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An Investigation of the contribution of 4IR to Competencies of Architects

Linda Akoth[1], Saidi Finzi[2], Rebecca Alowo[3],
[1,2]Department of Architecture, Faculty of Art, Design and Architecture, University of Johannesburg, South Africa
[3]Department of Civil Engineering Sciences, Faculty of Built Environment, University of Johannesburg,
55 Beit Street Johannesburg, South Africa
orandopolal@gmail.com, finzis@uj.ac.za, ralowo@uj.ac.za

ABSTRACT

This article aims to investigate the role/contribution of 4IR to competencies of architects in the pre-construction project development planning in South Africa. The study will explore the knowledge, skills, and abilities required by architects during the early stages of project development, focusing on their ability to conceptualize, design, and plan projects to meet client requirements, adhere to regulatory standards, and achieve sustainability goals. The research will include an overview of the potential application of 4IR technologies to enhance the competencies of architects as well as a comprehensive literature review to identify the existing body of knowledge on this topic, followed by a quantitative survey to collect data from architects working across various architectural firms in South Africa. The findings will provide insights into the current competencies of architects in pre-construction project development planning, identify gaps in their skills, and suggest recommendations for architectural education and professional development programs in South Africa. Ultimately, this research aims to contribute to the enhancement of architectural practice and the overall efficiency and sustainability of the construction industry in South Africa.

Keywords: 4IR, Competencies, Architects, pre- construction, delays

1. Introduction and Background

The development of construction projects involves a multi-faceted process that requires the involvement of various professionals, including architects. Architects play a crucial role in the early stages of project development, particularly in pre-construction project planning. This paper aims to investigate the competencies of architects in pre-construction project development planning in South Africa. By examining the knowledge, skills, and abilities required by architects in this context, the research seeks to identify potential gaps and contribute to the improvement of architectural practices in South Africa.

Project development in both South Africa typically follows a six-stage process [1]. These stages include project initiation, pre-design, design, procurement, construction, and project closeout [2]. Each stage is characterized by specific activities and milestones that contribute to the overall success of the project [3]. However, it is during the pre-construction stages that several challenges arise, often resulting in significant delays [4].

In the project initiation stage, the primary focus is on identifying the project's objectives, determining feasibility, and conducting a preliminary analysis [5]. This stage involves engaging stakeholders, conducting market research, and establishing project goals [6]. The pre-design stage follows, where the project concept is formulated, and initial design decisions are made, including site selection, preliminary layouts, and identification of key design elements [7].

The design stage involves the development of detailed design plans, documentation, and specifications [8]. Architects play a vital role during this stage, translating the project concept into tangible architectural designs that meet the client's requirements while adhering to regulatory standards and sustainable practices [9]. The procurement stage involves sourcing materials, selecting contractors, and negotiating contracts, paving the way for the construction phase [10]. Construction is the stage where the actual building process takes place, with architects providing oversight, quality control, and coordination of various construction activities [11]. The final stage, project closeout, involves completing final inspections, addressing any deficiencies, and ensuring the project meets quality standards before handover [12].

While each stage is critical, it is noteworthy that activities in the three pre-construction stages, namely project initiation, pre-design, and design, tend to be slow-paced in South Africa [13]. Delays during these stages can have a cascading effect on the entire project timeline and can lead to increased costs and frustrations for all stakeholders involved [14]. Therefore, understanding the competencies of architects in pre-construction project planning is crucial to addressing these challenges and

improving the efficiency of the overall project development process [15.

Against this backdrop, this study is designed to investigate the competencies of architects in pre-construction project development planning in South Africa and Uganda; not to mention what role 4IR technologies can play to enhance these competencies. By identifying potential gaps and limitations, the research aims to provide insights and recommendations for enhancing architectural education and professional development programmes. Ultimately, the findings of this study have the potential to contribute to the improvement of architectural practices and the overall efficiency and sustainability of the construction industry in South Africa.

2. Literature Review

The national, provincial, and local governments of South Africa each have three (3) branches [4]. It is the responsibility of the province government to carry out service delivery initiatives including the construction of primary healthcare and elementary school infrastructure. These various facets of government impede South Africa's infrastructure development [1]. Even though it would only take a year or less, the delivery of such infrastructure takes on average 2 to 5 years to complete the pre-contract working stages [2].

