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IN PERSON EVENT

CONSTRUCTION IN 5D: THE FINAL CHAPTER DECONSTRUCTION, DIGITALIZATION, DISRUPTION, DISASTER, DEVELOPMENT

"Learning and Innovation go hand in hand. The arrogance of success is to think that what you did yesterday will be sufficient for tomorrow." ~ William Pollard

There is little doubt that the construction industry has experienced exponential change and development in recent years. The 17th Built Environment Conference will examine five of these cutting-edge concepts to determine their state of the art in the construction sector both in practice and academic research. This conference therefore seeks responses to questions related to current conversations, debates and empirical research on:

- Deconstruction:** The dismantling or 'unbuilding' of buildings to maximise reusing and preserving the demolished fragments and involves taking a building apart piece by piece, essentially reversing the order of the construction.
- Digitalization:** The conversion and transformation of construction business processes to use digital technologies and embrace the ability of digital technology to collect data, establish trends and make better business decisions.
- Disruption:** Displacement of well-established construction technologies, techniques or products to disruptively affect the normal operation or function of the construction industry while potentially creating a new industry or market. Artificial intelligence, virtual/augmented reality, internet of things, blockchain technology, and an e-commerce are some of the disruptive technologies that are significantly influencing the future of the construction industry.
- Disaster:** An occurrence that disrupts the normal conditions of existence and operation causing a level of suffering and challenge that exceeds the capacity of adjustment of the affected community and the construction industry.
- Development:** In the context of construction refers to an industry that possesses the vision, leadership and capacity to bring about a positive transformation of itself within a condensed period of time.

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Papers will be reviewed according to:

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- Originality of the subject matter
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CONTENTS

AIMS & SCOPE	2
ADVISORY BOARD	3
DIGITAL COMPETENCE PROFICIENCY IN THE SOUTH AFRICAN CONSTRUCTION INDUSTRY: AN EXPLORATORY STUDY T. C Haupt	5
AN INVESTIGATIVE STUDY INTO THE CHALLENGES IMPACTING THE KWAZULU-NATAL PUBLIC SECTOR CONSTRUCTION INDUSTRY Z. A Armoed and T. C Haupt	15
COMMON MENTAL DISORDERS, COPING AND MENTAL WELL-BEING OF THE CONSTRUCTION WORKFORCE IN SOUTH AFRICA M. T. Raliile, T. C Haupt, K. Kajimo-Shakantu	25
INSTRUCTION FOR AUTHORS	38
EDITORIAL COMMITTEE	41

AIMS AND SCOPE

The Journal of Construction (JOC) is the official journal of the Association of Schools of Construction of Southern Africa. ASOCSA has committed itself to foster excellence in construction communication, scholarship, research, education and practice and the Journal provides this medium to achieve this commitment. There are four issues of refereed Journal of Constructions per year serving all stakeholders and participants in the Construction and Engineering sectors.

The Journal of Construction publishes quality papers written in a conversation style aiming to advance knowledge of practice and science of construction while providing a forum for the interchange of information and ideas on current issues. JOC aims to promote the interface between academia and industry, current and topical construction industry research and practical application by disseminating relevant in-depth research papers, reviews of projects and case studies, information on current research projects, comments on previous contributions, research, innovation, technical and practice notes and developments in construction education policies and strategies. Some issues might be themed by topic.

Topics in JOC include sustainable construction, educational and professional development, service delivery/customer service, information and communication technology, legislation and regulatory framework, safety, health, environment and quality management, construction industry development, international construction, risk management, housing, construction related design strategies; material, component and systems performance, process control; alternative and new technologies; organizational, management and resource issues; human factors; cost and life cycle issues; entrepreneurship; design, implementing, managing and practicing innovation; visualization, simulation, innovation, and strategies.

In order to maintain and ensure the highest quality in JOC, all papers undergo a rigorous system of blind peer review process by acknowledged international experts.

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DIGITAL COMPETENCE PROFICIENCY IN THE SOUTH AFRICAN CONSTRUCTION INDUSTRY: AN EXPLORATORY STUDY

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ABSTRACT

PURPOSE OF THE PAPER

The purpose of this paper is to explore the levels of digital competence of a sample of built environment practitioners in South Africa to identify the potential areas of deficient competence that need attention if digital technologies are to be used and engaged with optimally by the South African construction industry.

DESIGN / METHODOLOGY / APPROACH

The objectives of the paper are achieved by adapting the Digital Competence Framework 2.0 that has been developed and used in Europe to the context of the Southern African built environment or construction sector. The proficiency levels of the Framework were simplified and reduced to three, namely elementary, intermediate, and advanced levels of proficiency for the purposes of the exploratory quantitative survey of a national convenience sample of 24 built environment practitioners. The survey instrument was designed to measure the level of digital competence of the participants in five areas identified in the competence framework. The five areas were information and data literacy; communication and collaboration; digital content creation; safety and problem solving. The self-administered survey instrument included examples and explanations of each competence area to assist respondents to assess their own levels of digital competence. The data was analyzed using SPSS version 28.

FINDINGS

The study found that the sample did not have advanced levels of digital competence in any of the five areas that were measured, namely information and data literacy; communication and collaboration; digital content creation; safety and problem solving. Further, the sample reported slightly better than elementary levels of digital competence in the areas of digital content creation and problem solving.

RESEARCH LIMITATIONS / IMPLICATIONS

The findings of this exploratory study may not be generalized to the entire South African construction industry because of the small convenience sample of 24 construction practitioners. A future study will be conducted with a larger sample and the data analysed using a stratified approach to measure the impact of several other possible mitigating factors on digital competence such as gender, age, discipline, position, and length of engagement in the construction industry

PRACTICAL IMPLICATIONS

The findings of the paper can be used to provide an indication of the level of digital competence of the construction industry in South Africa and the areas that need attention to achieve advanced levels of digital competence if the industry is to become globally competitive. Opportunities exist for all stakeholders in the sector to contribute to the improvement of digital competence and proficiency given that South Africa cannot avoid the impact of advances in digital technology.

WHAT IS THE ORIGINAL / VALUE OF THE PAPER

The paper is of interest to the entire construction industry and can be used as a metric to determine and improve the level of digital competence of the industry in the face of exponential growth and development of digital technologies and their content.

Keywords: *Digital Competence, Data Literacy, Digital Content Creation*

INTRODUCTION

One of the reasons for the overall and consistent poor performance of the construction industry in countries such as South Africa is the slow pace of technological advancement and adoption of digital technologies that is characteristic of the industry in most developing countries. Arguably, the inevitable use of digital information and communications technologies places demands on the digital competence of practitioners in the architecture, engineering and construction (AEC) spaces where the increase in technology is significant¹. Acquisition of digital and knowledge competencies and skills through the use of digital and knowledge technologies is a process for increasing managerial competencies². Digital technology refers to any product that can be used to create, view, distribute, modify, store, retrieve, transmit and receive information electronically in a digital form, such as personal computers and devices, for example, a desktop, laptop, netbook, tablet computer, smart phones, PDA with mobile phone facilities, games consoles, media players, e-book readers, and digital television and robots³. Arguably, digital competencies provide competitive advantages¹ for those who are knowledgeable, skilled and experienced in their use. This slow pace of technological advancement is evident in the poor digital technology adoption experienced in the construction industry^{4,5}. Typically, the industry in the developing countries has been reluctant and slow to embrace and implement technological innovations that include modern and progressive digital technologies such as BIM technology¹. Consequently, the industry lacks innovation and its poor performance is perpetuated. If the industry is to improve its performance, a paradigm shift is necessary, failing which it will remain at the tail of the value chain and create more dissatisfaction in the products they deliver⁶. The practice of merely adopting digital technologies because they are current and the latest fad without possessing an adequate level of digital competence to optimize this adoption is counterproductive. This paper provides insight into just where the South African construction industry is relative to its level of digital competence.

DIGITAL COMPETENCE

In Europe, digital competence is regarded as one of the basic skills to be provided through lifelong learning as a key measure in its response to globalisation and the shift to a knowledge-based society³. It is understood as “the confident, critical and responsible use of the technologies from the society of information for work, entertainment and education”⁷. In this context, digital competence is defined as the application of knowledge, skills, values and attitudes to a defined standard of performance with respect to digital technologies. It is also defined as a set of abilities to use technology optimally^{4,8,9}. It has been described as the set of knowledge, skills, attitudes, abilities, strategies, and awareness that are required when using ICT and digital media to perform tasks; solve problems; communicate; manage information; collaborate; create and share content; and build knowledge effectively, efficiently, appropriately, critically, creatively, autonomously, flexibly, ethically, reflectively for work, leisure, participation, learning, socializing, consuming and empowerment^{8,9}.

Therefore, it involves the use of, and engagement with, digital technologies for learning, at work, and for participation in society. Digital competence is a broad concept that includes information and data literacy, communication and collaboration, media literacy, digital content creation that includes programming and coding, safety that includes digital well-being and competences related to cybersecurity, intellectual property related questions, problem solving and critical thinking¹⁰.

Arguably, with the advent of the exponential growth in digital technologies and their potential for growing application in the construction sector it is important for all stakeholders in the industry to be digitally competent. Digital competence is often used to point out the skills that are necessary to derive optimum benefit from the use of these technologies¹¹.

The motivation for this essential competence is based on individuals which in this case are those involved in the construction industry, inter alia:

- Understanding how digital technologies can support communication, creativity, and innovation, and be aware of their opportunities, limitations, effects, and risks;
- Understanding the general principles, mechanisms and logic underlying evolving digital technologies and know the basic function and use of different devices, software, and networks;
- Taking a critical approach to the validity, reliability and impact of information and data made available by digital means and be aware of the legal and ethical principles involved in engaging with digital technologies;
- Being able to use digital technologies to support their active citizenship and social inclusion, collaboration with others, and creativity towards personal, social or commercial goals;
- Having skills that include the ability to use, access, filter, evaluate, create, program, and share digital content.; and
- Being able to manage and protect information, content, data, and digital identities, as well as recognise and effectively engage with software, devices, artificial intelligence, or robots³.

