The relationship between craft and tectonics:

The influence of craft on timber construction in the South African built environment

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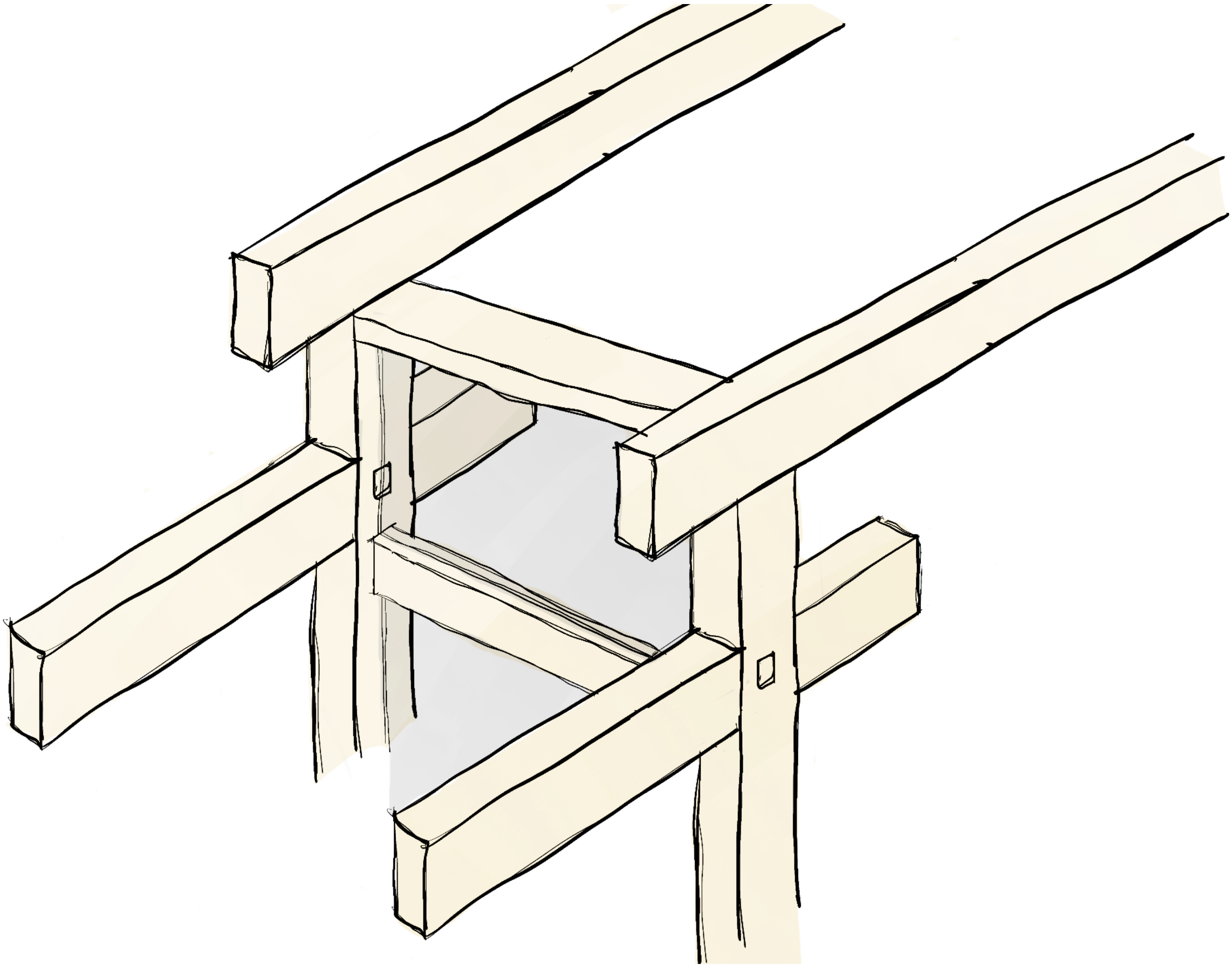
Research Report



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Abstract

This literature review and case study research report explore the values of emerging building technologies in South Africa, with a specific focus on timber construction and craft influenced by new digital fabrication and pre manufacturing practices. The discussion section highlights the growing trend of using timber in innovative ways within the architectural realm, emphasising its versatility, sustainability, and values added to the built environment. Architects and designers are creatively incorporating timber into building materials and structural systems, pushing the boundaries of modern architecture. The report delves into two main approaches: high-tech and low-tech. On a high-tech scale, the integration of computer-aided design (CAD) and computer numerical control (CNC) machining allows for precise planning and off-site prefabrication of timber components, reducing waste, construction time, and ensuring structural integrity. Projects like the freeform timber Yoga Studio and House Elliot showcase the seamless fusion of high-tech methods with traditional craftsmanship, resulting in sustainable and visually striking structures. Additionally, projects like The Ridge and House Paarman treehouse demonstrate the use of advanced technologies and innovative materials like Cross-Laminated Timber (CLT) for enhanced aesthetics, sustainability, and energy efficiency. On a low-tech scale, the research highlights the revival of traditional craftsmanship and timber bending techniques in projects like the Desmond Tutu Archway and Die Spens' Bosjes, preserving cultural heritage and personalising modern architectural designs. Furthermore, projects that combine both high-tech and low-tech elements, such as 'Die Spens' Bosjes and the House of the big Arch, demonstrate the groundbreaking results of synergizing innovation and craftsmanship.The report also explores the historical journey of South African architecture, showcasing the blend of local traditions and international influences. It emphasises the challenge of breaking away from traditional building technologies, like brick and mortar, to explore innovative alternatives that are economically viable, versatile, and responsive to the diverse environments in the country. The conclusion summarises the findings, highlighting the growing interest in sustainable and eco-friendly construction practices in South Africa, with timber construction being a prominent focus. The integration of digital design tools and manufacturing processes has allowed for intricate shapes and precise construction while preserving craftsmanship. Timber's prominence in these approaches is transforming the architectural landscape in South Africa and contributing to visually captivating, structurally sound, and environmentally friendly buildings. Embracing innovation while celebrating the country's diverse history and culture is key to shaping the future of South African architecture, ensuring its vibrancy and relevance for generations to come. By adopting emerging building technologies, like timber construction, the industry can contribute to a more sustainable and prosperous future for South Africa's built environment.

Declaration of Originality

"I declare that the mini-dissertation, "The relationship between craft and tectonics: The influence current day craft has on timber tectonics in the South African Built Environment.", which has been submitted in fulfilment of part of the requirements for the module of DIT 801, at the University of Pretoria, is my own work and has not previously been submitted by me for any degree at the University of Pretoria or any other tertiary institution.

I declare that I obtained the applicable research ethics approval in order to conduct the research that has been described in this dissertation.

I declare that I have observed the ethical standards required in terms of the University of Pretoria's ethical code for researchers and have followed the policy guidelines for responsible research."

Signature:

Date: 24 July 2023

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1.1 Key terms

Current building practice: The term *current building practice* refers to the present day use of *conventional building technologies* (Ampofo-Anti, 2017: 2). This practice is associated with well-defined and well-developed means of construction that have been trusted and currently used by the construction industry.

Building technology: *Building technology* includes everything the construction industry requires to create buildings and other objects that make up our physical environment, subsequently it takes into account not only the requirements of the building industry but also those of all other sectors that directly and indirectly support it (Mohammed M. Shahda, 2018: 55).

Emerging building technologies: In this research, the term denotes the realm of building material technology development which encompasses the sub- realms of non-conventional building technologies (Wienecke, 2010: 17 - 18). *Innovative Building Technologies* and their corresponding innovative processes and forward thinking. These processes of forward thinking and building material development fall within a time frame as recent as 5 to 10 years (McCoy and Yeganeh, 2021: 6), while the narrative and rate associated with continual development is completely dependent on the region of focus and the current state of its construction industry (Wienecke, 2010: 17 - 18).

With reference to the South African context, the development of said material technologies and corresponding processes are geared at "reforming society by making use of technology, which is environmentally sustainable, and allows equity in the access to resources." (Wienecke, 2010: 17 - 18). Furthermore, corresponding constraints to this realm of study suggest that the developed material technologies should encourage "the radical transformation of industrial society to facilitate a transition to a more ecologically harmonious, socially convivial, and economically steady-state society." (Wienecke, 2010: 17 - 18).

Innovative Building Technologies: *Innovative Building Technologies* or also referred to as *alternative building technologies*, refer to approved, fit-for-purpose, and nonconventional methods used in construction. These advanced approaches are believed to significantly enhance the building process (Olojede et al., 2019: 169). While IBTs may share some similarities with EBTs, they distinguish themselves by being innovative and alternative technologies. Unlike EBTs, IBTs do not fit within the emerging realm based on the time limitations set forth by our definition.

Tectonics: The term *tectonic* in architecture commonly pertains to the arrangement and construction of building elements and objects, or simply put, the way materials are assembled in a building (Loh, 2019: 25). Commonly employed to depict construction systems that are lightweight or skeletal in contrast to stereotomic systems, *tectonics* also extends beyond merely expressing structural elements. Instead, it embraces the entire creative process of design and construction, incorporating material properties and structural articulation in an artful manner (Louw, 2021, p. 8).

Craft: The term *craft* encompasses any profession that relies on skilled handiwork, involving a defined set of mechanical processes to create identical pieces of work repeatedly. (Hanlon, 2017: 25). *Craft* reveals its potential for fostering an open-ended and dynamic engagement with both material and process (Stein, 2011: 49).

1.2 Introduction & Background

1.2.1 South African Architecture

South African architecture has undergone numerous social and political changes and has been influenced by both local and international factors, resulting in a diverse blend of culture and history. The rural landscape of South Africa features a mix of traditional and European-influenced African architecture, which has greatly impacted modern architectural work (Conradie, 2021). South Africa's history of European political and economic dominance since the 17th century significantly impacted indigenous traditions. This control began with Jan van Riebeeck's arrival in 1652 under the Dutch East India Company, followed by conflicts involving Britain, France, and the Boers, shaping the country's urban development through colonisation (Dainese, 2015: 444). According to Sanders (2000: 68) nearly all of South Africa's architectural traditions have been influenced by European and American principles. Taking into consideration the influence of heritage and the prevailing state of affairs, the architectural landscape of South Africa during the 1800s witnessed the emergence of public works projects and private residences characterised by the Dutch, Victorian, and Edwardian architectural styles. Catalogue construction materials were transported to these locations and put together in colonial interpretations.

Before white settlement in the areas where Johannesburg formed in 1886, the dominant architectural style in the region was cone-on-cylinder dwellings with stone walls plastered with clay and thatch or reed roofs. The earliest white settlers lived in primitive structures of wattle and daub, leading to dismissive descriptions by the Zulu people. Eventually, clay and rammed earth were introduced, paving the way for brick structures (O'Toole, 2018: 1). Even after the establishment of the Union of South Africa in 1910, the government continued to promote European models of architecture and urbanisation, further influencing the country's development (Dainese, 2015: 444). During the emergence of South African architecture, Gerhard Moerdjik played a significant role in instigating radical regionalist responses aimed at countering Imperialist influences (Barker, 2015: 19). His advocacy for an 'Afrikaner (African) architecture' served as a means to challenge these prevailing tendencies. One of the most prominent expressions of this architectural reaction was the construction of the Voortrekker Monument in 1938, which drew inspiration from the Art Deco style.
Throughout the twentieth century, foreign architectural influences persisted in South Africa. The Modern Movement gradually but steadily made its impact in the country from the 1930s onwards (Sanders, 2000: 8). During this same period, the Transvaal Group emerged, embracing radical regionalism as a way to address the prevalent architectural style, characterised by its "eclectic, reiterative, and tired" nature, heavily relying on the 'neo-Renaissance' approach. To counter this trend, the Transvaal Group adopted the principles of the Corbusian and Bauhaus inspired Modern Movement, which they incorporated into their architectural endeavours (Barker, 2015: 19). This shift in architectural ideology aimed to infuse new ideas and design philosophies into the contemporary South African architectural landscape. Architect Rex Martienssen, also part of the Transvaal Group, embraced modern South African architecture and Le Corbusier's ideas, aiming for architectural integrity by balancing understanding, techniques, and available resources (Dainese, 2015: 444). The development of South African modernism can be traced back to these architects from Johannesburg engaging with the international Modern Movement (Fisher et al., 2003: 2).

Moving into the present state of the building industry and architectural environment, the architecture and *building technology* of South Africa finds itself at a crucial juncture, and this state of affairs may have persisted for quite a while. According to Wu, Wei & Peng (2019: 8) *building technology* can be defined as the combination of materials, techniques, and structural systems. In the realm of contemporary "commercial" architecture, there seems to be a lack of progress, as it remains stagnant (Sanders, 2000: 70). Furthermore Kloukinas (2014: 58) also describes the state of *building technology* in the architecture industry and built environment in South Africa as being stagnant and stuck in its ways. On the other hand, contemporary community and civic architecture, driven by social and political motives, are unearthing designs that draw inspiration from the local culture, essence, and *craft*. It is within these realms of advancement that we can find optimism for the future (Sanders, 2000: 70). Current building practice, over time, has developed a “reputation for its slow uptake of technology compared to other industries such as manufacturing, agriculture and entertainment” (Calitz & Wium, 2021: 1).

According to Ampofo-Anti (2017: 2) the majority of the building sector in South Africa uses *conventional building technologies*, which are brick and mortar structures, which take a long time to construct in part because wet work requires lengthy curing times . It has been challenging for the building industry to evolve due to its segmented structure, site-based operation, and the professionals' reluctance to transformation (Osunsanmi et al., 2018: 150). In South Africa, historical construction methods were tailored to suit the unique climate and topographical conditions of the region. However, contemporary building practices have fallen into a pattern of repetition and a constrained use of technology, limiting their potential for innovation and adaptation to diverse environments (Bothma, 2023: 2). The construction process linked to traditional building technologies, such as brick and mortar, is characterised by a slow pace primarily because of the technological demands involved. These demands include the need to use a wide variety of building systems, products, and components that are assembled on the construction site (van Wyk, 2013: 1-2).

1.2.1.b Use of alternative building technologies

Although the reluctance is evident, organisations such as Agremènt and the CSIR (Council for Scientific and Industrial Research) are pushing the boundaries of South African Architecture and the introduction of *innovative building solutions* (Conradie, 2014). In recent years, there has been a growing fascination with *Innovative Building Technologies (IBT)* in South Africa. Notably, in 2013, the CSIR (Council for Scientific and Industrial Research) proposed to the Presidential Infrastructure Coordinating Commission that IBTs should be embraced for enhancing social infrastructure delivery in the country (Olojede et al., 2019: 170).

