

Benefits of Concrete Prefabrication Panel Construction Technologies in Building Reconstruction and Development Programme (RDP) Housing Units in South Africa: A Literature Review

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Abstract

Prefabrication construction technologies offer a number of benefits, including reduced waste and assessment, energy efficiency revision, optimal construction, rapid work, safety, quality as well as sustainability. Prefabrication makes it possible to build year-round, in any type of weather. The use of self-supporting prefabricated components significantly reduces the requirement for shuttering, scaffolding, or formwork. This study explores and documents the benefits of implementing the use of concrete prefabrication panel construction technologies. The emphasis is on building housing units of the Reconstruction and Development Programme (RDP) in South Africa, a government-led low-cost housing initiative. This study used a qualitative methodology to gather data from a sample of participants in the construction industry. The data presented was compared with literature, with an intention to validate the views of the participants, but mostly importantly to determine whether participants' views are consistent with literature or contributes to the body of research. The study found that in a context of South Africa, a country with a high backlog of low-cost housing provision, lack of land spacing to build houses, and increased need for housing, traditional methods of construction are predominant. Such predominance is indicative of inadequate implementation of prefabrication construction technologies, which in turn signifies the lack of awareness regarding the potential benefits, perceived benefits, and or actual benefits of prefabrication in construction. Amongst the benefits that are discussed in this study are. The benefits of prefabricated building are its cost-effectiveness, speedy construction schedules and delivery, safety, and quality during construction activities (for construction workers) and post construction (for end-users i.e., RDP recipients), and minimal environmental impact. Thus, this study recommends that the engineering and construction sector priorities the establishment of research studies initiatives that assess the benefits of innovative technologies within the construction industry, including prefabricated construction technology. Additionally, instead of relying solely on traditional approach, the construction sector should focus on assessing the modern advancement of construction of the housing units in South Africa.

Keywords

Benefits of Prefabrication, Concrete Panel Construction, Concrete Prefabrication, Prefabricated Panel, RDP Housing Units.

1. Introduction

Globally, prefabrication has emerged as an innovative construction technique, recognized for its efficacy in achieving smart and sustainable construction practices (Bari et al., 2012). It is acknowledged for offering a myriad of advantages, including cost reduction, time efficiency, error minimization, improved health and safety conditions, enhanced overall quality, reliability, extended life efficiency, and increased profitability (Cai et al., 2023). By providing high-quality standardized construction materials produced under monitored working conditions, efficient productivity, and minimizing waste and other adverse environmental effects, prefabrication aims to shorten construction durations (Rocha et al., 2023).

Despite these global benefits, the applicability of prefabrication can vary significantly based on the unique contexts of each country or region. Factors such as materials, construction industry and management practices, housing

structure, existing building techniques, and other dynamics influence the extent to which prefabrication can be leveraged effectively. Nevertheless, the overarching goal of prefabrication remains consistent — fostering sustainable and smart construction. While the preceding paragraph provides a global overview of the benefits of prefabrication, it is crucial to delve into the specific context of the developing world, with a focus on Africa and, notably, South Africa, to identify research and practice gaps related to the benefits of its use.

One potential benefit of prefabrication, particularly relevant for developing nations like China, India, Africa, and parts of South America, is the ability to rapidly and affordably realize housing projects. However, it is recognized that an increased reliance on manufactured production may have both advantages and drawbacks for these societies (Smith & Narayanamurthy, 2009). In South Africa, prefabrication has not always been the preferred construction method, with some engineers perceiving it as a low-quality form of construction (Lombard, 2011). As a result, alternative construction methods have often been considered of inferior quality (Lombard, 2011; de Klerk, 2013). This perception issue highlights a research gap that needs attention to clarify the actual benefits that prefabrication can offer.

In a nation where it is evident that low-income households require access to affordable housing, and sustainable construction can play a pivotal role in meeting these needs (SAHIF, 2020), this study aims to examine and document the benefits of using concrete prefabrication panel construction technologies in the building of Reconstruction and Development Programme (RDP) housing units. By addressing this research gap, the study intends to contribute valuable insights into the potential advantages of prefabrication in the specific context of South Africa, ultimately informing more informed decision-making in the construction of affordable and sustainable housing solutions.

Consequently, this study evaluates the benefits of concrete prefabricated panel construction technologies in building Reconstruction and Development Programmes housing units in South Africa. Moreover, the study aims to contribute to the body of knowledge with regards to the concrete prefabricated panel construction technologies in South Africa for RDP housing units.