Engagement with digital technologies and content also requires, inter alia,

- a reflective and critical, yet curious, open-minded, and forward-looking attitude to the evolution of digital technologies and content; and
- an ethical, safe, and responsible approach to the use of these tools³.

Since 1994, South Africa is no longer an isolated pariah state. Rather, it has become open to influences from the rest of the world. Therefore, it is reasonably anticipated that the trends that occur elsewhere will also filter into South African industry. The construction industry will not be excluded from these influences and trends despite the current resistance to the pervasive uptake of digital technologies. This preliminary study therefore examines the digital competence of a national convenience sample of construction stakeholders in South Africa using an adapted form of the Digital Competence Framework 2.0^{12,13}. This Framework identifies the key components of digital competence in five areas. It creates an agreed vision of what is needed in terms of competences to overcome the challenges that arise from digitisation¹. The Framework aims to create a common understanding using an agreed vocabulary which can then be consistently applied in all tasks from policy formulation and target setting to instructional planning, assessment and monitoring³. The purpose of the study is to gain insight into the digital competence of the construction industry in South Africa to identify the areas of deficient competence that need attention if digital technologies are to be used and engaged with optimally. As far as the author is aware no previous study has been done that establishes the level of digital competence of industry practitioners and stakeholders. This preliminary study fills this research gap.

RESEARCH APPROACH

The Digital Competence Framework 2.0^{12,13} used in Europe was adapted within the context of the Southern African built environment or construction sector. The proficiency levels were simplified somewhat and reduced to 3, namely elementary, intermediate, and advanced levels of proficiency for the purposes of the quantitative survey of a national convenience sample of 24 built environment practitioners. The survey was conducted over a period of six months. The response is typical of how the South African construction industry responds to research especially in areas that they are unfamiliar with. The survey instrument was designed to measure the level of digital competence of these participants in five areas identified in the competence framework.

The self-administered survey instrument included examples and explanations of each competence area to assist respondents to assess their own levels of digital competence. They were required to respond to each item in the survey using the scale of 1=elementary, 2= intermediate and 3=advanced level of digital competence. The data of the duly completed survey instruments were analysed using SPSS version 28. The descriptive findings of this exploratory study are presented in this paper.

The areas that were examined are:

- Information and data literacy – 3 items;
- Communication and Collaboration – 6 items;
- Digital Content Creation – 4 items;
- Safety – 4 items; and
- Problem solving – 4 items.

DATA ANALYSIS

The data was analysed using descriptive statistics and the relative competence index (RCI). The RCI was calculated using the following formula:

$$RCI = \frac{\sum W}{AN}$$

where W is the weighting as assigned by each respondent on a scale of one to three with one implying elementary and three implying advanced levels of competence. A is the highest weight which is 3 in this case and N is the total number or size of the sample¹⁴. The relative competence indexes were calculated for each variable and the overall rankings were established for each variable. The RCI scores were calculated based on the formula and sorted in descending order from the highest to the lowest. The three competence levels were deduced from the RCI scores and interpreted as elementary (E) ($0.0 \leq RCI \leq 0.33$), intermediate (I) ($0.33 < RCI \leq 0.67$), and advanced (A) ($0.67 < RCI \leq 1.0$)¹⁵. Prior to assessing and reporting the descriptive and RCI statistics, the measurement scales were assessed for reliability.

FINDINGS

TEST FOR NORMALITY

The Shapiro-Wilk Test was conducted to test whether the variables were normally distributed in the population of construction stakeholders. The null hypothesis was that the variables were normally distributed. The null hypothesis was rejected because $p < 0.05$ for all the variables tested. Therefore, the variables were not normally distributed. However, there is nothing inherently wrong with non-normal data; some traits simply do not follow a bell curve. Therefore, if any further statistical analysis needs to be done non-parametric tests would have to be done. However, due to the exploratory nature and small sample of participants in this study no further detailed analysis was conducted.

• Reliability testing

The reliability of the scales used for each construction was tested by determining the Cronbach's Alpha coefficient. The rule of thumb for reliability is the Cronbach's Alpha score should be >0.70 . The findings are shown in Table 1.

Table 1. Reliability coefficients of digital competence constructs

Construct	No of items	Cronbach's Alpha	Interpretation
Information and data literacy	3	0.853	Acceptable
Communication and Collaboration	6	0.919	Acceptable
Digital Content Creation	4	0.847	Acceptable
Safety	4	0.821	Acceptable
Problem solving	4	0.923	Acceptable

All reliability coefficients were >0.70 and the reliability of scales of the constructs were therefore deemed to be acceptable.

• Information and data literacy

This area is defined as the ability to articulate information needs, to locate and retrieve digital data, information, and content; to judge the relevance of the source and its content; and to store, manage, organize digital data, information, and content. Digital data refers to a sequence of one or more symbols given meaning by specific act(s) of interpretation and can be analysed or used to gain knowledge or make decisions. The responses of the participants in the survey are shown in Table 1.

Table 1. Information and data literacy

	Competence	Mean	Std. Deviation	RCI	Competence Level	Rank
IDL1	Browsing, searching, and filtering data, information, and digital content	2,6667	0,48154	0,889	A	1
IDL2	Evaluating data, information, and digital content	2,5833	0,58359	0,861	A	2
IDL3	Managing data, information, and digital content	2,4583	0,58823	0,819	A	3

From the responses in Table 1, it is evident that the sample reported better than intermediate competence in all three items in the construct with the highest level of competence being the ability to locate and retrieve digital data (mean=2.67) and the lowest level of competence being the ability to store, manage and organize digital data, information and content (mean=2.46). Only ten (42%) of the respondents reported having advanced levels of digital competence in information and data literacy. Based on the RCI, the respondents have an advanced level of digital competence in information and data literacy.

• Communication and Collaboration

Communication refers to using digital technology. Various modes of communication exist such as synchronous communication or real time communication, for example, using skype or video chat or Bluetooth and asynchronous ones for example, email, forum to send a message, or SMS using for example, one to one, one to many, or many to many modes. This area examines the ability to interact, communicate and collaborate through digital technologies while being aware of cultural and generational diversity; to participate in society through public and private digital services and participatory citizenship; and to manage one's digital identity and reputation. The responses of the participants in the survey are shown in Table 2.

Table 2. Communication and collaboration

	Competence	Mean	Std. Deviation	RCI	Competence Level	Rank
CC1	Interacting through digital technologies	2,7500	0,44233	0,917	A	1
CC2	Sharing through digital technologies	2,5833	0,65386	0,861	A	2
CC3	Participating in society using appropriate public and private digital services and technologies	2,3333	0,70196	0,778	A	4
CC4	Collaborating through digital technologies	2,2727	0,70250	0,750	A	6
CC5	Netiquette by being aware of behavioural norms and know-how while using digital technologies and interacting in digital environments	2,3182	0,64633	0,763	A	5
CC6	Managing digital identity by creating and protecting one's own reputation	2,4167	0,82970	0,806	A	3

From the responses in Table 2, it is evident that the sample also reported better than intermediate competence in all six items in this construct. The highest levels of competence were the ability to interact (mean=2.75) and share (mean=2.58) through digital technologies. The lowest level of competence was the ability to collaborate through digital technologies (mean=2.27). Only five (21%) of the respondents reported having advanced levels of digital competence in communication and collaboration. Based on the RCI, the respondents had an advanced level of digital competence in communication and collaboration.

• Digital Content Creation

Digital content refers to any type of content that exists in the form of digital data that are encoded in a machine-readable format, and can be created, viewed, distributed, modified and stored using computers and digital technologies such as, for example, the internet. The content can be either free or pay content. Examples of digital content include web pages and websites, social media, data and databases, digital audio such as mp3s, and e-books, digital imagery, digital video, video games, computer programmes and software^{3,12}. This area deals with the ability to create and edit digital content; to improve and integrate information and content into an existing body of knowledge while understanding how copyright and licenses are to be applied; and to know how to give understandable instructions for a computer system. The responses of the participants in the survey are shown in Table 3.

Table 3. Digital content creation

	Competence	Mean	Std. Deviation	RCI	Competence Level	Rank
DCC1	Developing digital content in different formats	1,7917	0,72106	0,597	M	2
DCC2	Integrating and re-elaborating digital content through modification, refinement, and improvement to create new, original, and relevant content and knowledge	1,7083	0,75060	0,569	M	3
DCC3	Copyright and licenses by understanding how they apply to data, information, and digital content	1,8750	0,74089	0,625	M	1
DCC4	Programming by planning and developing a sequence of understandable instructions for a computer system to solve a specific problem or task	1,7083	0,80645	0,569	M	3

From the responses in Table 3, it is evident that the sample reported better than elementary competence in all four items in this construct. The highest levels of competence were understanding how copyright and licences were to be applied (mean=1.88). The lowest level of competence was the ability to improve and integrate information and content into an existing body of knowledge (mean=1.71). Only one (4%) of the respondents reported having intermediate or advanced levels of digital competence in digital content creation. Based on the RCI, the respondents had a medium level of digital competence in digital content creation.

• **Safety**

This area deals with the ability to protect devices, content, personal data, and privacy in digital environments; to protect physical and psychological health, and to be aware of digital technologies for social well-being and social inclusion; and to be aware of the environmental impact of digital technologies and their use. The responses of the participants in the survey are shown in Table 4.