1.2.2 Emerging Building Technologies

In the context of contemporary projects, the utilisation of alternative methods or approaches can be seen as the advancement of *emerging building technologies*. The incorporation of these nascent building technologies largely relies on the preferences of the architect or the client's specific demands. Notably, these *emerging building technologies* bring distinct advantages to the built environment, particularly in the case of South Africa, where persistent challenges have been mentioned earlier. The rationale behind adopting these *emerging building technologies* can be categorised into four primary values:

Economical: An alteration in the current practices aimed at expanding the utilisation of *emerging building technology* offers the potential for the South African built environment to become more “versatile, economical and contextually responsive” (Bothma, 2023: 2). Other benefits associated with implementing *innovative building technologies* for project delivery are described by Ampofo-Anti (2017: 2) to be reduced construction expenses, a decrease in the construction timeline, and improved building quality.

Versatile: As an example, utilising a *building technology* that centres around the precise assembly of factory-manufactured components represents a practical and significantly more reliable approach to attaining the desired performance levels of construction projects. In contrast, traditional construction methods, characterised by uncertainty and inconsistency, do not present a comparable prospect for achieving the same level of certainty. (van Wyk, 2013: 4)

Socially responsive & Contextually responsive: The limited and dependable access to transportation and the challenges of reaching remote construction sites often hinder the deployment of promising technologies and skilled labour. The portability of certain *emerging building technologies*, however, proves to be beneficial as it allows these innovations to reach and benefit a wider population (Mehta and Bridwell, 2005: 74).

Understanding what these *emerging building technologies* are will add to the discourse by having a better understanding of what practices are possible and successful to the extent where they can serve as examples on how to design and build in South Africa in the present and the future. The unconventional, alternative and/or innovative characteristics of these *emerging building technologies* provide information on materials, techniques and structural systems that we know little to nothing about.

1.2.3 Timber construction in South Africa

Architecture can be defined as either *stereotomic* or *tectonic*. Described by Schwartz (2016: 47), "*stereotomic* construction is characterised by piled or stacked mass elements such as stone, brick, or earth" and *tectonic* construction "refers to lightweight, assembled structures". When examining the building practices of South Africa, one cannot ignore the influence of conventional construction methods that have shaped the nation's architectural landscape. The term *stereotomic* aptly characterises the prevailing approach, both in its literal reliance on specific construction materials and in its figurative resistance to change. The essence of South Africa's conventional construction, can be described as the use of brick-and-mortar, concrete, stone, and emerging earth-based structures that have become increasingly popular.

The primary objective of this study centres around investigating the *tectonic* architecture of buildings in South Africa, with a specific emphasis on timber construction as a prominent and burgeoning *building technology* that holds immense potential for sustainable and eco-friendly development in the region. As the demand for environmentally conscious and resource-efficient structures grows (Aigbavboa et al., 2017: 3005), the exploration of timber's structural capabilities and its integration into contemporary construction practices becomes ever more crucial. According to Burdzik & Van Rensburg (1991: 287) the timber construction sector has been excessively comfortable in its standing in the construction industry. Burdzik & Van Rensburg (1991: 291) has the opinion that if the industry's annual revenue is taken into consideration, very little money has been invested in research into the development of new structural applications and the enhancement of current products.

South Africa's architectural landscape is witnessing an exciting evolution with the introduction of new timber construction methods. Timber, as a versatile building material, is now being explored across a spectrum that stretches from low-tech to high-tech approaches. This classification is influenced by both the composition of the material itself and the innovative methodologies employed in its processing and manipulation. In this dynamic environment, traditional timber sections crafted through conventional methods are juxtaposed with cutting-edge alternatives like mass timber, including Cross Laminated Timber (CLT) and Glue Laminated Timber (GLT), as well as digital production techniques such as CNC milling and laser cutting, which have emerged as novel modes of fabrication. The fusion of old and new techniques in timber construction is reshaping the architectural scene in South Africa, providing architects and designers with an array of possibilities to create sustainable, efficient, and aesthetically pleasing structures.

1.2.4 Craft

In the realm of modern architectural history, architects have frequently limited craft to a simple act of carrying out predetermined plans, symbolising the finalisation of a project. However, a deeper understanding of craft illuminates its true potential in nurturing an explorative and dynamic relationship with materials and processes. Going beyond conventional definitions, *craft* transforms into an evocative journey, indistinguishable from the process of discovery, and intimately intertwined with the relentless pursuit of mastery (Stein, 2011: 49). As architects embrace this broader perspective, they find themselves embarking on a creative odyssey, where each stroke of their hand and every choice of material becomes an opportunity to forge a meaningful connection between the built environment and human experience. For centuries, the realms of *craft* and artistry have thrived, standing as a testament to human creativity and ingenuity. During those times the remarkable ability of artisans and artists to bring their visions to life hinged on the seamless interplay between their thoughts and skillful hands, resulting in the birth of awe-inspiring tangible masterpieces that have withstood the test of time.

In the array of images presented, the discerning eye will undoubtedly perceive the manifestation of *craft* in every single one, where subtle nuances arise from the interplay of various factors, such as the choice of materials, the surrounding environment, the prevailing era, and the distinctive style of the architect or builder; harmoniously converging to impart a profound sense of craftsmanship. This enduring *craft*, though subject to evolution across time, remains a resilient force, at times diminishing during certain periods yet consistently leaving its indelible mark, irrespective of the product's ultimate success or failure.

Figure 1: Representation of indigenous mud huts -18th century style (Elena Castaldi, n.d)

Figure 2: Groot Constantia house - Simon van der Stel, 1865 (RapidEye, n.d)

Figure 3: Voortrekker Monument - Gerhard Moerdijk, 1938 (Voortrekker Monument, 2023)

Figure 4: House Martienssen - Greenside House - Rex Martienssen, 1939 (Ofhouses, 2021)

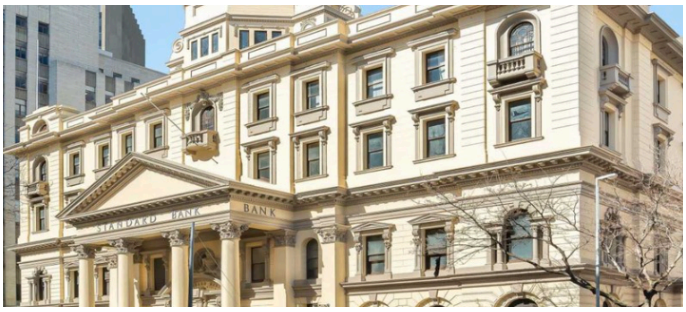

Figure 5: Standard Bank building Cape Town - Charles Freeman , 1881 (Pillay, 2021)

Figure 6: The conservatory - Nadine Engelbrecht , 2017 (de Klee, 2019)

Figure 7: House Paarman treehouse - Malan Vorster Architects and Interiors , 2017 (Tapia, 2020)

1.3 Problem statement (research problem)

This study is considering the classification of the *building technologies* that make up *current building practice* in the South African built environment with the aim of identifying *emerging building technologies*. The focus on *emerging building technologies* is due to the lack of widespread innovative and emerging ways of implementing existing or new technologies in the South African built environment and an attempt to further the information and research on this topic. As previously stated, the building industry's current practices appear to be entrenched and resistant to significant changes, particularly when it comes to adopting and integrating new and emerging building technologies. Subsequent investigations will be directed towards timber construction as an emerging technology. A key emphasis will be placed on examining the transformation of *craft* over time, its current implementation, and the potential impact of future timber construction methodologies.

1.4 Research objectives

Intended outcomes of the research will be:

A. **Identifying and Examining Specific EBTs in South Africa**: This objective entails gathering data and analysing it to identify the specific types of emerging building technologies currently being adopted by practitioners in South Africa. The study will also explore how these technologies are practically implemented and assess their value by examining relevant projects that utilise them.
B. **Assessing the Adoption of Emerging Building Technologies (EBTs) in South Africa's Timber Tectonic Trajectory**: This objective aims to demonstrate the increasing utilisation of emerging building technologies in South Africa's timber construction domain. The study will investigate how practitioners are incorporating these technologies alongside or in place of conventional building methods.
C. **Exploring the Feasibility of a Shift towards Timber Tectonic Approach**: This objective involves investigating the potential for a paradigm shift in the building industry towards a more timber tectonic approach. The study will consider the implications and feasibility of such a transition, taking into account various factors that might influence its adoption.
D. **Evaluating the Impact of EBT Adoption**: The research seeks to provide evidence supporting the positive impact of the rise in EBT adoption in the building industry. It will focus on the growth of the building sector and highlight the associated environmental and economic benefits of implementing these technologies.
E. **Understanding Practitioners' Utilisation of EBTs**: The research aims to develop a comprehensive understanding of how current practitioners employ emerging building technologies in their projects. This involves exploring the systems and thought processes involved in using EBTs within the context of current practice.
F. **Data Analysis and Conclusion Formulation**: The final objective is to analyse the collected data and extract relevant information from the research catalogue to answer the research

questions. The findings will guide the author in formulating a conclusion based on the results of the study.

Overall, this research aims to shed light on the growing utilisation of emerging building technologies in South Africa's timber construction sector, while also exploring the associated benefits, practical implementation, and potential for industry-wide adoption. Through comprehensive data analysis and interpretation, the study intends to contribute valuable insights to the field of timber tectonics and its future trajectory in the region.

1.5 Research questions

The research inquiries were initially supplied by our esteemed study leader for the DIT 801 research module, serving as the foundation for our investigation.

Main research question:

- Which building technologies can be considered to form part of current building practice in the South African built environment and which can be considered as emerging building technology?

Building upon this initial framework, the author further contributed to the formulation of specific research questions with a pronounced emphasis on timber construction as the central theme of our scholarly pursuit. The addition of these focused research questions not only aligns with the academic rigour expected of our research module but also ensures that our study transcends the realm of generalisation, delving into the specifics that hold significance within the field of timber construction. Through this enriched inquiry framework, we anticipate shedding light on innovative approaches, emerging trends, and potential challenges that might impact the effective utilisation of timber in contemporary construction practices.

Secondary research questions:

- Can timber construction become a suitable building method for the South African building industry?
- What does the new way of craft look like in South Africa with specific focus on timber construction and digital fabrication and manufacturing in the architecture industry.

2. Literature review

South African Architecture

South Africa's architectural landscape has been significantly shaped by international influences, primarily as a result of its extensive colonial history (Sanders, 2000: 68). The origins of these influences can be attributed to various European nations like Germany, the Netherlands, and Britain (Osunsanmi et al., 2018: 151). A noteworthy architectural influence emerged during the early days of Dutch occupation when the Dutch East India Company established a presence in the Cape in 1652. This influence, known as Dutch-Flemish architecture, gave rise to a distinctive regional style called Cape Dutch. Characterised by sturdy stone or masonry walls and charming thatched gabled roofs, Cape Dutch architecture became an integral part of South Africa's architectural heritage (Greyling, 2020: 29).

Throughout the 20th century, South African architecture was marked by persistent foreign influences. Notably, the Modern Movement gradually gained traction in the country from the 1930s onward, leaving a lasting impact (Sanders, 2000: 8). Concurrently, the Transvaal Group sought to confront the prevailing architectural style, which was criticised for its "eclectic, reiterative, and tired" characteristics, heavily relying on the 'neo-Renaissance' approach (Barker, 2015: 19). To counter this prevailing trend, the Transvaal Group adopted the principles of the Corbusian and Bauhaus-inspired Modern Movement and seamlessly integrated them into their architectural endeavours (Barker, 2015: 19). This ideological shift aimed to infuse fresh ideas and design philosophies into the contemporary South African architectural landscape. By embracing radical regionalism, the Transvaal Group intended to create a distinct architectural identity that moved away from the conventional and embraced the progressive principles of the Modern Movement. In doing so, they sought to invigorate the architectural discourse and stimulate a renewed sense of creativity or *craft* in the profession. Alfoldy (2012: 67) posits that John Ruskin, a notable philosopher of architecture, held distinct views that significantly influenced the position of the Arts Deco Movement. Central to this stance was the conviction that craft played a pivotal role in architectural design and was an indispensable element in the realisation of harmonious structures and interiors.

The period between 1970 and the 1980s, characterised as the darkest years of apartheid, saw the construction of airports, civic centres, and corporate buildings within the expanding central business districts (CBDs), resulting in the emergence of predominantly conformist and uninspiring architecture (Sanders, 2000: 70). The profession of architecture had its confidence undermined by the international cultural boycott, which hindered its ability to engage with global developments. In an attempt to maintain ties with "world trends" and resist isolation, many architects abandoned the pursuit of a locally relevant architecture and instead embraced designs transplanted from foreign publications (Sanders, 2000: 70).

In the aftermath of the apartheid era, the government took significant steps towards the growth and advancement of the construction industry. To achieve this, new construction policies and entities were established, including the Construction Industry Development Board (CIDB). The primary objective of CIDB was to promote the standardisation and regulation of the construction sector (Osunsanmi et al., 2018: 151). In the 1920s, the built environment was significantly shaped by global contemporary movements. Notably, the Modern movement of the early 20th century played a prominent role, introducing reinforced concrete and steel as primary construction materials. Throughout the remainder of the century, these materials, alongside masonry and glass due to their accessibility, continued to dominate the field of construction (Greyling, 2020: 29).

Current building practice in South Africa

In the realm of contemporary "commercial" architecture, there seems to be a lack of progress, as it remains stagnant (Sanders, 2000: 70). Presently, the built environment in South Africa consists of a limited number of proficient workers and consultants, alongside a significant proportion of unskilled workers who possess a matric level of education or lower. This situation exerts considerable strain on the industry, given that a substantial amount of the tasks involved require specialised skills (Greyling, 2020: 31). The construction industry in South Africa is of great importance to the country's economy and serves as a major driver of economic growth, when compared to numerous other sectors (Windapo & Cattell, 2013: 1).