The National Building Regulations in South Africa aim to enhance preconstruction planning. ensures that planning rules are applied effectively since it must be done so by professionals to ensure effectiveness of applications and practices [3]. To incorporate professionalism in its practices and applications, the South African National Building Regulations, which is the primary regulation for building design planning, has undergone revisions [4].

The National Building Regulations Act, 1977 (No. 103 of 1977) of South Africa was revised and modified in 2008 to add new definitions [5]. One of the significant modifications was the addition of a qualified individual who would prepare plans and submit them to the local government. Because the definition of "competent person" was ambiguous prior to this modification in the law, a building owner was permitted to create a plan without consulting an architect or designer (Regulations, n.d.) [6]. According to the Architectural Professions Act of 2000, the Engineering Profession Act of 2000, the Natural Scientific Professions Act of 2003, and any other applicable Acts, the qualified individual must be registered. The South African National Standards (SANS) 10400 "The Application of the National Building Regulations" code of practice now contains these standards [7]. This non-statutory document provides the technical details required for the Regulations to be used in practice [7]. The building is Apart.

Any professional is now able to use the South African National Regulation Act in its development plans thanks to improvements and amendments made to it in 2008 [8]. For instance, the Architectural Profession Act, 2000 (Act No. 44 of 2000) states that a registered professional architect's primary responsibility in the development of construction projects is to carry out building design planning in accordance with the National Building Regulations and the Building Standards Act, 1977 (No. 103 of 1977) [9]. The following building and construction kinds are among those that the architect may be involved in, according to the Architectural Professional Act of 2000 (Act No. 44 of 2000) [10]:

Lighthouses, heliports, generating and distributing facilities for energy, water towers, pumping stations, bridges, sewage and water purification facilities, and storage sheds are examples of public services.

• Transportation - Goods stations, buildings along the lines, signal boxes, workshops, repair facilities, bus, engine and carriage sheds and subterranean parking lots.

• Industries - Engineering works, warehouses, storage sheds, buildings directly needed for mining operations, factory buildings in proclaimed or approved industrial areas, and in other areas reserved under any law primarily for specific or general industrial purposes, as well as purposes incidental thereto, but excluding in all cases detached and semidetached factory offices. Pools for recreation are available.

• Scientific structures, such as observatories and seismographic, geophysical, and meteorological stations.

• Agricultural structures: Sheds for tools and fodder, repair shops for farm machinery, etc.

Despite the above improvement of the National Building Regulations (NBR) it was also noted that the delays in the building construction permit approval processes in South Africa were also contributed by the lack of knowledge and skills of the building design professionals [11,12,13,14,15].

The average practicing architect spends less than 15% of their time on doing feasibility studies and conceptual design [16].

They spend the rest of their work time inspecting building sites, dealing with planning applications, negotiating tenders, and drawing up technical specification and email correspondence [17]. It therefore makes sense to design and apply AI to take care of the dull, back-to-back, time consuming and mandate tasks for example AI that could check drawings for compliance with the building regulations to make the approval process straightforward and quick [18]. As the history of technology has shown, new technologies always start with more promise than practical application [19]. Credit cards, mobile phones, the internet and electric cars all started as expensive technologies with serious limitations but overtime they became much more useful and applicable in facilitating our livelihoods [20]. There is therefore an unlimited potential and possibilities as to the role 4IR can play in enhancing the competencies of architects.

Considering the foregoing, it is suggested that this study investigates the capabilities of an architect in South Africa's pre-construction project planning. To successfully manage pre-construction project development planning in South Africa, the study will investigate the roles and practices, the knowledge required, and the education and training of the architect. The secondary data from the analysis will be used to offer remedies for the delays in South African building project planning. It is anticipated that the solutions found will contribute to greater efficiency and a quicker development and implementation of construction projects in South Africa.

