other firms to produce innovations and this is facilitated by some degree of continuing cooperation between those concerned with the development of products, processes and designs (Anderson and Manseau, 1999).

The structure of production in the construction industry involves challenges that can be met through the existence of robust industry relationships that can enhance knowledge flows. Innovation brokers, especially those with a multi-industry focus, can assist in maximizing knowledge flows, helping to overcome the limitations of 'technology watch' in the industry (Anderson and Manseau, 1999).

2.2.4 PROCUREMENT SYSTEMS

Procurement systems that tend to discourage construction firms from risking the adoption of non-traditional processes and products are most injurious to innovation. These systems include those that place a premium on speed and urgency or on competition on the basis of price alone, establish rigid role responsibilities, or promote adversarial and self-protective behavior (Kumaraswamy and Dulaimi, 2001).

A number of procurement systems are available to construction clients, including traditional lump-sum (fixed price), design-build, construction management, project management, on-call multi-task contracting, guaranteed maximum price, full cost reimbursable, and BOOT (build, own, operate, transfer). The traditional lump-sum contract is the most conservative, and the most detrimental to innovation, drawing the most criticism in the literature (Walker and Hampson, 2003). It involves the highest cost risk for contractors, the highest incidence of adversarial relationships, the lowest level of integration across the supply chain, and the poorest innovation outcomes (Kumaraswamy and Dulaimi, 2001).

Higher levels of innovation arise when a more innovative procurement method is chosen. From an innovation perspective, it is the presence of a well-integrated team that is of most importance, as this aspect of a procurement system is key in driving innovation (Walker *et al*., 2003). This might involve partnering alongside fixed cost contracts to improve communication, learning, and innovation outcomes on straightforward projects. For more complex projects, a design-build, construction management or project management can have good innovation outcomes.

These approaches integrate design and construction functions (and sometimes financing and operation), leading to improved design constructability and economy, through innovation. Communication, learning, and innovation are also improved across the supply chain through

management by a single entity. Further, incentives for innovation are enhanced as there is greater scope for capturing benefits (Kumaraswamy and Dulaimi, 2001; Walker *et al*., 2003).

2.2.5 REGULATIONS/STANDARDS

Gann and Salter (2000) argue that government regulatory policies exert a strong influence on demand and play an important part in shaping the direction of technological change. According to Dubois and Gadde (2002), this has generally been a negative influence internationally, with many government regulations and industry standards hampering innovation. Although performance approaches are often seen to promote innovation more vigorously than prescriptive approaches, the ultimate impact of any regulation or industry standard depends on the capabilities of the regulators (Gann *et al*., 1998)

The process of developing regulations is complex, relying upon the knowledge of key players. The extent to which technical change is encouraged depends on the availability of new knowledge, together with the development of appropriate mechanisms. If the design of regulations and standards is approached strategically, positive innovation outcomes may be expected through the codification of existing technology and the creation of demand for new practices and technologies (Gann *et al.,* 1998).

2.2.6 BARRIERS TO INNOVATION

Benmansour and Hogg (2002) stated that innovation within the construction sector is occurring and evidence of this can be found in the list of issues and activities that has emerged in recent years. However, notwithstanding such developments, within the context of the framework outlined above, evidence of the existence of barriers to innovation can be identified within the construction industry. They further stated that construction literature is full of explanations of barriers to innovation. Winch (1999) considers the project-based nature of the construction industry as a significant barrier to innovation. Egan (1998) reports that the fragmentation of the construction industry inhibits performance improvement while Morledge (2000) points to the supply-side reluctance to embrace new ideas and the weak demand-side in terms of number of clients who have access to innovative or improved techniques. In the report 'Value for Money' (Gray 1996) underlines the problem of the need for bespoke designs with the design of highly engineered and non-standardised buildings and suggests that the production-oriented approach to building design and construction common in other countries should be extended to greater use in the UK.

Hogg (2000) stated that the tendency in construction toward the production of unique, non-standard products leading to buildings that are complex to construct, with each building requiring a new learning experience, may be regarded as a fundamental aspect of the industry's culture that, at the level of the firm, may be a significant barrier to innovation. Likewise, resistance to the adoption of recognised and proven methods of improving the service given to clients, be it from contractors or consultants must be regarded as damaging and examples appear to be common in construction. One such example relates to the extent of use of the practice of Value Management. Despite the level of recognition and promotion given to this activity, there appears to be a hesitance by many practitioners to embrace the opportunity Value Management provides (Hogg, 2000).

To summarise the above literature, the following can be identified as the key barrier to innovation in the construction sector:

- ***Project-based nature of the industry***
- ***Fragmentation of the industry***

- ***Supply-side reluctance towards innovation***
- ***Weak demand-side in terms of clients access to innovative techniques***
- ***Need for bespoke designs (need for non-standardised buildings)***
- ***Resistance to adapt to new methods from contractors and / or consultants***

2.3 CONSUMER SATISFACTION LEVELS AND THE ACCEPTANCE THEORY

2.3.1 THE CONCEPT OF CONSUMER SATISFACTION AND DISSATISFACTION

Feçiková (2004) defines satisfaction as the result of "things not going wrong". Researchers have widely identified it as one of the key challenges facing the construction industry (Torbica, Ž.M., & Stroh, R.C., 2001; Chan, L.K., Hui, Y.V., Lo, H.P, Tse S.K., Tso, G.K.F., & Wu, M.L., 2003; Constructech, 2001 & 2005; Dulaimi, M.F., 2005; Kärnä, S.' 2004; Kujala, J., & Ahola, T.' 2005) satisfaction is achieved or exceeded if a product or service outcome meets or exceeds the customer's expectation. Maloney (2002) further explains that satisfaction entails recognizing the customer needs, requirements and devising measures to meet the requirements.

Construction client satisfaction was defined as the measurement of the extent to which a client's expectations for a service or a project overall are met (Parasuraman, A., Zeithaml, V.A. & Berry, L.L., 1988; Samwinga, V. & Proverbs, D., 2003; Soetanto, R., & Proverbs, D., 2004; Siu, N. & Cheung, J., 2001). Thus, it is essential to distinguish the two components of satisfaction - client expectations and the actual or perceived quality of the service offered. More so, satisfaction should not be considered as a global entity due to the various expectations of clients and the quality of services perceived. A proper measure of satisfaction includes a separate assessment of both client expectations and the quality of service provided.

Kometa *et al. (1995)* observed that "evidence abounds to suggest that clients are largely misunderstood and dissatisfied with the performance of their consultants and contractors." Previous studies have identified several factors responsible for client dissatisfaction in the construction industry. For instance, Nkado & Mbachu (2003) attempted to differentiate between objective reality and client's perceptions of it. Accordingly, they argued that client satisfaction/dissatisfaction is a subjective phenomenon, which may not be based on objective reality (e.g. delivery of the project within time, cost, and quality targets), but on client's perceptions of the objective reality. Many authors have emphasized the significance of customer satisfaction and its use for evaluating the quality from the customer's perspective in construction literature (Barrett, P., 2000; Maloney, W.F., 2002; Torbica, Ž.M., & Stroh, R.C., 2001; Yang, J. & Peng, S., 2008). In line with high-level requirements, dissatisfaction is growing among consumers with design and construction, because building projects are widely seen as unpredictable regarding delivery on time, within budget and to the standards of quality expected. Property occupiers and owners require facilities that will be comfortable to occupy, cost-effective and efficient to run while ensuring added value assets. The construction industry tends to define quality as the ability of products and processes to conform to the established requirements.

Tang *et al.* (2003) highlighted ***eight key factors for evaluating customer satisfaction***:

- Professionalism of service
- Competitiveness of service
- Timeliness of service

- Quality of design
- The degree of innovation
- Completeness of other considerations
- Availability of support for the client
- Supervision at implementation.

More recently, Yang and Peng (2008), in their study on client requirements for construction project management service highlighted cost, quality, time, communication, amongst other factors as dimensions for evaluating satisfaction.

FACTORS DETERMINING CLIENTS' SATISFACTION WITH PROJECT QUALITY

Clients have been increasingly concerned with the overall profitability of projects and the accountability of projects. Cost overruns, in association with project delays, are frequently identified as one of the principal factors leading to the high cost of construction (Charles, T.J. and Andrew, M.A., 1990). To the client, quality may be defined as one of the components that contributes to "value for money" (Flanagan, R. and Tate, B., 1997). Previous research has identified several factors that determine client satisfaction. Many of those are associated with service providers' performance or service quality and clients' strategic decisions, which include:

- Inability of consultants to accurately determine client requirements and transform into reality (Ahmed, S.M. & Kangari, R., 1995)
- Understanding of the client needs client orientation, communication skills and response to consultants' feedback (Cheng, J., Proverbs, D.G., & Oduoza, C.F., 2006; Dainty, A., Moore, D. & Murray, M., 2006)
- Service quality factors and cooperation of service providers (Kärnä, S., 2004; Kometa, S.T., Olomolaiye, P.O., & Harris, F.C., 1995) recognized four important clients" needs in the built environment, which are functionality, safety, quality, and completion time.

Maloney (2002) emphasizes the importance of the physical product and service delivery when assessing customer satisfaction in the construction industry. Effective communications between the client and service providers also play a significant role in the overall satisfaction of the client. Communication within project-based environments presents unique challenges, and different perspectives highlight the diversity of communication problems facing those working within the project-based environments (Dainty, A., Moore, D. & Murray, M., 2006)

DEFINITION OF QUALITY

Joubert (2002) revealed that quality to a producer means "conformance to specifications," while to a customer it means "fitness for use." Meanwhile, per Juran (1993), quality can be defined regarding conformance to the agreed requirements of the customer and a product or service free of deficiencies. Harris and McCaffer (2001) described quality as meeting the requirements of the customer. In the building construction industry, quality can be defined as meeting the requirements of the designer, constructor, and regulatory agencies as well as the owner (Arditi, D. & Lee, D.E., 2003). However, Abdulkarim (2011) include the legal, aesthetic and functional requirements of a project. According to Bamisile (2004), quality is "the totality of features and characteristics of a product or service that bear on its ability to satisfy the stated needs." Milakovich (1995) consider quality as a subset of performance, in conjunction with productivity, safety, and timeliness, while others seem to think of it regarding "conformity to established requirements" or "fitness for purpose." According to Nzekwe (2010), the following quality requirements must be present in any project; quality of the project is of the

desired standard; project design and supply specifications contain sufficient details. Others are excellent client services; effective communication; client's actions and interactions; tender assessment of quality, not just price; minimal reworks and defects.

QUALITY ISSUES IN CONSTRUCTION MANAGEMENT

According to research conducted by the Building Research Establishment (BRE) (Egbu, Ellis & Gorse, 2004: 308), 90% of building failures are due to problems arising in the design and construction stages. These problems include poor communication; inadequate information or failure to check information; inadequate checks and controls; lack of technical expertise and skills, and inadequate feedback leading to recurring errors. Egbu *et al*. (2004: 308) note that most of these problems are mainly 'people'-related problems. A great number of the defects in low-income houses occurred during the construction stage and were mostly due to poor communication and inadequate checks and controls (Sommerville, 2007: 395). As an illustration, Alink (2003: 18) states that failures have resulted from incorrect building procedures and poor on-site supervision and workmanship.

GOOD CLIENT SERVICES

Service is a crucial factor required by clients. The pressure and demand generated by construction customers or clients for quality and improved service have challenged the industry to become more efficient, devising and integrating means to meet, improve and possibly exceed its client requirement and satisfaction (Smith, J., Love, P.E.D., & Wyatt, R., 2001). Services rendered by an organization, or contractor has a significant impact on client retention. Per Maloney (2002), the services provided by a contractor to the customer provide an avenue for contractors to enhance their satisfaction strategies to the customers. He further argues that the positive or negative service encounter of the client would result in high or low satisfaction. Moreover, Yasamis *et al.* (2002) states that project owners do expect the provision of quality service from the contractors. However, it is vital that goals and strategies for client service in the construction industry be set such that it incorporates all the project participants, the industry policies, and the stakeholders' satisfaction attributes, indicating that adequate service is an attribute required by all project participants. Yasamis et al. (2002) in a study on assessing contractors' quality performance stated that quality performance in construction is results oriented, and seeks evidence of quality awareness within the operations and output of a project organization. For example, cost overruns and time delays of construction activities are often used to measure the impact of rework occurring during the process.

DEVELOPING A QUALITY CULTURE IN THE CONSTRUCTION INDUSTRY

Culture is unique to each organization. There are ten (10) essential part of quality culture which Total Quality Management (TQM) practitioners generally agree should be present in organizations whose culture complements TQM implementation (Adebanjo, D., Kehoe D., 1999; Ahire, S.L. Golhar, D.Y., & Waller, M.A., 1996; Ahmed, S.M. & Kangari, R., 1995; Bubshait, K. A., 2000; Dellana, S. A., & R. D. Hauser., 1999; Haupt, T. C., & Whiteman, D. E., 2004; Ngowi, A. B., 2000; Rita, E., 2003; Shammas-Toma, M., Seymour, D.E. & Clark, L.A., 1998; Zhang, Z. Waszink, A. & Wijngaard, J., 2000). This included:

1. Leadership and top management commitment
2. Customer management
3. Training and education
4. Teamwork

5. People management and empowerment
6. Supplier partnership
7. Quality planning
8. Strategic, process management
9. Rewards and recognition
10. Effective communication.

2.3.2 ACCEPTANCE THEORY

Louho, Kalliojaand and Oittinen (2006) state that acceptance is about how people agree to take and adopt some new technology for use. User acceptance of new technology is further described as the noticeable readiness within a group to employ new technology to achieve a goal previously with a different method (Dillon 2001). Hence, acceptance can be viewed as a function of user involvement in technology use.

Acceptance can be further described as the critical factor in determining the success or failure of any technology and acceptance has been conceptualized as an outcome variable in a psychological process that users go through in making decisions about technology (Dillon and Morris 1996). Shi (2005) states that most studies in relation to the satisfaction acceptances of the consumers towards a new construction technology are based on the housing needs, wants, values, norms, preferences, satisfaction and acceptability. Hence, from the current literature it emerges that are three most important social aspects namely housing needs, preference and norms, which determine the social acceptancy of the implementation of new construction technology.

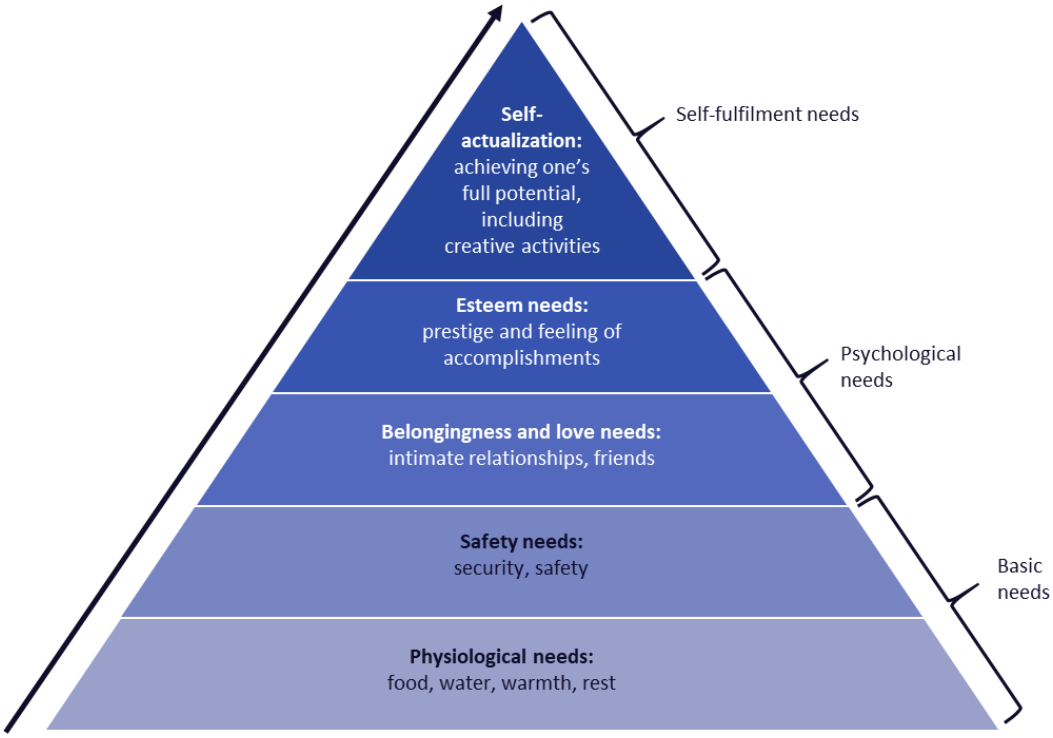
Housing Preferences: The preferences of the recipients of the house aims for specific elements in a house and are normally very shifted and tend to change after some time. It is reliant on a large number of perspectives, which can be partitioned into households' financial profile, socio-statistic profile and what value they hold for housing (Shi, 2005).

Housing needs: According to Simons (1987) Maslow's framework, which is largely represented as a triangular hierarchy of levels, hypothesizes that the requirements of individuals can be partitioned into a few unique layers of significance. This chain of command of necessities was produced by Abraham Maslow in 1943 in his mission to qualify the hypothesis of human motivation. Despite the fact that his study has been superseded by advanced Connection Hypothesis in sociological and mental research (which just considers the way which people relate to each other over a periods), it is centred on the idea that still demonstrates legitimate for the meaning of fundamental human housing needs and provision.

As per the definition as set out by Maslow, the requirements of people can be partitioned into five unique layers (Figure 2.2), with every layer coming first before alternate layers. Alluding to Figure 2.2 the graph above, the primary level relates to essential physiological needs, which are the minimal positioned level in the chain of importance.

From here, every single other level begins, up to the fifth level. In the event that a level's need has not been met to then the upper levels' impact is immaterial; subsequently, every level must be satisfied to advance to the following. In spite of the fact that this progression was produced to incorporate the entire of human needs, it can be contracted down to a definition that exclusively delivers needs specifically identified with housing. Hence, this basically supports that for any new technology to be accepted and be termed suitable it has to first meet a certain level of acceptance the lower level (Merriam-Webster Inc., 1994).

Figure 2.2: Maslow's hierarchy of needs (McLeod, 2016)



Housing norms: Despite the fact that a house may satisfy the requirements of the owner, it doesn't really imply that it will be satisfactory to him/her. This is because of the social desire that is available in every individual. To comprehend these complicated features of housing, particularly as it identifies with government sponsored minimal effort lodging in South Africa and as it relates to subsidized low-cost housing by the government in South Africa, it is necessary to investigate the extent of housing norms in all humans.

As depicted by Morris et al. (1986), the housing standards of individuals are based on social beliefs, weighted on by the precedency of what other have grown believe is a standard norm for it to be acceptable. Therefore, a housing unit has to adhere to specific guidelines and desires set by the community, or section of that group. This suggests that if a household does not consent to these standards, a deficit will exist. Thus, it will allow for the family to spur on the deficit, so as to remove the dissatisfaction of not meeting the norms. (Morris and Winter, 1978).

NEGATIVE PERCEPTION OF ALTERNATIVE HOUSING CONSTRUCTION SOLUTIONS

Even though several alternative housing designs have been proposed, tested and built as showcase examples by a variety of organisations in South Africa, the uptake of these solutions have not developed to implementation on a massive, nationwide scale. Negative perceptions that prospective homeowners have about new building materials and technologies contribute to this sector's exclusion, and community input has shown this to be a widespread problem (Department of Human Settlements, 2010). "Thus, the underestimation of the complex relationship between society and housing in the alternative low-cost housing sector is evident. ***This objection stems from the sociological view of a traditional "home".*** From the general viewpoint of the beneficiaries, a traditional home consists of a brick and mortar top structure with adequate living space, kitchen, ablution facilities and bedrooms, together with a back- and front yard. The solidity provided by modern brick structures contributes to

inhabitants feeling safe and comfortable inside their homes, as opposed to the ***perceived lower quality*** of IBT systems.

"The household will then have a choice to either ***adjust its conditions*** (by changing the housing) or to ***adapt to the conditions*** (by changing the household) to remove this deficit. By incorporating the housing norms of a household, Morris and Winter (1973) then developed a new type of housing suitability approach, known as the ***Housing Adjustment Model***".

HOUSING ADJUSTMENT THEORY

The theory of housing adjustment behaviour is a framework aimed at getting accustomed to the method by which households pursue to maintain to find an equilibrium, the things that cause disequilibrium, and the consequences of existing in a state of disequilibrium. In this sense, ***equilibrium*** refers to a ***state in which the household's current housing is in accordance with the norms of both society and the household itself, and it fits the needs of the household***. Housing norms include:

- Space
- Tenure and Structure type
- Quality
- Expenditure
- Neighbourhood

When one or more of these norms is not met by the household's current housing, the household experiences a ***housing deficit***. Hence there needs to be some sense of ***equilibrium met*** when bringing in and trying to introduce ***the use of innovative construction technology*** (Morris and Winter, 1978).