2. Research Methodology

The study investigated the benefits of concrete prefabricated panel technologies in building RDP housing units in South Africa. The study utilised the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA). The PRISMA approach involves several stages to conduct a literature review. This approach includes conducting literature search. The literature search for this study was conducted on Google scholar database, as it offers wide ranges of articles related to this concept. Additionally, for articles to be determined from the database, the following keywords were formulated, 'benefits of prefabrication', 'concrete panel construction', 'concrete prefabrication', 'prefabricated panel', 'RDP housing units', and 'South Africa'. These keywords were used in conjunction with the Boolean operators, including AND operator and OR operator.

The articles used for this study were from conference papers, journals, dissertations, and books to mention a few. All articles were considered as this concept is not much dominant in South Africa, which led to papers from different sources to be considered. Additionally, the papers between the year 2010 and 2024 were considered with an intent to determine the trend of this technology in South Africa after hosting the 2010 FIFA World Cup. All the articles extracted were subjected to screening of titles and abstract with an aim to determine the papers that are suitable for this study and those that will add to the body of knowledge. The considered articles were synthesized, and findings were drawn up. Moreover, concise conclusion and recommendations were made based on the findings from the literature.

3. Background of South Africa's Construction Industry in the context of RDP

3.1 Construction Sector

As of the year 2020, the construction industry in South Africa employed a significant workforce of 473,214 individuals, according to Statistics South Africa (2022). This robust employment figure underscores the vital role played by the construction sector in the country's economy. Direct employment is generated through various activities such as building, operating, and maintenance, encompassing laborers employed by major contractors, subcontractors, professionals, executives, and additional qualified experienced staff, as highlighted by Tanzarn and Gutierrez (2015).

The construction industry's significance is further emphasized despite challenges like the scarcity of available land for construction. In addition to grappling with these challenges, the construction sector must also navigate the opinions of end-users regarding innovative building systems and feasible alternative construction techniques, particularly within the affordable housing market (Windapo & Cattel, 2014). A notable aspect is the ongoing conflict between labor and technology within the industry (Windapo & Cattel, 2014).

Since 2007 and in every subsequent year, the Construction Industry Development Board (CIDB), a regulatory body, has been actively encouraging construction companies to align with government policies. One of the key directives involves the hiring of more workers, aiming to contribute to the increase of the Gross Domestic Product (GDP) and the reduction of poverty (CIDB, 2007). This policy initiative reflects the government's commitment to utilizing the construction sector as a means to stimulate economic growth and address social challenges such as poverty reduction.

3.2 Study Participants (Sample) Representing the Construction Industry

In this study, the participants that took part in responding to the qualitative questions and this helped the research reach qualitative insights. Participants were mostly those working in roles such as: Civil/Structural Engineer; Contractor; Quantity Surveyor; Construction Project Manager; Architect; Mechanical Engineer; Electrical Engineer; unspecified construction related professionals.

3.3 Low-Cost Housing Initiative: Reconstruction Development Programme (RDP)

The Reconstruction and Development Programme (RDP) played a crucial role in the transformation of South Africa, aiming towards the abolition of apartheid and the establishment of a democratic, non-racial, and non-sexist future. It served as an integrated socioeconomic policy framework designed to benefit all South Africans and national assets (Moolla et al., 2011; Webster & Adler, 1999). Corder's (1997) findings indicated that half of the black urban respondents in his survey felt they obtained benefits from the RDP. Over the period between 1994 and 2018, 3.2 million RDP buildings were constructed, as reported by Melzer and Garbers (2019). However, despite the program's quantitative success in terms of the number of houses constructed, studies assessing South Africans' satisfaction with RDP housing units reveal strong objections to the subpar construction quality, standards, and the absence of amenities and services (Moolla et al., 2011; Parliamentary Liaison Office, 2017).

The legacy of apartheid in South Africa persists, with insufficient housing more than two decades after the democratically elected government assumed power (Marutlulle, 2019). While 3.3 million affordable homes have been built, the state program has struggled to keep up with rapid population growth, resulting in shanty settlements proliferating in cities (StatsSA, 2017). Despite the provision of RDP housing, there is limited emphasis on the opinions and satisfaction levels of beneficiaries as integral elements of people-centered housing provision in South Africa (Penxa, 2022). The pervasive issue of low-quality construction remains a common challenge across the country (Manomano & Tanga, 2018).

Given these challenges, it is crucial to provide an overview of prefabrication in the South African context to evaluate its potential benefits, particularly concerning its capacity to address the issues associated with inadequate housing within the context of low-cost housing. The examination of prefabrication becomes essential in the quest for improved housing quality, efficiency, and the overall well-being of South African communities.