A few challenges faced by the South African building industry described by Windapo and Cattell (2013: 2) as “mismatches between available skills and required skills, poverty, technology, increases in the costs of building materials, statutes and regulations”. When considering continuity and change, Kloukinas (2014: 58) states that the belief in the building industry, that building technology in South Africa tends to be unchanging and resistant to innovation. The construction industry often functions in a heavily fragmented manner, and this fragmentation negatively affects its potential for growth and overall success (Wienecke, 2010: 34). Mohd Nawi et al (2014: 3) describe that fragmentation in the realm of the construction industry manifests in two primary forms: internal fragmentation and external fragmentation. Internal fragmentation pertains to the challenges surrounding the integration and coordination among distinct alliance organisations, such as clients and consultants. On the other hand, external fragmentation involves the engagement of non-alliance entities, like local authorities, at various stages of the design process. Fragmentation within the realm of construction professionals, as elucidated by Papo (2017: 20), pertains to the deliberate decoupling and distinct separation of construction services and processes from the integrated project team, all in pursuit of effectively fulfilling the clients' deliverables. The design of structures, choice of materials, and construction methods are often influenced by established norms and proven solutions that have stood the test of time (Kloukinas, 2014: 58).

During the latter part of the 19th century, there existed a distinct architectural tension resulting from the conflicting influences of mass production and the unique characteristics of craft-based design (Barker, 2013: 2). In the realm of current day practice, a crucial factor that warrants examination is the interplay between architecture and craft, particularly in terms of scale. As highlighted by Chang (2018: 58), this dynamic reveals how architecture engages in a meaningful dialogue with smaller objects. Consequently, the significance of craft within the architectural context comes to the forefront of discussion.

Tectonics

Originating from Greek, the term *‘tectonic’* has its roots in the word *‘tekton’*, which means carpenter or builder. The corresponding verb is *‘tektainomai’*. This term is closely connected to the Sanskrit word *‘taksan’*, which denotes the art of carpentry and the utilisation of an axe (Frampton, 2001: 3). On the other hand, according to Golański (2018: 760), ‘*tectonics’* refers to the emphasis on the physical properties and the arrangement of construction components. Although tectonics is predominantly focused on structure and construction, it encompasses more than just the mechanical and load-bearing aspects of a building but Louw (2021: 24) has the opinion that it is about the “potentially poetic manifestation of structure in the original Greek sense of poiesis as an act of making and revealing". The term *'tectonic'* in architecture commonly pertains to the arrangement and construction of building elements and objects, or simply put, the way materials are assembled in a building (Loh, 2019: 25).

Tectonics on its own may not be the driving force for the creation of architecture and this is supported by Frampton (2001: 2) stating that although the tectonic aspect does not inherently support any specific architectural style, it does play a role, along with the "site and type", in countering the prevailing trend where architecture seeks validation from alternative discourses. Louw (2021: 26) suggests that there is a need to find a balance between technology as a modern, efficient process and craft technique as a traditional yet adaptable skill that can harmonise various modes of productivity and levels of intentionality. The *"joint"* or "*connection"*, often referred to as the "*primordial tectonic element*," is considered essential in architecture as it signifies the fundamental transitions that shape its essence.

Newly formed digital design methods and concepts have given the notion of tectonics developing life (Golański, 2018: 759). He further states that the pursuit of material and tectonic unity of skin, structure, and effect—a modern interpretation of Vitruvius' firmitas, utilitas, and venustas is a particularly interesting trajectory. The tectonic is both social and technical, as well as both a process and a system and a finished product. Over the course of the last three centuries, technological development has been swift, and it has frequently been sparked by important changes or transitions that started "in one or two countries" and later spread over the world (Louw, 2021: 28).

3 Research methodologies

3.1 Research approach

The research approach of this study embraces a larger theoretical framework and aims to explore the theme of *Emerging Building Technologies (EBTs)* through qualitative data collection via case studies. Defining the term 'emerging building technology,' the study will present a comprehensive catalogue illustrating projects in South Africa that utilised these technologies for designing, developing, or constructing new buildings or structures. These case studies will then be assembled into a cohesive catalogue, followed by data analysis to facilitate inductive reasoning. The results obtained will be integrated with the literature review during the discussion phase. Ultimately, the study will conclude by proposing a potential solution to the identified problem.

The researcher will employ an inductive reasoning approach when analysing the case studies. The author will summarise the collected data and the literature reviewed to formulate a final conclusion. This conclusion will not only provide new insights into EBTs but also contribute to addressing the current research problem.

3.2 Definition

In this research, the term denotes the realm of building material technology development which encompasses the sub- realms of non-conventional building technologies (Wienecke, 2010: 17 - 18). Innovative Building Technologies and their corresponding innovative processes and forward thinking. These processes of forward thinking and building material development fall within a time frame as recent as 5 to 10 years (McCoy and Yeganeh, 2021: 6), while the narrative and rate associated with continual development is completely dependent on the region of focus and the current state of its construction industry (Wienecke, 2010: 17 - 18). The methodology employed to define emerging building technologies comprises a series of steps. Initially, individual participants conducted separate desktop searches to develop their own definitions. Subsequently, group discussions were conducted to refine and modify the definitions, with the potential for further adjustments throughout the study to align with specific sub-themes under examination.

Table A (addendum B) presents the primary topics that emerged from the individual searches for definitions. It also compares the results obtained from two databases/search engines, namely Google Scholar and ProQuest.

To conduct the searches, a Boolean method was utilised, where search phrases were entered within inverted commas, combined with relevant phrases that defined the limitations or scope of the search. The scope was delimited by including the following terms: "Architecture," "Building Industry," "Construction Industry," and "South Africa." The initial sample for this research was obtained by conducting an 'export' of search results from the ProQuest database using the search term "emerging building technologies." This search yielded a total of 74 articles, which were exported and organised in Excel. The articles were then sorted in descending order by publication year, allowing for the prioritisation of the most recently published literature. Abstracts were read, and articles were assigned a Y (yes), N (no), or M (maybe) designation next to the abstract, serving as a filter based on their relevance to the study.

Relevant articles were saved and organised using the software 'Zotero'. During the reading process, annotations were made in the PDFs, accompanied by one-sentence summaries of each article. Furthermore, the articles were reviewed by examining keywords and abstracts to filter out both relevant and irrelevant articles.
The following keywords were considered potentially relevant:

- Materials,
- Architecture,
- Building Industry,
- Construction
- Structural systems,
- Technology,
- Innovation/Innovative,
- Alternative,
- IBT (Innovative Building Technology),
- Craft,
- Digitalization,
- Circular design.

Next, the articles were analysed to isolate and redefine their descriptions of *emerging building technologies*. As a result of this process, the definition became more extensive and focused more on establishing a taxonomy. The taxonomy of emerging building technologies is clearly illustrated in Figure 8, showcasing the comprehensive breakdown of the term. This diagram also highlights the analytical approach that can be employed while studying the articles collected on this subject. Consequently, the terms "current day practice" and "building technologies" were identified as foundational elements for the primary definition of "emerging building technologies."

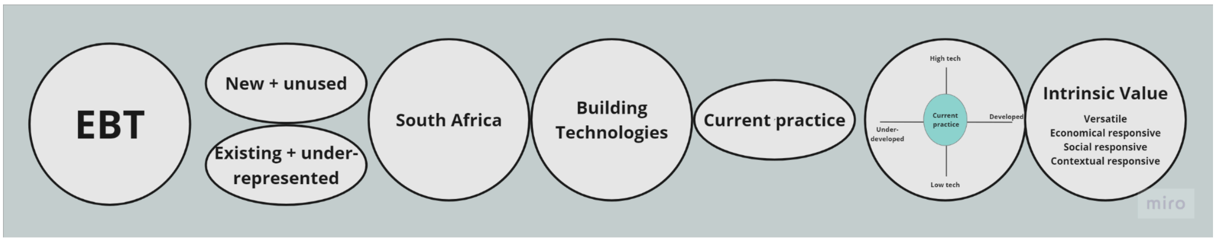

Figure 15: EBT definition flow diagram adapted from DIT DIT 801, 2023 (Author, 2023).

3.3 Data capturing (Case studies)

A process of selection to find case studies happened as follows:

List unconventional or underutilised materials

- Timber
- Straw Bales
- Plastic
- Concrete (variances such as fibre concrete)
- Bamboo
- Earth / mudbrick
- Light Steel Frame
- Structural engineered Bamboo
- Plywood
- Corten Steel
- Oriented Strand Board (OSB)
- Thermowood

List unconventional or underutilised techniques

- Hand woven
- Pressed (bricks, tiles, etc.)
- On site construction / Manufacturing
- In-situ
- Prefabrication
- CNC
- Lasercut

With these two lists a desktop search commenced to find case studies in South Africa making use of the aforementioned materials or techniques or both.

‘*Current practice*'' such as conventional brick and mortar, steel, concrete, stone structures were not considered, except when another part of the building or design can be seen as an ‘*emerging building technology*’ i.e. a specific way the facade or roof is constructed/applied. The catalogue's classification of emerging building technologies falls into three groups, namely building materials, construction processes, and structural systems, and introduces certain limitations. These are then further distinguished between high-tech and low-tech modes of production and further differentiates between underdeveloped and developed technologies.

3.4 Literature review

The objective of this literature review is to provide a comprehensive understanding of the current state of the building industry in South Africa and the emerging use of timber building technologies and its variations. By exploring the reintroduction of craft in the industry, this review will emphasise the emergence of a new form of craftsmanship facilitated by advancements in technology and production methods. Specifically, the concept of "timber tectonics" will be defined, focusing on the incorporation of mass timber in the building industry and its implications for the future of timber construction in South Africa. Through this review, the study aims to uncover the ongoing tectonic trajectory in South Africa and gain insights into its potential future developments.

The methodology employed for conducting the literature review in this research report involves utilising the Google Scholar database as the primary resource. A targeted search will be conducted using specific keywords such as "craft," "tectonics," "digital fabrication," "South Africa," and "architecture." The purpose of this search is to obtain relevant articles that offer valuable insights into the research questions under investigation. By employing this approach, the aim is to identify and analyse scholarly works that directly contribute to the understanding and exploration of the research topics at hand.

3.5 Data analysis

The data within the case studies listed in the catalogue will be analysed through the lens of tectonics, craft, digital fabrication methods leading to a new way of production with either traditional timber or new timber tectonics. The analysis will also reveal which EBT category is the most prevalent one (building material, construction process, or structural system). The results may provide an insight into what specific area would be the focus area to define the new way of craft within the South African building industry.

3.6 Research Paradigm

Quantitative methods are deeply rooted in the research paradigm of positivism. They rely on theory testing, which is based on reasoned arguments and verified through value-free observations (Somekh and Lewin, 2005, p. 197). Conducted primarily in a qualitative manner, the study relies on sampling to choose specific cases (Gerring, 2017: 18). Particular case studies would be chosen to work with, forming the basis of the investigation. Subsequently, the data obtained from these cases is subjected to quantitative analysis, aiming to validate the identified patterns. After the selection process, the data is carefully catalogued, enabling a comparative examination of results.

3.7 Limitations

1. Temporal Scope: The research report's limitations lie in the selection of projects that qualify for inclusion in the catalogue. The report focuses on projects built within the last 10-15 years to ensure relevance to emerging building technologies. However, this temporal restriction may exclude older case studies that employed emerging technologies at the time but are no longer considered innovative today.
2. Geographical Scope: The case study's limitations are evident in its requirement for projects to be situated in South Africa. This geographical constraint is necessary to investigate emerging building technologies specifically within the South African building industry. This geographical constraint is necessary to stay within the limits of the definition to find emerging building technologies specifically pertaining to the South African building industry.
3. Categorization of Emerging Building Technologies: The catalogue's classification of emerging building technologies into three groups, namely building materials, construction processes, and structural systems, introduces certain limitations.
4. Classification parameters: The limitations distinguish between high-tech and low-tech modes of production and further differentiates between underdeveloped and developed technologies.

Overall, these limitations in the research report's selection criteria, geographical scope, categorization framework, and Limitations should be considered when interpreting the findings and applying them to broader contexts.

3.8 Delineations

Excluding all projects completed before the year 2000 from this study is necessary because they no longer fall within the 15-year timeframe from the current date, rendering them ineligible as Emerging Building Technologies (EBTs) within the South African context according to this report's definition. Therefore, these building technologies used in those projects will be classified as alternative building technologies within the scope of this report.

4. Data - Case studies

Please consult Addendum A for a comprehensive catalogue of projects showcasing emerging building technologies. Presented below are diagrams extracted from the catalogue of Kleine Rijke by David Krynauw, 2017, illustrating its functionality, along with an example of an identified emerging building technology.

A	B	C	D	E	F	G
	Architect	**Project**	**Images & Diagrams**	**Year of Completion**	**Location**	**General Project Description**
21	Krynauw, David & Khanye Architects	Kleine Rijke Restaurant		2017	Hartebeespoort, Gauteng	A restaurant timber structure - columns and trusses with brick gable ends and infill. Galvanised steel roofing

Figure 16: Architect, Project, Photo, Year, Location, description of the project (DIT 801, 2023, 2023).

I	J	K
Emerging building technology		
Building material (I)	**Construction process (II)**	**Structural system (III)**
N/A S.A Pine		
	Timber members made of rafters are cut out by CNC machines. Members are then routered and sanded down to smooth curved edges by hand.	
		N/A Timber columns and trusses as only structural system

Figure 17: Emerging building technologies and sub-categories (DIT 801, 2023, 2023)

L	M	N	O
Mode of production		**Developmental status**	
Low-tech (traditional or hand-based)	**High-tech (industrialised)**	**Under-developed**	**Developed**
	Structural elements are cut out by a CNC machineroutered for rounder edges	CNC manufactured timber structural elements are underdeveloped	

Figure 18 : Mode of production and Development status with sub-categories (DIT 801, 2023, 2023)

Value	**List of References**
Cutting out members by CNC machine ensures precision with each individual member. The need to router and sand down the members to have the smoothed edges ensure the human touch to still be evident in the building.	Figure 22: Kleine Rijke interior (Vicky Gerbello, 2018) Krynauw, D. (2017) Modular Mobile Home Pods: David Krynauw, David Krynauw Design. Available at: https://www.davidkrynauw.com/build (Accessed: 07 May 2023).