COLLABORATIVE PLANNING THEORY

Collaborative planning followed the realization that people were not saying much about planning for their community development. The collaborative planning theory was meant to encourage ***previously silent groups***, including the ***poor, women, and the disabled***, to come to the centre of community development and say what they think could help them (Giddens, 1985). Collaborative planning downplayed the central expert role of the planner and instead adopted a ***people-centred approach*** where people could drive their development process and decide as a collective (Healey, 1998). Participants in collaborative planning theory are encouraged to find ways of ***practically achieving their planning desires*** and to question what is put before them rather than simply agreeing with everything.

According to Ntema (2011) the National Housing Policy specifies that ***all housing subsidies offered should be met with a contribution from the recipient either in the form of funds or labour, to encourage a culture of responsibility and saving for housing***. The government introduced the People's Housing Process and promise to fund households who are willing to participate in building their own house. People can now, with assisted help, choose alternative construction methods to build dwellings that are of a good quality, of a design that reflects individual needs and taste, and from which they can work.

One of the advantages of collaborative planning is that ***participants are able to interact with the planners***; their indigenous knowledge is not simply taken for granted, which means there is a ***mutual learning process*** where knowledge passes from the expert to the local people and from the people to the expert (Tewdwr-Jones, 1997). Secondly, collaborative planning ***empowers people because they become part of the planning process in that they are***

able to question and reason throughout the process of planning (Tewdwr-Jones, 1997). Thirdly, collaborative planning adopts a more open style of practices in such a way as to open ***communication between the expert and the stakeholders*** (Tewdwr-Jones, 1997). Moreover, with collaborative planning participants are able to ***collaborate and change*** the existing conditions into what they think could best suit all of them.

INTEGRATION AND COORDINATION APPROACH

Smit (1998, 77) stated that "in order to improve people's lives in a meaningful way and be able to cope with the complexities of informality, it is essential that informal settlement upgrading policies and programmes are integrated…" Smit (1998) further cites examples of successful integrated approaches to informal settlement upgrading from India and Kenya. ***Integration, as a concept is used specifically as a tool of bringing together different sectors, policies or programmes*** in informal settlement upgrading. Mabin and Smit (1997) as cited by Pieterse (2003) define integration approach as coordination and integration of sectorial investments in cities to ensure that, among other things, ***design and spatial planning come together and reinforce social development.***

From the literature it could be concluded that acceptance and satisfaction levels of new innovative building technologies by the consumers could be higher as a result of their involvement in planning and development processes.

2.4 CASE STUDIES

Case studies were conducted to understand the situations in other countries regarding the use of IBT's (or as previously stated Modern Methods of Construction as it is termed in most other countries), how it is perceived and accepted in these countries, and how the respective governments promote the use thereof in residential construction. The following countries were covered:

- Developed, First-World category:
  - Sweden
  - United Kingdom
- Developing, BRICS category:
  - India

2.4.1 SWEDEN

About ***eight out of 10 detached houses in Sweden are built using modern methods***, according to a study by University of California, Berkeley. The study also revealed at least 30% of new-build multi-residence buildings in the country use a significant degree of ***prefabrication***, meaning at least 45% of overall housing is produced using some form of offsite manufacturing.

The country has a history of building with timber as 70% of its area is forest. This has created a housebuilding market well-suited to ***offsite manufacturing***, because timber lends itself well to many of the processes used in prefabrication. In an interview with a leading Swedish timber company's sales director, Mr Andreas Jonasson, he was quoted as saying: "We have a lot of housing factories around Sweden that are producing timber homes for families. We have a tradition of building that way." He states that the one reason for this tradition is Sweden's severe climate. Its extreme climate has been a driver in the development of offsite construction in Sweden. With temperatures that routinely fall to -20°C in the winter, the ground is soft

enough to be built on for only a very limited time. This makes the use of offsite manufacturing key to delivering homes on site efficiently in the months when they can be installed.

There has also been a push by the Swedish government to improve sustainability within the construction industry and to reduce the environmental impact. In fact, the **government has allocated areas in cities around the country where any new structure must be manufactured from timber in order to promote sustainable building practices**, for example the city of Växjö in the country's south, new buildings must by law be built using offsite timber manufacturing.

2.4.2 UNITED KINGDOM

According to the British Standards Institution only about 10% of all building projects in the UK are delivered using offsite methods, with its use much more common in the construction of hotels and schools than housing. The UK has a history of building in brick and concrete, while for Britons the notion of manufactured homes often conjures up images of drafty post-war prefabs that all look the same. Professor Alex de Rijke, a director at architecture practice dRMM, says: "The legacy left was that ***modular homes were considered cheaper, poor quality, ugly and uninspiring.***"

But more significant than negative public preconceptions, according to Jeremy English from Södra, is the ***view of many in the construction industry that offsite manufacturing is no more than a back-up plan for traditional building methods***. English, who is UK sales director for the Swedish Timber Company to manufacturers, says: "In the drive to offsite manufacture, people have taken a traditionally built home and turned it into a timber-framed home by taking the same set of drawings and saying 'How can we make these walls out of timber?' – but that's not the best way. The best way is to say 'We want to build this way' and plan from there."

There are also issues around ***capacity***, with Stephen Kinsella, Homes England's executive director for land, saying the big housebuilders have traditionally been ***reluctant to invest in new technologies*** because of uncertainties around a long-term pipeline. Södra's English agrees, saying: "If you can rely on the demand you can invest the cash; it's as simple as that." "If you give me an order for a thousand houses, I'll invest the cash, but if you give me an order for one […] I'm not so sure."

Despite all this, ***the housing market could be at a tipping point*** when it comes to the uptake of modern methods of construction. The UK is in a ***housing crisis*** and the government is touting a goal to build 300,000 homes a year by the mid-2020s to tackle it. Such a target seems unachievable unless housebuilders increase the use of modern methods. On top of this a recent report by housing charity Shelter says the country needs to build 3 million social homes over the next two decades. Meanwhile, chronic labour shortages in the construction industry are set to worsen as the clock ticks toward Brexit.

Mark Farmer, chief executive of consultant Cast and author of Modernise or Die, says: "The UK is facing a growing structural skills shortage as more workers age and retire, while Brexit will reduce access to European labour. Without pushing for an ***increase in modern methods of construction to substitute the labour gap with improved productivity***, our housebuilding capacity will shrink."

There is also a huge opportunity to ***improve quality assurance*** in the UK new-build market, where chronic snagging issues and worse have been a blight on the sector for years. Farmer says: "**A more widespread uptake of modern methods of construction would in theory dramatically reduce quality issues, through the increasing control over variables**

related to the housebuilding process. We are finding that things need to be done multiple times.

"This risk reduction is achieved primarily through transferring activity from highly variable on-site environments using a transient workforce of variable competence, to one where ***standardisation***, process, and protection from the elements allow for more rigorous quality control." Farmer believes this, combined with the skills shortage, should be a driving factor in increasing methods of construction, saying: "The ***negative stimulus of the skills crisis*** and the ***growing risk of reputational damage*** from consumer complaints is the long overdue catalyst for change that housebuilding needs."

There also seems to have been a genuine push by government to improve productivity in the construction industry by pushing firms to increase the uptake of modern methods, with delivery agency Homes England given powers to drive this within the housing sector.

It does seem the circumstances have never been more favourable for an overhaul of the sector. As Homes England's Kinsella says, the country's shortage of both homes and skilled construction workers highlights the obvious benefits of using modern methods to build new homes: "If it builds houses quicker and reduces the number of professional construction skills needed, it's a winner for me."

The government agency is doing its best to put its money where its mouth is, according to Kinsella. He says Homes England is now running pilot sites in Birmingham, Hemel Hempstead, Cambridge, Milton Keynes and Warrington to stimulate the uptake of modern methods of construction in housing, as it has recognised the industry needs a push. "There is a cost for innovation, so something has got to give," he says. "We [Homes England] decided to ***set up the contract structure*** that allowed for innovation and bring forward good sites in good locations that allows for innovation."

Moreover, he says, the agency is working to ensure it is ***easier for companies to get on board***, saying there is work that needs to be done to tackle the ***red tape surrounding manufactured homes and the technologies used to produce them***. "We have been working closely with a group led by Mark Farmer, in partnership with the Ministry of Housing, Communities and Local Government, with funders, suppliers, insurers, warranty providers and so on to try and address some of the ***barriers around warranties, insurance and funding assurance*** – because it's quite difficult to get your system up and running and accepted."

And Homes England is not the only public body pushing for change. On a more local level, Birmingham council has announced it is preparing to launch a modular housing development programme this spring. The council-owned Birmingham Municipal Housing Trust is planning to trial a 50-home offsite manufactured housing development using volumetric and modular solutions, with a larger roll out programme to follow next year.

Change is afoot within the industry, says Kinsella: "It feels like it's with us now. Over the last 12 months we have seen several players entering the market as well as the established players recognising – albeit because they've got to because they can't get the skills on site – that we need to embrace technology and move forward in a different direction."

Disruptors such as L&G and Urban Splash have attracted attention in the sector, with the former rolling out its first manufactured homes last autumn. Urban Splash has continued to score contract wins, last week announcing a £55m housing venture for Peel Land at Wirral Waters. It will deliver 347 units in four modular designs covering one- to three-bedroom homes. The units will be assembled at SIG's former manufacturing site in the East Midlands, which Urban Splash acquired for £1 last year. And the big boys are coming along too, with

Södra's English revealing Persimmon's offsite manufacturing arm Space4, which produces wall panels and roof cassettes, is a customer of the Swedish firm, which acquired UK company Crown Timber in March 2016. Work started last June building Berkeley Homes' new factory in Ebbsfleet, and the company has begun looking for staff for the facility, seeking systems engineers to support first the development of the volumetric modular production facility and then the day-to-day management of the manufacturing system once the factory is up and running. These are all good signs and modern methods of construction seem to be an answer to a lot of the problems facing the UK housing industry, but is it all enough to get England to a similar position as Sweden?

Williams' idyllic description of a cosy, fault-free home that can be delivered on site within a matter of days may still feel much closer to a dream than a reality. Yet there are signs the 80% market share that prefabrication boasts of the housebuilding market Sweden may not be so far out of the UK;s grasp.

The Construction Leadership Council has been working to develop a joined-up approach to procurement to shore up a pipeline of work for offsite manufacturers in the housing sector, while Homes England's eight strategic partners, which were announced last year and are set to deliver more than 14,000 affordable homes by March 2022, have all guaranteed to use modern methods of construction to deliver a chunk of these.

So, momentum is gathering and all that remains is to see how quickly the revolution will take hold among all UK housebuilders.

2.4.3 INDIA

Rapid economic growth and limited availability of affordable land have restricted the horizontal mode of construction leading to vertical construction in most of the Indian cities. Urban India is mostly marked by tall buildings that are being built. Due to the economic slowdown and some governmental interventions, these building projects are seeing ***significant time and cost overrun***, ultimately impacting the end-user. As these market pressures rise more and more, real estate developers are considering ***adopting emerging technologies to compensate for these construction issues***. Indian construction industry is undergoing a paradigm shift from traditional methods of construction to modern methods of construction. ***Precast technology*** is one such move which is expected to enhance the productivity of the construction process, thereby, optimizing the requirement of resources on the site, reducing waste generation and resulting in a faster delivery of the projects. While internationally precast technology is considered as a mature technology, in India, it is not widely utilized, despite the advantages. ***Commonly cited constraints are high costs in comparison to traditional construction, economies of scale, logistics, skill level required, end user friendliness, etc.***

In most of the developing countries like India, the cost of executing the project with conventional method is always cheaper than the cost incurred in adopting emerging technologies (such as precast) due to various reasons such as labour dominated industry with low wages, lack of research and development, logistics issues, lack of congenial relationship between stakeholders, lack of technological advancement in construction and inadequate training of labour for working with emerging technologies

As per census data available in government repositories, out of all the residential buildings or buildings used for residential-cum-other use, 50.3% have been categorized as "good", 44.5% as "livable" and 5.2% of them as "dilapidated". Apart from a large number of houses being merely livable or even dilapidated, there are millions of people in the country who are either

homeless or live in unauthorised colonies. And more notably, a large chunk of this population is based out of urban areas.

India has experienced a significant uptick in the trend of people migrating from rural areas to urban cities in search of better living in the past couple of decades since the full-fledged advent of globalisation. In spite of all the positivity and possibilities within in such a scenario, this trend and the concomitant uptick also contributes to the inherent socio-economic disparity prevalent in India since times immemorial. Adding to the aggravation would be the rapid advancements in building and construction technologies. Most of the livable or dilapidated buildings, on which a majority of this migrating population relies upon, will soon be rendered obsolete.

With the new cabinet in place, the government can be expected to advance on the implementation of their ***holistic development and all-inclusive growth schemes*** such as "Housing for All by 2022" and "Smart Cities Mission". This would not only mean development in terms of economic inclusivity or betterment of living standards but will also help in upskilling the future generations of India regardless of class divide and help all sections of the society in being contributors to the mainstream economy of the country. Government data suggests that the country would need a capital investment of around Rs 50 trillion to build proper housing and other support infrastructure and achieve sustainable development by 2022. As the government lays the foundation of "India New.0", all other stakeholders of the society including individuals, small businesses and multinationals have to do their part to ensure successful attainment of holistic growth.

In an attempt to offer an affordable housing solution for small cities where residential land is available for construction; ***pre-engineered buildings*** are being developed by US-based architecture firm KieranTimberlake in partnership with RICS South Asia, Sam Circle Venture, and ProjectWell.

India Concept House is a housing solution under development where the entire house will be designed and manufactured in factories and then assembled into a house at the construction site. The concept targets an affordable cost of Rs 9,500-12,000 per square metre.

Currently, these houses are being designed as single-storied expandable housing units in sizes ranging between 32 m2 and 98 m2. Owing to its modular design, the houses can be expanded according to owners' financial capability and changing needs over time.

A 98-m2 house can be assembled and built on site in six weeks. These concept homes have been designed to suit varied climates in the country. Natural and solar-powered ventilation systems maintain interior temperature between 21 degrees Celsius to 29 degrees Celsius. It also provides for water harvesting and recycling of wastewater. Solar heaters are used for hot water supply.

2.5 SITUATIONAL ANALYSIS OF LOW-INCOME HOUSES IN SOUTH AFRICA

The bulk of South Africa's housing units are built using conventional construction techniques to provide a durable, 40m^2 brick and mortar home. This is in unembellished contrast with other countries, where the use of alternative building technologies provides a stream of innovative solutions for the built environment and make up a large segment of the affordable housing sector (Slawik, et al., 2010).

In a peer-reviewed article "Perceptions of the quality of low-income houses in South Africa: Defect and their causes" Zunguzane et al states that quality is a fundamental term in the construction industry. The non-achievement of such a crucial aspect of construction can result in the failure of a construction project and in the dissatisfaction of clients and/or building occupants. Furthermore, the non-achievement of quality can result in delays in building projects and the need for rework, which can result in a significant financial loss. Quality focuses on eliminating defects and variations and seeks to avoid waste of time, materials, and financial resources due to rework (Love, Edward & Smith, 2005: 197).

In the case of low-income houses, Carmona, Carmona & Gallent (2003: 3) contend that poor-quality housing, whether poorly planned in the wider sense, or badly designed, has been the hallmark of a commodity culture whereby housing is viewed as merely a 'demand good' to be thrown up wherever the price is right. According to Carmona *et al*. (2003: 7), ***quality should be provided with the end-user in mind in order to create a healthy and safe living environment***. However, the features of inadequate housing quality include:

- Overcrowding;
- Relatively small sizes of houses;
- Poor building standards in terms of inadequate sound attenuation or heat insulation, and
- Lack of basic urban design amenities, and inadequate supply of services (Carmona *et al*., 2003: 7).

In brief, research studies indicate that the ***quality in the building of low-income houses is one of the reasons for dissatisfaction*** expressed by occupants. For instance, a case study investigation conducted in Pelindaba, Bloemfontein, revealed that in general 74% of the respondents recorded negative perceptions about the quality of their public sector-built low-income houses (Mehlomakulu & Marais, 1999). The respondents observed prevalence of cracks in their houses (78%), roof leakages (58%) and, in general, they were not satisfied with the physical structure of the houses.

Similarly, the study conducted by Madzidzela (2008) at Nyandeni Local Municipality discovered that 85% of the respondents experienced problems with the low-cost houses they are occupying. Reported problems include flooding (27.5%), lack of water (25%), lack of electricity (12.5%), and drainage-related issues (35%). Therefore, as state-delivered subsidy or low-income houses will continue to dominate the South African landscape in terms of housing provision for lower income households (Landman & Napier, 2010), ***it is imperative to address the quality issue in low-income housing with a view to finding a practical solution***.

2.5.1 CHALLENGES RELATED TO LOW INCOME HOUSES IN SA

Despite the considerable modifications and revisions to the housing policy over the years, concerns related to ***quality, efficiency, effectiveness and sustainability of housing programmes*** still define and frame discussions (Khan & Thring, 2003: 18). The challenges usually dominating the low-income housing sector include ***poor design of houses; houses that are environmentally unsound; houses that are not suitable to the local climate, and houses that entail high maintenance costs***. According to Goebel (2007: 292), other problems associated with low-income housing processes include:

- New houses and townships continue placing poor and low-income blacks in 'ghettos' on urban peripheries, far from jobs and services;

- New houses and infrastructure such as sewerage services are of poor quality, are rapidly deteriorating and require maintenance;
- People dislike the model of housing used, and would prefer larger houses – the main model was changed in 1998 when the DHS increased the minimum size of new houses to 30m^2, and
- Because of these problems, people often sell or rent out their subsidised low-income houses bought through the subsidy and move back to squatter or other informal settlements closer to their economic activities.

2.5.2 CAUSES OF DEFECTS IN LOW-INCOME HOUSING

Lubisi & Rampedi (2010: 2) contend that the primary causes of delays are related to the perception that emerging subcontractors with ***capacity challenges*** were always appointed to execute projects, and to poor performance by the contractor. Another media report noted that the ***use of alternative building technologies by less experienced contractors*** has also contributed to the housing problem. In a study conducted in Limpopo, Mpumalanga, the Western Cape, Eastern Cape and Gauteng, which investigated the use of alternative building technologies such as ***compressed earth, interlocking blocks, shutters and concrete, and eco-frame***, it was found that there is ***little knowledge or awareness on the part of beneficiaries of low-income housing*** with regard to building systems approval requirements, and whether the building method used carried an *Agrément* certificate (Mgiba, 2007: 16).

The study by Mgiba, also showed that 4 of the 5 developers who were part of the study had used ***construction methods that were not certified***.

Advantages found in the study were that these alternative construction methods were ***cost-effective*** on the part of developers, ***enhanced speedy delivery***, and some construction methods were found to be ***easy to maintain***.

The ***disadvantages*** were the inability of the houses to ***resist extreme weather conditions***, ***structural defects*** such as cracks that are not easy to repair in some materials, ***poor workmanship***, and structures that are ***not compatible to future extensions*** (Mgiba, 2007: 16).

2.5.3 THE NEED FOR INNOVATIVE BUILDING TECHNOLOGY IN LOW-INCOME HOUSING PROJECT

The “growing population of urban habitant in the world has unavoidably resulted in a very severe rise in the demand for housing. The gap between demand and supply creates a very complex problem, driving the housing sector towards less efficient and more-expensive solutions and new city dwellers towards informal independent construction of dwellings in informal settlement” (Rust, 2006). “The building sectors are the primary consumer of resources and energy in the modern environment. Therefore, it is of great importance to ***develop technologies to deal and reduce adverse environmental effects, while reducing time and cost of production without compromising quality of the house***. The need for consideration of the potential and performance of innovative ideas to try to curb these challenges, find the paramount solution, a consistent set of yardsticks need to be developed with the consideration of sustainability in mind.” “Additionally, the evaluation of sustainable building technologies and solutions entails the development of comparison schemes and benchmarks that will highlight the challenges and opportunities of technology” (Saler, et.al. 2012).

The importance of alternative building approaches in support of sustainable low-cost housing development, in light of the ever-increasing costs of traditional building materials and the high expectations of those demanding free housing. Alternative and innovative building methods are said to be more economically effective building materials and construction methods should be sought to tackle the ever-growing South African housing backlog.

Getting IBT off the ground is however proving to be a slow process due to the ***lack of community trust and participation and the lack of information and understanding of the products on offer*** (NHBRC Western Cape, 2014). IBT include, for example, framed panels fabricated off-site and assembled on-site. They are classified according to mass into heavy or light materials, and on-site or off- site fabrication (CSIR, 2013).