Table 4. Safety

	Competence	Mean	Std. Deviation	RCI	Competence Level	Rank
Safe1	Protecting devices	2,3750	0,71094	0,792	A	2
Safe2	Protecting personal data and privacy	2,3182	0,77989	0,764	A	3
Safe3	Protecting health and wellbeing by avoiding health risks and threats to physical and psychological wellbeing while using digital technologies	2,3750	0,64690	0,792	A	1
Safe4	Protecting the environment from the impact of digital technologies	2,0417	0,80645	0,681	A	4

From the responses in Table 4, it is evident that the sample reported slightly better than elementary competence in all four items in this construct. The highest level of competence was protecting physical and psychological health (mean=2.38). The lowest level of competence was the awareness of the environmental impact of digital technologies and their use (mean=2.04). Only four (17%) respondent reported having advanced levels of digital competence in safety. Based on the RCI, the respondents had an advanced level of digital competence in safety.

• **Problem solving**

Problem solving refers to an individual's capacity to engage in cognitive processing to understand and resolve problem situations where a method of solution is not immediately obvious. It includes the willingness to engage with such situations in order to achieve one's potential as a constructive and reflective citizen^{3,12}. Problem solving examines the ability of respondents to identify needs and problems, and to resolve conceptual problems and problem situations in digital environments; to use digital tools to innovate processes and products; and to keep up to date with the digital evolution. The responses of the participants in the survey are shown in Table 5.

Table 5. Problem solving

	Competence	Mean	Std. Deviation	RCI	Competence Level	Rank
PS1	Solving technical problems when using devices and digital environments	2,0417	0,75060	0,681	A	2
PS2	Identifying needs and technological responses by assessing needs, identifying, evaluating, selecting, and using digital tools and technological responses	2,1667	0,76139	0,722	A	1
PS3	Creatively using tools digital technologies to create knowledge and innovate processes and products	1,7917	0,77903	0,597	M	3
PS4	Identifying digital competence gaps and supporting others with their digital competence development	1,7500	0,73721	0,583	M	4

From the responses in Table 5, it is evident that the sample reported a mixture of levels of digital competence in this construct. Two items were reported as slightly better than intermediate levels of competence and the remaining two better than elementary levels of digital competence. The highest level of competence was the ability to identify needs and problems (mean=2.17). The lowest level of competence was the ability to identify digital gaps and supporting others with their digital competence development (mean=1.75). Only two (8%) of the respondents reported having advanced levels of digital competence in safety. Based on the RCI, the respondents had between a medium and advanced level of digital competence in problem solving.

COMPARISON OF DIGITAL COMPETENCE AREAS

The composite means of each of the five areas of digital competence were determined and compared as shown in Table 6. None of the areas of digital competence were at an advanced level as their composite means were below 3.

Table 6. Ranking of the digital competence areas

Digital competence area	Mean	RCI	Importance Level	Rank	Level of competence
Information & data literacy	2,569	0,856	A	1	Advanced
Communication & collaboration	2,446	0,813	A	2	Advanced
Digital content creation	1,771	0,590	M	5	Intermediate
Safety	2,277	0,757	A	3	Advanced
Problem Solving	1,938	0,646	M	4	Intermediate

It is evident from Table 6 that the sample had advanced levels of digital competence in three areas, namely information and digital literacy (mean=2.57;RCI=0.86), communication and collaboration (mean=2.45; RCI=0.81) and Safety (mean=2.28; RCI=0.76). The sample had intermediate levels of digital competence in the remaining areas, namely problem solving (mean= 1.94; RCI=0.65) and digital content creation (mean= 1.77; RCI=0.59).

CONCLUSION

The findings of this exploratory study suggest that if South African construction is to remain globally competitive and optimize its access to and use of the rapidly growing range of available digital technologies it will have to improve its levels of digital competence. The study showed that the sample had advanced levels of competence in three of the five digital competence areas measured. The findings suggest that the areas that will need the most improvement are problem solving and digital content creation. Industry practitioners will, therefore, need to improve their ability to identify needs and problems, and to resolve conceptual problems and problem situations in digital environments; to use digital tools to innovate processes and products; and to keep up to date with the digital evolution. Further, they would need to improve their ability to create and edit digital content; to improve and integrate information and content into an existing body of knowledge while understanding how copyright and licenses are to be applied; and to know how to give understandable instructions for a computer system.

These findings suggest that academic programs in South Africa would need to adapt their curriculum offerings to adequately equip their graduates with digital competence and skills. Students during their time at universities will need to be exposed increasingly to digital technologies and their content to adequately prepare them for the world of construction work and professional practice. Further, instructors in construction programs at universities will need to become digitally competent and proficient themselves as they through their instruction produce 21st century entry-level construction professionals not only for the South African construction sector but also for the global construction market where these skillsets will be in demand.

Opportunities must also be created in the construction industry for the acquisition of the basic skills of digital competence and proficiency through lifelong learning as a key measure in its response to the inevitable shift to a knowledge-based society in South Africa. Continuous professional development (CPD) programs promoted and supported by professional bodies could play a key role.

The next phase of this study will include a larger stratified sample of construction industry stakeholders and include the demographic/profile characteristics of these stakeholders. This broader study the findings of which will be generalisable will either confirm or refute the trends in digital competence levels reported in this exploratory study

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AN INVESTIGATIVE STUDY INTO THE CHALLENGES IMPACTING THE KWAZULU-NATAL PUBLIC SECTOR CONSTRUCTION INDUSTRY

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ABSTRACT

PURPOSE

Within South African literature, there exists an empirical gap on the key challenges that impact the successful delivery of construction and engineering projects in the public sector. Earlier research has focused on select aspects of construction and engineering project delivery within a refined context. This study focuses on obtaining a greater understanding of various unique influences that influence and impact the South African construction and engineering industry. An empirical investigation assists the study by refining the key challenges that impact the successful delivery of public sector construction projects in South Africa.

DESIGN

The study employs methodological triangulation to discern the views of research participants and their respective opinions regarding the challenges impacting the South African public sector construction industry. The research data collected through triangulation methods were empirically analysed through the adoption of Statistical Product and Service Solutions and AMOS for the purpose of structural equation modelling.

FINDINGS

The findings highlighting the key project challenges contribute theoretically and practically to the current body of knowledge. The findings also provide the base for public sector stakeholders to develop a **Strategic Model** for implementation by public sector institutions.

RESEARCH LIMITATIONS

The study was limited to Kwazulu-Natal due to the coronavirus pandemic. It was conducted among 750 construction and engineering sector stakeholders from organisations registered with the Construction Industry Development Board through the adoption of survey questionnaires, which present the views and opinions of their respective organisations.

VALUE

The study contributes directly to the existing body of knowledge and promotes a basis for further research into the South African public sector construction industry and the management systems within.

Keywords: Public Sector, Construction Industry, Project Delivery, Statutory Frameworks, Structural Equation Modeling

INTRODUCTION

South Africa had been labeled as a divided nation, plagued by racial inequalities imposed upon by the former Apartheid regime. Segregationist policies and practices among others, have impacted the construction sector. Over the past three decades, the nation embarked on a transition to democracy and transformation, with national and global progression of transformation policies, legislative frameworks and strategies that are directed at addressing past inequalities; in an effort to promote infrastructure stability, and increase economic and socio-economic growth^{1,2,3,4,5,6}. Various authors highlight that public sector socio-economic has a significant impact on the GDP of a country, with the construction sector being actively involved in societal development since the dawn of time². In a present-day democratic South Africa, the public sector construction industry has experienced an evolution and enhancement in the national and socio-economic development policies of the country, with the sector being recognised as a noteworthy contributor to the economy, which promotes economic expansion and provides employment opportunities^{7,8,9}.

The construction sector is seen as highly project-centric and often operates in an environment of intense complexity and uncertainty, with the nature of the sector being poorly understood by society. It is further plagued by challenges, with the sector being described as suffering with a negative image brought upon by poor project performance; increased costs; schedule overruns; poor communication; fragmentation in supply chain processes; quality defects; adversarial relationships; complex project characteristics; poor health and safety practices; conflicts and disputes; socio-economic factors; national and global dynamics and an overall lack of coordination between the various project stakeholders¹. Delays and disruptions have become prevalent in the public sector construction industry, accompanied by inept resolute strategies that promote enhanced levels of dissatisfaction among clients and end users. The reasons posited by authors further suggest that the South African public sector is lagging behind in terms of technological advancements and outdated operational procedures¹⁰. A lack of research exists within the context of the South African public sector, to highlight the key challenges and in proposing strategies to respond to these challenges that permeate throughout the sector. This research study aims to investigate the key challenges assumed to influence the project performance and successful project delivery of the South African public sector construction industry, through understanding the nature of the industry and its challenges, organisational bottlenecks, legal frameworks and statutory policies. The study will contribute to developing a modality for improving public sector construction project performance.

LITERATURE REVIEW

THE SOUTH AFRICAN PUBLIC SECTOR CONSTRUCTION INDUSTRY

The South African public sector construction industry is a highly complex, project centric industry that is diverse and capital intensive in nature. However, the development of economic and socio-economic infrastructure in the country has had an extensive and troubled history, having been controlled by an apartheid state regime during the 19th and 20th centuries; with favour being granted to the minority white population. The era was beset by racial injustices, policies and resultant sanctions which inhibited the economy's growth and the construction industry as a consequence. In 1994, South Africa underwent democratic change and experienced the dawn of a new era under the new political rule of the ANC. In an effort to address the discriminatory practices of the past, the Constitution of the Republic of South Africa (RSA, 1996) led to the development of transformative statutory and legislative policies, such as the Public Finance Management Act, 1 of 1999 (PFMA) (RSA, 1999); the Preferential Procurement Policy Framework Act, 5 of 2000 (PPPFA) (RSA, 2000); and the Broad-Based Black Economic Act, 53 of 2003 (B-BBEE). These policies encouraged the increased participation by the black population in all facets of the construction industry and are essential in closing the gap that was created through apartheid within the economy and in infrastructure development. As a result, the new democratic government became the public sector's largest client in contributing immensely to infrastructure development within the construction industry^{2,3,6,11,12}. However, despite implementing new economic policies and frameworks across three decades, unemployment remains high. Productivity growth remains low, reflected in the GDP per capita growth⁵.