Figure 19: Value of the EBT and references (DIT 801, 2023, 2023)

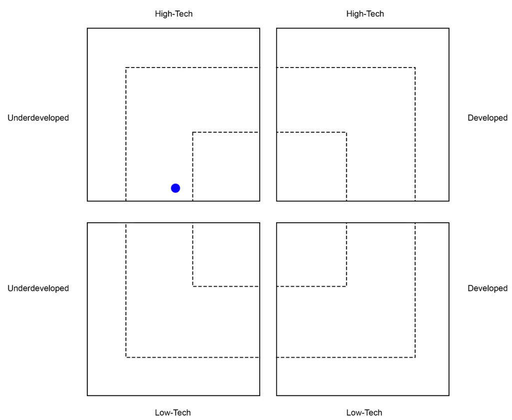

Figure 20: Plotting of the project (DIT 801, 2023, 2023)

5. Results

The diagrams exhibited below were derived using a collaborative decision-making approach during the examination of data from the group catalogue (figure 21) of 50 projects discovered in South Africa, encompassing various emerging building technologies.

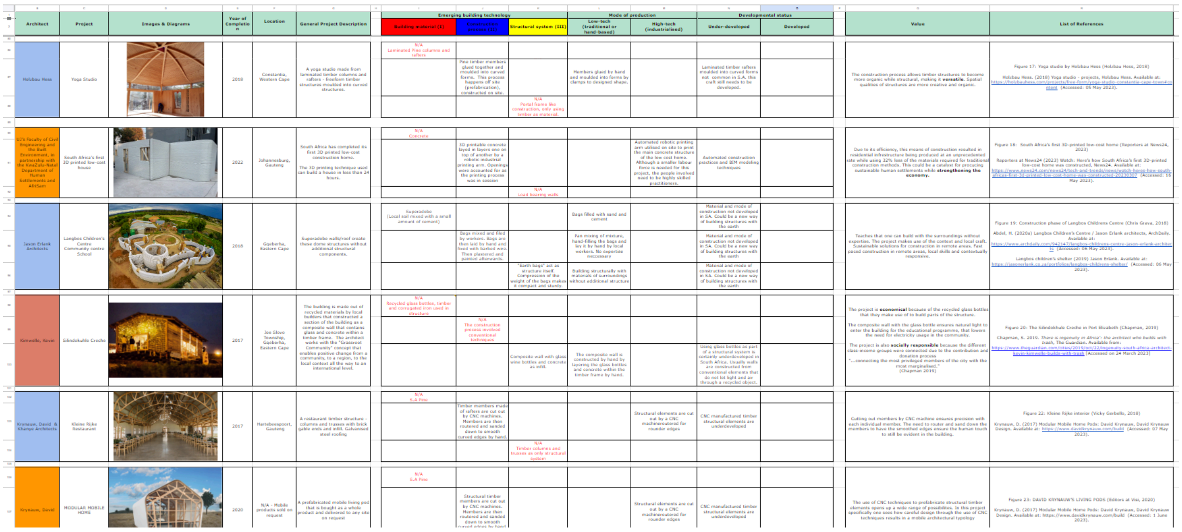

Figure 21: Catalogue excerpt (DIT 801, 2023, 2023)

The aim was to represent the mode of production and development status characteristics on a quadrant-based plot. This plot was organised along two axes: one representing the level of technological advancement, ranging from high-tech to low-tech from top to bottom, and the other representing the level of development, ranging from underdeveloped to developed from left to right (Figure 22).

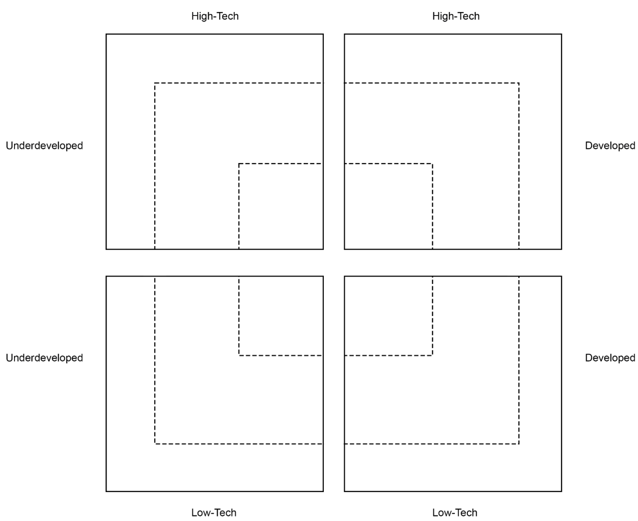

Figure 22: Catalogue plotting base (DIT 801, 2023, 2023)

Notably, the diagram does not incorporate the current building practice (CBP) building technologies, which encompass materials, construction processes, and structural systems. However, these CBP technologies can be indicated diagrammatically, as shown in Figure 23.

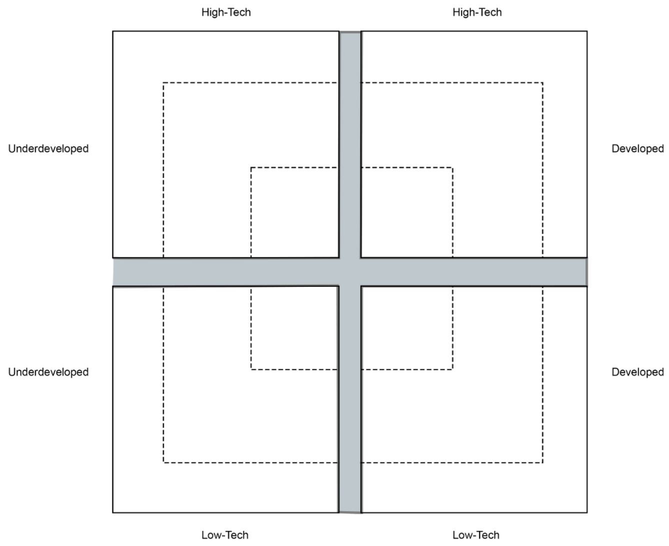

Figure 23: Current Building Practice (Author, 2023)

Each quadrant in the diagrams is further divided into three levels of emergence. The inner corners of the quadrants represent the least emerging technologies, which are most likely to be integrated into the CBP realm (as depicted in Figure 24).

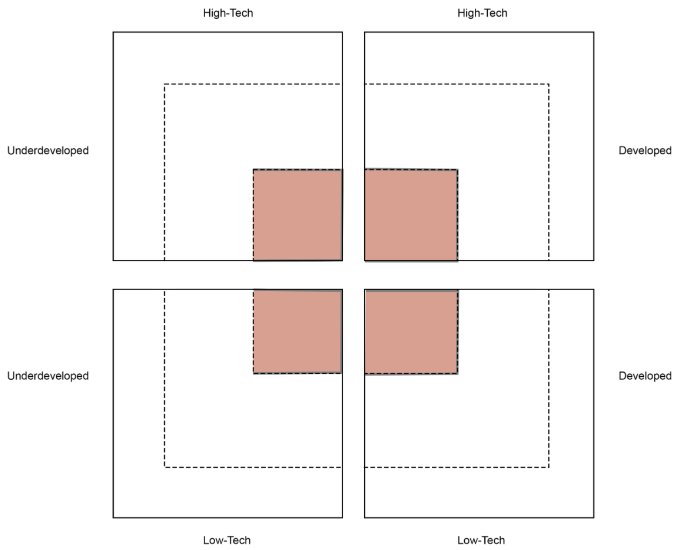

Figure 24: Inner quadrant - least emerging building technologies (Author, 2023)

On the other hand, Figure 25 illustrates the most emerging level of building technologies, which are highly unlikely to be absorbed into the CBP realm. The middle level of emergence includes building technologies that have a fair chance of becoming part of the CBP realm.

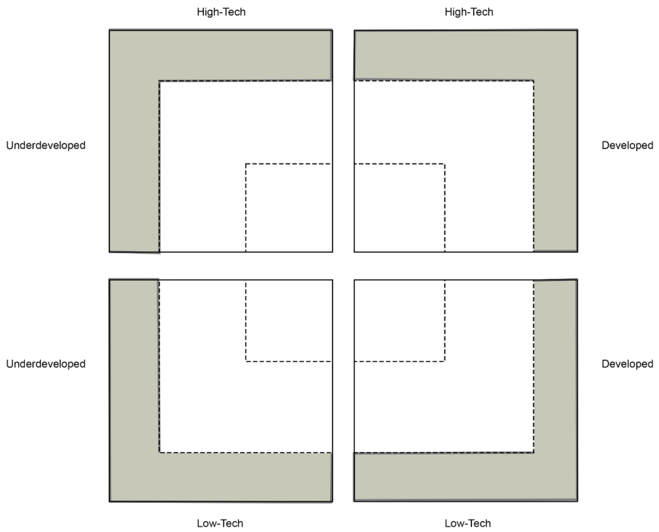

Figure 25: Outer quadrant - most emerging building technologies (Author, 2023)

The provided diagrams below depict the combined plotting of building materials, construction processes, and structural systems that were identified as emerging technologies during a group discussion. These building technologies were evaluated based on the definition of emerging building technologies and were categorised according to their level of emergence. The assessment of their emergence was made by considering the building industry's current understanding of these technologies and their feasibility and applicability within the country's context.

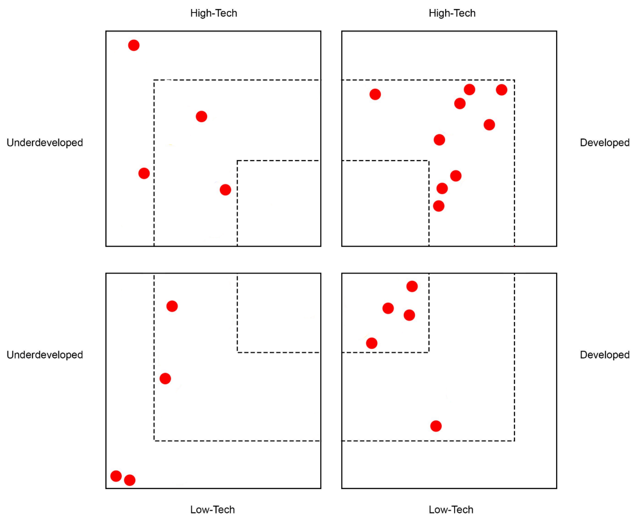

Figure 26: Building materials (DIT 801, 2023, 2023)

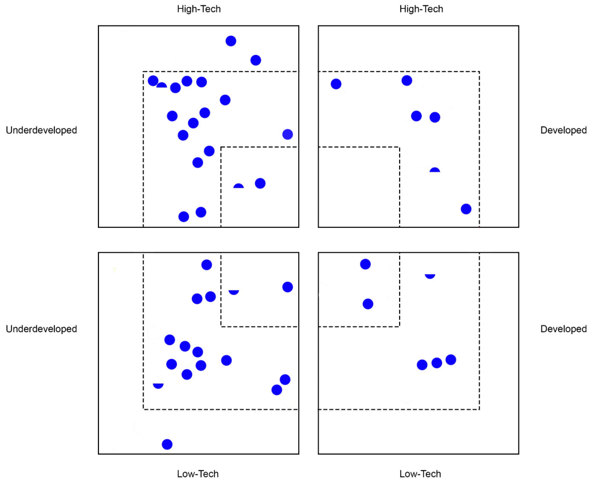

Figure 27: Construction processes (DIT 801, 2023, 2023)

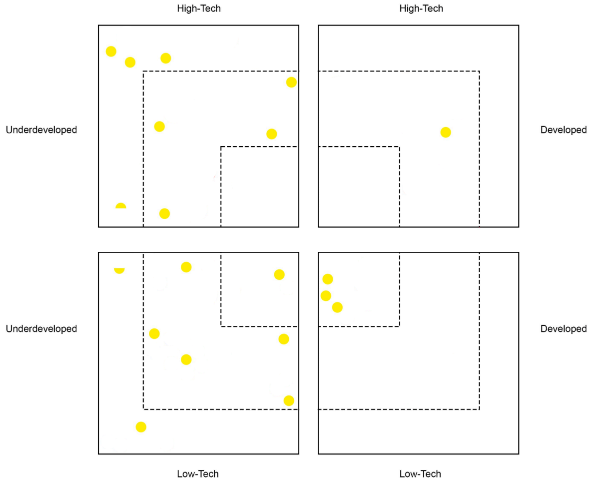

Figure 28: Structural systems (DIT 801, 2023, 2023)

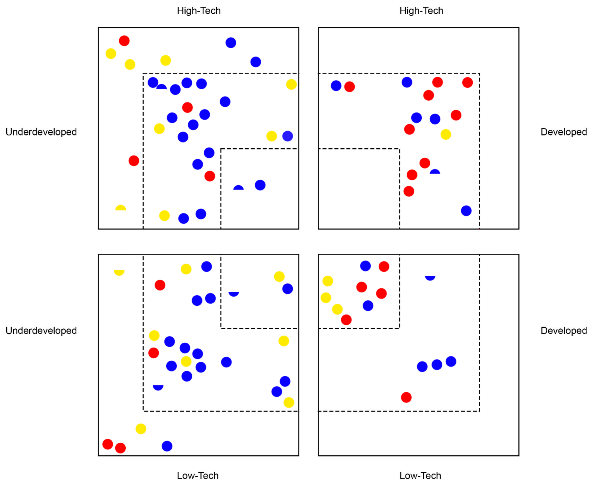

Figure 29: Combined (DIT 801, 2023, 2023)

Regarding emerging building technologies, the building materials that have been identified can be visualised through the diagrams provided. Figure 30 illustrates the projects wherein these emerging building materials were utilised. Among the total of 50 projects, 16 of them incorporated these emerging materials, and in aggregate, 18 distinct materials were identified. Notably, a significant proportion of the materials employed consisted of timber products, accounting for 44.4% of the total (Figure 31). Additionally, the Western Cape region stood out with a predominant usage rate of 43.8% (Figure 32), while the majority of the materials fell under the category of high-tech (66.7%) (Figure 33) and were developed materials (66.7%) (Figure 34).