Therefore, ***quality should be viewed as equally important to time and cost, to lower the risks of higher costs and extended project time-frames***. Bowen et al. (2002) argues that the majority of project management control systems highlight time and cost however overlook the relative importance of quality. Therefore, for a successful project, the three parameters of time, cost and quality management should be embraced (Bowen et.al, 2002).

While great strides have been achieved with the alternative building programmes, there have been major issues. ***Dissatisfaction with the quality of the houses has been clearly articulated by the government, beneficiaries and housing analysts***. These houses were often badly built, poorly located on the urban periphery and too small (Tomlinson, 2015).

The ***use of alternative building materials could excel the building process substantially***. A 40m² house may be built in four to seven days, using alternative materials, compared to the average thirty-day period required to build a unit of the same size using conventional brick and mortar construction (Human Settlements Review, 2010). Given the backlogs experienced in South African housing development and the urgency related to supplying homes for the disadvantaged, time savings can be of substantial benefit.

However, ***numerous issues*** in regard to the utilization of alternative technology as substitutes for more conventional methodologies obstruct the usage of these alternatives. These challenges are outlined in Table 2.1.

Table 2.1: Challenges facing the Implementation of alternative technology in South Africa

Problem	Explanation
Perceptions of beneficiaries	• Alternative materials do not always carry acceptance from beneficiaries • Beneficiaries are not always familiar with products and their benefits • Beneficiaries often believe they are receiving a devaluated product • Suppliers of alternative systems do not market their products sufficiently to the public
Quality of structures	• Structural defects are often found a few months after completion • In some cases, units need to be demolished due to substandard workmanship • Quality troubles contribute to the existing negative perceptions surrounding alternatives
Institutional support	• Procurement and tender processes ○ A lack of procurement policies for alternative materials constrain usage • Inspections

Problem	Explanation
	○ The inspection of units might be carried out by qualified engineers but are not always undertaken by officials who understand the comprehensive certification conditions which the material or system carries ○ In-house provincial inspectors are not experienced in the quality assurance of alternative building materials

Source: Ncube (2017) ex Human Settlements Review (2012)

2.6 CONCLUSION

The background and literature review highlight the need for alternative or innovative building technology in residential construction given the rising housing backlog and housing demand. However, the majority of project management control systems related to and driving IBTs, highlight time and cost, and overlook the relative importance of quality. For a successful project, the three parameters of time, cost and quality management should be equally embraced. It is for this reason that the process of getting IBTs off the ground has been so slow – due to overlooking the importance of quality (or more specifically perceived quality) communities lack trust and participation due to a lack of information and understanding of the products on offer.

The literature review indicates that consumer satisfaction is achieved or exceeded if a product or service outcome meets or exceeds the customer's expectation. Satisfaction entails recognizing the customer needs, requirements and devising measures to meet the requirements. It is important to note though that consumer satisfaction/dissatisfaction is a subjective phenomenon, which may not be based on objective reality (e.g. delivery of the project within time, cost, and quality targets), but on consumer's perceptions of the objective reality. Consumer satisfaction levels can be influenced by a number of factors such as cost, quality, time, communication, amongst others.

Consumer acceptance relates to how the consumer agrees to take and adopt some new technology for use. Consumer acceptance of new technology is further described as the noticeable readiness within a group to employ new technology to achieve a goal previously with a different method. Consumer acceptance of IBTs is directly related to the consumer satisfaction levels and are based on the housing needs, wants, values, norms, preferences, satisfaction and acceptability. Hence, from the current literature it emerges that there are three important social aspects namely housing needs, preference and norms, which determine the social acceptancy of the implementation of new construction technology.

The current situation in South Africa with regards to IBTs suggest that these three important social aspects are not being met – this objection stems from the sociological view of a traditional "home" and consumers not accepting IBTs in terms of their housing needs, preference and norms.

The following section will investigate stakeholder perceptions regarding IBT systems and consumer preferences.

3. STAKEHOLDER INTERVIEWS

3.1 INTRODUCTION

The focus of this chapter is to test the perceptions of various stakeholders and key informants with regards to IBTs and the industry's acceptance of IBTs. This chapter is based on qualitative interviews conducted with the various stakeholders involved in the building industry and specifically also IBTs. The target market that was approached for participation in the research included the following:

- All spheres of government (National, Provincial, and Local) and relevant governmental departments
- Universities' Research Units
- Suppliers of IBT products and services, Builders and Developers (accredited by NHBRC/Agrément)
- Financial Institutions (Commercial banks, National Housing Finance Corporation, etc.) and Donors (e.g. Finland, Germany, Sweden, USAID, etc.)
- Professional bodies (e.g. the Construction Industry Development Board, the South African Bureau of Standards, the Council for Scientific and Industrial Research, Agrément, etc.) and Industry Associations (e.g. SACQSP, SAIA, ECSA, etc.)

Qualitative responses for each category of stakeholders are subsequently discussed.

3.2 GOVERNMENT PERCEPTIONS AND VIEWS

3.2.1 INTRODUCTION

Various national and provincial government departments were contacted and invited to participate in the research. Responses were obtained from three provincial Departments of Human Settlements, namely Western Cape, Gauteng and KwaZulu-Natal, although some were limited in the responses provided.

The research questions that were formulated in conjunction with the NHBRC to guide the structured interviews are as follows:

- What is your department/unit/municipality's stance on IBTs?
- What are you doing to promote the awareness and use of IBTs?
- Have you received any complaints or reporting of defects on specific IBT systems?

3.2.2 GOVERNMENT STANCE ON IBTs

The Gauteng Provincial Department felt that an opportunity exists to transform human settlements through IBTs. It was indicated that their provincial department believes that there is potential in IBTs to make government housing products more sustainable in that they can catalyse the enhancement of the environmental performance of the housing product by making it more energy efficient. They also highlighted the probability to lower the cost of construction and shorten the conventional time period required to complete the building of a

house- which is attractive for them as a department given the extensive housing demand and backlog in their province, but also nationally.

In the 2009/2010 financial year, the Gauteng Provincial Department of Human Settlements explored building with IBT through seven pilot projects within the three metropolitan municipalities in Gauteng. The pilot projects undertaken in Zola, Atteridgeville and Mamelodi were directed at the provision of backyards for rental accommodation to facilitate income generation for households. The rest were RDP housing units allocated to beneficiaries as per the qualification criteria. Four of the seven projects used Imison Fibrecote as an innovative building material with asbestos roofing and **Isofoil** inside the roof to improve the thermal efficiency of the house. The other three used **Goldflex, Moladi** and **Robust structures**. The table below reflects these attempted projects.

Table 3.1: Attempted IBT projects in Gauteng Province

Area	Municipality	IBT used	Site visit in 2017
Zola	CoJ	Imison fibrecote	Not included
Kaalfontein Ext 23	CoJ	Goldflex	Yes
Diepsloot	CoJ	Moladi	No
Zonkizizwe Ext 6	CoE	Robust structures	No
Atteridgeville backyard	CoT	Imison fibrecote	Yes
Mamelodi Backyard	CoT	Imison fibrecote	Yes
Soshaguve LL	CoT	Imison fibrecote	Yes

The Western Cape Provincial Department indicated that although they feel there is opportunity for IBTs to alleviate the housing backlog burden and to transform human settlement; it has been observed in their area that the consumer might not understand the product and the advantages associated with it. It was indicated that one of the projects implemented in their area of jurisdiction was disrupted due to communities that protested and resisted the use of IBTs in the construction of houses. They did however indicate that they are in the process of conducting some research of their own investigating not only consumers' perceptions but also the costs related to IBTs, as this is something that they are still not completely clear on.

From the KwaZulu-Natal Provincial Department responses were only received from the Social Housing Division. In their instance, they indicated that they have not yet explored IBTs on the social housing side.

3.2.3 GOVERNMENT MEASURES TO PROMOTE AWARENESS AND USE OF IBTs

The Gauteng Department of Human Settlements indicated that as a means of advancing the momentum in innovative building technologies implementation in the province, a site tour of good practices within the Province was undertaken in 2017/2018 as a second phase of the research study which they undertook in the 2016/17 financial year. The objective of these site visits was to investigate the different models of IBT being implemented. One of the most important fundamentals was that these models should be aligned to the NHBRC requirements and relevant Agrément certification. This has provided a useful baseline of what is working well in implementation and critical features that can be identified in suitable IBT systems. Following this investigation, the Gauteng Department has been working on specifications to undertake a tender process purely with the focus on constructing units using IBT. These units would then be allocated to communities to occupy and test their viability on the ground.

The Western Cape Department of Human Settlements said that due to a recent community protest against the use of IBTs which delayed one of their housing projects severely, they have decided to commission a similar research study in their area of jurisdiction, with the main purpose of determining consumer perceptions as well as determining the issues/complaints/defects related to specific IBT systems. Once a better understanding is obtained of consumer perceptions but also of complaints and defects surrounding IBTs, it will be possible for the Department of strategically plan on how to best promote the use of IBTs in residential construction, and especially housing delivery projects.

3.2.4 COMPLAINTS/DEFECTS REPORTED TO GOVERNMENT

The Gauteng Department of Human Settlements indicated that they undertook site visits in 2017 to examine the current state of the pilot projects implemented in 2010 (see Table 3.1). The state of the housing products in many of the project areas was less than satisfactory. Most were not well maintained and some even exhibited a range of defects. There were also some significant challenges that were identified by the beneficiaries residing in these housing units:

- The resident of one of the units in Kaalfontein highlighted that the house is cold in winter. This can be attributed to the fact that the roofing has no isolation (as illustrated above) which is problematic since most of the heat is lost through the roof. This defeats the purpose of the then alternative building technologies which are supposed to be thermally efficient and thus contributing towards energy savings. There were also comments regarding concerns about the inability to extend the house because of the nature of the building material.
- The beneficiaries of the housing units in Mamelodi had issues with the fact that the water connections to this backyard were non-functional. They are under the impression that since the government built the backyard, they should return and fix any components that are not working. It was clear from the site visit that the Isofoil on the ceiling was peeling off as well as the plastering on the walls.
- The issues at the Atteridgeville backyard resembled those in Mamelodi with complaints about plumbing, the Isofoil on the ceiling is peeling off as well as the plastering on the walls. The inhabitants were of the opinion that they were given substandard products.

The Gauteng Department of Human Settlement further indicated that the IBT projects implemented in the provinces were generally not successful as a result of the following challenges:

- Limited detailed knowledge on the availability, costs, performance, maintenance costs and longevity of IBTs
- Beneficiaries highlighted the difficulty for alteration once the building is complete.
- Public sector (Authorities, Government and Implementing Agencies) knowledge was still at infancy. This impacted on the capacity to plan and manage the implementation of IBTs as there was limited understanding the standards and thus difficulties with being able to do quality assurance.
- The scarcity of materials was also somewhat of a factor since the building innovations were being introduced into the market.
- End-users remain largely suspicious and distrustful about the IBTs. What is also important is the acceptance of the community regarding these building technologies **prior to the commencement of construction** and a willingness to learn to use them

so that they can begin to take advantage of the growing market and the economic opportunities which it presents.

- Limited beneficiary education with regards to responsibilities associated with the ownership of the backyard unit and a continued expectation for Government to maintain the units.

The respondent from the Gauteng Provinces did however indicated that there is a recognition that the nature of innovative technologies has changed since the pilot projects implemented in 2010. There is also a recognition that innovative building technologies need to be tied to the local community to facilitate local economic development and increased success. From the pilot experience it becomes clear that the criteria for IBT should comprise the following critical elements that will ensure effective implementation of the IBT system into the mainstream:

- Speed: The system should significantly reduce the time for construction.
- Value for Money: The system should cut costs through materials and labour whilst ensuring that the reliability of the structure is retained.
- Technical Performance: The system should consider critical elements of energy efficiency, acoustics, durability and fire protection.
- Contractor Friendly: It should be easy to transfer the technology. Technology owners should be able to easily train local people as part of local economic development and capacitation.
- End User Acceptance: It is imperative to deal with the perceptions associated with IBT systems. The functionality of the system must consider the local context and the consumers which need to be aware of the system features and maintenance.

According to the Gauteng Department of Human Settlements, these are the main challenges that impede the large-scale roll-out of IBTs:

- Contracting and maintenance is constrained by the predominant business model, i.e. franchising. (Intellectual Property (IPs) controlled by a few licensed Service providers (SPs) and some are external).
- There are limited contractors that are registered/ Licensee to construct using IBTs. In most cases, existing conventional contractors are not in a position to independently undertake construction of IBTs.
- Quality assurance is critical- the NHBRC needs to assist in this regard so that our inspectors are able to quality check the different innovative technologies for compliance
- The costing aspect of IBTs is illusive. As the Department we are allocated a budget and we need to understand the costing model for IBTs. From our interactions with various innovators IBTs come across as expensive in small scale developments in comparison to conventional brick and mortar. It appears the benefits would only be apparent in large scale developments, which presents a challenge for the smaller to medium scale contractors. The Housing Subsidy Quantum funds certain components of the top structures built using conventional methods – and therefore a breakdown of costs needs to be provided by developers. Many of the innovative technology providers are unable to provide such a breakdown of costs in terms of their various technologies. This means that the technology providers need to work towards developing a similar

bill of quantities which will help the Department understanding the basis of the costing for the innovative technology.

3.3 UNIVERSITY RESEACH UNITS

3.3.1 INTRODUCTION

The research units of the University of Witwatersrand, University of Limpopo, University of Stellenbosch, North West University, University of the Free State and University of Cape Town was contacted as part of the sample. Three of the universities responded.

The research questions that were formulated in conjunction with the NHBRC to guide the structured interviews are as follows:

- What research has the university conducted related to the use of IBTs in residential construction?
- What has been your findings?

3.3.2 RESEARCH CONDUCTED & FINDINGS

The University of Stellenbosch indicated that they have conducted quite a number of research studies on the topic of IBTs. These studies, along with their findings, include the following:

- **Regulation of alternative building materials and systems in South Africa (2012)**, published in the SAHF Conference Paper, Authored by Wibke De Villiers & Billy Boshoff
  Findings:
  - In South Africa the definition and quantification of performance requirements of housing are lacking or understated and there is a shortage of expertise to accurately predict the performance of IBTs, especially in aspects such as durability. However, a performance-based regulatory framework is considered the most effective in enabling the diffusion of IBT's into the market and it is well aligned with the World Trade Organisation Agreement on Technical Barriers to Trade.

- **Development of a multi-criteria assessment tool to determine the most appropriate IBT for low-income housing (2014)**, Authored by Thesis Petrus Theart (M Eng Thesis), Supervisor Prof Jan Wium.
  Findings:
  - The Evidential Reasoning Approach was used to develop a multi-criteria decision making model to assist low-income housing developers in selecting the most appropriate IBT (specifically walling) solution according to the following criteria: cost, time, quality, environmental performance, density, alteration capability, resource availability and additional features. Limitations of this model that were identified include future changes to housing regulations, maintenance cost, quality assurance, demolition of the house and scope of data available.

- **Life cycle assessment of residential buildings (2015)**, Authored by Arina van Noordwyk (M Eng Thesis), Supervisor Wibke De Villiers.
  Findings:
  - A complete life cycle assessment tool was compiled to quantify the environmental impact of buildings and applied to a residential building structure model that uses consistent energy to regulate the interior thermal environment. Nine different external walling systems were modelled to identify an optimal walling choice. The results showed that a minor increase in the materials impact is countered by a decrease in the energy impact, leading to a net decrease in environmental impact in most cases. With an increase of the R-value of the external walling system, the environmental impact of the building steadily decreases in terms of four of the five impact categories, with the exception of waste generation.
- **Development of performance-based criteria for alternative masonry units for low-income housing (2019)**, Authored by Wibke De Villiers (PhD Dissertation), Supervisors Prof Gideon van Zijl & Prof Billy Boshoff
  Findings:
  - Performance-based regulation of alternative masonry units (AMU's) is recommended for the high-end residential sector in the form of material non-specific masonry unit standards and testing standards based on EN 771 and EN 772, respectively. Performance-based regulation of AMU's is recommended for the low-income housing sector in the form of material non-specific minimum performance levels for masonry compressive, flexural and shear strength in conjunction with revised National Building Regulation (NBR) deemed-to-satisfy wall layout provisions (SANS 10400-K). Revision of the NBR wall layout provisions is deemed necessary, since current provisions were found to be incompatible with the recently revised South African loading code (SANS 10160), especially for out-of-plane resistance to wind loading and in-plane resistance to seismic loading, even for conventionally used concrete masonry units.
- **3D Printing Concrete (3DPC) (2019),** Authored by PJ Kruger (PhD Dissertation) Rheo-mechanics modelling of 3D concrete printing constructability, supervisors Prof GPAG van Zijl and Dr S Zeranka
  Findings:
  - A 3D concrete printer was built by the research team in the Structures Laboratory. Suitable concrete and lightweight foam concrete mixes have been developed for 3D printing, and the first structural wall parts have been 3D printed and assembled in the laboratory. Ongoing work is developing labour-intensive industrialised digital construction (3DPC) of residential buildings.
- **Development of Ecobrick (plastic bottles filled with non-recyclable items) homes considering fire resistance (ongoing),** Zara Sanders (MEng) Supervisor Dr Richard Walls.
  Findings:
  - This project is ongoing and testing will begin shortly. It has been seen that the plaster layer on the outside of recycled product walls is very important for providing fire resistance, otherwise these structures will burn fast whilst releasing toxic gases. It needs to be identified what thickness of plaster layer is required, how to fix this to walls, and how to consider joints and penetrations.

The University of the Witwatersrand indicated that they have written a journal paper on Green Building Technology in Residential assets. Unfortunately the research was not made available, nor was any findings disclosed. The research could also not be found in the public domain. Other research includes the following (along with its findings):

- **Perceptions on the Use of Light Steel Frame Construction Methods for Primary Schools (2017)**, Authored by Nyiko Gift Michavi (Master of Science in Building), Supervisor Prof. David Root
  Findings:
  - The key findings were that the technology is perceived to be a threat to the established contractors and suppliers to the traditional building sector. The survey findings indicate a level of resistance within the South African construction industry to accommodate innovative initiatives despite their potential and demonstrated benefits. It was therefore concluded that the client department together with the implementing agent department should revisit this building method as specifications for building primary schools for South Africa.

3.4 SUPPLIERS, BUILDERS AND DEVELOPERS

3.4.1 INTRODUCTION

Various suppliers, builders and developers within the construction industry, and specifically those involved with IBTs were contacted. A general observation that was made during the data collection process was that some builders/system owners felt that they were being investigated and was subsequently sceptical or unwilling to participate.

The research questions that were formulated in conjunction with the NHBRC to guide the structured interviews are as follows:

- How does consumers receive the concept of IBTs
- What does consumers prefer – conventional or innovative building technologies and why?
- How does the costs relate between conventional versus innovative building technologies?
- As a builder/consumer, what do you prefer conventional or innovative building technologies and why?
- Have you received any complaints or reporting of defects on specific IBT systems?

3.4.2 SUPPLIERS/BUILDERS/DEVELOPERS VIEW ON CONSUMPER PERCEPTIONS AND PREFERENCES

It was unanimous in the responses from suppliers, builders and developers that consumers generally receive IBTs positively, both for subsidised and non-subsidised, especially once occupation has taken place. In the case of subsidised it generally originates from a place of gratefulness for having received a house as the majority of these beneficiaries normally would have resided in informal housing prior to receiving the subsidised IBT house. In the case of non-subsidised, there seem to be an increase in consumers seeking to employ IBTs in residential construction due to the long-term cost-saving advantage and being less dependent on the grid.

All of them however indicated that consumers will always choose conventional building techniques as the first option – based on perceptions of the concept of IBTs. It was indicated that the housing market is generally very conservative and IBT's are still a relatively new concept which is unknown and unfamiliar to the consumer. Subsidised housing consumers related IBTs to temporary housing or low-end housing associated with historically built prefab-type structures built during apartheid times. This is a perception that can be overcome from what the industry refers to as the knock test - consumers want a solid wall feel that can give them the comfort which brick and mortar gives. Non-subsidised housing consumers, on the other hand, are mostly concerned with the resell-value of a house built with IBTs (especially given the large investment required).

Some system owners indicated that the scepticism and low acceptance levels of consumers are echoed by the actions of government. It was said that although government talks about supporting and implementing Innovative Building Technology, this is not common practice in the industry and it was stated that government generally makes it very difficult for IBT systems to be implemented in housing projects especially, with a requirement of a CIBD level of 8 or 9. It was furthermore stated that consumers are more open to the concept of IBTs than government/decision makers.

It was also indicated that there seems to be a gradual increase in the demand for IBT systems as consumers become more aware of the overall benefits from a living comforts perspective and that the demand will increase if information is shared and consumers are educated regarding IBTs overall reliability, durability and easy maintenance.