3. Approach/ Methodology

3.1 Research design

A systematic explanation of plans for the gathering and analysis of data allowed the researcher to obtain answers to the questions addressed. It served as the research design. [21]. This study was positioned within the functionalist paradigm [22]. This study employed a mixed method research design [23]. As a result, a research design contained presumptions and reflections that guided the procedures towards the use of measures to collect empirical data to achieve the desired study objective [24]. A mixed methods research design was used for the study because it enabled the researcher to gather data and use the analysis to meet the study's goals [25].

3.2 Population and Sample framework

The study examined civil engineering and building projects in both the public and private sectors, as well as various facility kinds (such as commercial or educational ones). To limit and maintain uniformity and to make sure that the findings represented the overall trend in South Africa, the study concentrated on construction projects carried out within the country of South Africa. The construction employees in South Africa's construction industry made up the research population. Practicing architects, contractors and property developers, consulting engineers and quantity surveyors, scholars, representatives of municipal and provincial/federal governments, experts in the built environment employed by the government, and 50 to 100 operatives/construction industry workers made up the targeted demographic.

4. Results

Construction projects are typically developed in South Africa in six stages, including project initiation and briefing, concept and feasibility, design development, tender documentation and procurement, and construction. administration of construction documents and project closure. The following activities occur during project initiation and briefing: the facilitation of the development of a clear project brief; establishment of a procurement policy; appointment of various consultants for various tasks; establishment of site information and statutory requirements for design; creation of an initial viability assessment of the project; creation of a project initiation programme; and facilitation of client agreement and approval of all initiation and briefing activities. The following activities occur during the concept and feasibility work stage: the appointment of additional consultants for various tasks, the hiring of a health and safety consultant, the identification of additional planning statutory requirements, the distribution of the project brief to all consultants, the creation of a cost management plan, the creation of the project's initial cost estimate, the creation of an initial design and construction schedule, and integration of the concept and viability solutions for the clients' acceptance and approval of all the activities in this work stage is facilitated.

All the remaining different consultants for the various tasks are hired, communication channels are established, a documentation development plan is created, design documents are integrated to match quality and accepted programme, all planning laws and building regulations are facilitated in accordance with statutory compliances, and health and safety requirements are facilitated and integrated. The emphasis of this research is to look at the activities are primarily related to the planning stage of preconstruction project development by the South African council for project management (SACPCMP) and South African council for architects (SACAP). Table 1 shows the responses based on the questionnaire administered. The respondents described the phases and activities they engage in the various work stages.

Table 1: Planning phase of preconstruction project development

Work stages	**Description**	**Activities**
1	Project Initiation and briefing	The activities will include: a clear project brief development is facilitated, procurement policy is established, different consultants for different tasks are appointed, site information together with statutory requirement for design is established, an initial viability assessment of the project is made, project initiation program is made, and the client is facilitated to agree and approve all the activities of initiation and briefing.
2	Project Concept and Feasibility	The activities will include more different consultants for different tasks are appointed, health and safety consultant is appointed including identification of other statutory planning requirements, all the consultants are given the project brief, the concept design and viability assessment is made, cost management plan is made, project initial cost estimate is made, initial design and construction programme is made, and integration of the concept and viability solutions for the clients' acceptance and approval of all the activities in this work stage is facilitated.
3	Project design development	The activities will include: all the remaining different consultants for different tasks are appointed, communication channels are established, documentation development programme is made, design documents are integrated to match quality and accepted programme, facilitation of all planning laws and building regulations in line with statutory compliances is achieved, facilitation and the integration of health and safety requirements in the design, and the improvement of cost estimates and confirmation of project budget for clients' acceptance and approval of all the activities of this work stage is achieved.

Based on the responses, there doesn't seem to have been much done on design delays during the project start and briefing, concept and feasibility, and design development stages of construction project development. They left the question on delays blank.

Alos the respondents said the use of land for development should be done in an effective and environmentally friendly

manner during the three pre-construction work stages, namely: initiation and briefing, concept and feasibility, and design development. In the three work stages, it will be necessary to effectively adhere to the land use plan, the environment, and all statutory requirements. Preconstruction planning clearances are incredibly slow in South Africa.