	Architect	Project	Year of Completion	Location
1	BuildCollective and S2arch	Ithuba Communtiy College	2009	Ekurhuleni, Gauteng
2	Bottle2Build	School	2016	Gauteng
3	Carin Smuts Architects	GUGA S'THEBE Phase 2	2015	Langa, Western Cape
5	Choromanski Architects - Rod Choromanski and Dean Ramlal	uMkhumbane Museum	2017	Berea, Durban, Kwazulu-Natal
7	Elliott, Paul	House Elliott	2021	Cape Town, Western Cape
12	Frankie Pappas	House of the Big Arch	2020	Limpopo
15	GLH Architects	Witklipfontein Eco lodge Residential	2018	Vredefort, Freestate
24	Local Studio	Limpopo Youth Hostel	2019	BELA-BELA, Limpopo
26	Marais, Paul	House Gardiner	2014	Monaghan Farm, Johannesburg, Gauteng
27	MMA Architects	Sandbag Houses Residential	2009	Mitchells Plain, Western Cape
31	Nieuw Architects	House Newlands	2023	Newlands, Cape Town, Western Cape
37	Rothoblaas South Africa	Residence in Constantia	2022	Constantia, Western Cape
39	StudioMas & Arup	The Ridge Deloitte Cape Town	2020	Cape Town, Western Cape
42	SRLC Architects	Westcliff House		Westcliff, Johannesburg, Gauteng
43	SRLC Architects	Darymple Pavilion		Westcliff, Johannesburg, Gauteng
50	WOLFF ARCHITECTS	Cheré Botha School	2017	Oakglen, Cape Town, Western Cape

Figure 30: Combined list of projects mentioning timber in the catalogue Part A (DIT 801, 2023)

Emerging building technology Building material (I)	Mode of Production	Development status
Compacted straw and light clay as infill mixed with minimum amounts of cement	Low-tech	Developed
Custom-made PET plastic bottles, BPA free and modular empty water bottles are made in the shape of interlocking bricks.	High-tech	Developed
Adobe packed panels for insulative purposes	Low-tech	Developed
"Firelight Satin" bricks - increased compressive strength	High-tech	Developed
CLT timber	High-tech	Underdeveloped
Composite Amorim Cork Panels	High-tech	Underdeveloped
Glulam Structural timber	High-tech	Developed
Compacted Earth Bricks (CEB)	Low-tech	Developed
Composite Lightweight Hebel concrete block	High-tech	Developed
Composite timber (thermally modified and wax impregnation)	High-tech	Underdeveloped
Structural Rammed earth walls	Low-tech	Underdeveloped
Sand filled bags	Low-tech	Developed
Lightweight, composite Aertec AAC blocks	High-tech	Developed
Cross Laminated Timber (CLT)	High-tech	Developed
Cross laminated timber (CLT)	High-tech	Underdeveloped
Cross laminated timber (CLT) Ceiling Panels	High-tech	Developed
Lead Wood	Low-tech	Underdeveloped
Glulam Structural timber	High-tech	Developed

Figure 30: Combined list of projects mentioning timber in the catalogue Part B (DIT 801, 2023)

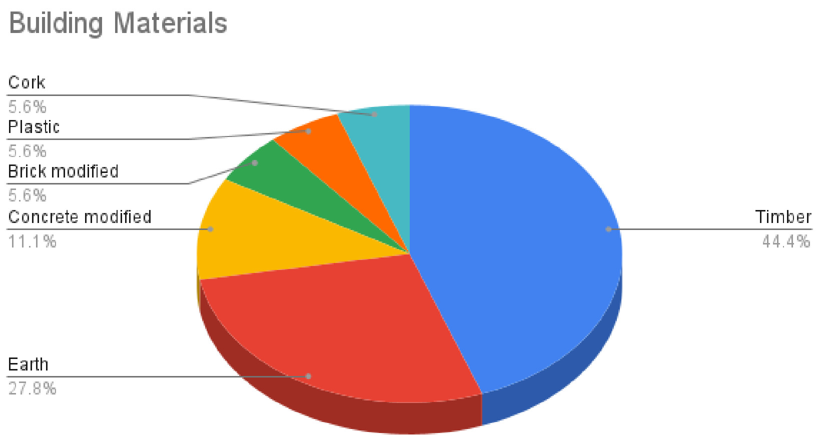

Figure 31: Building materials (Author, 2023)

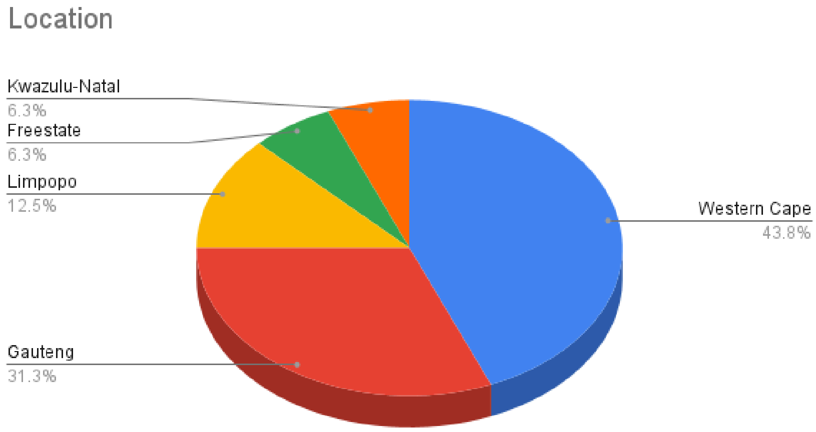

Figure 32: Location of building materials (Author, 2023)

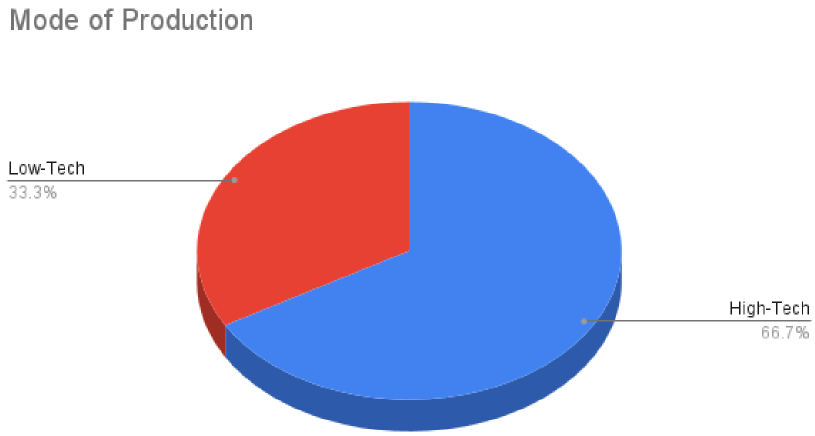

Figure 33: Mode of production - Building materials (Author, 2023)

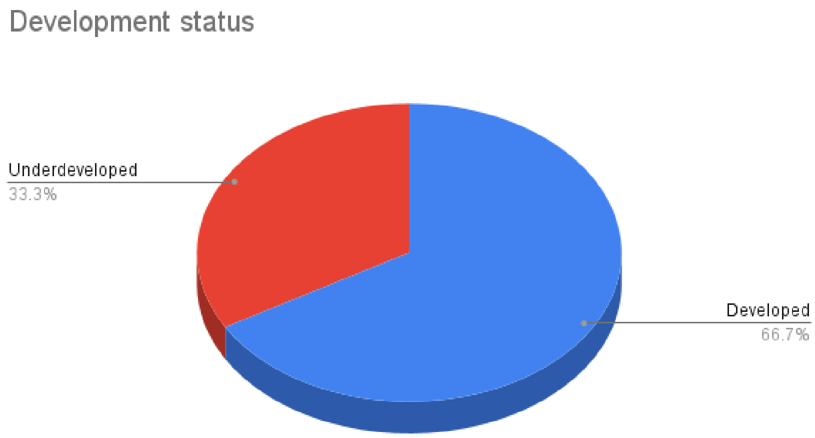

Figure 34: Development status - Building materials (Author, 2023)

The construction processes that have been identified can be visualised through the diagrams provided below. Figure 35 illustrates the projects wherein these emerging construction processes were utilised. Among the total of 50 projects, 36 of them incorporated these emerging construction processes.

	Architect	Project	Year of Completion	Location	Emerging building technology Construction process (II)	Mode of Production	Development status
1	BuildCollective and S2arch	Ithuba Communtiy College	2009	Ekurhuleni, Gauteng	Mixing by hand	Low-tech	Developed
2	Bottle2Build	School	2016	Gauteng	Community involvement - circular process	Low-tech	Underdeveloped
3	Carin Smuts Architects	GUGA S'THEBE Phase 2	2015	Langa, Western Cape	Community involvement - circular process	Low-tech	Underdeveloped
4	cseventysix Architects	"Writers retreat" Residence	2019	Lanseria, Gauteng	Designed for dissasembly - circular process	High-tech	Underdeveloped
6	Eartworld Architects	KoSPAZA Pop-up restaurant	2021	Garsfontein Pretoria Gauteng	Computer Aided Design; Prefabrication CNC production	High-tech High-tech	Developed Underdeveloped
7	Elliott, Paul	House Elliott	2021	Cape Town, Western Cape	Prefabrication	High-tech	Underdeveloped
8	ELMO SWART ARCHITECTS	Wright House	2011	Ocean View, Durban, Kwazulu-Natal	Computer Aided Design; Prefabrication	High-tech	Underdeveloped
9	Entity Architects & Blockhouses	Cradle Boutique Hotel	2018	Cradle of Humankind Muldersdrift North-West	Computer Aided Manufacturing; Prefabrication; Computer Aided Design	High-tech	Underdeveloped
10	Elphick Proome Architects	Durban Christian Centre	2021	Durban, Kwa Zulu-Natal	Prefabrication	High-tech	Underdeveloped
11	Field Architecture	Karoo Wilderness Center	2013	Karoo, Northern Cape	Collecting materials from site.	Low-tech	Developed
13	Galland, Simon and LYT Architecture	Walmer Crèche	2021	Walmer, Gqeberha, Eastern Cape	Designed for dissasembly - Circular process Prefabrication	Low-tech Low-tech	Underdeveloped Underdeveloped
14	GASS Architecture Studios	GASS Architecture Studios	2021	Paarl Valley, Western Cape	Compacting earth to form a wall Hand knotting elements	Low-tech Low-tech	Developed Underdeveloped
15	GLH Architects	Witklipfontein Eco lodge Residential	2018	Vredefort, Freestate	Collecting materials from site.	Low-tech	Developed
16	Heatherwick Studio	Zeitz Museum of Contemporary Art Africa (Zeitz MOCAA)	2017	Cape Town, Western Cape	Computer Aided Design	High-tech	Developed
17	Holzbau Hess	Yoga Studio	2018	Constantia, Western Cape	Prefabrication; Computer Aided Design	High-tech	Underdeveloped
18	UJ's Faculty of Civil Engineering and the Built Environment, in partnership with the KwaZulu-Natal Department of Human Settlements and AfriSam	South Africa's first 3D printed low-cost house	2022	Johannesburg, Gauteng	3D printing; Computer Aided Design	High-tech	Underdeveloped
19	Jason Erlank Architects	Langbos Children's Centre Community centre School	2018	Gqeberha, Eastern Cape	Filling bags with sand	Low-tech	Underdeveloped
21	Krynauw, David & Khanye Architects	Kleine Rijke Restaurant	2017	Hartebeespoort, Gauteng	CNC production	High-tech	Underdeveloped
22	Krynauw, David	MODULAR MOBILE HOME	2020	N/A - Mobile products sold on request	CNC production; Prefabrication	High-tech	Underdeveloped
23	Local Studio	Hillbrow Counselling Centre	2017	Johannesburg, Gauteng	CNC production; Prefabrication	High-tech	Developed
25	Malan Forster Architecture & Interior Design	House Paarman Treehouse Residential	2017	Constantia, Western Cape	Prefabrication; On-site fabrication	Low-tech & High-tech	Underdeveloped
26	Marais, Paul	House Gardiner	2014	Monaghan Farm, Johannesburg, Gauteng	Compacting earth to form a wall	Low-tech	Underdeveloped and Developed
27	MMA Architects	Sandbag Houses Residential	2009	Mitchells Plain, Western Cape	Collecting materials from site.	Low-tech	Developed
28	Moladi	Western Cape Education Centre	2018	Parrow, Western Cape	Reusable formwork - shorter construction time	Low-tech	Underdeveloped
29	Moladi	Melkbos High School	2019	Melkbosstrand, Western Cape	Reusable formwork - shorter construction time	Low-tech	Underdeveloped
30	NEO Architects	DOXA DEO CHAPEL	2022	Brooklyn, Pretoria, Gauteng	Prefabrication	Low-tech	Underdeveloped
32	Paragon Architects	105 Corlett Drive	2013	Johannesburg, Gauteng	Computer Aided Design	High-tech	Developed
34	Pietro Russo	The Ecomo Home	2010	Franschhoek, Cape Town, Western Cape	Prefabrication	High-tech	Underdeveloped
35	RAW Module	28 Day house Residential	2020	Sterkfontein, Krugersdorp, Nort-West	Computer Aided Design; unskilled labour	Low-tech & High-tech	Underdeveloped
36	Rich, Peter	Mapungubwe Interpretation Centre	2009	Mapungubwe National Park, Musina, Limpopo	Computer Aided Design; unskilled labour	Low-tech & High-tech	Underdeveloped
37	Rothoblaas South Africa	Residence in Constantia	2022	Constantia, Western Cape	CNC production	High-tech	Developed
38	Snøhetta and Local Studio	Desmond Tutu Archway	2017	Cape Town, Western Cape	Prefabrication; Computer Aided Design; Steam bending	Low-tech & High-tech	Underdeveloped
46	Urban Think Tank	Residence	2014	Khayelitsha, Cape Town, Western Cape	Community involvement	Low-tech	Underdeveloped
47	van Sittert, Bertus	Curtain House Residential	2021	Brooklyn, Pretoria, Gauteng	Hand scraping plaster; Computer Aided Design	Low-tech & High-tech	Underdeveloped
48	Veld Architects	Soil and Serenity	2022	Rhenostersprut Conservancy, Centurion, Gauteng	Compacting earth to form a wall	Low-tech	Developed

Figure 35: Combined (DIT 801, 2023, 2023)

Significantly, a considerable portion of the construction procedures utilised were centred around prefabrication, accounting for 25% of the total. Additionally, CNC production contributed 8.9% to the overall construction methods, while Computer Aided Design (CAD) played a significant role, making up 19.6% (see Figure 36). Once more, the Western Cape region exhibited a noteworthy utilisation rate of 41.7% (refer to Figure 37). The construction processes were distributed between high-tech (42.1%) and low-tech (44.7%), with a small percentage representing a hybrid approach combining high-tech and low-tech elements (13.2%) (refer to figure 38). Moreover, the majority of construction processes in the region were categorised as underdeveloped (68.4%) (refer to Figure 39).