Through the interviews conducted it became clear that the lack of knowledge about IBT capabilities and qualities are the most common issue influencing consumers' perceptions and acceptance levels. It was further stated that the lack of knowledge is not only amongst the consumers themselves (i.e. the beneficiaries) but also amongst decision makers such as housing departments and agencies/government.

3.4.3 SUPPLIERS/BUILDERS/DEVELOPERS PREFERENCES & COSTS

Responses obtained from the stakeholders indicated that the IBT industry is quite specialised and once you have started specialising in innovative building technology and given the costs associated with obtaining the necessary skills, materials and certifications, it is unlikely that the business will continue or revert back to conventional building technology. One particular builder/supplier indicated that they prefer using high quality IBT on projects where the time and financial benefits can be realised. It was stated that in countries with higher levels of acceptance of IBTs as a solution for housing the skills levels are generally higher and the amount of research spent on developing IBTs is very impressive. It was stated that IBTs has potential to roll out housing units at a faster rate and with better insulation and less construction waste, specifically water. These benefits are all very important in SA where the skills levels in the built industry have been eroded, scarce water resource and poor building materials for affordable housing units.

Reasons stated of why suppliers/developers prefer IBTs to conventional building technologies include the following:

- Fast installation of IBT system
- Quality
- Safer and cleaner building sites
- Systematic installation of services
- Less skilled trade labour required

- Extra usable space without compromising wall properties
- 2 hour fire rating
- Acoustic and thermal better than conventional

It was however indicated by one developer/system owner that due to the NHBRC failing the company by one percentage point and therefore no longer being listed as approved on the NHBRC database, the developer to some extent has been forced to revert back to conventional building technology.

In terms of costs, stakeholders interviewed were reluctant to provide any detail regarding costing of IBT systems. It was however indicated by a number of system owners/developers that small-scale projects do not present opportunity to fully realise cost and time benefits using IBTs. For benefits to be fully realised a project must have scale ad design repetition such as classrooms, residential units with standardised designs, and internal wall partitioning of high-rise apartments or walk-up residential units. Stakeholders indicated that on projects of scale and where buildings are designed with load savings in consideration, consumers can see a reduction of 15-20% in costs.

It was further indicated that although upfront or initial costs of IBT's are more expensive – in the longer term it is much more economical – especially if the time factor is considered and looked at as an important factor.

3.4.4 COMPLAINTS OR DEFECTS

Stakeholders indicated that beneficiaries were generally happy with the houses that they received. The complaints received were normally minor problems (which is also typical with conventional building technologies) such as external shrinkage hairline cracks which need to be painted over with a good quality PVA. These complaints isn't structure in anyway and it's not dis-similar to plaster cracks on conventional buildings, often known as settling cracks. Other complaints received also related to storm damage and lack of maintenance to doors and windows, which again is similar to complaints that would emanate from conventional building technologies.

One particular stakeholder indicated that in the initial phases of rolling-out a specific IBT system, they received complaints related to cracks appearing above doors. Which they then investigated and found that the problem had to do with the settlement of the raft foundations. They have since corrected this and has not had any similar complaints since.

Another stakeholder indicated that they have not received any structural complaints against the IBTs that they manufacture, but that the concerns or problems raised were normally due to bad workmanship and not depending on the product/system itself.

3.5 FINANCIAL INSTITUTIONS AND DONORS

3.5.1 INTRODUCTION

Financial institutions that were contacted as part of the same include Absa, FNB, Standard Bank and Nedbank, while the Donors include USAID and GTZ.

The research questions that were formulated in conjunction with the NHBRC to guide the structured interviews are as follows:

- Funding criteria for residential constructions (especially IBTs)

- How do financial institutions and donors perceive IBTs?
- What does financial institutions/donors prefer in terms of funding/loans – conventional or innovative building technologies and why?
- What has been the market trend in the past 4-5 years with regards to funding/loan-applications for residential construction using IBTs? Has there been a rapid increase and why do you believe this is happening?

3.5.2 FUNDING CRITERIA

Requirements posed by commercial banks primarily relates to the following criteria:

- All eco-friendly systems must be approved by the bank
- Applicants may also require a community acceptance letter from the local homeowners' association or estate, if there could be concerns over the innovative building plans affecting the value of surrounding properties
- Builders that will be used need to be registered with the NHBRC
- Homes be enrolled with the NHBRC at least 15 days before construction begins. Some builder enrol houses on behalf of clients, but not all builders provide this service – it is ultimately the responsibility of the homeowner to enrol with the NHBRC.

3.5.3 FINANCIAL/FUNDING INSITUTION PREFERENCES & PERCEPTIONS

Commercial banks interviewed indicated that they do not have a specific stance/preference when dealing with IBTs. They indicated that when assessing a home loan application the main criteria is the affordability of the product and the consumer/customers means to be able to pay, irrespective of whether it is conventional or innovative building technology.

It was indicated that there are increasing demand for innovative building materials or measures that can increase the energy efficiency of a house – but more in relation to energy and water-saving measures such as solar panels and rainwater harvesting tanks.

3.6 PROFESSIONAL BODIES

3.6.1 INTRODUCTION

Professional bodies that were included in the sample includes CIDB, SABS, CSIR, Agrément SA, South African Institute of Architects and the Pretoria Institute of Architecture (PIA).

The research questions that were formulated in conjunction with the NHBRC to guide the structured interviews are as follows:

- How does consumers receive the concept of IBTs
- What IBT systems do you supply/endorse?
    - What are the characteristics?
    - What are the costs involved?
- Have you received any complaints or reporting of defects on specific IBT systems?

3.6.2 PROFESSIONAL BODIES' VIEWS ON CONSUMER PREFERENCES AND PERCEPTIONS

Agrément SA indicated that although they do not directly interact with the consumer, they are aware of the belief that the consumer is not satisfied with the IBT systems being used in the

construction of residential houses. They indicated that they believe this stems from the fact that consumers do not understand IBT systems. Agrément SA is of the opinion that this could be mitigated through hosting “awareness campaigns” on IBT systems and how they are economically beneficial and sustainable.

The Architectural Profession indicated that consumers generally prefer conventional building technology. It was indicated that the housing market is very conservative and consumers are generally sceptical and concerned about reselling value of homes built with IBTs. It was also indicated that the concept of innovation is relative and perception-based.

3.6.3 SYSTEMS ENDORSED

Agrément SA do not have any specific preferences but there is are performance factors/criteria that are looked at (e.g. durability, ability to resist fire, and other performance criterion, through a process of testing, etc.). It is then established by Agrément if the system is suitable for building schools, houses, roads, etc. They do not favour or recommend any, as their primary mandate is testing fitness for purpose. If the structure is fit then it is put out there for people to choose. All systems’ advantage is that the time frame is short. Agrément endorses all systems that are approved as per the testing for fitness criteria (housing/walls, airports also use their approved systems, SANRAL roads innovative systems, paint (RDP wall paints), etc.).

IBT systems costs vary, although the advantage of IBTs is that houses may be built within a week. Costs that IBT houses save/benefits of IBT costs versus brick:

- Life cycle (not including the design and construction stage)
- Reduction of electricity costs (the IBT system effect of cooling or heating)
- Construction contractors: money is saved as time of construction and employing contractors is shortened (completing of houses/buildings, etc.)
- One month versus 1 year, for example.)
- In the long run saving of costs occurs with the IBT systems.

3.6.4 COMPLAINTS OR DEFECTS

Agrément SA indicated that complaints regarding IBT systems are mostly due to poor workmanship such as project management or not delivering what is approved on the Agrément certificate – and not necessarily about the systems themselves. Agrément only approves and certifies systems that meets a specific set of performance factors or criteria. Agrément is of the opinion that a lot of complaints can also rather be due to the social acceptance of IBTs due to a lack of knowledge and consumer preferences based on the industry/traditional norms.

3.7 CONCLUSION

In terms of the stakeholder interviews it is clear that the industry role players generally are in favour of IBTs, especially due to the reduced speed of construction as well as value for money and long-term cost effectiveness. Stakeholders unanimously said that consumers however prefer conventional building technology to IBTs, but agrees that this can primarily be attributed to the lack of knowledge by the consumer.

4. CONSUMER (BENEFICIARY) INTERVIEWS

4.1 INTRODUCTION

Due to certain limitations (refer to Chapter 1 Section 1.4) a total of 205 surveys were successfully completed, of which 8 beneficiaries were specifically identified as a focus group and the remaining 197 as a broader sample. The specifically identified 8 beneficiaries were identified as beneficiaries that received housing through the NHBRC. The analysis will make distinction between these two groups.

The relatively small sample size enabled the use of Microsoft Excel to perform the quantitative data analysis. Various Excel statistical and macro functions were used such as Pivot Tables, Arrays and the Analysis ToolPack, to calculate and display data results in output tables and to generate charts. The qualitative data analysis was conducted using a deductive approach to both content and narrative data analysis. The analysis was based on interpretative questions from the questionnaire in structured text format. Qualitative data analysis and interpretation is presented in this Chapter in context of the quantitative data, providing insight and further explanation of the quantitative data.

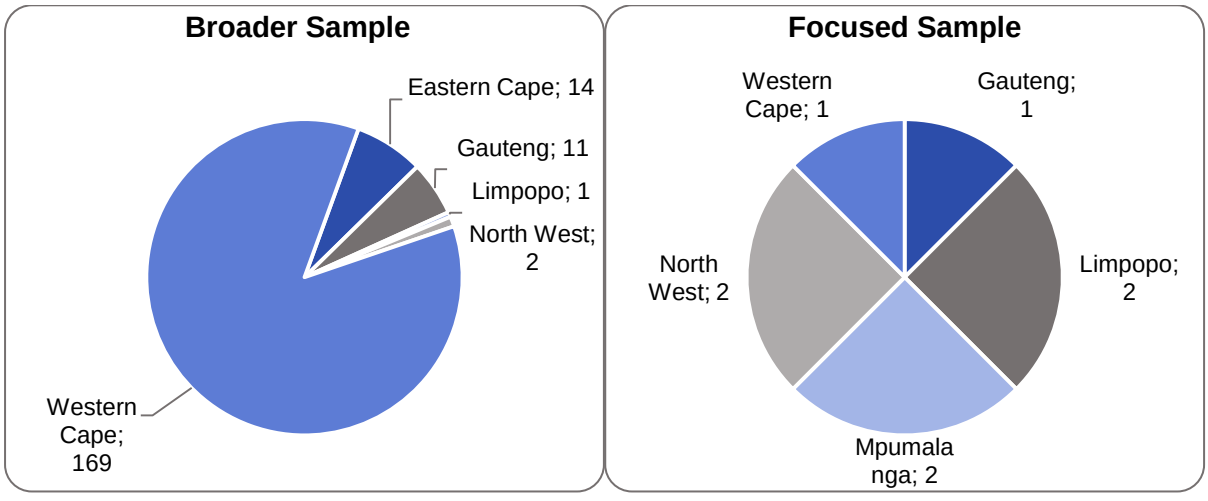
The following key research questions were developed for the consumer surveys:

- Is the consumer aware of IBTs and what it involves?
- How much knowledge does the consumer have relating to IBTs?
- How does the consumer perceive IBTs?
- Are current consumers satisfied with the use of IBTs in residential construction?

4.2 DEMOGRAPHIC INFORMATION

The focused sample consisted of two beneficiaries from Limpopo, Mpumalanga and North West provinces respectively, as well as one beneficiary from Gauteng and Western Cape provinces respectively. Two beneficiaries could not be reached/located, one in the Northern Cape and one in the Free State. The majority of respondents that were interviewed resided in the Western Cape Province, more specifically Delft Extension 5 in a project known as the Delft Symphony project (as reflected in Figure 4.1 and Table 4.1).

Figure 4.1: Provincial distribution of respondents based on willingness to participate



Source: NHBRC Consumer Perception Surveys, 2019/20

Table 4.1: Geographical distribution of respondents

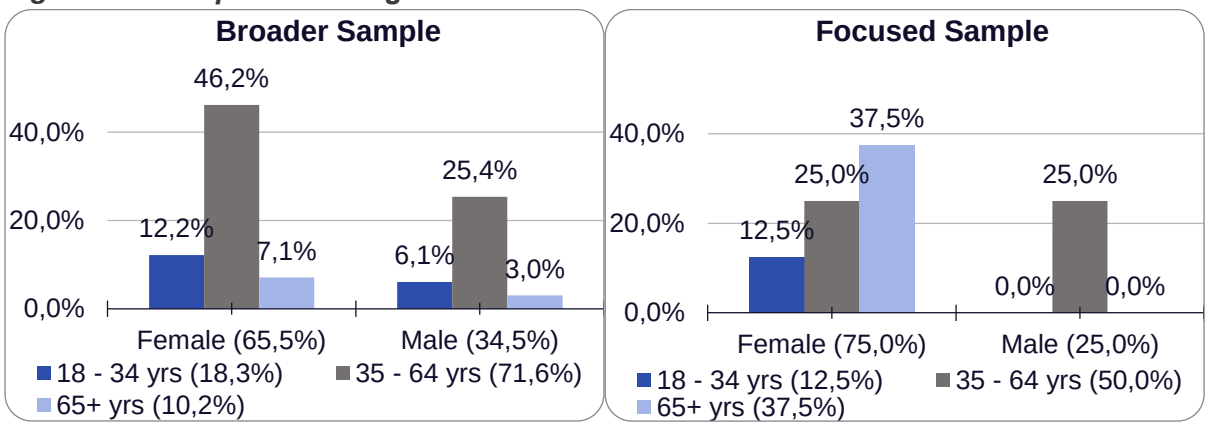
	PROVINCE	TOWN/VILLAGE	NUMBER OF RESPONDENTS
Broader Sample	Western Cape	Bluedowns	2
		Delft	167
	North West	Sesobe Village	1
	Limpopo	Ndzelele Ndzi	1
	Gauteng	Diepsloot	3
		Tembisa	1
		Soshanguve	8
	Eastern Cape	Emthumbane	14
Focused Sample	Gauteng	Evaton	1
	Limpopo	Thabazimbi	1
		Tshikuwi, Makhado	1
	Mpumalanga	Leeuwfontein, Siyabuswa	1
		Moloto	1
	North West	Sesobe Village	1
		Ledig	1
	Western Cape	Bluedowns	1
		TOTAL	**205**

Source: NHBRC Consumer Perception Surveys, 2019/20

From the list of 10 beneficiaries provided by the NHBRC for the focused sample 8 beneficiaries could successfully be interviewed. In addition, the Research Service Provider managed to identify and personally interview and additional 197 beneficiaries in Bluedowns, Delft, Sesobe Village, Ndzelele Ndzi, Diepsloot, Tembisa, Soshanguve and Emthumbane.

The age and gender profile of the respondents that were successfully interviewed are presented in Figure 4.2.

Figure 4.2: Respondents' Age and Gender Profile



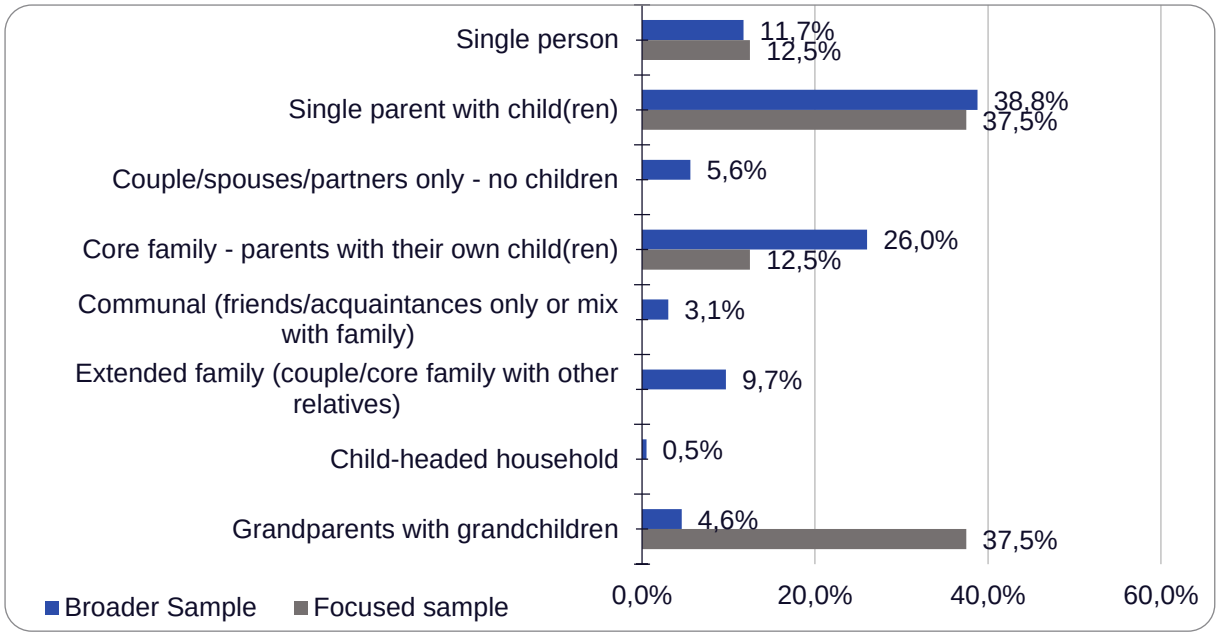
Source: NHBRC Consumer Perception Surveys, 2019/20

From the age and gender profile it is clear that the focused sample had a larger proportion of elderly respondents than the broader sample, which in turn were predominantly aged between 35 and 64 years. Both samples were more representative of female respondents.

The households that formed part of the focused sample survey comprised mainly of single parents with children (37.5%) and grandparents with grandchildren (37.5%). The households that formed part of the broader sample survey process comprised of mainly single parents with children (38.8%), followed by core families (26.0%), as can be seen from Figure 4.3.

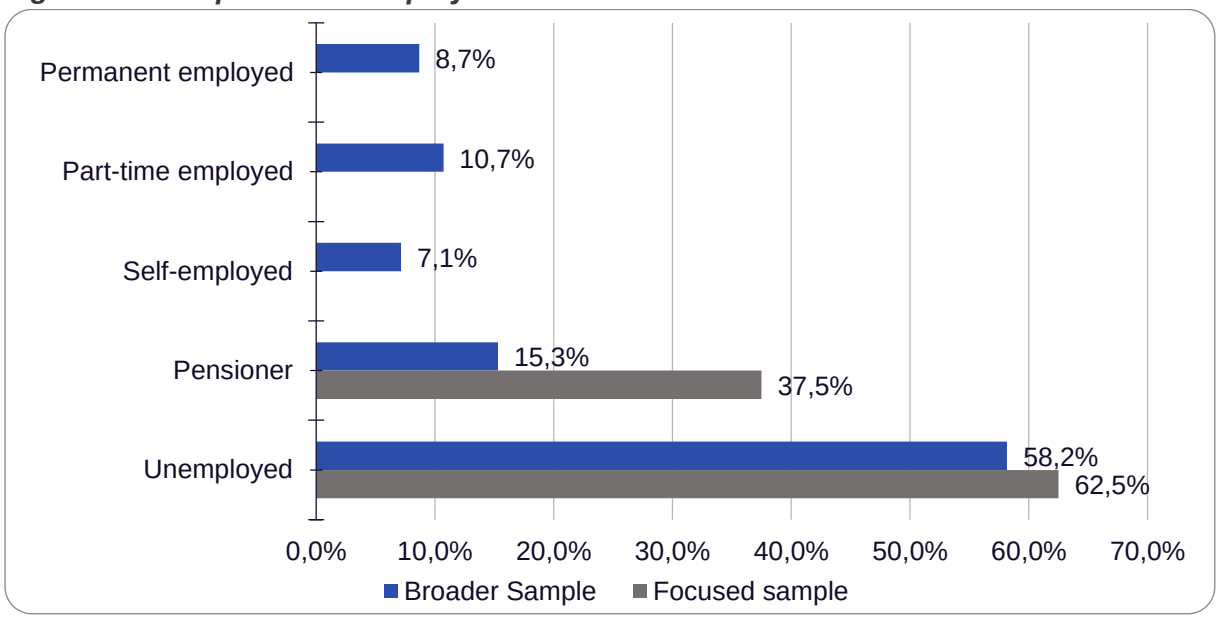
Figure 4.4 presents the employment status of the respondents that took part in the survey. From the figure it is clear that the majority of respondents of both samples were unemployed.

Figure 4.3: Respondents' Household Composition



Source: NHBRC Consumer Perception Surveys, 2019/20

Figure 4.4: Respondents' employment status



Source: NHBRC Consumer Perception Surveys, 2019/20

In cross tabulating the household composition against the respondents employment status (Table 4.2), it is clear that high levels of unemployment is recorded amongst households that are comprised of a single parent with children or a core family comprising of parents with their own children– suggesting that these households are mainly dependent on child support grants as a source of income.