The successful development of capital infrastructure projects contributes to the development of regions, provinces and communities in countries throughout the world. Notably, the public sector construction industry contributes significantly to the country's economic and societal development; having appeared in the economy's GDP, GNP, GNI and GFCF. In the 2017/2018 financial year, the public sector infrastructure expenditure over the medium-term expenditure framework (MTEF) period accounted for an estimated R947.2 billion.

This contribution promoted the growth of the economy and socio-economic capital infrastructure development by 77%. A cumulative 20% of public sector infrastructure expenditure is for the provision of services, while 5% is for education and 4% for health services. However, in the 2021/2022 financial year, public-sector infrastructure spending over the MTEF period is estimated at R791.2-billion. Calculating to a reduction of R156 billion from the 2017/2018 financial year, with the public sector is estimated to spend R226.1-billion on infrastructure development^{13,14}. To ensure successful economic and socio-economic development, capital infrastructural projects are expected to be delivered within budget, timeously, in accordance with the stipulated specifications and quality standards; and in keeping with the stakeholder's satisfaction^{3,5}.

However, in recent years there has been a significant increase in construction-related challenges of public sector projects such as infrastructure delays, disruptions and overall poor performance. Due to the central dynamics, complexities and uncertainties of construction projects, the management and completion of construction projects have faced numerous difficulties, regardless of the policies, legislations and interventions employed. Unemployment within the industry remains volatile with project productivity remaining low, which is reflected in the GDP per capita growth^{5,15,16}.

PUBLIC SECTOR CHALLENGES

The public sector construction industry is considered high risk in contrast to other industries due to its level of intricacy and interconnectedness, and is known to face a constant array of challenges, across various facets of the industry. Developing nations face these challenges at increased levels due to historical prejudices and inefficient systems that plague the industry^{8,17}. This is evident alongside institutional and operational weaknesses that result in socio-economic stresses. In the South African public sector construction industry, challenges have become exacerbated in their severity and overall scope of projects. These challenges include implemented government policies, procedures, legislative frameworks; financial contributions and management; volatile economic environments; skills adversities; inequality; unemployment; a distressed socio-economic culture; stakeholder misrepresentation and management; outdated technological infrastructure development within the industry; a reliance on colonial standards; force majeure events, national and global markets; and an overall lack of sustainable development all of which impact successful project performance and delivery in the public sector^{5,6,18,19,20,24,26,28,29}.

Improved levels of public sector efficiency across all spheres of governance, will result in the successful delivery of construction industry projects. This will result in socio-economic and economic growth. As a result, the key challenges that impact successful project delivery in the public sector construction industry are to be identified as a foundation for public sector stakeholders to develop a strategic infrastructure delivery model for implementation by public sector institutions^{6,12,25}.

RESEARCH METHODOLOGY

This research paper informs a greater mixed methodological research study, with the research approach providing the most informed manner for the collection of data to produce evidence that assisted in answering the research question of the study as succinct as possible. The research approach further offers a platform for an indepth data analysis to produce research findings that can inform public sector takeholders and encourage the development of new systems and practices. Exploratory semi-structured interviews were developed and conducted alongside the main questionnaire survey and administered to public sector construction industry stakeholders and professionals, to gather data that were in keeping with the main research question. A random selection through probability sampling was achieved for the qualitative methodology. A simple random stratified sampling method was employed for the survey questionnaire, which allowed for an equal opportunity for all participants of the target population. The semi-structured interviews and questionnaire survey were disseminated via an electronic mailing during a global pandemic among public sector industry professionals actively involved in the Kwazulu-Natal region. The participants included construction industry professionals, consultants, senior managers, managers and heads of public sector departments.

A total of 50 invitations were distributed with responses received from eight participants. The findings from the exploratory semi-structured interviews contributed to the development of key constructs and factors of the main quantitative questionnaire survey. The questionnaire sought to discover the views and opinions of public sector construction industry stakeholders and professionals. A total of 853 organisations in the Kwazulu-Natal region who are registered at Grade 6 with the Construction Industry Development Board were selected for the research study. After screening the organisations, 103 organisations were removed from the database. As a result, only 750 questionnaire surveys were distributed to organisations, via email as well as by invitation through their registered associations. A total of 103 respondents participated in the questionnaire survey. Responses from 8 participants were removed as the data presented irregularities.

As a result, a total of 96 respondents were considered, indicating a response rate of 13% as indicated in Table 1. IBM SPSS Software v26 and AMOS v27 Structural Equation Modelling were adopted for this research study to analyse the collected data collected and perform an indepth statistical analysis in order to reliably test hypothetical relationships among theoretical constructs and their observed indicator. Findings are presented in Tables 2, 3 and 4 which include confirmatory factor analysis, reliability, validity, model modification and model refinement.

Table 1: Profile of Respondents

Profile of Respondents		
Gender Composition		
Gender	Frequency	Validity %
Male	89	92.7
Female	7	7.3
Total	96	100.0
Age Composition		
Age Group	Frequency	Validity %
30 - 39	28	29.1
40 - 49	29	30.2
50 - 59	32	33.4
60 - 69	7	7.3
Total	96	100.0
Profession Composition		
Profession	Frequency	Validity %
Main Contractor	82	85.4
Project Manager	7	7.3
Engineer	7	7.3
Total	96	100.0
Professional Position Composition		
Professional Occupational Position	Frequency	Validity %
Chief Executive Officer	49	51.0
Senior Manager	21	21.9
Manager	19	19.8
Employee	7	7.3
Total	96	100.0
Professional Experience Composition		
Professional Experience (years)	Frequency	Validity %
0 - 9	14	14.6
10 - 19	41	42.8
20 - 29	22	22.9
30 - 39	19	19.7
Total	96	100.0

PRESENTATION OF FINDINGS

The data expressed 38 factors that impacted successful project delivery that were categorised within a single construct titled "Project Challenges". These were further reduced through factor analysis to 16 factors across five sub-constructs presented in the final structural model. Table 2 highlights the rankings of each factor with Table 3 expressing the mean ratings, standard deviation and normality testing of a single construct, "Project Challenges" and the factors that influence public sector construction project delivery. This will further be refined through SEM to identify the key contributing factors within each sub-construct that informs the structural model of the main study.

Table 2: Mean Rating and Ranking of Influencing Factors

Code	Influencing Factors	Rank	Code	Influencing Factors	Rank
PCHF5	Project Budget Size	1	PCF7	Sustainability	20
PCHF3	Project Size	2	PCF6	Information Technology	21
PCHF4	Project Complexity	3	PCF8	Industry Development	22
PCHF2	Project Scope	4	SEF8	Social Services	23
PSI2	Consultant Influence	5	SEF12	Transformation Policies	24
PSI3	Contractor Influence	6	PCF9	Force Majeure Events	25
PCF2	Financial Contributions	7	SFLF3	Equity Policies	26
PCHF1	Project Type	8	SEF4	Employment Rate	27
PCF5	Stakeholder Management	9	SEF9	Monetary Policies	28
SFLF5	Construction Contracts and Procurement Processes	10	SEF10	Investor Confidence	29
SFLF1	Political Policies	11	SEF11	Fiscal Policies	30
PSI1	Client Influence	12	NGD3	National Economic Trends	31
PCF4	Socioeconomic Culture	13	PSI4	Public Sector Officials Influence	32
PCF3	Skills Capacity	14	SEF6	Poverty and Inequality	33
PCF1	Government Policies Legislature and Frameworks	15	SEF1	Gross Domestic Product	34
SFLF4	Building Regulations	16	SEF2	Consumer Price Index	35
SEF7	Crime	17	SEF3	Gross Fixed Capital Formation	36
PCF3	Skills Shortage	18	NGD2	Global Economic Trends	37
SFLF2	Public Sector Policies and Management Systems	19	NGD1	Global Political Dynamics	38

The Kolmogorov-Smirnov and Shapiro-Wilk methods were applied to measure the levels of normality, with Table 3 indicating that the data was significantly different from the normal distribution at 0.000 and as a result, maximum likelihood estimation and chi-square were employed to justify the non-normality of the dataset.

Table 3: Project Challenges: Mean Rating, Standard Deviation and Normality Testing

	N	Mean	Std. Dev	Kolmogorov - Smirnov ^a			Shapiro-Wilk		
				Stat	df	Sig.	Stat	df	Sig.
Project Challenges									
Government Policies, Legislatures and Frameworks	96	7.416	1.658	.200	96	.000	.889	96	.000
Financial Contributions	96	8.041	2.275	.222	96	.000	.799	96	.000
Skills Capacity	96	7.427	2.279	.235	96	.000	.866	96	.000
Socio-Economic Culture	96	7.479	1.722	.155	96	.000	.899	96	.000
Stakeholder Management	96	7.895	2.438	.295	96	.000	.798	96	.000
Information Technology	96	6.947	1.700	.211	96	.000	.915	96	.000
Sustainability	96	6.968	1.497	.252	96	.000	.885	96	.000
Industry Development	96	6.843	1.778	.194	96	.000	.899	96	.000
Force Majeure	96	6.572	2.606	.127	96	.001	.903	96	.000

Table 4 illustrates the reliability and the corrected item-total correlation statistics through exploratory factor analysis (EFA) with the findings reflecting the unidimensional and reliability of the construct 'project challenges'. The results of the analysis illustrated that the corrected item-total correlation values were > 0.3, and as a result, the factor elements refined from 9 to 5, were adequate and good measures of the construct. Table 4 further indicates the Cronbach's reliability tests, with findings being greater than or equal to the recommended 0.7, indicating a dataset that was both reliable and valid.