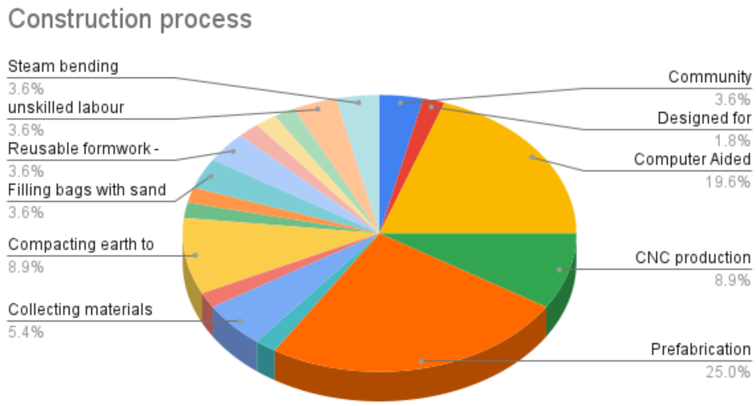

Figure 36: Construction processes (Author, 2023)

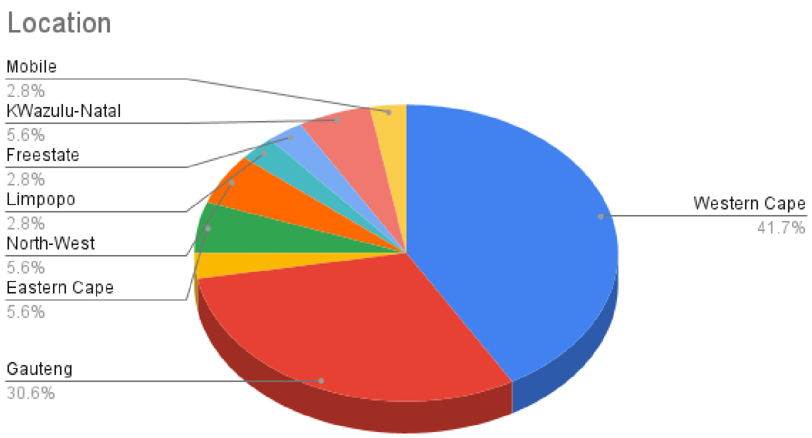

Figure 37: Location of Construction processes (Author, 2023)

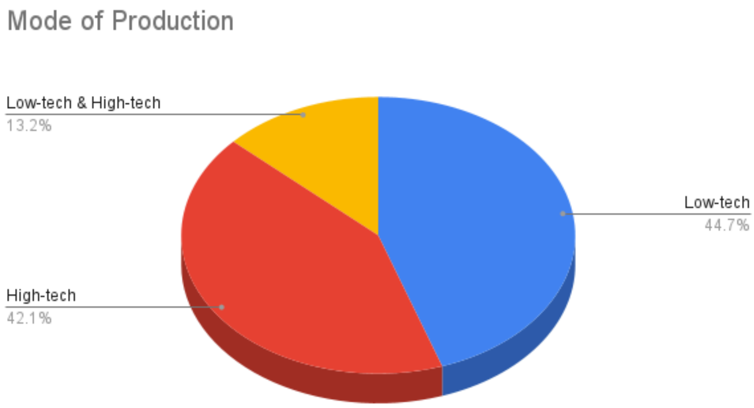

Figure 38: Mode of production - Construction processes (Author, 2023)

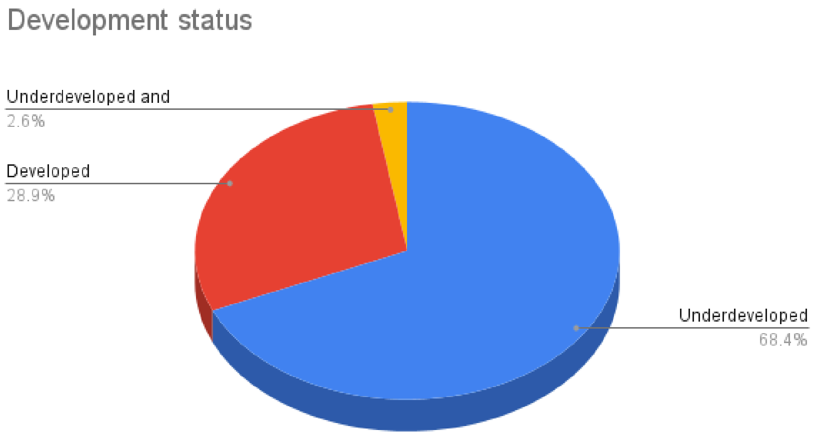

Figure 39: Development status - Construction processes (Author, 2023)

Regarding emerging building technologies, the structural systems that have been identified can be visualised through the diagrams provided. Figure 40 illustrates the projects wherein these emerging structural systems were utilised. Among the 50 projects analysed, 16 of them integrated emerging structural systems. Notably, a significant portion of these systems were based on Cross Laminated Timber (CLT) technology, constituting 18.8% of the total projects. Furthermore, Earth-centred approaches, such as rammed earth (12.5%) and earth bags (12.5%), also played a notable role in the projects (refer to Figure 41). Interestingly, the regions of Western Cape and Gauteng stood out, as they exhibited a predominant adoption rate of these emerging structural systems, with rates of 31.3% and 37.5% respectively (see Figure 42).

In terms of materials used, the majority of projects utilised low-tech materials, accounting for 66.7% of the overall projects (see Figure 43). Additionally, a significant proportion of the systems employed were classified as underdeveloped, amounting to 88.2% of the projects (see Figure 44).

	Architect	Project	Year of Completion	Location	Emerging building technology Structural system (III)	Mode of production	Development status
1	BuildCollective and S2arch	Ithuba Communtiy College	2009	Ekurhuleni, Gauteng	Adone Wall & straw infill	Low-tech	Underdeveloped
6	Eartworld Architects	KoSPAZA Pop-up restaurant	2021	Garsfontein Pretoria Gauteng	Plywood interlocking elements	High-tech	Underdeveloped
7	Elliott, Paul	House Elliott	2021	Cape Town, Western Cape	CLT	High-tech	Underdeveloped
12	Frankie Pappas	House of the Big Arch	2020	Limpopo	CLT	High-tech	Underdeveloped
15	GLH Architects	Witklipfontein Eco lodge Residential	2018	Vredefort, Freestate	Rammed earth	Low-tech	Underdeveloped
					Earth bags	Low-tech	Underdeveloped
19	Jason Erlank Architects	Langbos Children's Centre Community centre School	2018	Gqeberha, Eastern Cape	Earth bags	Low-tech	Underdeveloped
20	Kimwelle, Kevin	Silindokuhle Creche	2017	Joe Slovo Township, Gqeberha, Eastern Cape	Glass & concrete fill	Low-tech	Underdeveloped
26	Marais, Paul	House Gardiner	2014	Monaghan Farm, Johannesburg, Gauteng	Rammed earth	High-tech	Underdeveloped
36	Rich, Peter	Mapungubwe Interpretation Centre	2009	Mapungubwe National Park, Musina, Limpopo	Timbrel vault with soil tiles	Low-tech	Underdeveloped
37	Rothoblaas South Africa	Residence in Constantia	2022	Constantia, Western Cape	CLT	High-tech	Underdeveloped
40	Steyn Studio	The Bosjes Chapel	2016	Worcester, Western Cape	Self supporting concrete shell	High-tech	Underdeveloped
41	Steyn Studio	'Die Spens' Bosjes	2021	Ceres, Western Cape	Freeform timber	High-tech	Underdeveloped
43	SRLC Architects	Darymple Pavilion		Westcliff, Johannesburg, Gauteng	Lead wood	Low-tech	Underdeveloped
45	Tsai Design Studio	The Visserhoek School	2014	Malanshoogte, Cape Town, Western Cape	Shipping containers	Low-tech	Developed
46	Urban Think Tank	Residence	2014	Khayelitsha, Cape Town, Western Cape	Timber frame	Low-tech	Underdeveloped
49	Wall, Sean	New Jerusalem Orphanage	2013	Midrand, Johannesburg, Gauteng	Shipping containers	Low-tech	Developed

Figure 40: Catalogue - Structural systems (Author, 2023)

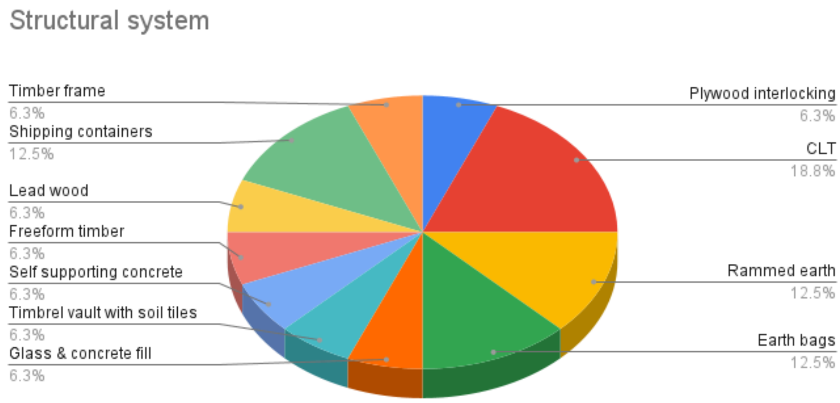

Figure 41: Structural systems (Author, 2023)

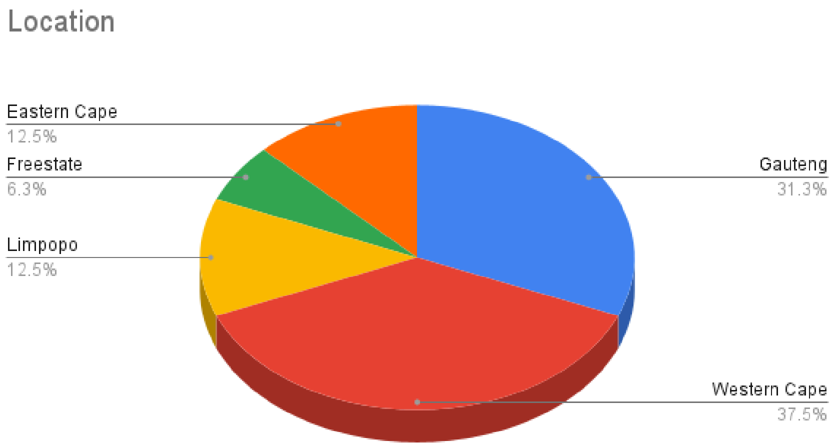

Figure 42: Location - Structural systems (Author, 2023)

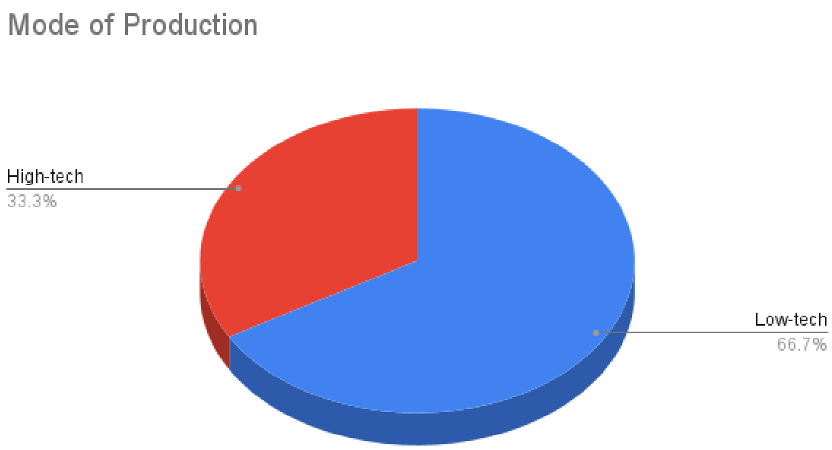

Figure 43: Mode of Production - Structural systems (Author, 2023)

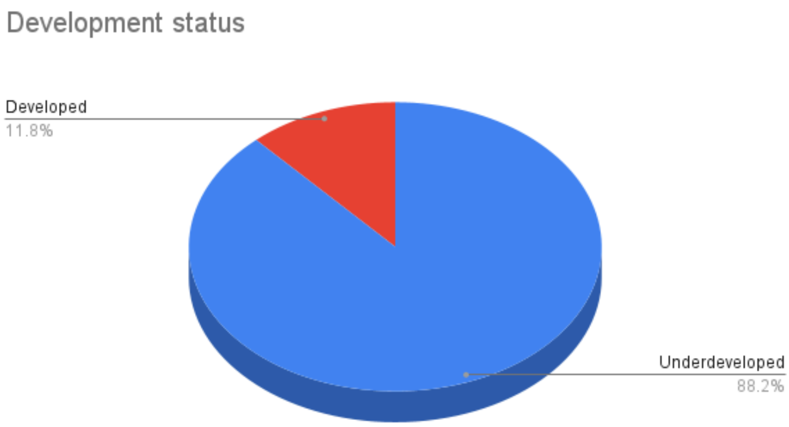

Figure 44: Development status - Structural systems (Author, 2023)

This section discusses the projects featured in the catalogue, with a specific focus on those incorporating timber in their building materials, construction processes, or structural systems. Out of the 50 projects analysed, 15 demonstrated the influence of timber in innovative ways. The table below demonstrates the distribution of the identified projects.

Among these projects, four exclusively utilised Cross-Laminated Timber (CLT) in their building materials, representing an emerging timber technology in South Africa. Additionally, five projects showcased emerging trends in construction processes, such as Computer-Aided Design, prefabrication, CNC machining, and steam bending. Two projects stood out due to their comprehensive incorporation of timber in all three building technology realms. In both cases, CLT was adopted as both a building material and a structural system, with CNC machining and prefabrication employed during the construction process. Another two projects demonstrated emerging approaches in both construction processes and structural systems. For instance, Earthworld Architects utilised premanufacturing and CNC machining in the construction process for the KoSpaza coffee shop, with plywood employed as the structural system. In another project, Steyn Studio utilised a freeform timber trellis as the structural system for the "Die Spens" project. Furthermore, two projects exhibited emerging trends in the realms of building materials and structural systems. SRLC's Dalrymple pavilion in Westcliff utilised leadwood as its structural system, while Frankie Pappas employed glulam columns and beams for the "bridges" in a residence.