Table 4.2: Household Composition vs Employment Status

Broader Sample	Permanent employed	Part-time employed	Self-employed	Pensioner	Unemployed
Single person	0,5%	1,0%	1,5%	3,6%	5,1%
Single parent with child(ren)	2,6%	5,6%	2,6%	3,6%	24,5%
Couple/spouses/partners only - no children	0,0%	0,5%	0,0%	0,0%	5,1%
Core family - parents with their own child(ren)	4,6%	1,5%	2,0%	1,5%	16,3%
Communal (friends/acquaintances only or mix with family)	0,5%	0,5%	0,5%	0,0%	1,5%
Extended family (couple/core family with other relatives)	0,5%	1,0%	0,5%	3,1%	4,6%
Child-headed household	0,0%	0,0%	0,0%	0,0%	0,5%
Grandparents with grandchildren	0,0%	0,5%	0,0%	3,6%	0,5%
Focused Sample	**Permanent employed**	**Part-time employed**	**Self-employed**	**Pensioner**	**Unemployed**
Single person	0,0%	0,0%	0,0%	0,0%	12,5%
Single parent with child(ren)	0,0%	0,0%	0,0%	12,5%	25,0%
Core family - parents with their own child(ren)	0,0%	0,0%	0,0%	0,0%	12,5%
Grandparents with grandchildren	0,0%	0,0%	0,0%	25,0%	12,5%

Source: NHBRC Consumer Perception Surveys, 2019/20

Table 4.3: Household Composition vs Employment Status per Province

Broader Sample	Permanent employed	Part-time employed	Self-employed	Pensioner	Unemployed
Eastern Cape					
Single person	0,0%	0,0%	0,0%	1,0%	0,5%
Single parent with child(ren)	0,5%	0,0%	0,0%	0,0%	1,5%
Core family - parents with their own child(ren)	0,5%	0,5%	0,0%	0,0%	0,0%
Extended family (couple/core family with other relatives)	0,0%	0,0%	0,0%	0,0%	1,0%
Grandparents with grandchildren	0,0%	0,5%	0,0%	0,5%	0,5%
Gauteng					
Single person	0,0%	0,5%	0,5%	0,5%	0,0%
Single parent with child(ren)	0,0%	0,0%	0,0%	0,5%	1,0%
Couple/spouses/partners only - no children	0,0%	0,5%	0,0%	0,0%	0,0%
Core family - parents with their own child(ren)	0,5%	0,0%	0,0%	0,0%	1,5%
Communal (friends/acquaintances only or mix with family)	0,5%	0,0%	0,0%	0,0%	0,0%
Grandparents with grandchildren	0,0%	0,0%	0,0%	0,0%	0,0%
Limpopo					
Child-headed household	0,0%	0,0%	0,0%	0,0%	0,5%
North West					
Core family - parents with their own child(ren)	0,0%	0,0%	0,0%	0,5%	0,0%
Western Cape					
Single person	0,5%	0,5%	1,0%	2,0%	4,6%
Single parent with child(ren)	2,0%	5,6%	2,6%	3,1%	21,9%
Couple/spouses/partners only - no children	0,0%	0,0%	0,0%	0,0%	5,1%
Core family - parents with their own child(ren)	3,6%	1,0%	2,0%	1,0%	14,8%
Communal (friends/acquaintances only or mix with family)	0,0%	0,5%	0,5%	0,0%	1,5%
Extended family (couple/core family with other relatives)	0,5%	1,0%	0,5%	3,1%	3,6%
Grandparents with grandchildren	0,0%	0,0%	0,0%	3,1%	0,0%

Focused Sample					
	Permanent employed	Part-time employed	Self-employed	Pensioner	Unemployed
Mpumalanga					
Grandparents with grandchildren	0,0%	0,0%	0,0%	12,5%	12,5%
Gauteng					
Grandparents with grandchildren	0,0%	0,0%	0,0%	12,5%	0,0%
Limpopo					
Child-headed household	0,0%	0,0%	0,0%	0,0%	25,0%
North West					
Core family - parents with their own child(ren)	0,0%	0,0%	0,0%	0,0%	12,5%
Western Cape					
Core family - parents with their own child(ren)	0,0%	0,0%	0,0%	0,0%	12,5%

Source: NHBRC Consumer Perception Surveys, 2019/20

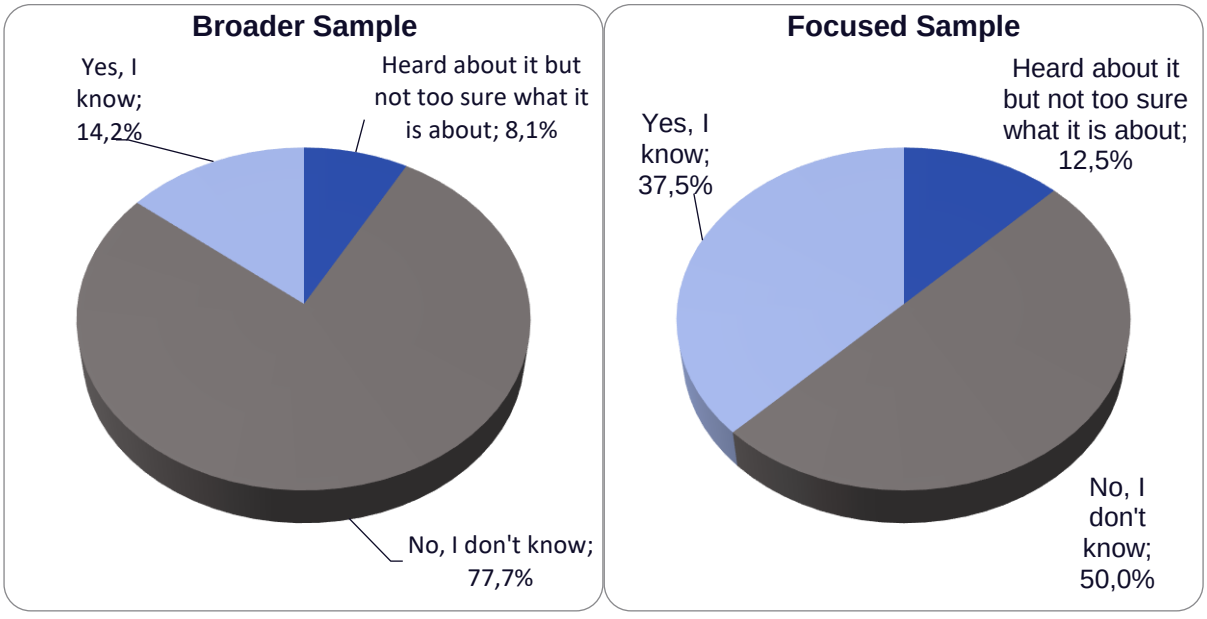
4.3 KNOWLEDGE OF NHBRC AND IBTs

Respondents' were probed in terms of their knowledge of the NHBRC as well as their knowledge on IBTs.

The majority of respondents did not know about the NHBRC or the role it plays in regulating the home building industry (50.0% in the focused sample and 77.7% in the broader sample) and even less respondents knew about IBTs with 50.0% of the focused sample respondents and 83.8% of the broader sample respondents indicating that they did not know what IBTs were.

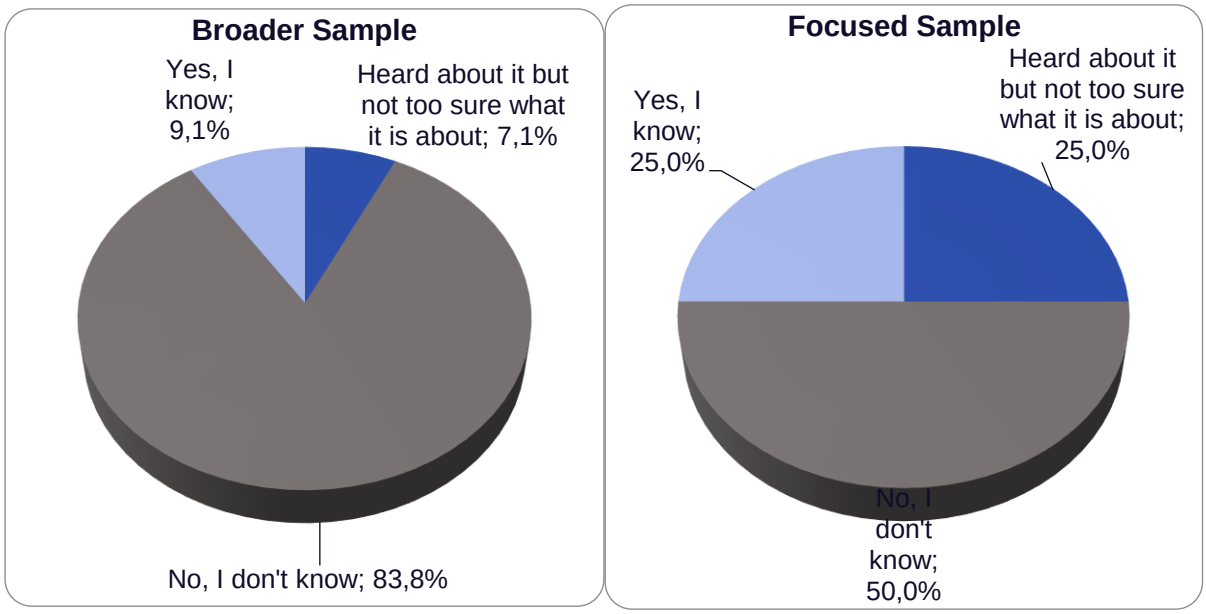
This was a general trend observed during the fieldwork, with people mostly not knowing that they occupy IBT houses, but only that they received a subsidy house.

Figure 4.5: Knowledge of the NHBRC and the role it plays in regulating the home building industry



Source: NHBRC Consumer Perception Surveys, 2019/20

Figure 4.6: Knowledge of what IBTs are

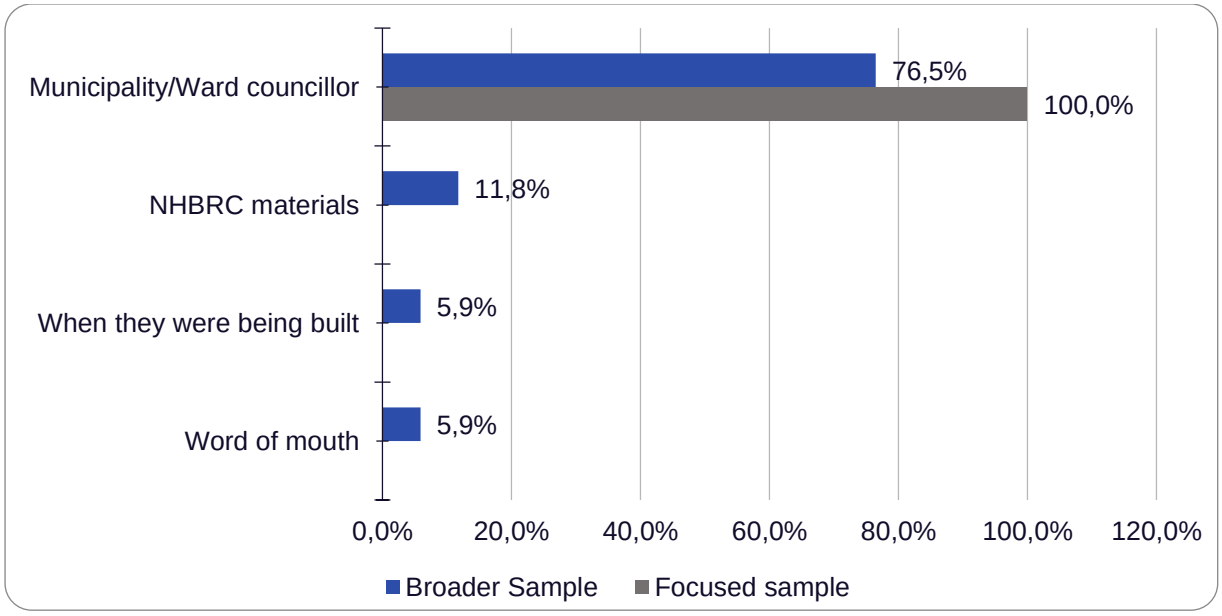


Source: NHBRC Consumer Perception Surveys, 2019/20

Respondents that indicated that they did not know what IBTs were, were subsequently informed and educated on what an IBT house is, and provided of some examples of different types of IBTs that are used countrywide, to enable them to make a valuable contribution to the survey.

Those respondents that knew what IBT's were, were asked to indicate how they came aware of IBTs. The respondents from the focused sample that knew what IBTs were indicated that they were informed or educated by the Municipality/Ward Councillor. From the broader sample, the respondents indicated that mostly they were informed by the Municipality or Ward Councillor, but some were also informed by NHBRC materials, from the builders (when the units were being built) and through word of mouth.

Figure 4.7: How respondents became aware of IBTs

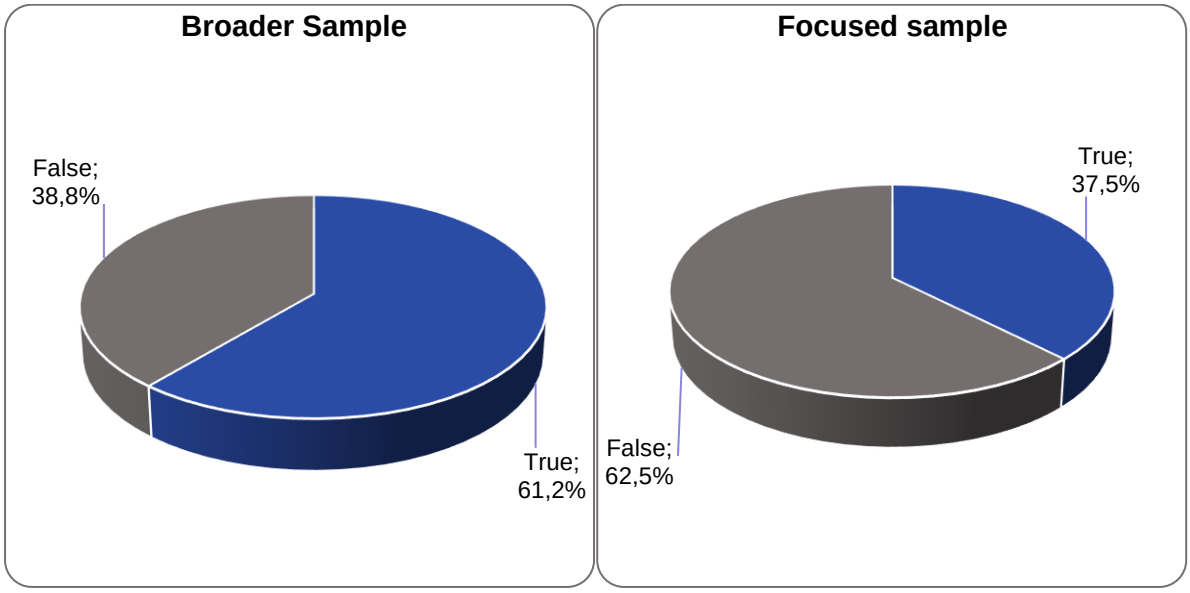


Source: NHBRC Consumer Perception Surveys, 2019/20

Respondents were furthermore asked to indicate whether the statement *"It is NOT possible to extend an IBT house"* were true or false (Figure 4.8). From the results it is clear that the focused sample were more of the opinion that this statement was false (62.5%) – in other words they understood that it is possible to extent an IBT house, while only 38.8% of the broader sample felt the same way.

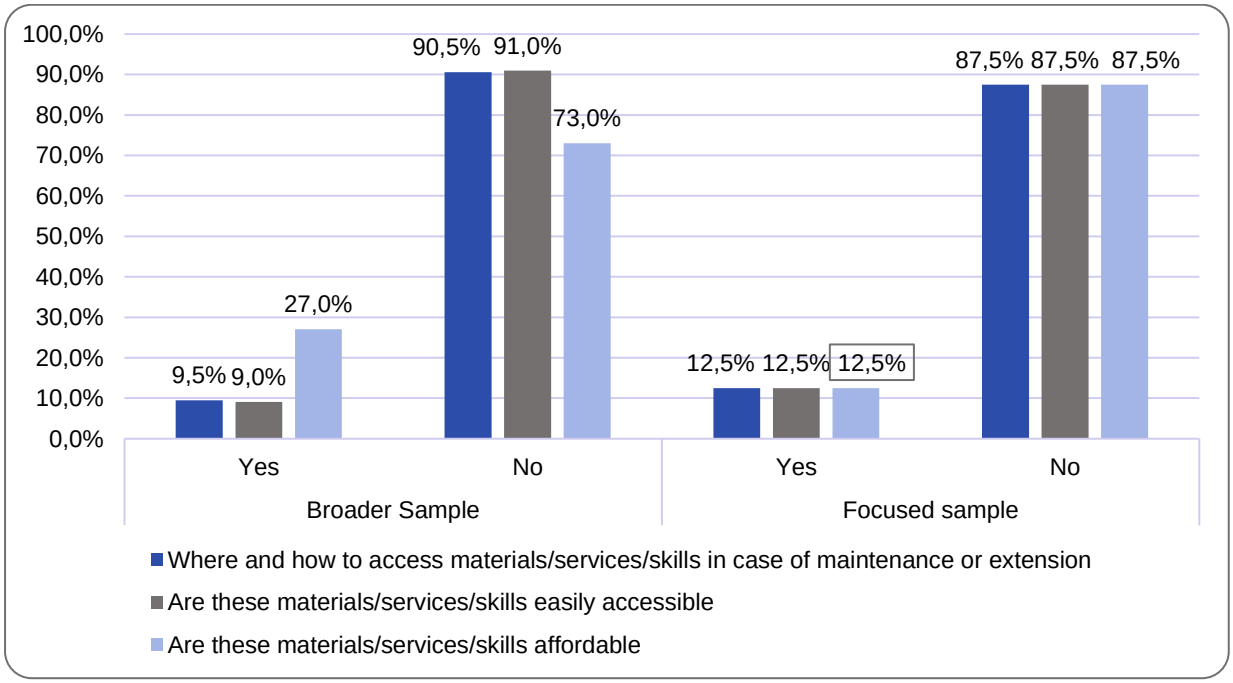
This was further emphasised when respondents were probed on the accessibility and affordability of IBT materials/services/skills for maintenance and extension of their IBT house (Figure 4.9). The overwhelming majority of respondents in both samples (>85%) indicated that they did not know where and how to access the materials/services/skills and therefore did not feel that it is easily accessible.

Figure 4.8: True or False statement – It is NOT possible to extend an IBT house



Source: NHBRC Consumer Perception Surveys, 2019/20

Figure 4.9: Accessibility and affordability of IBT materials/services/skills for maintenance/extension

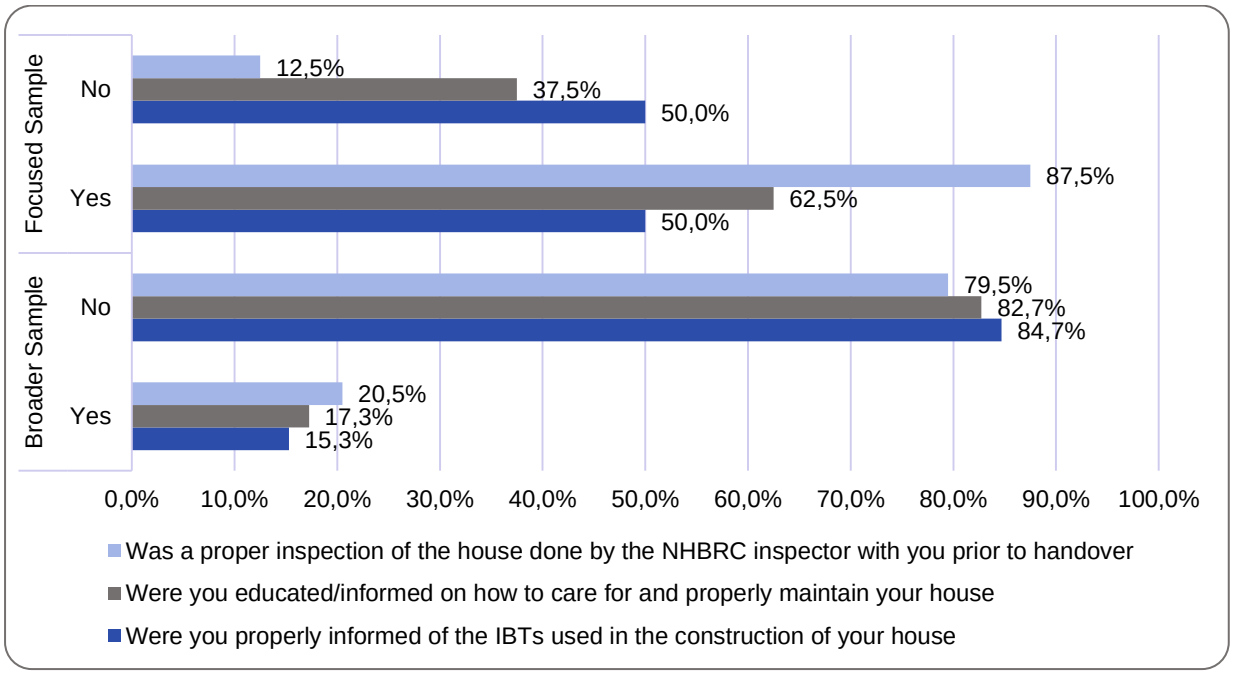


Source: NHBRC Consumer Perception Surveys, 2019/20

4.4 CURRENT PRODUCT OFFERING

Respondents were asked a set of questions regarding the handover process when they received their IBT house, the results are presented in the figure below.