Table 4: Exploratory Factor Analysis

Construct	Factor Elements	Corrected Item-Total Correlation	Cronbach's Alpha if item deleted
Project Challenges	Government Policies, Legislatures and Frameworks	.855	0.850
	Financial Contributions	.613	
	Socio-Economic Culture	.778	
	Stakeholder Management	.828	
	Information Technology	.512	

Structural equation modelling was used in the main research study to develop a structural model to measure how well the collected data fit the hypothesised conceptual model. Figure 1 illustrates the path diagram and highlights the various hypothesised relationships after the refinement of the hypothesised conceptual model. Project Challenges presents itself as an intervening variable, with 5 measuring variables. A second-order factor analysis was conducted with factor loadings used to determine model parameters. The overall association between the observed variables and the latent construct was determined by employing standardised and unstandardised factor loadings. Standardised factor loadings > 0.50 were investigated as they indicated a reasonably good construct and convergent validity of the structural model²⁶.

Standardised regression weights were used to accept or reject the hypotheses from the structural model. According to^{26,27}, a hypothesis with a standardised regression weight < 0.1 should be rejected. The research study's latent construct, and project challenges were supported at the 95% significance level.

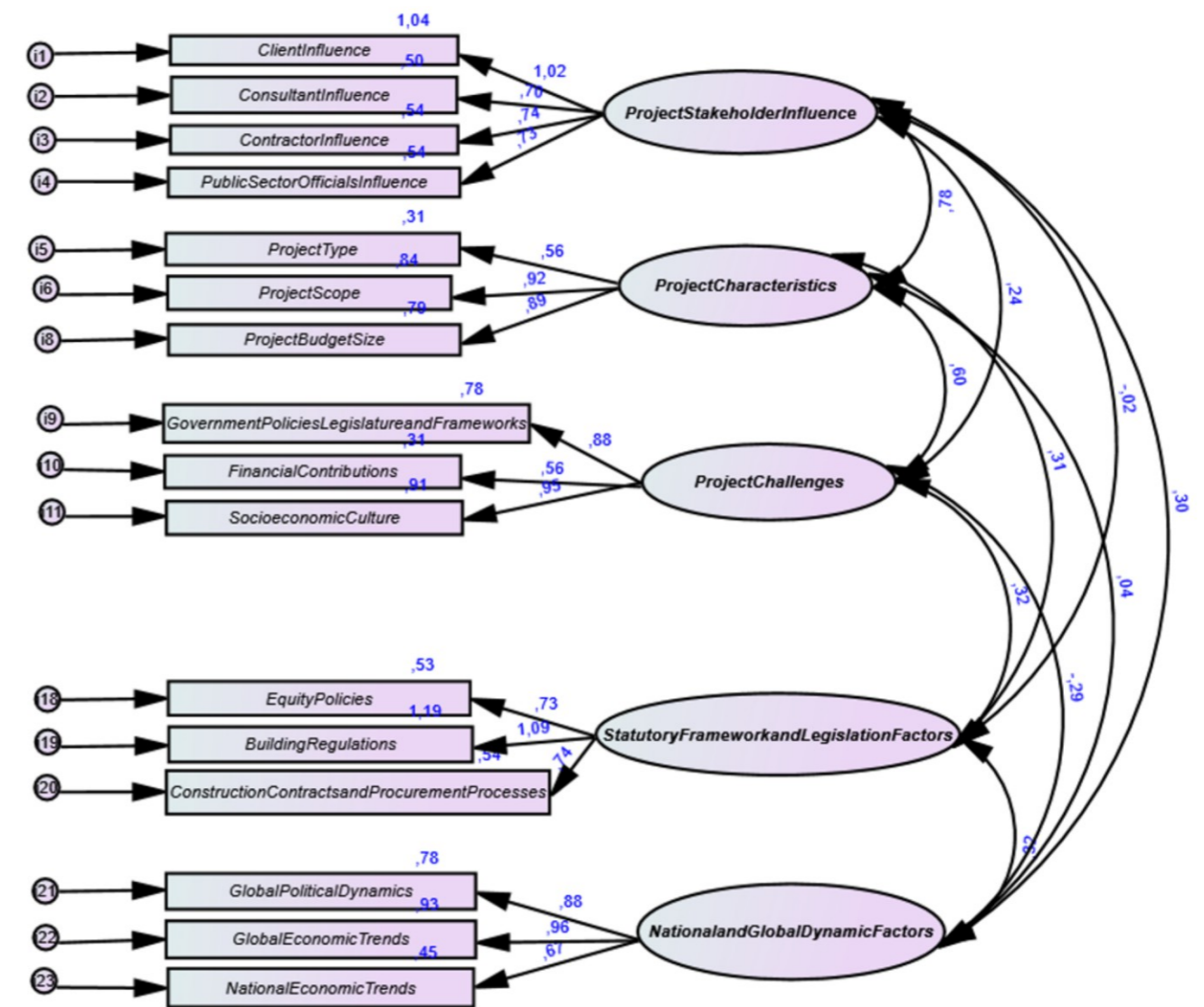


Figure 1: The Final Structural Model

Table 6 highlights the standardised regression weights of the structural model's latent construct project challenges that were > 0.1. The hypothesised relationship between project challenges and successful project delivery presented a CR value between 9.060 that positively supports the relationship. The research analysis results positively indicate that the participants of the research study considered the latent construct and five key project challenges as essential factors that influenced successful public sector project delivery.

Table 6: Structural Model Hypothesis Testing

Latent Constructs	Estimate	SE.	C.R	p-Value	Conclusion
Project Challenges	0.997	0.119	9.060	***	Cannot be rejected

Table 7 illustrated the factor loading of each variable exceeding > 0.50, with the resulting composite reliability index of 0.850 for latent construct project challenges. This finding signifies that the construct attained composite reliability, adequacy and appropriateness contributing towards the final structural model of the main study. The measurement error of the structural model was also considered. The average variance extracted value of the model indicates measured the level of variance of a construct concerning the measurement error of the structural model. The constructs confirm that the model had achieved the average variance extracted value of 0.665 and an internal reliability > 0.7, - 0.819.

Table 7: Reliability and Validity of the Structural Model

	Observed Variable	Factor Loading	CR	AVE	Cronbach's Alpha
Project Challenges	PCF1	0.954	0.850	0.665	0.819
	PCF2	0.592			
	PCF4	0.876			

DISCUSSION

This research paper sought to address the central question of "What are the key project challenges that impact the public sector construction industry?" The objective arising from this question was to investigate and identify a set of key challenges contributing to poor performance in the public sector construction industry. Furthermore, the study aims to provide a foundation for public sector construction industry stakeholders to develop and establish a strategic modal for successful construction project delivery. The model could be implemented within existing infrastructure delivery frameworks and management systems within the South African public sector environment.

Findings from the exploratory semi structured pilot interviews and the survey questionnaire based on the views and opinions of the participants highlighted eight factors that contributed to the latent construct of 'project challenges'. After data analysis using SPSS, SEM, confirmatory factor analysis, reliability and validity testing eight factors were further refined to five key influencing factors. These factors are government policies, legislature and frameworks, financial contributions, socio-economic culture, stakeholder management and information technology. The findings contribute theoretically and practically to the current body of knowledge regarding improved construction project performance and successful construction project delivery within the South African context. The findings further inform the public sector or the unique challenges such as the country's socio-economic factors and statutory legislations. These factors contribute towards the sectors image, nature and overall performance of the industry. Previous studies have highlighted numerous challenges and associated factors within the construction industry at large yet have fallen short in providing a key focus on the unique nature of the South African construction industry and the prevalent challenges that contribute to poor project performance and delivery in the public sector. The findings further informs public sector stakeholders in revising existing infrastructure delivery and management systems to ensure the effectiveness of infrastructure delivery and management systems in the South African public sector environment.

CONCLUSION AND RECOMMENDATIONS

The Structural Equation Modelling construct and five key challenges form part of a larger study, with the structural model illustrated in Figure 1. The model is recommended for implementation by public sector institutions, with focus on construction industry stakeholders and organisations; as a tool during operational planning, implementation and management of project challenges across the lifecycle of a project in order to achieve improved project performance in the public sector environment. Public sector stakeholders are required to identify key challenges such as government policies, legislature and frameworks, financial contributions, socio-economic culture, stakeholder management and information technology and integrate these concepts into existing infrastructure delivery management systems to ensure project success is achieved. Industry professionals are then advised to adhere to these revised strategic systems to achieve collaboration among the project lifecycle processes and delivery management systems to mitigate project challenges and ensure successful project delivery. Enhanced project performance in the 21st century should be the main focus of the public sector construction industry, with the aim to improve the image of the public sector.

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COMMON MENTAL DISORDERS, COPING AND MENTAL WELL-BEING OF THE CONSTRUCTION WORKFORCE IN SOUTH AFRICA

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ABSTRACT

PURPOSE

The purpose of this study is to assess the antecedents to common mental disorders (CMDs), coping strategies and psychological wellbeing of the construction workforce in South Africa.

DESIGN

In this cross-sectional study, data were collected from contractors working in South Africa. The sample were conveniently selected based on proximity and familiarity to the researcher. A total of 201 participants were obtained achieving 56% response rate. A quantitative research approach was used, and data were analysed using IBM SPSS v28 for EFA and descriptive statistics and IBM Amos V18 for SEM. Further, the WHO-5 Wellbeing Index Measure was used to assess the subjective wellbeing in workers and the results were interpreted using the prescribed WHO-5 scoring system.

FINDINGS

The overall WHO-5 index score revealed overall acceptable but not optimal mental wellbeing. Based on the hypothesised relationships, there was a positively significant relationship between CMDs and maladaptive coping (MLC); a non-significant relationship between CMDs and adaptive coping (ADC); a negatively significant relationship between CMDs and wellbeing; adaptive coping was positively and significantly associated with wellbeing and maladaptive coping had a non-significant relationship with wellbeing.

The instrument for CMDs is designed by the author, therefore, EFA was conducted prior to analysis for CMDs to determine the construct validity of measure and the sample size was adequate with all factors loading under one component. Further, reliability and validity for CMDs, maladaptive coping and adaptive coping were tested and reported met recommended thresholds.