Projects concerning emerging timber use		
Building Materials	Construction processes	Structural systems
- Limpopo Youth Hostel by Local Studio, 2019 - The Ridge - Deloitte by StudioMASS, 2020 - Westcliff residence by SRLC, 2019 - Cheré Botha School by Wolff Architects, 2020		

Projects concerning emerging timber use		
	- Yoga studio by Holzbau Hess, 2018 - Kleine Rijke by David Krynauw, 2017 - Modular pods by David Krynauw, 2020 - House Paarman treehouse by Malan Vorster Architects and Interiors, 2017 - Desmond Tutu Archway by Snøhetta and Local Studio, 2017	
- House Elliot by Paul Elliot, 2021 - Constantia residence by Rothoblaas, 2022	- House Elliot by Paul Elliot, 2021 - Constantia residence by Rothoblaas, 2022	- House Elliot by Paul Elliot, 2021 - Constantia residence by Rothoblaas, 2022
	- KoSpaza by Earthworld Architects, 2021 - 'Die Spens' Bosjes by Steyn Studio, 2021	- KoSpaza by Earthworld Architects, 2021 - 'Die Spens' Bosjes by Steyn Studio, 2021
- Dalrymple pavilion by SRLC, 2019 - House of the big arch by Frankie Pappas, 2020		- Dalrymple pavilion by SRLC, 2019 - House of the big arch by Frankie Pappas, 2020

Projects discussing building materials only

The Limpopo Youth Hostel, skillfully designed by Local Studio, showcases an innovative use of thermally treated and wax impregnated cladding, enveloping the entire structure in an eco-friendly and visually captivating façade. With meticulous attention to detail, the architects strategically selected the perfect balance of cladding material, considering both the building's scale and the desired aesthetic, which resulted in an impressive architectural marvel that radiates a harmonious blend of modernity and natural charm, a truly captivating sight highlighted in the catalogue.

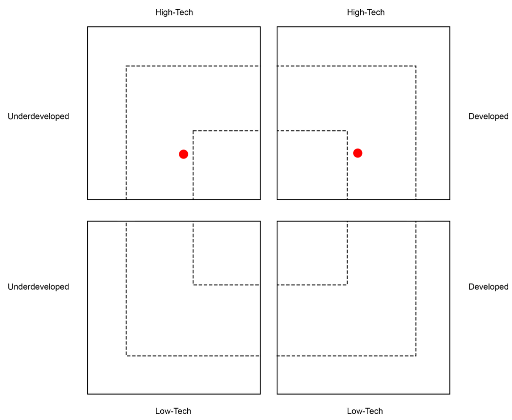

Figure 45: Building materials plotting - Limpopo Youth Hostel by Local Studio, 2019 (DIT 801, 2023, 2023)

The residence designed by SRLC in Westcliff, Johannesburg, stands out as a true masterpiece of innovative architecture. With its incorporation of light steel framing solutions, expressive shapes, and a delightful blend of eclectic architectural styles, it captivates the eye from every angle. However, what truly sets it apart and adds a touch of modern allure is found in the main bedroom area, where an extraordinary feat of engineering and design unfolds with the ceiling elegantly adorned in Cross-Laminated Timber (CLT) panels, creating a harmonious marriage of sustainability and sophistication.

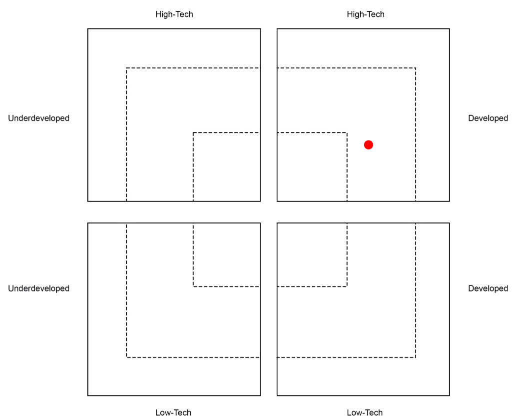

Figure 46: Building materials plotting - Westcliff residence by SRLC, 2019 (DIT 801, 2023, 2023)

The Ridge, designed by StudioMASS and located in Cape Town, stands as a pioneering architectural marvel in South Africa. Particularly noteworthy are the vertical CLT panels adorning the building's façade, which serve a dual purpose of solar control and aesthetics. This innovative approach presents a compelling alternative to traditional solar "louvres" made from aluminium or pine, embracing sustainability and leaving a lasting impact on the environment. By seamlessly integrating cutting-edge design with eco-friendly materials, The Ridge sets a remarkable precedent for future construction projects seeking to marry aesthetics and sustainability.

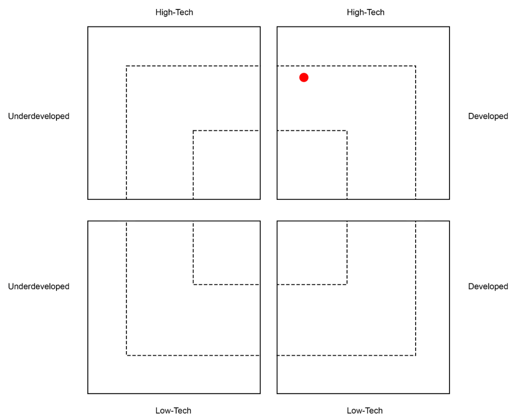

Figure 47: Building materials plotting - The Ridge - Deloitte by StudioMASS, 2020
(DIT 801, 2023, 2023)

Wolff Architects, renowned for their commitment to cutting-edge design, spearheaded the creation of the Cheré Botha School using a blend of innovative and emerging construction practices. Embracing the concept of sustainability and efficiency, they opted for glulam columns and beams instead of conventional SA pine trusses. By incorporating these robust glulam components, the architects not only enhanced the building's structural stability but also opened up exciting opportunities for larger and more expansive interior spaces, all while leaving a lasting positive impact on the environment.

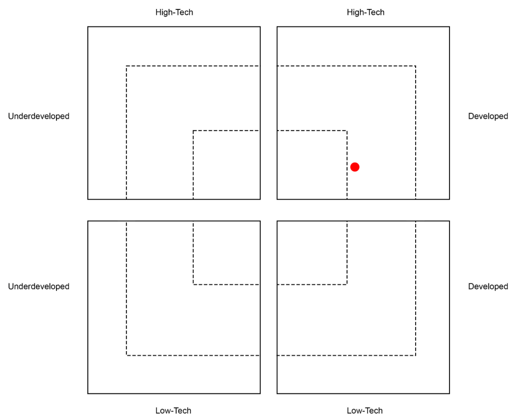

Figure 48: Building materials plotting - Cheré Botha School by Wolff Architects, 2020
(DIT 801, 2023, 2023)

Construction processes where timber was used

The freeform timber Yoga Studio by Holzbau Hess is a groundbreaking architectural marvel, setting new standards in design and construction. Notably, it marks the first of its kind in many aspects, spearheading the emerging trend of freeform timber structures in South Africa. What makes this project truly innovative is the extensive use of Computer-Aided Design (CAD) to meticulously plan and prefabricate all the components off-site, showcasing the rapid growth of this technology within the region. Utilising CAD's precision and flexibility, the individual pieces of timber were expertly glued together and skillfully bent to match the CAD shapes, ensuring seamless integration and structural integrity. The assembly process involved a perfect fusion of modern technological advancements and the time-honoured craftsmanship of a renowned carpenter, bringing the vision to life. The use of clamps to hold the components together during the drying phase further highlights the ingenious fusion of old and new techniques, resulting in a stunning yet functional masterpiece that transcends convention. This exemplary project not only showcases the potential of freeform timber construction in the region but also serves as an inspiring example of how technology and craftsmanship can harmoniously coexist to create sustainable, aesthetically pleasing, and environmentally friendly architectural wonders.

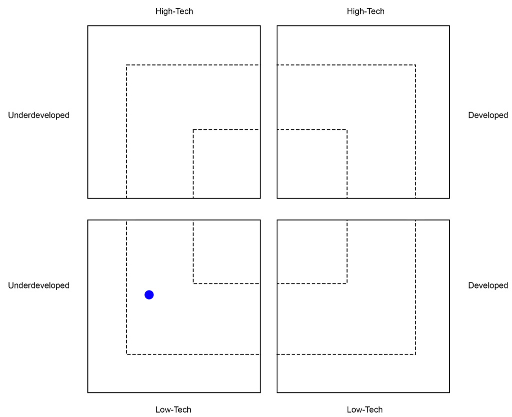

Figure 49: Construction processes plotting - Yoga studio by Holzbau Hess, 2018 (DIT 801, 2023, 2023)

David Krynauw, a true visionary renowned for his innovative contributions to both the architectural and furniture industries, showcases his extraordinary talent in the following two remarkable projects. Leveraging the power of modern-day technology, particularly CNC machining, Krynauw masterfully transforms conventional SA pine into awe-inspiring structures. In the captivating Kleine Rijke wedding venue/restaurant, the CNC machine expertly cuts out elegantly curved elements that seamlessly interlock, forming a mesmerising portal frame that blends aesthetics with functionality. Similarly, in his ingenious "Modular pods" concept, Krynauw ingeniously employs CNC-cut components, allowing for an incredibly versatile and efficient system of interlocking modules, creating endless possibilities for flexible living and working spaces.

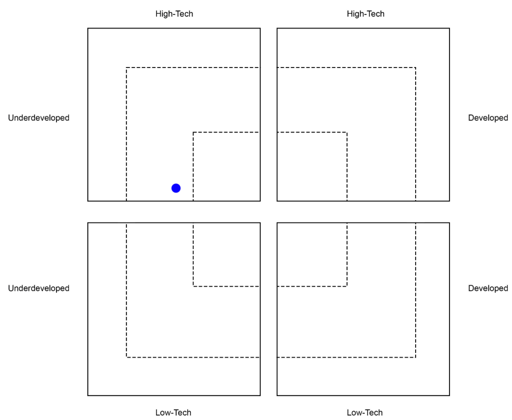

Figure 50: Construction processes plotting - Kleine Rijke by David Krynauw, 2017 (DIT 801, 2023, 2023)

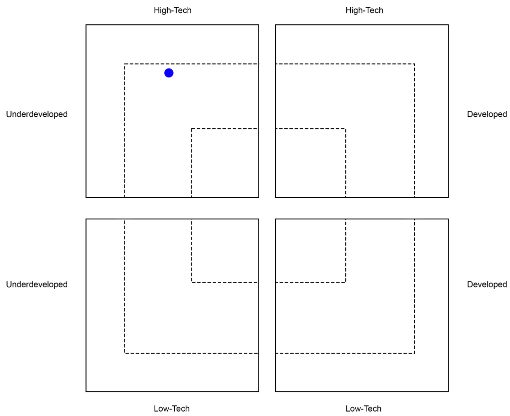

Figure 51: Construction processes plotting - Modular pods by David Krynauw, 2020 (DIT 801, 2023, 2023)

By adopting a premanufacturing approach and beginning with full-scale prototyping, House Paarman treehouse, skillfully crafted by Malan Vorster Architects and Interiors, stood out prominently in the architectural realm. While the majority of building components were expertly premanufactured, the architects, engineers, and a masterful carpenter remained deeply involved throughout the entire process, fostering a harmonious and iterative circular design process. Recognizing the importance of accommodating potential variations, certain sections of the structure were constructed on-site, ensuring meticulous attention to detail and seamless integration within the captivating design.

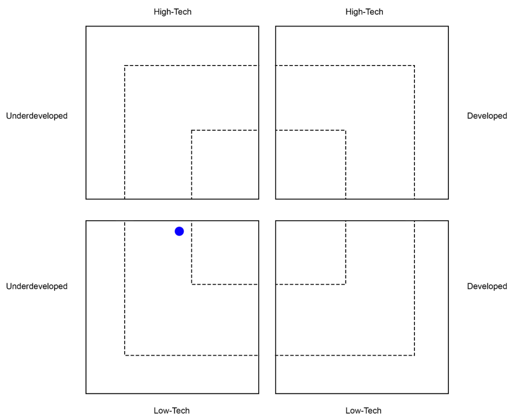

Figure 52: Construction processes plotting - House Paarman treehouse by Malan Vorster Architects and Interiors, 2017 (DIT 801, 2023, 2023)

The Desmond Tutu Archway's stunning artwork exemplifies the innovative and emerging craft technique that has been gaining popularity in South Africa. By skillfully steam bending timber elements, the architects created a captivating circular pavilion/archway that serves as a touching tribute to the life and remarkable work of Bishop Desmond Tutu in South Africa. This craft of timber bending not only showcases the country's artistic prowess but also holds the potential to reintroduce the invaluable personal touch that seems to have been gradually lost in contemporary building practices throughout the nation. Embracing this traditional method could pave the way for a renewed appreciation of craftsmanship and cultural heritage in the architectural landscape of South Africa.

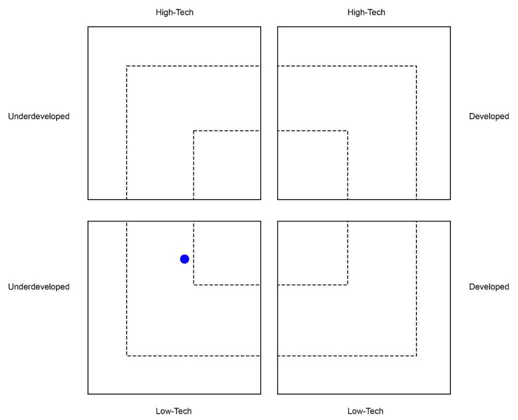

Figure 53: Construction processes plotting - Desmond Tutu Archway by Snøhetta and Local Studio, 2017 (DIT 801, 2023, 2023)

Projects emerging in all three realms using timber.

House Elliot by Paul Elliot is an exceptional architectural endeavour that seamlessly integrates elements from all three realms: building material, construction process, and structural system.. The innovative design incorporates Cross-Laminated Timber (CLT) panels, which not only provide a sturdy and durable structural system but also showcase a commitment to environmentally friendly building materials. These CLT panels were meticulously CNC machined and pre-fabricated off-site, ensuring precise construction and minimising on-site waste. To further enhance the house's energy efficiency and eco-consciousness, the panels are ingeniously clad with cork, not only providing superior insulation but also bestowing a striking and natural exterior finish to the building.