Figure 4.10: Experiences with regards to the hand-over process

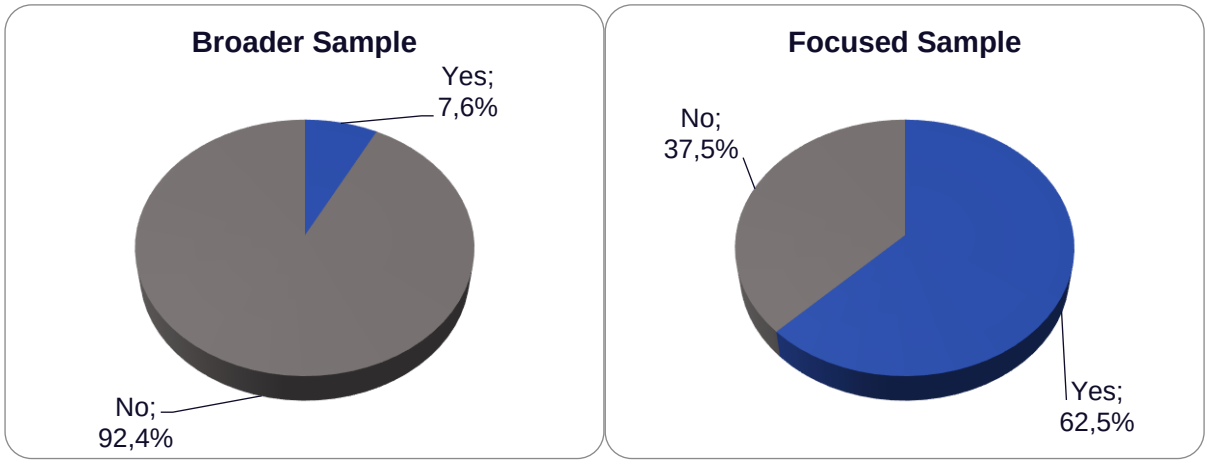


Source: NHBRC Consumer Perception Surveys, 2019/20

Firstly, respondents were asked whether upon handover of the house, they were properly informed of the IBTs used in the construction of their house – the respondents in the focus sample were evenly divided with half saying they were informed and the other half saying they were not informed, while the majority in the broader sampled indicated that they were not informed at all (84.7%). Secondly, they were asked whether they were educated on how to care for and properly maintain their house – the majority of the focused sample indicated that they were informed in this regard (62.5%), while the opposite is true for the broader sample where the majority indicated that they were not properly educated (82.7%). And thirdly, respondents were asked whether a proper inspection of the house was done by the NHBRC inspector with them – again the majority of the respondents in the focus group indicated that such an inspection was indeed done (87.5%) while the majority of respondents in the broader sample indicated that such an inspection was not done (79.5%). Based on the preceding results, it seem as though beneficiaries of projects initiated/commissioned through provincial housing/human settlement departments are not properly informed and educated, compared to the houses commissioned/funded by the NHBRC.

Respondents were then asked whether they knew which system was used in the construction of their house (Figure 4.11). In the case of the focused sample, the majority of respondents (62.5%) indicated that they were informed of the system used, while the majority of the respondents in the broader sample (92.4%) of respondents indicated that they did not know which system was used. However, in both instances when respondents were further probed and asked to name the system that was used, none of the respondents were able to provide the name of the system used, but rather listed materials/specific aspects that was used during the construction of their house.

Figure 4.11: Awareness of the type of system used in constructing the house



Source: NHBRC Consumer Perception Surveys, 2019/20

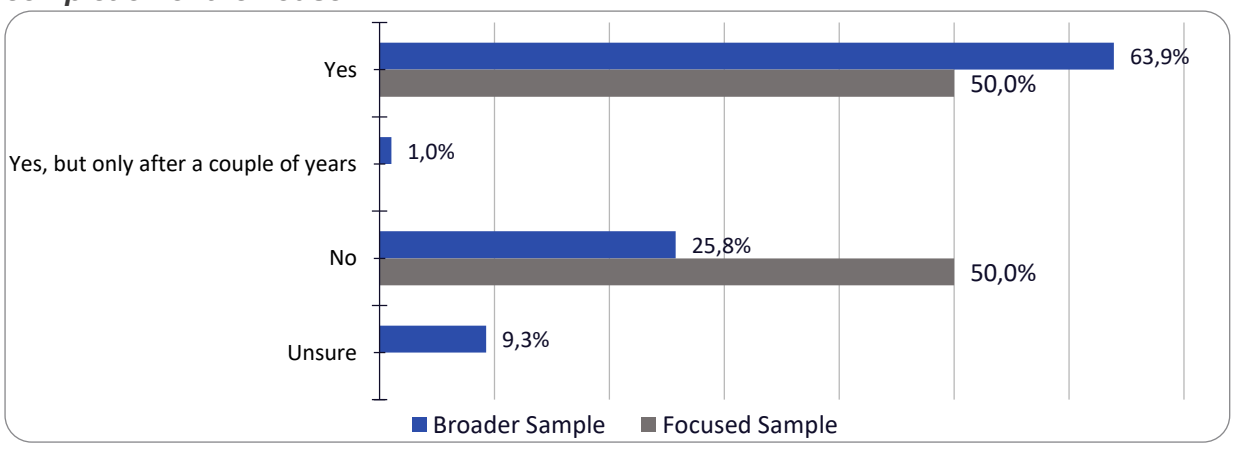
Respondents were asked whether they were given a Certificate of Occupation (also known as a Happy Letter) upon the completion of their house (Figure 4.12). In the case of the focused sample, half the respondents indicated that they did indeed receive a Happy Letter, while the other half did not. In the case of the broader sample, the majority indicated that they did receive such a letter (63.9%). It should in this case be noted that a significant proportion of the broader sample respondents were unsure on whether they have received a happy letter or not.

An Occupancy Certificate is a document that is issued by the Building Control sub-directorate in accordance with the National Building Regulations to certify that a building has been completed in accordance with the approved building plan and all other relevant City Council requirements (for example, the installation of firefighting equipment to the approval of the Fire Department, payment of all fees and contributions, approved water and electricity connections etc.).

An Occupation Certificate is compulsory for every building before occupation, as required by the National Building Regulations and Building Standards Act. This is to show that all requirements have been met and to safeguard the owner.

It is therefore concerning that 25.8% of the broader sample and half (50%) of the focused sample respondents did not receive such a certificate and 1% of the broader sample respondents indicated that they only received such a certificate after a couple of years – as they are not legally allowed to occupy a house without such a certificate.

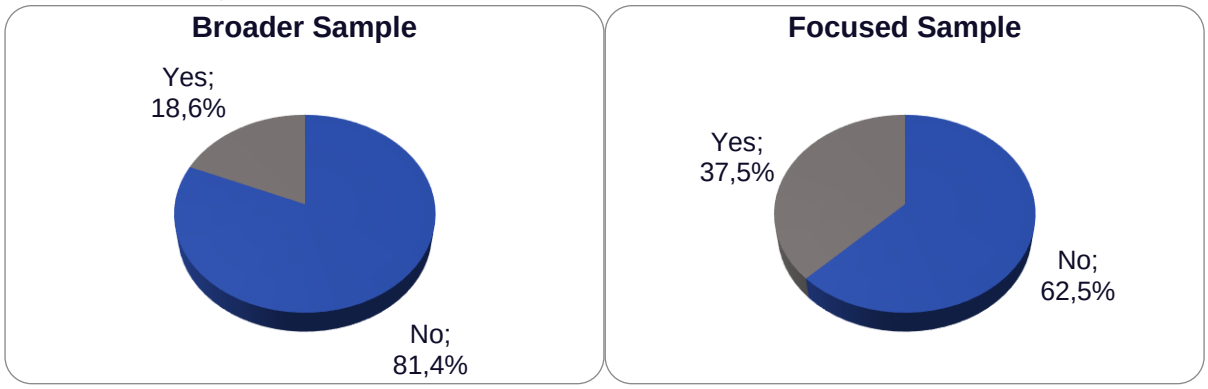
Figure 4.12: Were you given a happy letter (i.e. Certificate of Occupation) upon completion of the house



Source: NHBRC Consumer Perception Surveys, 2019/20

When respondents were asked whether, with handover, they were provided with any contact numbers in case they should need any assistance, the majority in both samples (62.5% and 81.4% in the focused and broader samples respectively) indicated that they were not provided with contacts.

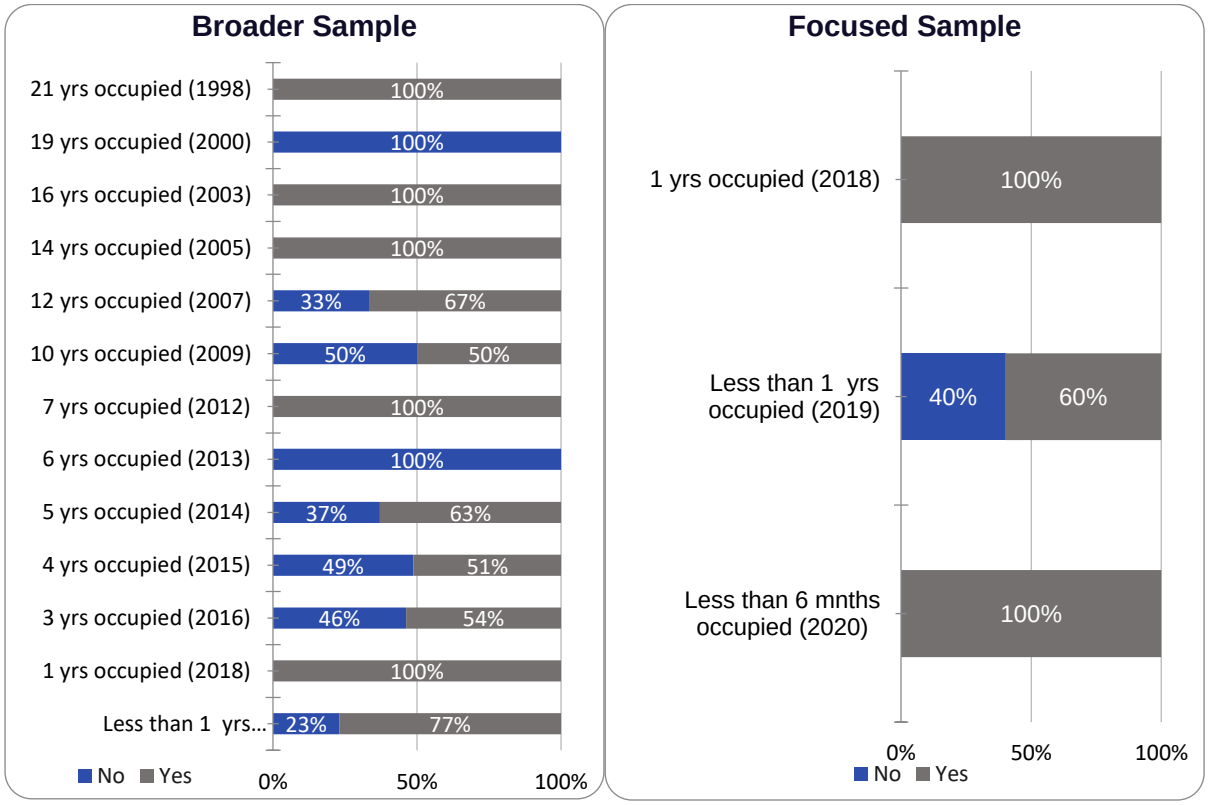
Figure 4.13: With handover, were you provided with any contact numbers in case you should need any assistance



Source: NHBRC Consumer Perception Surveys, 2019/20

Respondents were asked if it had been necessary for them to report any defects since occupying the house. Figure 4.14 presents the results cross-tabulated with the number of years that the respondent has occupied the house. In the case of the focused sample, the majority of respondents (71.4%) indicated that they had to report defect even though they haven't occupied the units for longer than a year. In the case of the broader sample, overall 56.0% of respondents indicated that it had been necessary for them to report defects since occupation. It is important to take cognisance of the high percentages of respondents who had to report defects whilst not having occupied the house for longer than 5 years.

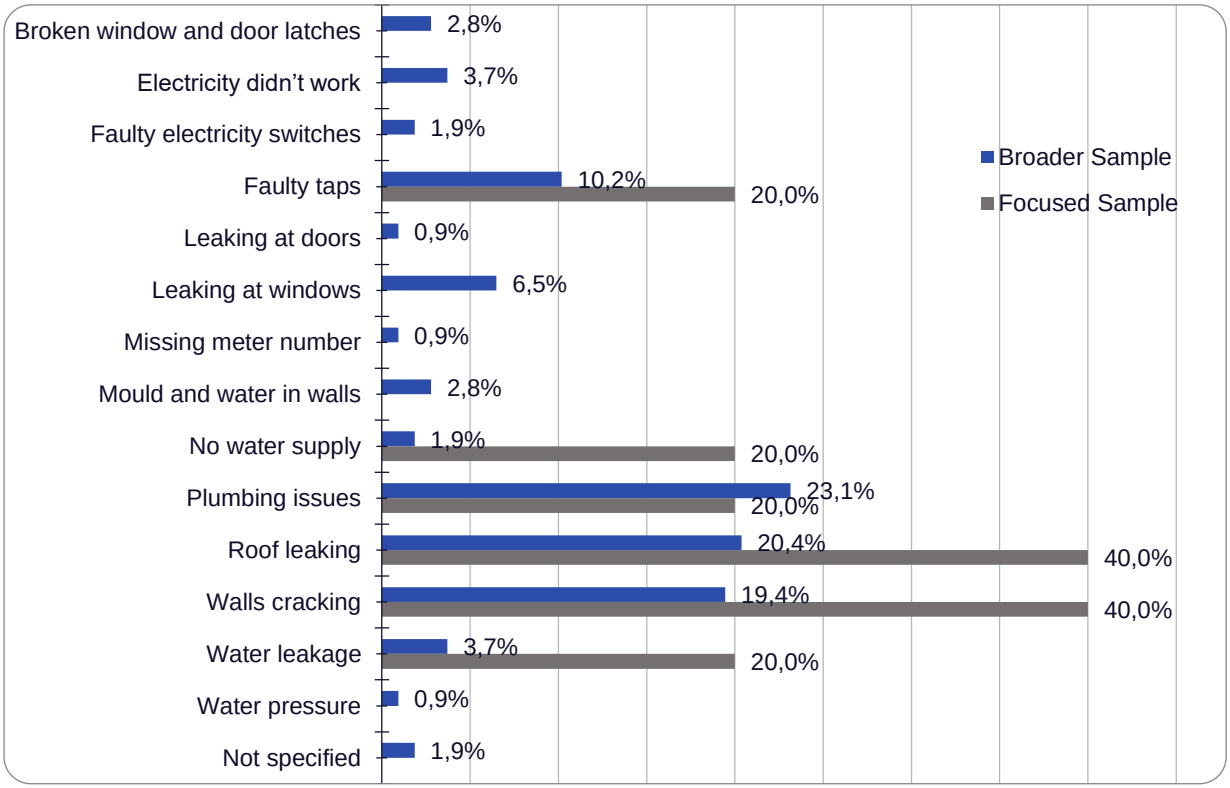
Figure 4.14: Since occupation has it been necessary for you to report any defects



Source: NHBRC Consumer Perception Surveys, 2019/20

When probed further regarding the defects that were reported it became clear that respondents (in both samples, although the broader sample had more defects reported) generally had a lot of the same issues. Defects related to walls cracking, roofs leaking, plumbing issues, etc. (Figure 4.15)

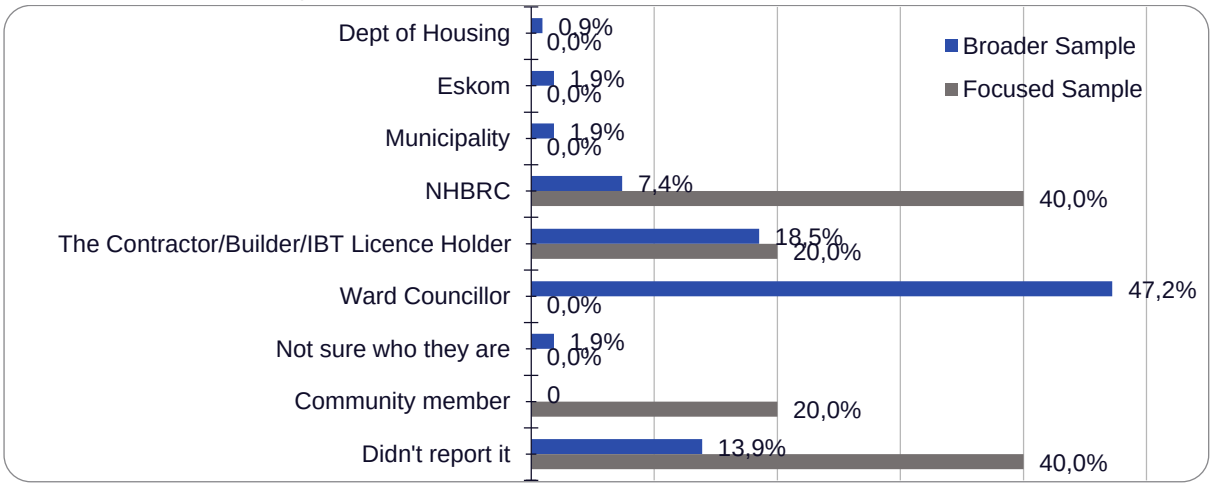
Figure 4.15: Reported defects



Source: NHBRC Consumer Perception Surveys, 2019/20

Figure 4.16 presents the results from when respondents were asked who they had reported the defects to. The focused sample mainly reported to the NHBRC, if they in fact reported the defects. It is however clear that respondents from the broader sample mainly reported the defects to the ward councillor (47.2%), followed by the contractor/builder/IBT license holder (18.5%). A significant portion of respondents in both samples indicated that they did not report the defects, mainly because they did not know who to report it too, but also because some said they just fixed the issues themselves (if they were able to).

Figure 4.16: Who did you report these defects to?



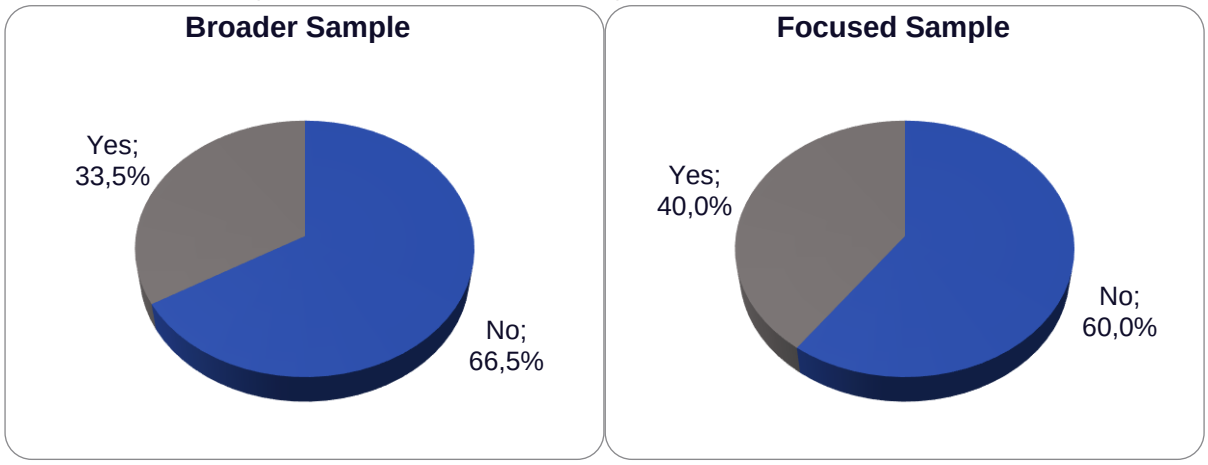
Source: NHBRC Consumer Perception Surveys, 2019/20

In the focused sample the majority of respondents that reported defects (66.7%) indicated that someone had responded to their complaint, while only 33.3% of respondents in the broader sample indicated the same. In all these instances it would be the same entity that they reported it to that would also respond. With 71% of respondents indicating that these entities responded within a week.