RESEARCH LIMITATIONS / IMPLICATIONS

The study only assessed the common mental disorders and psychological wellbeing on a conveniently sampled population using self-report questionnaire. The study may also suffer from limitations associated with self-reporting such as response bias, social desirability, introspective ability, understanding and limitations with rating scales.

VALUE

This study reveals the state of mental wellbeing among a sample of the South African construction workforce which provide insight into how this aspect can be managed better to ensure improved quality of life and extended working lifespans. It also suggests a practical model that can be used to improve the management of mental wellbeing of construction workers

Keywords: Construction Industry, Construction Workforce, Mental Well-being, Mental Health, WHO-5

INTRODUCTION

The issues of mental health problems and poor well-being have recently become increasingly important in the workplace^[1]. Assessing the well-being of employees is beneficial to both employers and employees^[1]. This information obtained from surveys can be used to establish well-being leads and strategies, aimed at the areas of workers well-being and engagement where help is needed the most. Furthermore, feedback enables employees to take positive steps themselves to improve their own health and well-being, subsequently improving their overall well-being.

The WHO^[2] defines health as a state of complete physical, social, and mental well-being, and not merely the absence of disease. Well-being is a positive state experienced by an individual and is influenced by both physical and mental health^[3,4] where mental health is considered a state of mental well-being that enables individuals to cope with the demands of life^[2]. Well-being is a constituent of health and well-being that underpins the ability of an individual to make decisions, form relationships and shape their working environment^[2]. Therefore, poor mental health results in poor mental wellbeing.

In construction as with other workplaces, mental ill-health and well-being problems are rife^[5,6,7]. Traditionally, health and safety issues in the construction industry tended to focus on safety and the mitigation of physical injuries as opposed to focusing on mental health and well-being^[8]. The construction industry needs to consider mental health problems seriously^[9]. Mental health and well-being issues are attributed to the demands and the nature of the industry. These demands emanate from several stressors such as unrealistic expectations, physically demanding work, poor working conditions, lack of communication, complicated interrelationships among different stakeholders, multiple stakeholders, lack of support, difficult tasks, deadlines and working overtime in some instances^[10]. Most workers in construction commute long distances to work and some travel far away from their homes to work which could result in loneliness and be a significant factor contributing to stress, depression, and anxiety^[11]. Construction projects are seasonal, which leads to job insecurity which is another major stressor^[11]. Over and above dangerous working conditions and strict deadlines, workers must adhere to safe working procedures which can be extremely difficult when working under pressure. As a result, workers worry about their wellbeing and become increasingly stressed and the stress is usually a precursor to common mental disorders such as depression, anxiety, boredom, frustration, other negative emotions and in some extreme cases suicide^[11].

In alleviating job demands which lead to common mental disorders, construction workers resort to different coping strategies generally classified as either positive adaptive coping strategies or negative maladaptive coping strategies^[12]. Mental health protective factors can be categorised into ten broad groups, namely marital status; high job control; high job support; low job demand; low workplace discrimination; family-friendly job opportunities; workplace justice; better welfare; positive socioeconomic measures; and positive adaptive coping strategies^[12]. Increased job demand, reduced work support, and reduced job control are associated with maladaptive coping strategies such as alcohol, drugs, and substance abuse (ADSA)^[12,13]. Coping through alcohol abuse may be attributed to the heavy drinking culture in construction^[14]. Furthermore, other studies have reported ADSA as a coping strategy that may trigger anxiety, high job incidents, mental ill-health, physical illness and thoughts of suicide^[15,16,17].

Bowen et al.^[18] conducted a study in South Africa to determine the effects of avoidance coping behaviours such as ADSA among CPPs. The study revealed that despite the prevalence of ADSA among CPPs as a coping strategy for stress, empirical evidence suggests that avoidance coping is inimical in reducing job stress^[18]. Furthermore, other studies have suggested that problem-focused coping is more effective than emotional coping in stress management, depression, and anxiety among CPPs^[19, 18]. Although previous studies have revealed that positive coping strategies improve mental health wellbeing, it remains unclear whether there is a direct relationship between coping strategies and CPPs performance, which subsequently translates into project performance^[20].

Stress and unhealthy working conditions are also known to manifest as psychosomatic symptoms such as headaches, low energy, insomnia, back pain, or chest pain^[11,10]. Furthermore, increased job demands can lead to unintentional blindness as too much focus on complex tasks often leads to low levels of concentration^[10]. It is evident that as mental and physical fatigue mount during prolonged work activities, workers are most likely to engage in unsafe behaviours^[24]. Mental ill-health has detrimental impacts on health and safety and therefore, workers in the construction industry need to be aware that mental health issues are just as important as their physical wellbeing^[9,19,121,122,123].

A comprehensive examination of both the psychosocial work environment and the prevalence of mental ill-health in construction will enable a deeper understanding of the magnitude and scope of psychosocial risk factors as well as mental health issues experienced in construction^[9,19,121,123]. Consequently, this comprehensive understanding can substantially contribute towards selecting the relevant interventions for the workers, more so, because workers spend most of their time in the workplace environment. Therefore, it is necessary to assess the mental well-being of the workforce to better understand the impacts on their mental health and to subsequently reduce injuries, prevent disabilities, and increase productivity^[23].

To assess the well-being of the workforce, it is necessary to use a validated measure such as the World Health Organization-Five Well-Being Index (WHO-5). The WHO-5 is among the most widely used questionnaires assessing subjective psychological well-being since its first publication in 1998^[25,126]. Also, several stress-related studies have been conducted using the WHO-5 to measure distress or poor well-being^[26]. The rating scales used to assess well-being are designed to be disease anonymous (generic) because such scales provide information relating to the overall effect of a clinical intervention^[27,127]. Furthermore, a generic scale enables a comparison with mean values from the general population or with mean values from other clinical populations regardless of the disease entity or condition under examination^[26]. Therefore, the WHO-5 is a generic scale for the assessing of general well-being.

The current study assessed the common mental disorders, coping and subjective wellbeing of the construction workforce in South Africa using the WHO-5 scale. To date, no studies in SA have been conducted using the WHO-5 or other validated measures to assess the mental well-being of the construction workforce. Possessing knowledge and understanding about specific mental well-being challenges may assist in the recognition management and subsequently the prevention of mental health issues by promoting help-seeking behaviour among workers. It remains unclear what proportion of the general construction workforce in South Africa is facing challenges with mental well-being which could subsequently lead to detrimental mental health risk factors. Therefore, the absence of these knowledge makes it difficult for the industry to address mental health issues, develop interventions and for workers to seek the necessary help.

METHODOLOGY

In this cross-sectional study, data were collected from contractors in South Africa. The sample was conveniently selected based on proximity and familiarity to the researcher. This form of sampling maximised the response rate as the study was conducted over a short period. Some respondents were referrals recommended by other participants – a variant of snowballing sampling technique. A total of 201 questionnaires were suitable for analysis and a 56% response rate was achieved. The questionnaire included the demographics, common mental disorders, and WHO-5 Wellness Index Measure. The WHO-5 measure for general wellbeing was chosen due to its simplicity to interpret and understand and, because it is a validated measure used across all disciplines to measure the subjective wellbeing of the general population. This study employed a quantitative research approach and data were analysed using IBM Statistical Package for Social Sciences (SPSS) v28 for descriptive statistics and Exploratory Factor Analysis (EFA), and IBM Amos v18 for Structural Equation Modelling (SEM).

Furthermore, descriptive statistics was used to analyse data and further interpreted using the prescribed WHO-5 scoring system. The WHO-5 comprises of five items “I have felt cheerful and in good spirits.”, (2) “I have felt calm and relaxed.”, (3) “I have felt active and vigorous.”, (4) “I woke up feeling fresh and rested.”, (5) “My daily life has been filled with things that interest me.” The respondents were instructed to read “Please indicate for each of the five statements which is the closest to how you have been feeling over the last two weeks”. Composite reliability, Average Variance Explained and Cronbach's Alpha were conducted to determine reliability and validity of the constructs. Ethical clearance to conduct the study was approved by the General Human Research Ethics Committee (GHREC) (Ethical Clearance Number: UFS-HSD2021/2006/22) at the University of the Free State. Informed consent was granted from the respondents before conducting the study and all research protocols were followed according to the requirements of the GHREC.

DATA ANALYSIS

This section presents the analysis of the data collected and discusses the findings. Data were analysed using IBM Statistical Package for Social Sciences (SPSS) version 28. Tables were used to present data and key findings.

PROFILE OF THE RESPONDENTS

The respondents of the study were the construction workforce working for contractors comprising of artisans, construction professionals and construction labourers.

Table 1 Respondents Profile

Job Description		
	Frequency	Percent
Gender		
Male	164	81.6
Female	37	18.4
Age		
18 to 24	16	8.0
25 to 34	87	43.3
35 to 44	65	32.3
45 to 54	24	11.9
55 to 64	9	4.5
Education Level		
Primary/Elementary School	24	11.9
Secondary/High School	119	59.2
Technical/Vocational Qualification	19	9.5
University Degree	35	17.4
No formal schooling	4	2.0
Architect	4	2.0
Construction Manager	7	3.5
Health and Safety Manager/Officer	10	5.0
Project Manager	5	2.5
Quantity Surveyor	11	5.5
Civil Engineer	6	3.0
Forman/Supervisor	15	7.5
Artisan	15	7.5
Construction Worker/Labourer	124	61.7
Other (site clerk and storage managers)	4	2.0
Architect	4	2.0
Total	201	100.0

There were more male respondents (81.6%) than female respondents (18.4%) in the sample. This finding differs from the general gender distribution of the construction workforce in South Africa which usually has approximately 12% female workers (MBAWC, 2018). Most respondents were between the ages of 25 to 34 years (43.3%). And the second most prevalent age group was between 35 to 44 years (32.3%) of age followed by 45 to 54 years (11.9%), 18 to 24 years (8.0%) and lastly 55 to 64 years (4.5%). The construction workforce consists of older workers relative to other sectors as a result of the ageing workforce and lack of interest from the youth to seek employment in the sector. The average age of construction workers is 42.5 (BLS, 2019). However, from Table 1, most respondents were between the ages 25 and 34 years. This can be attributed to recent changes because of Covid-19 as [28] employment trends resulted in the youth experiencing the highest employment between February 2020 and March 2021 (32.5% to 35%), while older workers experienced a decrease from 45% to 41%. Therefore, the findings represent the current employment-to-population ratios in the industry. The responses were obtained from site personnel working for contractors, and are representative of the construction workforce. Construction workers (labourers) and artisans make up about 55% to 70% of its workforce, while construction professional between 30% to 45%. When categorising the working groups into CPPs, and artisans/labourers, the percentage distribution is 29%:71%. Therefore, the sample represents the population of interest adequately.