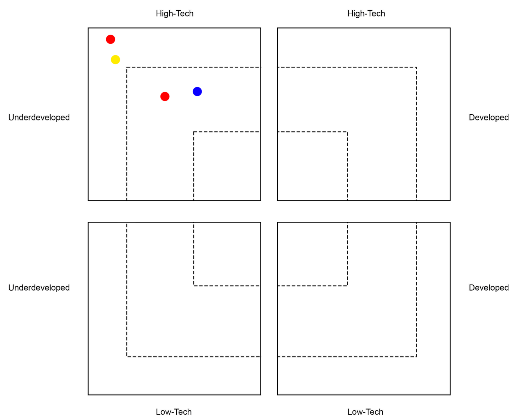

Figure 54: All three realms plotting - House Elliot by Paul Elliot, 2021 (DIT 801, 2023, 2023)

The residence located in Constantia showcases Rothoblaas' significant contribution to the project, featuring a cutting-edge design that relies on Cross-Laminated Timber (CLT) panels as the primary structural element for the entire first floor, ingeniously constructed above a sturdy brick semi-basement. By ingeniously integrating CLT into the floor slab, wall panels, and roof panels, this exceptional architectural masterpiece serves as a remarkable testament to the versatility and viability of CLT as a comprehensive building material for the entire structure. A pivotal role is played by the innovative Computer Numerical Control (CNC) manufacturing process, which expertly cuts out precise door and window openings in the CLT panels, substantially reducing on-site construction time and effectively minimising waste generation throughout the building process.

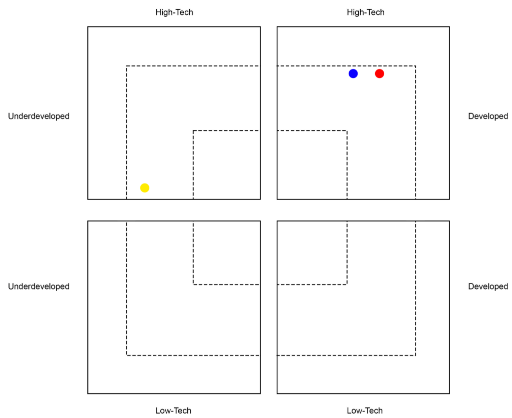

Figure 55: All three realms plotting - Constantia residence by Rothoblaas, 2022 (DIT 801, 2023, 2023)

Projects emerging in the construction process and structural system realms using timber.

Earthworld Architects incorporated innovative construction techniques such as pre manufacturing and CNC machining into the building process of the KoSpaza coffee shop. The structural system of the café was ingeniously crafted using plywood, demonstrating an emerging trend in architecture and design. By utilising Computer-Aided Design (CAD), the architects seamlessly integrated individual components into the cohesive final product, streamlining the construction process.

Plywood's application as a structural element brings forth cost-effective advantages compared to traditional building practices like brick-and-mortar or steel. Its versatility and sustainability make it an environmentally friendly choice for modern construction projects. Furthermore, the use of premanufacturing allows for meticulous planning and designing for the assembly of the entire building, resulting in reduced construction time and enhanced precision. Through this combination of cutting-edge techniques and materials, Earthworld Architects not only delivered a visually striking coffee shop but also set a remarkable example of how innovation in construction practices can create functional and aesthetically pleasing spaces that align with the principles of sustainable architecture.

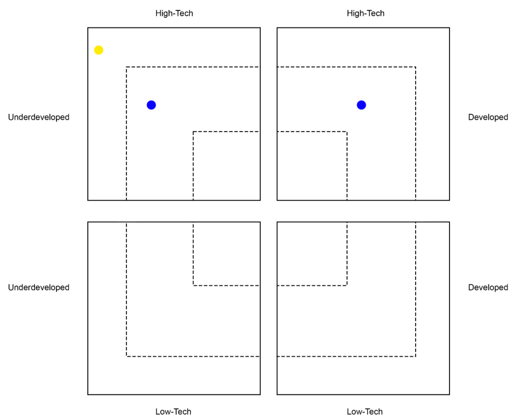

Figure 56: Construction Process and Structural system - KoSpaza by Earthworld Architects, 2021 (DIT 801, 2023, 2023)

'Die Spens' Bosjes by Steyn Studio represents a revolutionary approach to timber structures, redefining the boundaries of architectural possibilities. Embracing the power of Computer-Aided

Design (CAD) and steam bending techniques, this groundbreaking project enables the creation of freeform structures that elegantly follow the organic and fluid contours found in nature. It seamlessly fuses the wisdom of traditional construction methods with the boundless potential of future innovation, resulting in a mesmerising hybrid masterpiece that harmoniously blends low-tech craftsmanship with cutting-edge high-tech advancements. 'Die Spens' Bosjes stands as a testament to the limitless creativity and ingenuity that can be achieved when embracing the synergy between artistry and technology.

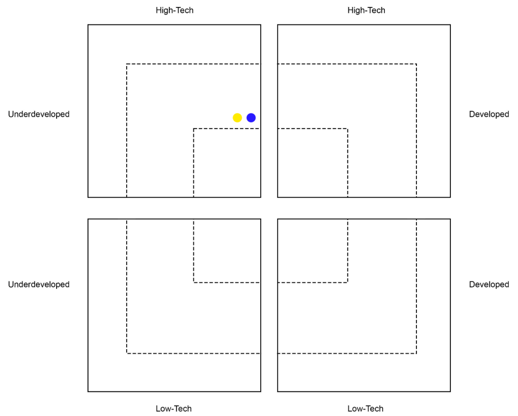

Figure 57: Building materials plotting - 'Die Spens' Bosjes by Steyn Studio, 2021 (DIT 801, 2023, 2023)

Projects emerging in the building materials and structural system realms using timber.

SRLC's Dalrymple pavilion, nestled in the charming neighbourhood of Westcliff, stands as an architectural marvel, ingeniously utilising leadwood as its primary structural system. This exceptional choice involves subjecting the leadwood to controlled burning, a meticulous process that imbues it with remarkable resilience against the harshest elements, ensuring its longevity and strength. The pavilion's innovative design further showcases a post-and-beam structural system, elegantly fashioned with leadwood, which has been garnering widespread acclaim within the architectural community, as it embodies the cutting-edge approach to sustainable construction.

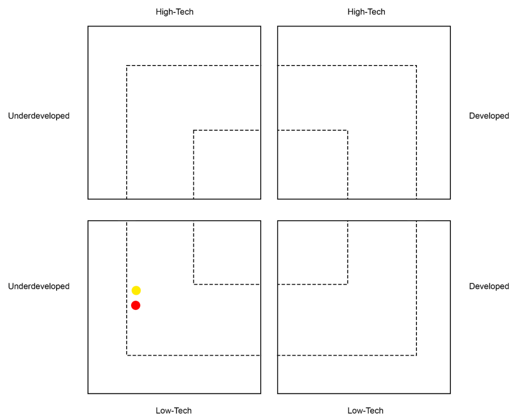

Figure 58: Building materials and Structural systems plotting - Dalrymple pavilion by SRLC, 2019 (DIT 801, 2023, 2023)

Designed by Frankie Pappas, the House of the big Arch boasts a stunning architectural feat, employing glulam columns and beams to create captivating "bridges" that house the dining room and living areas. This innovative use of natural materials not only provides a seamless blend with the abundant surrounding trees but also establishes a harmonious connection between the interior and the enchanting exterior landscape.

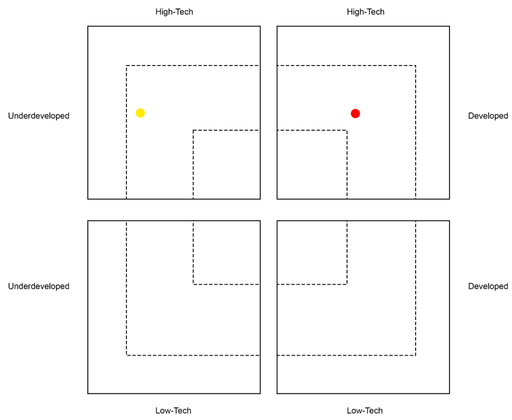

Figure 59: Building materials and Structural systems plotting - House of the big arch by Frankie Pappas, 2020 (DIT 801, 2023, 2023)

6. Discussion

The projects discussed above highlight the growing trend of using timber in innovative ways within the architectural realm of South Africa. Timber's versatility, sustainability, and aesthetic appeal have led to its increasing popularity in construction projects across the country. From low-tech craftsmanship to high-tech advancements, architects and designers are finding ingenious ways to incorporate timber into building materials and structural systems, pushing the boundaries of what is possible in modern architecture.

On a High-Tech Scale: The integration of technology, such as Computer-Aided Design (CAD) and Computer Numerical Control (CNC) machining, has allowed architects to precisely plan and prefabricate timber components off-site. This approach minimises on-site waste, reduces construction time, and ensures structural integrity. Projects like the freeform timber Yoga Studio by Holzbau Hess and the House Elliot by Paul Elliot demonstrate how high-tech methods can seamlessly merge with traditional craftsmanship, resulting in stunning, sustainable, and functionally efficient structures. Furthermore, projects like The Ridge and House Paarman treehouse showcase the use of advanced technologies and innovative materials, such as Cross-Laminated Timber (CLT), which not only add to the aesthetic appeal but also contribute to sustainability and energy efficiency.

On a Low-Tech Scale: Several projects celebrate the timeless artistry of traditional craftsmanship and timber bending techniques. The Desmond Tutu Archway and Die Spens' Bosjes exemplify the reemergence of these craft techniques and their potential to infuse cultural heritage and personal touch into modern architectural designs. By embracing low-tech methods, architects can not only create visually striking structures but also preserve and promote the rich cultural heritage of the region.

Combining High-Tech and Low-Tech: The projects that seamlessly integrate high-tech and low-tech elements, such as 'Die Spens' Bosjes and the House of the big Arch, illustrate how combining artistry with technology can yield groundbreaking results. These projects demonstrate that the synergy between innovation and craftsmanship can lead to awe-inspiring and sustainable architectural marvels. The use of timber in both high-tech and low-tech approaches is transforming the architectural landscape in South Africa. From the innovative use of Cross-Laminated Timber (CLT) and glulam beams to the integration of Computer-Aided Design (CAD) and CNC machining, architects are embracing technology to create environmentally friendly, visually captivating, and structurally sound buildings. Simultaneously, the resurgence of traditional timber bending techniques highlights the importance of preserving cultural heritage and infusing personalised craftsmanship into modern designs.

The projects discussed offer a glimpse into the future of architecture in South Africa, where timber plays a leading role in sustainable, functional, and aesthetically pleasing construction projects. As technology continues to evolve and awareness of sustainability grows, timber's prominence is likely to increase further, shaping the architectural landscape of the country for years to come.

South African architecture is a reflection of the country's complex history, shaped by a blend of local traditions and international influences. The architectural landscape has evolved significantly over time, from the colonial interpretations of Dutch, Victorian, and Edwardian styles to the emergence of modernism and the incorporation of international design philosophies. Throughout this journey, architects have sought to challenge prevailing tendencies and create an architecture that speaks to the unique South African context.

The present state of the building industry and architectural environment in South Africa presents a dichotomy. On one hand, the commercial architecture sector appears stagnant and slow to adopt new technologies, while on the other hand, community and civic architecture are embracing local culture and craft to create meaningful and contextually responsive designs. The challenge lies in breaking away from traditional building technologies, such as brick and mortar, and exploring innovative alternatives that offer economic, versatile, and socially responsive solutions to the country's diverse environments.

One promising avenue for architectural advancement lies in the exploration of emerging building technologies, which offer distinct advantages over traditional methods. Timber construction, in particular, is gaining momentum in South Africa as a sustainable and versatile building material, ranging from conventional timber sections to cutting-edge mass timber and digital fabrication techniques. By incorporating craft into the design process, architects can elevate their creations to a higher level, forging a meaningful connection between the built environment and human experience.

The journey of South African architecture is one of continuous evolution, a delicate dance between tradition and innovation, past and future. As architects, builders, and designers continue to push the boundaries and explore new possibilities, they carry the responsibility of shaping a built environment that responds to the needs of its people, embraces its cultural heritage, and seeks to harmonise with the natural world. The enduring force of craftsmanship remains an integral part of this journey, infusing each creation with a sense of artistry and dedication that withstands the test of time. Ultimately, the future of South African architecture lies in embracing innovation while celebrating the richness of its diverse history and culture.

7. Conclusion

In conclusion, the literature review and case study research on the values of emerging building technologies in South Africa, particularly timber construction and craft influenced by digital fabrication and pre manufacturing practices, have shed light on the dynamic and promising landscape of the country's architecture. The findings revealed that South Africa is experiencing a growing interest in sustainable and eco-friendly construction practices, with a notable emphasis on timber products. The Western Cape region emerged as a leader in adopting these materials, reflecting a regional inclination towards environmentally conscious building approaches. The construction industry in South Africa is witnessing a shift towards more efficient and streamlined construction techniques, with prefabrication standing out as a prominent method. The integration of Computer-Aided Design (CAD) highlights the increasing use of technology in the sector, enhancing design precision and project management.

Regarding emerging structural systems, Cross Laminated Timber (CLT) technology demonstrated significant potential, with several projects incorporating it. Additionally, earth-centred approaches are gaining attention, showcasing a renewed interest in environmentally sensitive building practices. While there has been progress in the adoption of innovative materials and processes, the dominance of low-tech materials and underdeveloped systems in many projects indicates that there is still room for further exploration and advancement in the field of emerging building technologies. The architectural landscape of South Africa has been influenced by international styles and historical events, contributing to its diverse heritage. However, the post-apartheid era has brought its own set of challenges, including skills mismatches, poverty, technology gaps, and regulatory issues, which the construction industry is working to address.

In this evolving context, timber has emerged as a versatile and sustainable building material, offering architects and designers a wealth of possibilities. The integration of digital design tools and manufacturing processes has allowed for intricate shapes and precise construction, while also preserving the craftsmanship that defines architecture's history. By seamlessly combining high-tech methods with traditional craftsmanship, architects are creating groundbreaking and sustainable architectural designs. Timber's prominence in these approaches is transforming the architectural landscape in South Africa and contributing to visually captivating, structurally sound, and environmentally friendly buildings. South African architecture is on a journey of continuous evolution, where tradition and innovation coexist harmoniously. The responsibility of architects is to create designs that respond to the unique local context, respect cultural heritage, and meet the needs of the people while integrating with the natural world.

Embracing innovation while celebrating the country's diverse history and culture will pave the way for the future of South African architecture, ensuring that it remains vibrant and relevant for generations to come. By adopting emerging building technologies like timber construction and incorporating them into mainstream practices, the industry can contribute to a more sustainable and prosperous future for South Africa's built environment.

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9. Addendums