When respondents were probed regarding warranty certificates, 60-66.5% of respondents (focused and broader samples respectively) indicated that they were not issued with warranty certificates when their houses were handed over to them (Figure 4.17). This is concerning because all of the projects that formed part of the survey sample were government funded housing projects and it is therefore compulsory that the Builders enrol with NHBRC and contribute towards the Warranty Fund.

The other portion of respondents that indicated that they were issued with warranty certificates were mostly unsure of the type of warranty certificate that they received (i.e. which institution issued the warranty certificate) or that the certificate did not specify who issued the warranty.

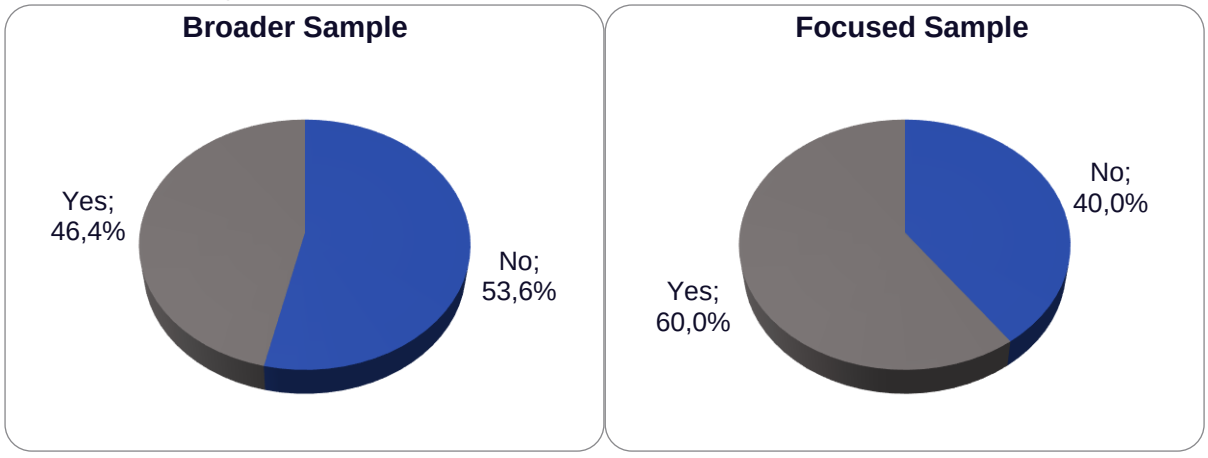
Figure 4.17: Were you issued with a warranty certificate upon hand-over of the house?



Source: NHBRC Consumer Perception Surveys, 2019/20

Respondents were also asked whether they felt that the community was sufficiently involved in the construction of their houses, whereby 60% of the focused sample and 46.4% of the broader sample felt that they community was not sufficiently involved while the remainder felt that they were.

Figure 4.18: Do you feel that your community was sufficiently involved in the construction of your house?



Source: NHBRC Consumer Perception Surveys, 2019/20

4.5 CONSUMER SATISFACTION

To test the satisfaction levels of consumers, respondents were firstly asked to rate their level of satisfaction regarding certain aspects of their house on a scale of 1.5, with 1 being not satisfied at all and 5 being very satisfied. The results are reflected in Table 4.4.

Table 4.4: Respondents' satisfaction levels

Broader Sample					
	Not satisfied at all	Not satisfied	Neutral/ no opinion	Satisfied	Very satisfied
Structural strength and stability	38,3%	29,6%	4,1%	19,9%	8,2%
Thermal and energy performance and/or efficiency	42,9%	18,9%	8,7%	19,9%	9,7%
Water penetration/ waterproofing	38,8%	15,8%	7,7%	27,0%	10,7%
Dust proofing	48,2%	17,4%	14,4%	12,8%	7,2%
Fire resistance	47,2%	15,4%	19,5%	10,3%	7,7%
Durability	42,6%	13,3%	23,1%	12,8%	8,2%
Condensation	33,2%	14,3%	28,1%	13,3%	11,2%
Design & aesthetics	32,3%	13,8%	8,7%	33,8%	11,3%
Quality of materials	53,3%	16,9%	14,9%	8,7%	6,2%
Acoustics	60,5%	14,4%	8,7%	10,3%	6,2%
Frequency & cost of maintenance	50,0%	16,3%	12,8%	14,3%	6,6%

Focused Sample					
	Not satisfied at all	Not satisfied	Neutral/ no opinion	Satisfied	Very satisfied
Structural strength and stability	0,0%	12,5%	0,0%	37,5%	50,0%
Thermal and energy performance and/or efficiency	12,5%	12,5%	0,0%	50,0%	25,0%
Water penetration/ waterproofing	0,0%	12,5%	12,5%	50,0%	25,0%
Dust proofing	0,0%	12,5%	0,0%	50,0%	37,5%
Fire resistance	0,0%	0,0%	25,0%	37,5%	37,5%
Durability	0,0%	0,0%	12,5%	37,5%	50,0%
Condensation	0,0%	0,0%	12,5%	50,0%	37,5%
Design & aesthetics	0,0%	0,0%	0,0%	50,0%	50,0%
Quality of materials	0,0%	0,0%	0,0%	50,0%	50,0%
Acoustics	0,0%	0,0%	0,0%	50,0%	50,0%
Frequency & cost of maintenance	0,0%	0,0%	12,5%	50,0%	37,5%

Source: NHBRC Consumer Perception Surveys, 2019/20

From the preceding results it is clear that the respondents from the focused sample were generally more satisfied than the respondents from the broader sample. Aspects with which respondents from the focused sample were most satisfied with ranked as follows (in order of most satisfied):

- Design & Aesthetics

- Quality of Materials
- Acoustics
- Structural Strength and Stability
- Durability
- Dust Proofing
- Condensation
- Frequency and cost of maintenance
- Fire resistance
- Thermal and energy performance and/or efficiency
- Water penetration/waterproofing

Aspects with which respondents from the broader sample were most dissatisfied with ranked as follows (in order of least satisfied):

- Acoustics
- Quality of Materials
- Structural Strength and Stability
- Frequency and cost of maintenance
- Dust Proofing
- Fire resistance
- Thermal and energy performance and/or efficiency
- Durability
- Water penetration/waterproofing
- Condensation
- Design & Aesthetics

Respondents were given certain statements and were asked to indicate whether the statement rings more true to conventional or innovative building technologies. It was clear that the respondents from the focused sample had a more favourable view towards IBTs with the majority of the respondents indicating that the statements provided rang true to IBTs rather than conventional building technologies. In the broader sample, respondents generally struggled to make a definitive choice, however the following key findings can be made from the broader sample results:

- Innovative Building Technologies scored higher than conventional building technologies in terms of the following statements:
    - Improved upfront costs
    - Improved market value
    - Improved profitability in the long-term
    - Improved speed of construction
    - Reduced labour costs
    - Ease of construction
    - Lower maintenance
    - Improved energy efficiency
    - Less wastage

Table 4.5: Conventional vs Innovative Building Technology

Broader Sample			
	Conventional building technology	Innovative building technologies	Not sure/no answer
Improved upfront costs	19,4%	28,6%	52,0%
Improved market value	21,1%	24,7%	54,1%
Improved profitability in the long-term	21,9%	26,5%	51,5%
Improved speed of construction	12,2%	39,3%	48,5%
Reduced labour costs	13,3%	36,7%	50,0%
Ease of construction	17,3%	32,1%	50,5%
Lower maintenance	18,9%	30,1%	51,0%
Improved energy efficiency	20,4%	21,4%	58,2%
Improved embodied energy	23,5%	21,9%	54,6%
Less wastage	20,4%	27,0%	52,6%
Social acceptability	39,3%	16,8%	43,9%
Architectural innovation/Design	29,2%	20,0%	50,8%
Involving the community whilst constructing	34,9%	15,9%	49,2%
Training whilst constructing	35,2%	13,3%	51,5%

Focused Sample			
	Conventional building technology	Innovative building technologies	Not sure/no answer
Improved upfront costs	12,5%	75,0%	12,5%
Improved market value	0,0%	87,5%	12,5%
Improved profitability in the long-term	0,0%	87,5%	12,5%
Improved speed of construction	0,0%	87,5%	12,5%
Reduced labour costs	12,5%	75,0%	12,5%
Ease of construction	0,0%	87,5%	12,5%
Lower maintenance	12,5%	75,0%	12,5%
Improved energy efficiency	0,0%	87,5%	12,5%
Improved embodied energy	0,0%	87,5%	12,5%
Less wastage	0,0%	87,5%	12,5%
Social acceptability	0,0%	87,5%	12,5%
Architectural innovation/Design	0,0%	87,5%	12,5%
Involving the community whilst constructing	0,0%	87,5%	12,5%
Training whilst constructing	0,0%	87,5%	12,5%

Source: NHBRC Consumer Perception Surveys, 2019

- Conventional building technologies scored higher than innovative building technologies in terms of the following statements:
  - Social acceptability
  - Architectural innovation and design
  - Involving the community whilst constructing
  - Training whilst constructing

Image 4.1: Selected imagery from units visited during primary data collection

Respondents were asked whether they would recommend IBTs to family/community or others. All of the respondents from the focused sample (100%) said that they would, while the majority of respondents from the broader sample (67.5%) indicated that they would not. Reasons provided related mostly to water leakages (through the walls, roof and windows when it rains, but also through faulty water pipes), poor quality material and walls that crack, thin walls that are not soundproof, electricity issues as well as high maintenance costs and materials that are not easily accessible. A number of respondents described the houses as not being suitable for humans to reside in.

Those that indicated that they would recommend IBT houses to family/community/others, based their decision mostly on the design and aesthetics of the houses saying that the houses looked beautiful, while others were merely thankful saying that at least it is a house and better than living in a shack/shelters.

4.6 CONCLUSION

From the survey results it is clear that the respondents from the focused sample were generally satisfied with the IBT houses, although they were not always properly educated and informed during the handover process regarding maintenance, etc. These respondents were generally grateful for the houses that they received.

In contrast, the majority of respondents from the broader sample were not satisfied with the IBT houses. When asked if they wanted to make any general comments that were not covered through the survey itself, a number of respondents indicated that they would prefer it if government reverted back to the conventional homes rather than the IBT houses, as the IBT houses are just prone to more defects and issues.

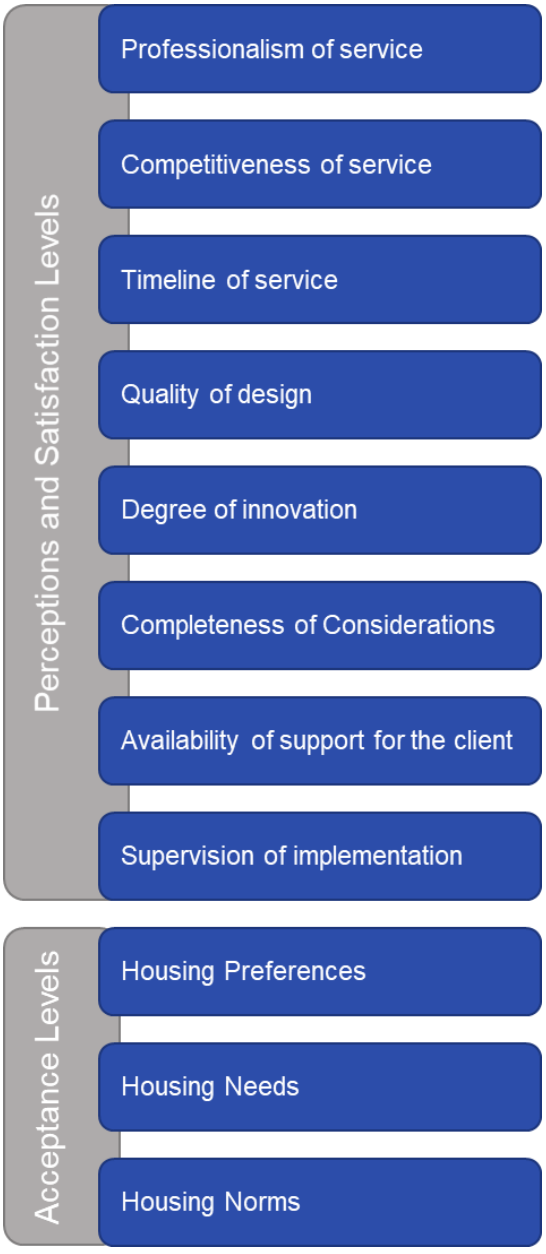
5. ANALYSIS AND RECOMMENDATIONS

5.1 INTRODUCTION

The purpose of this section is to provide an in-depth analysis of the information and data collected in the preceding sections of this report.

5.2 SECONDARY DATA ANALYSIS

In most countries, there is a perception that the industry is generally not innovative, and that there is much room for improvement. Although the latter can be true, as further improvement and expansion is always possible. However, the statement that the industry is generally not innovative is perception based and mostly so due to a lack of knowledge and information.



It is furthermore stated by Barlow that “the more demanding and experienced the client, the more likely it is to stimulate innovation in projects they commission”. This can however only happen if the end-user or client is well informed and experienced regarding the innovations available to him/her. Primary research with industry stakeholders revealed that clients that initially approach a developer/designer/architect with the idea of using IBTs are sometimes recommended to rather revert back to conventional building technology for various reasons, including resale value, etc.

The main aim of this research study is to determine and understand the consumer and stakeholder perceptions and acceptance of IBTs used in residential construction. It was therefore important to understand what influences consumers satisfaction levels and ultimate acceptance of an innovative product or service.

Consumer acceptance relates to how the consumer agrees to take and adopt some new technology for use. Consumer acceptance of new technology is further described as the noticeable readiness within a group to employ new technology to achieve a goal previously with a different method. Consumer acceptance of IBTs is directly related to the consumer satisfaction levels and are based on the housing needs, wants, values, norms, preferences, satisfaction and acceptability. Hence, from the current literature it emerges that there are three important social aspects namely housing needs, preference and norms, which determine the social acceptancy of the implementation of new construction technology.

The current situation in South Africa with regards to IBTs suggest that these three important social aspects are not being met – this objection stems from the sociological view of a traditional "home" and consumers not accepting IBTs in terms of their housing needs, preference and norms.

Sweden's housing delivery approach has transformed quite significantly towards IBTs, with at least 45% of housing produced using some form of offsite manufacturing. The transformation in the industry has been driven primarily by climatic conditions, the availability of timber as an innovative building material as well as Government's strategies and policies to improve sustainability. In some areas of Sweden, all new building must by law be built using offsite timber manufacturing.

The secondary research further revealed that in most developing countries, like India and South Africa, the cost of executing the project with conventional method is always cheaper than the cost incurred in adopting emerging technologies due to various reasons such as labour dominated industry with low wages, lack of research and development, logistics issues, lack of congenial relationship between stakeholders, lack of technological advancement in construction and inadequate training of labour for working with emerging technologies.

5.3 PRIMARY DATA ANALYSIS

In terms of the stakeholder interviews it is clear that the industry role players generally are in favour of IBTs, especially due to the reduced speed of construction as well as value for money and long-term cost effectiveness. Stakeholders unanimously said that consumers however prefer conventional building technology to IBTs, but agrees that this can primarily be attributed to the lack of knowledge by the consumer.

The majority of respondents did not know about the NHBRC or the role it plays in regulating the home building industry and even less respondents knew about IBTs and what it entails. The lack of knowledge can negatively influence the consumer's perceptions of IBTs. This was a general trend observed during the fieldwork, with people mostly not knowing that they occupy IBT houses.

The majority of respondents indicated in their opinion it is not possible to extend an IBT house – this clearly demonstrates that consumers all not informed and educated on IBTs and more specifically the system that is used in the construction of their home.

Defects that were reported by respondents related to walls cracking, roofs leaking, plumbing issues, etc. These are general problems observed even with conventional building technologies and is not indicative of any major structural problems. What did however become clear is that respondents are not informed on who to report defects to, as the majority of respondents reported defects to the Ward Councillor.

Although respondents were not well-informed about IBTs and what it entails, it does seems as though they have been educated on the advantages of Innovative Building Technologies , with the following aspects being listed as true to IBTs: Improved upfront costs

- Improved market value
- Improved profitability in the long-term
- Improved speed of construction
- Reduced labour costs
- Ease of construction
- Lower maintenance
- Improved energy efficiency

- Less wastage

Respondents from the focused sample were generally satisfied with the IBT houses, although they were not always properly educated and informed during the handover process regarding maintenance, etc. These respondents were generally grateful for the houses that they received. In contrast, the majority of respondents from the broader sample were not satisfied with the IBT houses. When asked if they wanted to make any general comments that were not covered through the survey itself, a number of respondents indicated that they would prefer it if government reverted back to the conventional homes rather than the IBT houses, as the IBT houses are just prone to more defects and issues.

5.4 COST-BENEFIT ANALYSIS

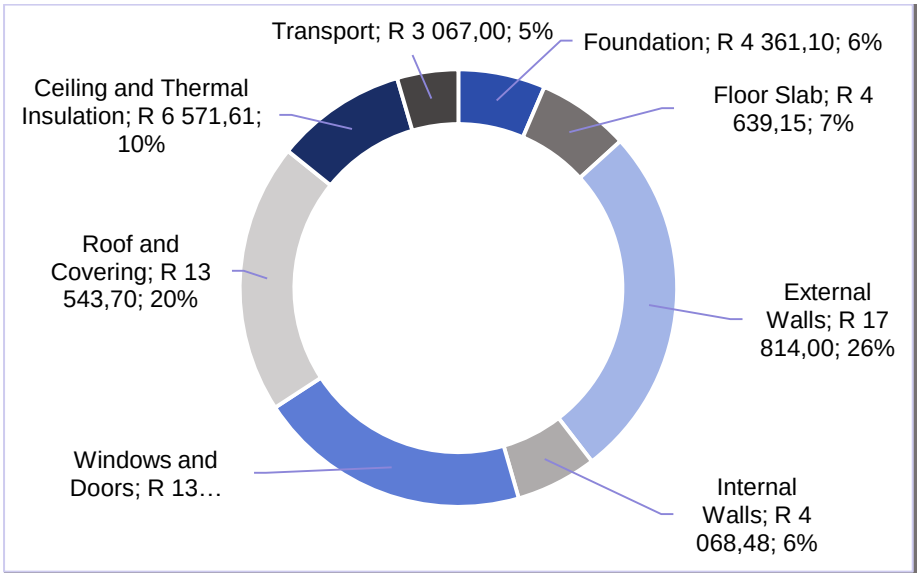
Based on conversations with various stakeholders and funding institutions, it is clear that unit cost and project scale remain important considerations.

Two somewhat contradictory findings were made in regards to project costs and benefits. The apparent contradiction in findings may be the result of project scale and subsequent scale economies. Opposing views were expressed with regard to respectively RDP housing schemes on the one hand and individual high-end houses on the other. RDP housing schemes are typically characterised by scale and a relatively large number of residential units typically approaching and exceeding 1000 units. On account of scale the research indicates that certain cost economies and subsequent savings can be achieved.

Ncube (2017) provides a breakdown of costs that go into the construction of the low-cost housing, using the government subsidy quantum of R110 000 (Figure 5.1 and Figure 5.2).

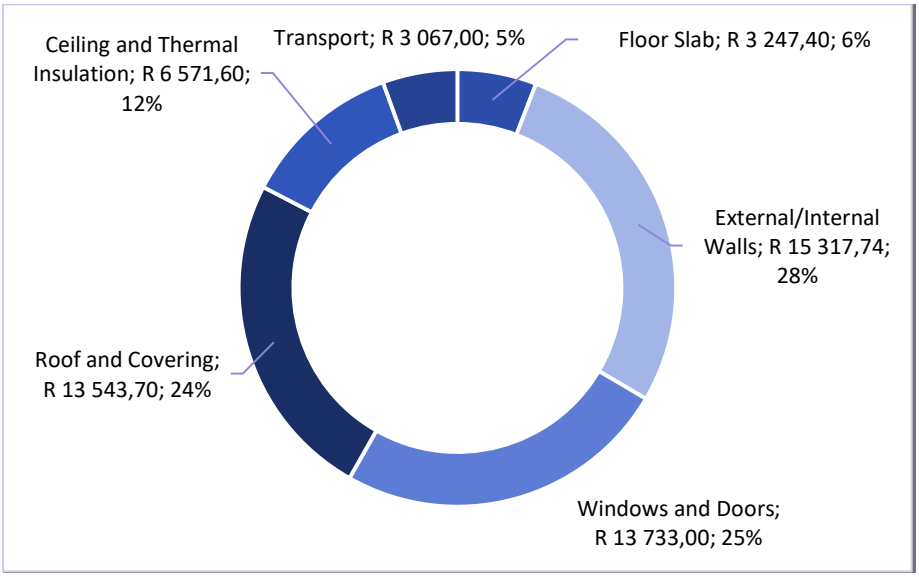
Comparing the traditional methods to IBTs (as a case study Ncube used Moladi Construction Technology), it proves to be less in production cost, as it uses cheaper construction methods allowing for a 30% saving on the total cost of construction of the house. This substantial saving attributed to the fact that most of the money is saved on the installation of the external and interior walls on an IBT house. Ncube states that with the saving in cost, IBT houses on a larger scale will allow communities to construct bigger houses than the normal government conventional houses.