EXPLORATORY FACTOR ANALYSIS

Exploratory factor analysis (EFA) was used to determine construct validity and the number of factors necessary to explain the interrelationships among a set of variables measuring Common Mental Disorders (CMDs). The measuring instrument for data collection used to measure CMDs among the construction workforce was developed by the researcher from the literature. Therefore, in order to adequately measure CMDs, it was necessary to conduct EFA to identify the dimensions which may or may not measure the factors of concern.

Data Inspection for CMDs

The KMO was 0.804 for CMDs shown in Table 2 and the Bartlett's Test of sphericity was also significant. Based on the results in Table 3.1, the sample meets the size and variance requirements for conducting EFA based on the recommended thresholds for KMO (above 0.60) and Bartlett's Test for Sphericity ($p < 0.05$)^{[29],[30],[31]}.

Table 2 KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0,804
Bartlett's Test of Sphericity	Approx. Chi-Square	421,066
	df	15
	Sig.	0,000

Factor Extraction

Principal Component Analysis (PCA) was the preferred factor extraction method because the research instrument of this study was designed by the author. PCA is data driven and provides an empirical summary of the data. In this study, no underlying theory about the factor structure was available precluding factor analysis (FA). Therefore, no prior assessment of the factor structure of the primary data existed.

Results presented in Table 3 show one factor with eigenvalue of 3.212, which accounted for 53.541% of the variance. Only one solution was extracted and there was no need for factor rotation. The solution was therefore, considered unidimensional and adequate evidence of convergent and discriminant validity was provided for the CMDs construct.

Table 3 Total Variance Explained

Component	Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %
1	3,212	53,541	53,541

Extraction Method: Principal Component Analysis

Table 4 shows that the correlation values for the 6 components for CMDs were above the recommended cut-off value of 0.30 and < 0.90^[32].

Table 4 Component Matrix

	Component 1
Depression	0,801
Stress	0,779
Anxiety	0,757
PTSD	0,731
Burnout	0,669
Suicidality	0,640
Extraction Method: Principal Component Analysis.	
a. 1 components extracted.	

WHO-5 WELLNESS INDEX

The WHO-5 was used to measure the subjective wellbeing of the individuals. It is a validated wellbeing measure and there was no need to conduct EFA. However, CFA and validity and reliability for the instrument were conducted along with other constructs of the study. In the Table 5, descriptive statistics are reported to determine the overall score. WHO-5 measures wellbeing by calculating the raw score which is calculated by totalling the numerical values of the five answers - in this case the five means - where the raw scores range from 0 to 25, 0 representing the worst possible and 25 representing the optimum quality of life. The raw score is multiplied by 4 to obtain a percentage score ranging from 0 to 100 whereby, 0 represents the worst possible, whereas a score of 100 represents the optimum quality of life.

Table 5 WHO-5 Wellness Index Measure

	N	Mean	Std. Deviation
WHO1	201	4,04	1,296
WHO5	201	3,95	1,379
WHO4	201	3,87	1,412
WHO2	201	3,85	1,244
WHO3	201	3,77	1,341

For the result in Table 5, the total was determined by adding 4.04 + 3.95 + 3.87 + 3.85 + 3.77 which equated to 19.48. Furthermore, 19.48 x 4 = 77.92. Therefore, the WHO-5 score = 77.92. The score is above the cutoff score which is determined as ≤50. Scores < 50 are indicative of poor wellbeing. Therefore, it may be inferred that the workers had an overall good wellbeing but not optimum wellbeing. This score suggests that much more needs to be done to improve the overall quality of life and wellbeing of construction workers in the sample.

CONFIRMATORY FACTOR ANALYSIS (CFA)

AMOS v18 was used to perform CFA. The model was assessed for reliability and validity, namely convergent validity, and discriminant validity. Contrary to CFA, EFA is based on reasoning which is a posteriori in that it is data driven while CFA is based on reasoning which is a priori in that it is based on theoretical considerations. Therefore, assessing reliability and validity is a further check on how well the measurement items fit the theory a priori. The reliability and validity statistics are based on the factor loadings from the CFA and are shown in Table 6.

Table 6 Reliability and Validity

	Constructs	Item Correlation	Factor Loading	CR	AVE	Alpha
Common Mental Disorders (CMDs)						
1	Depression	0,683	0,756	0,782	0,446	0,825
2	Stress	0,528	0,628			
3	Anxiety	0,653	0,735			
4	PTSD	0,588	0,644			
5	Burnout	0,621	0,677			
6	Suicidality	0,488	0,546			
Maladaptive Coping						
1	CopingMLC1/MLDP	0,532	0,724	0,543	0,462	0,710
2	CopingMLC2/MLDP	0,559	0,69			
3	CopingMLC3/MLDP	0,525	0,622			
Adaptive Coping						
1	CopingAC1	0,568	0,622	0,765	0,426	0,807
2	CopingAC2	0,630	0,728			
3	CopingAC3	0,611	0,728			
4	CopingAC4	0,689	0,761			
5	CopingAC5	0,465	0,539			
6	CopingAC6	0,448	0,491			
WHO Wellness Index						
1	WHO1	0,683	0,804	0,805	0,747	0,863
2	WHO2	0,737	0,81			
3	WHO3	0,686	0,666			
4	WHO4	0,709	0,761			
5	WHO5	0,597	0,813			

The result of CFA shows that the model had good fit statistics including $\chi^2/df=1.653$, $GFI=0.892$, $RMSEA=0.057$, $NFI=0.850$, $RFI=0.811$, $IFI=0.935$, $TLI=0.916$, $CFI=0.933$ and $CN= p<0.000$. The recommended values that are provided in the bracket are based on the guidelines of ^{[33], [34]} ($RMSEA<.08$, $GFI>.90$, $CFI/RFI/IFI/NFI/TLI>.90$, $CN = p<0.05$). The standardised factor loading of all items were > 0.40 which is the minimum recommended for a sample size of 200^[35]. The recommended threshold values for the parameters are $AVE \geq 0.5$. However, $AVE = 0.40$ can be accepted if the $CR > 0.60$ for the construct^[36]. The recommended threshold for CR between 0.60 and 0.70 is appropriate^[36]. Although 0.60 is sometimes used as a lower cut-off value, 0.50 is considered acceptable^[35]. The Cronbach alpha and composite reliability for all variables are > 0.70 so it shows that the variables had good reliability.

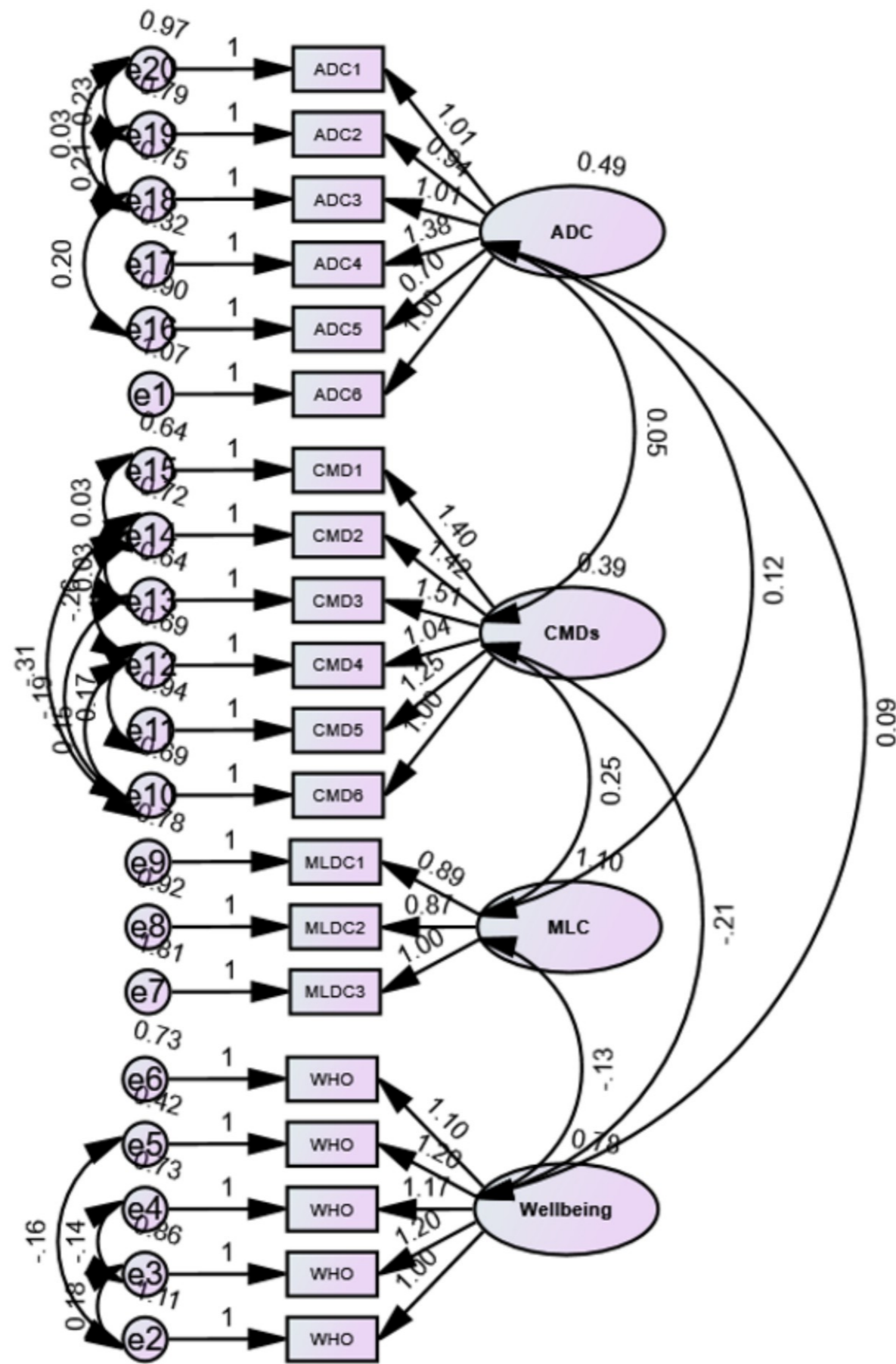


Figure 1 CFA Final Model

TESTING THE RELATIONSHIPS OF THE STRUCTURAL MODEL

To examine the relationship between common mental disorders, coping (maladaptive coping (MLC) and adaptive coping (ADC)), and subjective wellbeing of the workers, structural equation modelling was used to test the relationships between the constructs indicated in Figure 3.2.