Based on the responses, issues of building project development planning delays in South Africa appears to be mostly related to the rules governing land development. These pertain to various industries, are managed by various organizations, and take place within several governmental areas. The environment and planning are two important fields. The land development procedures are governed by laws in these two sectors in several ways: First, by using different land use plans, and then second, by obtaining permissions or authorizations from decision-making organizations that are mandated to accept, consider, and make decisions on the merits of land development applications. Planning and the environment have always worked in tandem with a few successful attempts at integration. This appears to demonstrate a lack of vision and a lack of coordination across the numerous South African building codes and planning legislation.

Again, based on the responses, there are several issues with the existing situation. Plans are developed and carried out in separate areas. Additionally, there is no streamlined decision-making process for property development, which greatly increases the likelihood of legal disputes. This occurs because of how the two places perceive the law differently. All parties involved may find the various permissions bewildering. For instance, public participants frequently find the documentation that goes along with two separate development ideas to be overwhelming, unclear, and dishonest. Objectors frequently take advantage of this duplication to halt socially motivated evolution. Parallel systems also increase the cost and duration of land development, which has a detrimental influence on the system's efficiency. The appears to also demonstrate that there is a lack of coordination regarding the application of building regulations and planning legislation in South Africa between various branches of government and between various departments.

The techniques used to create land, determine its use, and control activity on it are all covered by land use management. By suggesting that the broad concept of planning has two parts: those activities that are "geared towards shaping development over a period of time," such as IDPs, and those that implement the strategic plans, and provide a helpful method for locating LUM activities. The numerous legal and regulatory tools used to control land use and development, such as zoning plans, are included in these implementing and monitoring instruments and are "also known as land use management systems".

Town planning strategies are used for the purposes of land use management daily. Each plan also lays out the legal parameters and standards for the freedom to use and develop any piece of property within a municipality in accordance with the designated zonings. These rights serve as the foundation for determining property values, making them an essential component of the municipal property rating system.

Artificial Intelligence covers domains such as machine learning, deep learning, neural networks, natural language processing, knowledge base export systems which has made its way into computer vision and image processing. Just like a student learns overtime and because of this machine learning feature, AI can also graduate into more accurate and useful technologies that enhance the competencies of architects. The nature of work tasks that are employed in Project initiation and briefing, Project concept and feasibility and Project design development include.

- Extraction of information from documents such as statutory standards, compliance and specified requirements that are relevant, pertinent, and applicable to the project. There are possibilities of setting up ICT digital search platforms with in-built AI, machine learning and image recognition software to analyse these documents, extract key data points and clauses in a matter of seconds thus capping on delays that would come from reviewing such documents literally or manually. This AI could also be employed to carry-out data collection, analysis and make assessments which are necessary in the production of feasibility studies, developing of reports and drawing up of programs.
- Communication facilitation and client engagements through meetings. Here there is opportunity for the application of virtual reality assistants that can facilitate work tasks that involve communication, correspondence, booking meeting appointments with reminders thus improving efficiency with client engagements.

Architectural design and production of drawings. There are emerging AI systems which create realistic images and artwork from written descriptions in natural language. Such AI systems would be useful for graphic creatives or clients without an architectural background to communicate their ideas to the architect who would then develop them further. To date however there is not yet an AI system with architectural intelligence to design spaces or do detail design. It is debatable whether AI can

ultimately replace the architect however there is real potential and opportunity to create AI systems than can generate detail or working drawings from schematic design drawings in a third of the time it would have taken draft technicians to do the job.

5. Conclusion

The average practicing architect spends less than 15% of their time on doing feasibility studies and conceptual design. They spend the rest of their work time inspecting building sites, dealing with planning applications, negotiating tenders, and drawing up technical specification and email correspondence. It therefore makes sense to design and apply AI to take care of the dull, back-to-back, time consuming and mandate tasks for example AI that could check drawings for compliance with the building regulations to make the approval process straightforward and quick. As the history of technology has shown, new technologies always start with more promise than practical application. Credit cards, mobile phones, the internet and electric cars all started as expensive technologies with serious limitations but overtime they became much more useful and applicable in facilitating our livelihoods. There is therefore an unlimited potential and possibilities as to the role 4IR can play in enhancing the competencies of architects.

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