4. Concrete Prefabrication Technologies' Benefits

In examining the perceived benefits of concrete prefabrication technologies, 15 key variables/items were identified related to the Reconstruction and Development Programme (RDP). The responses to these variables were assessed on a 5-point Likert scale, indicating a range from strongly disagree to strongly agree.

4.1. Cost-Effectiveness

Cost-effectiveness emerged as a crucial aspect, with findings consistent with literature suggesting that prefabrication results in savings due to manufacturing economies of scale. The variables "Cost Savings due to Mass production" and

"Lower Costs" received positive and significant responses from participants, aligning with the notion that prefabrication can be a cost-saving technique (Tam, 2011; Bah et al., 2018).

4.2. Quick Delivery and Productivity Construction Work

Participants expressed agreement with literature emphasizing the quick assembly advantages of prefabricated structures, leading to optimised productivity and time savings. Variables such as "Faster Construction" and "Cost Savings due to Mass production" received positive responses, supporting the idea that prefabrication enhances productivity and expedites construction processes (Ganiyu, 2016).

4.3. Quality Housing and Safety

Quality housing and safety were key considerations, echoing literature highlighting the benefits of prefabrication in producing high-quality buildings. Participants agreed that "Quality can be controlled prior to construction" and that prefabrication results in "High quality" buildings. Quality and safety were interconnected, emphasizing the importance of setting standards for prefabricated products to ensure both aspects (Tavares et al., 2021; Adeyeye et al., 2010; El-Abidi, 2018). The association of prefabrication with "Less Risk Factors" was also acknowledged by participants, linking quality and safety with lower risks post-construction.

4.4. Sustainability Accomplishments

Sustainability emerged as a significant theme, with literature emphasizing the environmentally friendly nature of prefabrication. Participants concurred with the idea that prefabrication leads to a "Lower environmental Impact," aligning with the sustainable development goals of South Africa. The integration of wood chips and cement to create a sustainable building material was recognized as a benefit, aligning with environmental goals and waste reduction efforts (Greyling, 2010; Pescari et al., 2022).

Overall, the findings highlighted a consistent understanding among participants of the perceived benefits associated with the use of concrete prefabrication technologies, reinforcing the potential advantages in terms of cost-effectiveness, productivity, quality, safety, and sustainability.

5. Discussion

Several valuable lessons have been gleaned from the study:

- **Addressing Housing Scarcity:** Leveraging prefabrication for building RDP houses can be a potent solution to the housing scarcity issue in South Africa. Prefabrication proves cost-effective, requires less labour, and accelerates construction pace, offering a promising avenue to alleviate the shortage of affordable housing.
- **Low Environmental Impact:** Prefabrication emerges as an environmentally friendly construction method, resulting in less environmental impact during construction. This implies energy efficiency, water conservation, and waste reduction, aligning with sustainable construction practices.
- **Improved Design and Safety:** The use of prefabrication in building RDP structures is anticipated to enhance design and reduce safety issues post-construction. This underscores the potential of prefabrication to not only expedite construction but also elevate the overall quality and safety of the built environment.
- **Addressing Construction Backlog:** Prefabrication stands out as a solution to address the backlog in housing provision caused by the prolonged construction processes associated with traditional methods like brick and mortar. The faster construction pace of prefabrication offers a means to efficiently address the housing demand.

6. Conclusion

This study has investigated the benefits of prefabrication application in the South African construction sector, specifically highlighting its implications for end-users, particularly RDP housing recipients, and the broader construction sector. The identified benefits of prefabrication include cost-effectiveness, rapid construction timelines, improved quality and safety, and minimized environmental impact.

Consequently, concrete prefabrication can minimise the cost through diminishing the labour cost and enhancing the project completion timeframe, and most importantly ensuring more cost-effective choice for extensive housing developments. Additionally, embracing these innovative technologies such as concrete prefabrication does not only help the construction sector but also align with the demands for sustainable of the housing unit in South Africa. Through advancing in concrete prefabrication, South Africa has opportunity to offer high-quality RDP housing units that incorporates the concrete prefabrication that enhances the Sustainable Development Goals (SDG) such as viable and efficient energy for housing.

Key recommendations stemming from the study advocate for engineering and construction associations to prioritize empirical studies and inquiries detailing the benefits of technological innovations, such as prefabrication construction technology. Emphasizing the need to move away from outdated, traditional methods, the study envisions a future where the construction sector optimally utilizes advancements to achieve controlled housing quality and rapid delivery. This proactive approach aligns with the evolving landscape of construction methodologies and the potential of prefabrication to revolutionize the sector.

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