Figure 5.1: Cost of Construct for a Conventional House



Source: Ncube (2017)

Figure 5.2: Cost of Construction of an IBT house (Moladi System)



Source: Ncube (2017)

In the case study performed by Ncube, an interview with an official from the System Owner revealed that the saving on total construction cost is also achieved through the following factors that allow for cost-effective, holistic designs and building technologies:

- Strengthen existing poorly designed structures by demonstrating the use of IBTs as opposed to costly solid concrete-block, masonry structures
- Eliminating waste
- Reduce theft
- Use of community members in the construction rather than expensive professionals

On the opposite side of the spectrum the market penetration of IBTs appears to be limited. The comparatively limited number of suppliers active in this segment of the market would appear to introduce challenges concerning geographic coverage, product back-up and project costing. An assessment of certain independent suppliers of IBT homes to the middle to high income segments of the market indicate that such a home may cost up to R14 500/m2 compared to a comparable home build on traditional construction methods of similar size and quality that could be completed for R10 500/m2. The latter would not yet offer off-grid solutions which cost more and takes approximately a decade to pay for itself through savings. In the present economic environment the added 20-30% upfront cost appears to be a considerable deterrent for the highly indebted middle class, who can, at best implement smaller ad-hoc off-grid solutions.

IBT systems that incorporate appreciable percentages of steel and glass tend to price towards the higher end of the spectrum. The major cost driver does not appear to be water harvesting but instead solar powers combined with batteries and inverter technology. The limited geographic spread of suppliers when compared to conventional building contractors introduces further transportation and accommodation costs for materials and staff to be carried by the home owner.

The cost of innovation is also not considered to be universally transferable to the next owner as perceptions on what constitutes innovation and optimal off-grid solutions vary greatly and resale value remains an important consideration.

Cost considerations, end-user affordability and perceptions therefore remain fundamentally important considerations in making decisions regarding building methods and associated technologies.

5.5 FINDINGS AND RECOMMENDATIONS

- **NHBRC members (System Owners/Builders/Contractors/Developers):**
  - Through the primary research interactions with these stakeholders, it became clear that a certain degree of scepticism existed regarding the NHBRC and the research being conducted. These stakeholders generally felt that they were being investigated and that their work are being questioned – thus feeling as though the NHBRC is siding with the consumer.
  - It is recommended that the NHBRC undertakes major Public Relations exercises with constructive interaction to build and foster an open relationship with its members (specifically those involved with IBTs)
  - It is also recommended that Workshops and Training Sessions are held within the housing sector (from construction companies to housing inspectors). Skilling across the entire value chain of housing delivery will seal any gaps and eliminate the possibility of poor quality in construction.
  - It was indicated that limited contractors exist that are registered/licensed to construct using IBTs; and in most cases existing conventional contractors are not in a position to independently undertake construction of IBT. This presents an opportunity for the NHBRC and Government to stimulate the IBT industry through business development, incubation and possibly procurement measures.
  - It was concluded from the primary research that the focused sample were better informed of how to care for and maintain an IBT house, than the broader sample. The recommendation is therefore made that developers and builders are properly trained in this regard and that beneficiaries are properly educated (and provided with the necessary contact details in case of defects/assistance required) as a prerequisite to hand-over.
- **Consumers:**
  - It is concluded that the resistance from the consumer with regard to IBTs is often an initial knee-jerk reaction primarily based on tradition. Most consumers can't distinguish whether the subsidised housing received was built with conventional or innovative building technologies. The use of IBTs is innovative and better value for money especially for subsidised housing projects and given the housing backlog in South Africa and the global economic climate. The Way Forward for subsidised housing in definitely in IBTs.
  - Acceptance of IBTs is key to achieving the government's targets. It is therefore recommended that consultative meetings are held to introduce IBTs to the general public to ensure that they adopt it and familiarise themselves with it **prior** to implementation
- **Local authorities:**
  - In South Africa, and more so within the informal and rural areas, society is characterised by a Do-It-Yourself culture. The majority of subsidised-housing beneficiaries will expand their house within the first 12 months, generally using easily accessible conventional building materials. These expansions however

are mostly unregulated, without the necessary building plan approvals, electricity certificates, water and sanitation provisions, etc. This poses a major problem and concern for the local authorities.

- It is recommended that the local authorities engage with these communities to educate them on the required processes and approvals and also the threats involved with not obtaining these approvals.
- In conjunction with the system owners it is important for the local authorities to ensure that IBT construction processes (as with any other economic activity in a local economic region) creates jobs and other economic opportunities – thereby also promoting acceptance and adoption of the activity amongst the local communities.
- One of the complaints against the IBT houses is that beneficiaries are of the opinion that they can't extend their houses, primarily based on the fact that the materials required are not easily accessible. Beneficiaries tend to extend using traditional or conventional building materials - most of which is easily accessible, especially in rural and township areas, where most municipalities have implemented brick-making projects as part of their LED programmes. Innovative building materials used in construction projects should therefore be easily accessible and readily available for supply. It is recommended that the Local Authorities engage with the System Owners/Building Contractors for possible small business development and contractor incubation in their local area.
    - Building Contractors are generally expected to train and upskill local labour as part of construction projects. The possibility exists to develop, incubate and mentor these local labour participants to be able to not only supply the innovative building materials locally but also providing the necessary skills to the local communities in terms of expansions and maintenance of their IBT homes.
- Local Authorities, in conjunction with the NHBRC need to ensure that the system specifications are constructed as per the certificate issued by Agrément. Ensuring good and proper workmanship, quality control and project management.
- It is furthermore recommended that local authorities investigate the development of procurement policies for innovative materials to support and promote the IBT industry
- It was found that a possible set-back is also the lack of knowledge and experience of in-house provincial inspectors regarding quality assurance of IBTs. It is therefore recommended that training and workshops are provided to upskills building inspectors in this regard.

- **Other stakeholders:**
    - From interaction with stakeholders it is clear that concept of IBTs are still fairly new and unknown – with the subject not enjoying the attention it deserves.
    - It is therefore recommended that wide consultation is done by the NHBRC with all players in the construction of the IBT houses and buildings – from city planners and municipalities to architects and designers, constructors and well as quality assurers.
    - Provide people with power of decision-making. If government is to reach the balance between the needs of the users and what is delivered, then community

participation should provide residents with choices amongst range of delivery options to choose from, than advancing one particular option and undermine the choices that the people may make.

6. CONCLUSION

In conclusion it is clear that the South African construction industry to a large degree has shown resistance to building houses using IBTs. There is clearly more that needs to be done to educate consumers in order to drive the demand of IBTs, and also to engage with system owners, builders and developers to foster a constructive and open relationship.

The benefits of IBTs are well documented and accepted – not only in providing housing at a faster rate but also in producing housing options that are energy-efficient, reducing the dependency level on electricity resources.

The target set by government to dramatically increase the number of houses constructed using IBTs has however experienced some challenges along the way. The main challenge is to educate and create awareness regarding IBTs – amongst end-users, but also amongst municipalities, developers, architects, planners and urban designers, ensuring that the adoption of IBTs is not manifested at the project implementation phase, but rather at the conceptualisation and planning phase.

ANNEXURE A: STAKEHOLDER ENGAGEMENT REPORT

A. INTRODUCTION

This annexure details how stakeholders were identified, how they were engaged and who the parties were that was engaged.

B. IDENTIFYING STAKEHOLDERS AND UNDERSTANDING RELATIONSHIPS

The identification of stakeholders to be engaged was primarily informed by the Scope of Work as set out in the original tender, which stipulates the following:

- Primary sample of IBT consumers (subsidy and non-subsidy)
- Secondary sample (potential and targeted consumers)
- Tertiary sample (all spheres of government, universities, suppliers, builders and developers, financial institutions, professional bodies, donors)

The sample was further expanded during the Inception meeting with the NHBRC held on the 15th of January 2019. During this meeting the NHTBC expanded on the sample which they wanted to be surveyed and included the following:

- Primary Sample:
  - IBT Consumers (subsidised and non-subsidised)
- Secondary Sample:
  - Potential and targeted consumers
- Tertiary Sample:
  - All spheres of government (National, Provincial and Local)
  - Various governmental departments including Departments related to Education, Health, Housing, Building, Water and Sanitation, Environmental Affairs, Public Works, Human Settlements, Housing, Science and Technology, etc.
  - Universities' Research Units
  - Suppliers of IBT products and services
  - Builders and Developers (accredited by NHBRC/Agrément)
  - Financial Institutions (Commercial banks, National Housing Finance Corporation, etc.)
  - Professional bodies such as the Construction Industry Development Board (CIDB), the South African Bureau of Standards (SABS), the Council for Scientific and Industrial Research (CSIR), Agrément, etc.
  - Industry Associations such as The Association of South African Quantity Surveyors (ASAQS), the South African Institute of Architects (SAIA), the Constructional Engineering Association of South Africa (CEA(SA)), etc.
  - Donors (e.g. Finland, Germany (GTZ), Sweden, USAID, etc.)

C. HOW WE ENGAGED

In order to undertake a statistically representative sample, a complete database of consumers were requested. The NHBRC indicated during the inception meeting that they have a database

which will be provided. However, the database provided by the NHBRC was not a complete database of beneficiaries/consumers, but rather a database of systems accredited by the NHBRC.

The Research Service Provider subsequently contacted the system owners, both telephonically and via email, which was involved in residential construction projects, through contact details as listed in the database, in an effort to obtain details of beneficiaries to ultimately compile a comprehensive database from which a sampling process could be undertaken. The contact details and database provided generally seemed out-dated with a significant portion of contact persons not being reachable. In instances where the listed contact persons were reachable, they generally seemed unwilling to cooperate stating that it is confidential client information.

The Research Service Provider was able to compile a beneficiary list, with information received from the NHBRC and one particular system owner, comprising 15 beneficiaries. These beneficiaries were contacted telephonically, although not all of them were reachable.

In an effort to expand the sample, The Research Service Provider obtained permission from a particular system owner to survey beneficiaries on site in the Eastern Cape and also arranged for surveys to be conducted with beneficiaries in the Delft area (as per the erf numbers obtained from the Western Cape Department of Human Settlements). These beneficiaries were all interviewed through face-to-face interviews.

Various stakeholders were contacted telephonically in an effort to set up meetings to conduct qualitative interviews. In some instances the stakeholders preferred to obtain the questions electronically, while others were interviewed face-to-face.

D. WHO WE ENGAGED WITH

Category	Parties engaged
Consumers	15 listed beneficiaries supplied by NHBRC and Mike Hill
	3 beneficiaries at a project in Diepsloot (identified through the database supplied by NHRBC)
	8 beneficiaries at a project in Soshanguve (identified through the database supplied by NHBRC)
	14 beneficiaries at a project in Port St Johns (Eastern Cape) supplied by Mr Kistnasamy (Everite)
	167 beneficiaries at a project in Delft (Western Cape) supplied by the Western Cape Department of Human Settlements
Government Departments	All nine Provincial Departments of Human Settlements: • Eastern Cape: Ms Hlobo • Western Cape: Mr Mguli • North West: Mr Mtoko & Ms Thapelo • Northern Cape: Mr Lenkoe & Ms Botha • Limpopo: Ms Dumalisile • Free State: Mr Mohale • Mpumalanga: Mr Matshebula • Gauteng: Mr Molokomme • KwaZulu-Natal: Ms Chiluvane
	National Department of Science and Technology: Mr Mosiea
	University of the Witwatersrand – Mr D Root
	University of Limpopo – Dr T Mabila

Category	Parties engaged
Universities' Research Units	University of Stellenbosch - Mr C Walker
	North West University– Prof N Kgabi
	University of the Free State – Dr G Mukwade
	University of Cape Town Ms J Thompsett
Suppliers, Builders & Developers	AV Light Steel – Customer Care. Email requested
	Moladi – Camalynne Botes
	UFCC – Mr Leon Bekker
	ReadyKit – Mr Mike Hill
	Everite – Mr Mannie Kitsnasamy
	Habitat Modular – Athi Magwentshu
	Sanjo FIBTec – Jonathan Peel
	Benex Cape Pty Ltd – Tony Marsh
	Cobute/Geoplast – Atillion Angelucci
Financial Institutions and Donors	ABSA – Customer Care
	FNB– Customer Care
	Standard Bank– Customer Care
	Nedbank– Customer Care
	NHFC– Customer Care
	USAID– Customer Care
	GIZ/GTZ– Customer Care
Professional Bodies	Construction Industry Development Board (CIBD) – Mr P Yengwa
	South African Bureau of Standards (SABS) – Customer Care
	Centre for Scientific and Industrial Research (CSIR) – S Sebake
	Agrément – Mr J Odhiambo
	Association of SA Quantity Surveyors (ASAQS) - Reception
	South African Institute of Architects (SAIA) - Reception
	SA Housing Foundation- Reception

ANNEXURE B: ACTIVITY REGISTER

The survey process in unconventional as the information required for the survey sample is not available in the public domain. The NHBRC had to furnish The Research Service Provider with lists of stakeholders and secondly lists of beneficiaries.

Date	Activity
15/01/2019	Inception meeting held between NHBRC and The Research Service Provider
21/01/2019	Request made by The Research Service Provider to NHBRC for the following: • Details of subsidised housing projects and beneficiary lists • Contact persons of other Stakeholders (if and where available) • Costs of IBT systems • Introduction letter to stakeholders and consumers
01/02/2019	Inception report submitted to NHBRC by The Research Service Provider
11/03/2019	• Draft questionnaires submitted to NHBRC by The Research Service Provider. • A further request was made by The Research Service Provider to NHBRC for details of subsidised housing projects and beneficiary details, introduction letter, contact persons, etc.
15/03/2019	Draft data analysis plan submitted to NHBRC by The Research Service Provider
27/03/2019	A further request was made by The Research Service Provider to NHBRC for details of subsidised housing projects and beneficiary details, introduction letter, contact persons, etc.
01/04/2019	Following information received by The Research Service Provider from NHBRC: • IBT System Database (CPT only includes 5 system owners) • Address for 1 beneficiary in Etwatwa (with the contact details of the ward councillor) • NDoHS database for IBTs (29a and 29b Nov 2014 – includes 4 system owners) The Research Service Provider immediately and continuously attempted to engage with the System Owners listed in these documents
03/04/2019	Progress meeting held between NHBRC and The Research Service Provider. Comments received on questionnaires and Data Analysis Plan.
10/04/2019	Final Data Analysis Plan submitted by The Research Service Provider to the NHBRC. A further request from The Research Service Provider to the NHBRC for database of beneficiaries.
25/04/2019	A further request from The Research Service Provider to the NHBRC for database of beneficiaries and Introduction letter.
06/05/2019	Hard copies of Inception Report and Data Analysis report delivered to the NHRBC offices. A further request from The Research Service Provider to the NHBRC for details of beneficiaries and Introduction letter
07/05/2019	Introduction letter received by The Research Service Provider from NHBRC
13/05/2019 – 24/05/2019	The Research Service Provider attempted to engage with all listed System Owners telephonically and via emails
29/05/2019	A further request from The Research Service Provider to the NHBRC for details of beneficiaries and Introduction letter. The Research Service Provider and NHBRC subsequently had a meeting to clarify the information that was

Date	Activity
	required by The Research Service Provider to be able to undertake sampling and ultimately conduct surveys with consumers.
14/06/2019	Letter of request for extension of time frames submitted by The Research Service Provider to the NHBRC. The letter of extension included a further request to NHBRC to assist in providing and obtaining consumer/beneficiary information.
24/06/2019	Certain stakeholders ultimately agreed to participate but requested a formal letter from the NHBRC to request system owners to offer their assistance. Request from The Research Service Provider to NHBRC for a letter addressed to the system owners asking for their cooperation and assistance in providing the details of beneficiaries occupying IBT houses.
01/07/2019	A further request from The Research Service Provider to NHBRC for a letter addressed to the system owners asking for their cooperation and assistance in providing the details of beneficiaries occupying IBT houses. Letter subsequently provided by the NHBRC to The Research Service Provider
08/07/2019 – 17/07/2019	System owners contacted telephonically and via email.
18/07/2019	NHBRC agreed as per email correspondence to intervene with regards to obtaining beneficiary details from System Owners, as The Research Service Provider was having very little success. The exact outcome of this intervention was not disclosed.
24/07/2019	Progress meeting between NHBRC and The Research Service Provider during which challenges were again discussed. NHBRC provided The Research Service Provider with some additional contact details of system owners and NHBRC also resolved to contact the provincial offices directly with a request for information regarding beneficiary details. NHBRC were able to provide contact details for 7 beneficiaries during this meeting.
24/07/2019 – 19/08/2019	Contacted the list of beneficiaries telephonically as per the information provided by NHBRC and certain System Owners
19/08/2019	Follow-up request from The Research Service Provider to NHBRC regarding beneficiary details from the various provincial offices. The Research Service Provider are provided with the email addresses for the provincial offices and asked to contact them directly.
23/08/2019	The Research Service Provider requests the NHBRC to assist and intervene with the provincial offices as little to no response were received
23/08/2019 – 26/08/2019	The Research Service Provider continuously followed-up with the provincial offices via email and telephone calls
18/09/2019	NHBRC provides The Research Service Provider with a list of 10 beneficiaries (some of which was already included in the list provided on 24/07/2019)
23/09/2019 – 05/10/2019	The Research Service Provider continues its attempts to reach and interview the list of beneficiaries compiled through information received from NHBRC and certain System Owners
11/10/2019	The Research Service Provider is successful in persuading Mr Kitsnasamy (Everite) to cooperate on the condition that the questionnaire is firstly made available to the company (they were sceptical that we were there to question their work).
14/10/2019	Continued follow-up with the Provincial Governments telephonically and via email

Date	Activity
15/10/2019	• Feedback provided by The Research Service Provider to NHBRC – indicated that field surveys were being organised in the Eastern Cape and Western Cape Provinces. • Response received from KZN Provincial Department of Human Settlements and Gauteng Department of Human Settlements • Mr Kistnasamy provided feedback and asked us to wait until the project manager on site has been able to engage with the community and received their approval
16/10/2019	Interview conducted with Agrement
17/10/2019	Response received from Western Cape Department of Human Settlements – included beneficiary lists for subsidy housing projects in Delft (limited to stand numbers and beneficiary names – no contact details)
21/10/2019	The Research Service Provider was advised by Western Cape Department of Human Settlements to go through the local structures when engaging the community in Delft. The Ward Councillor was subsequently contacted but was unreachable and unresponsive.
24/10/2019	Mr Peter Fowler (project manager on site at Port St Johns) gave permission for us to continue with the survey subject to certain conditions such as inclusion of local youth/unemployed
25/10/2019	Feedback provided by The Research Service Provider to NHBRC – indicated that field surveys were completed and data capturing and collation were in progress and reporting commenced.
29/10/2019 -02/11/2019	Surveying done in the Eastern Cape (Port St Johns). Contractor on site had to identify the locality of these houses to The Research Service Provider – only 15 houses were completed at the stage of surveying.
30/10/2019	Follow-up with Delft area Ward Councillor in an effort to liaise with the community and identify fieldworkers. Ward Councillor remained unreachable and unresponsive.
07/11/2019	Engaged with local religious organisations in an effort to identify local fieldworkers
20/11/2019 – 27/11/2019	Surveys conducted in the Delft area
07/12/2019	Draft report submitted by The Research Service Provider to the NHBRC
28/01/2020 – 13/03/2020	Further engagements with additional System Owners and Beneficiaries. An additional four beneficiaries' responses were obtained; and an additional five system owners' responses were obtained during this time period.
19/03/2020	A revised and final draft were submitted to the NHBRC.

Within this timeline, The Research Service Provider continuously engaged System Owners and Provincial Housing Departments and ultimately obtained agreement to interview beneficiaries in major areas such as Port St Johns and Delft towards the end of October.

ANNEXURE C: REFERENCES

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