Proposed Hypothesis	Regression Estimate	P Level	Remarks	
H1 MLC<---CMDs	Positive Significant	.640	***	Supported
H2 ADC<---CMDs	Significant	.124	.189	Rejected
H3 Wellbeing<---CMDs	Negative Significant	-.571	***	Supported
H4 Wellbeing<---ADC	Positive Significant	.235	.022	Supported
H5 Wellbeing<---MLC	Negative Significant	-.009	.912	Rejected

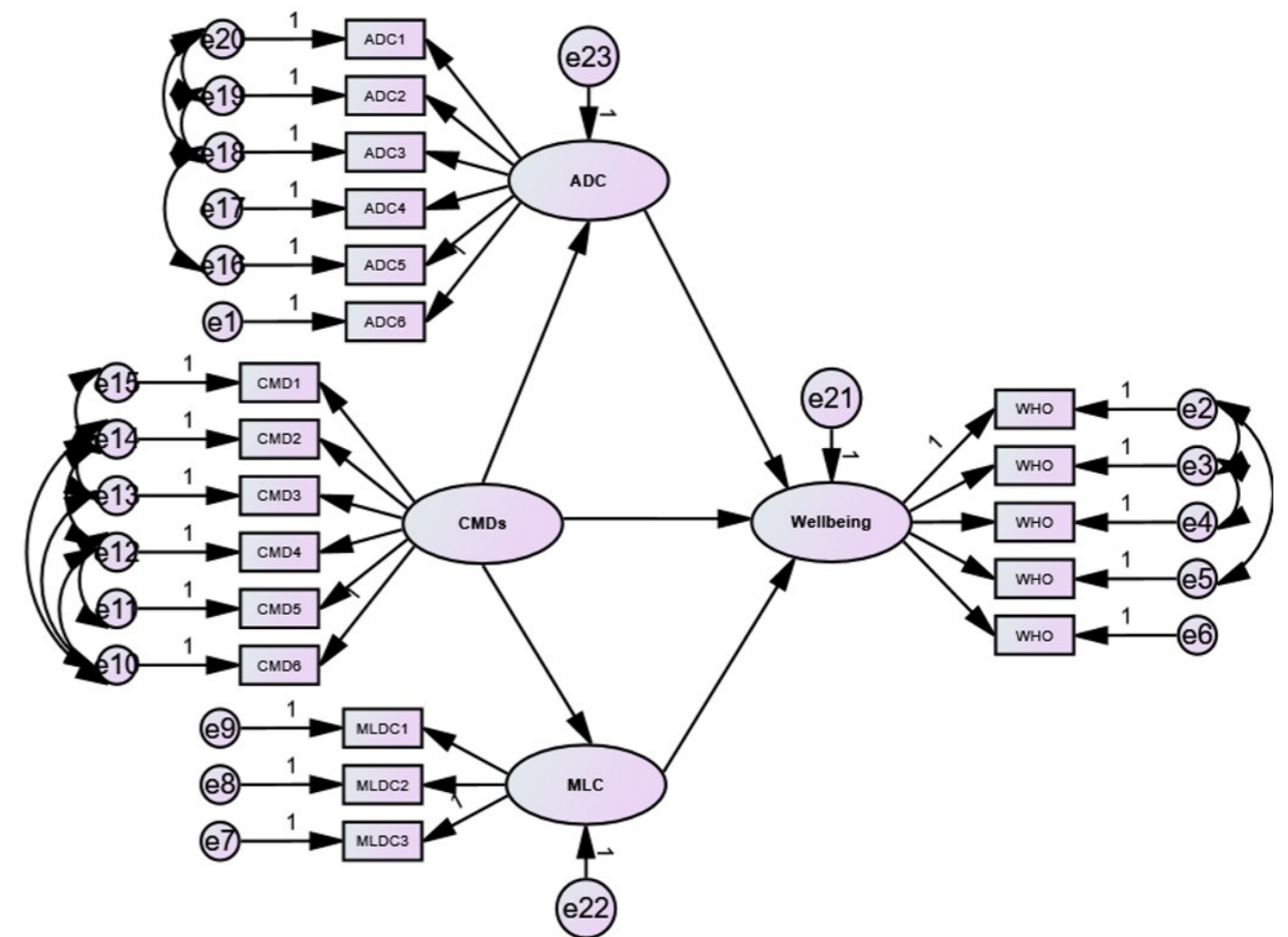


Figure 3.2 Structural Model

The hypothesised relationships based on path analysis show that common mental disorders are positively and significantly associated with maladaptive coping ($\beta=0.640$, $P=***$). Common mental disorders are not significantly associated with adaptive coping ($\beta=0.124$, $p=0.189$). Common mental disorders are negatively and significantly associated with wellbeing ($\beta=-0.571$, $p=***$). Adaptive coping is positively and significantly associated with wellbeing ($\beta=0.235$, $p=0.022$). Maladaptive coping has a non-significant relationship with wellbeing ($\beta=-0.009$, $p=0.912$).

DISCUSSION OF FINDINGS

Using the psychometric properties of the WHO-5 Wellness Index Measure, the general wellbeing score for the workforce was acceptable but not optimal at 77.92. Furthermore, there are currently no studies conducted using the WHO-5 measure in SA on the general population. Therefore, this study provides insight into the wellbeing of the workforce. In relation to the hypothesised relationships, the study revealed the following:

COMMON MENTAL DISORDERS AND MALADAPTIVE COPING

There is a positive significant relationship between common mental disorders such as stress, depression, anxiety, PTSD, burnout, and suicidality which lead to maladaptive coping strategies such as consumption of alcohol, cannabis smoking and cigarette smoking. These findings are aligned with most studies reported in the literature. Several studies have reported the use of alcohol, drugs and substance abuse as coping strategies linked to anxiety, high job incidents, mental ill-health, physical illness, and suicidality^{[15],[16],[17]}. In the South African construction industry,^[17] alcohol consumption among CPPs is widespread, with more than a third of respondents consuming 3 - 9 units/week and one in six respondents reporting smoking up to 40 cigarettes/day. Apart from alcohol consumption and cigarette smoking, construction workers resort to the use of psychotropic drugs that act as psycho-stimulants such as cannabis and South Africa is no exception^[38].

COMMON MENTAL DISORDERS AND ADAPTIVE COPING

There was no relationship between CMDs and adaptive coping. This is surprising as several stress and occupational stress theories have been postulated to explain the effects of occupational stress as an antecedent to mental ill-health. The most notable theories in relation to individual coping stem from the field of psychology such as the psychological theory of stress^[39], systematic theory of stress^[40] and the resources theories^[41]. Selye^[42] proposed the resistance stage while Lazarus and Folkman^[39] proposed coping as an alternative appraisal stage for individuals seeking homeostasis. Resources theories are holistic and mainly attributed to the temperament of an individual dealing with situations. Construction work is stressful, and workers seek ways to combat this stress. Adaptive coping strategies such as spending time with family, pursuing hobbies, and talking to someone were found to buffer the effects of occupational stress among the construction workforce in South Africa. However, this was not the case in this study based on the non-significant hypothesised relationship between CMDs and adaptive coping. This finding may be attributed to the lack of active coping strategies reported in the study. Social support was the main coping strategy and, in some instances, does not buffer the effects of occupational stress which leads to CMDs in construction^[48].

COMMON MENTAL DISORDERS AND WELLBEING

It is not surprising that CMDs have a negative significant relationship with wellbeing. As occupational stress increases, wellbeing decreases. Occupational stress theories such as the Job-Demand Control/Support and Effort Reward Imbalance theory^{[43],[44]} explain ways in which stressors/demands at work lead to physiological, behavioural or psychological manifestations of stress (strain), and subsequently result in poor wellbeing. Therefore, the findings align with the theoretical backgrounds for occupational stress as an antecedent to poor mental health.

ADAPTIVE COPING AND WELLBEING

Based on the psychological theory of stress, the systematic theory of stress, both coping and the desire of an individual to return to homeostasis after encountering a stressful situation contribute to an individuals' wellbeing. This claim is supported by the positive significant relationship between adaptive coping and wellbeing of the construction workforce. The Job Demand Control Support theory (JDC/S)^[43] further posits that social support is necessary for coping with stress and to minimising the negative impact of stress and improving workers' wellbeing. Therefore, adaptive coping is beneficial for workers in construction to achieve overall wellbeing. Although adaptive coping and wellbeing are positively significant, it is surprising that adaptive coping did not buffer the effects of CMDs among the study population and requires further investigation.

MALADAPTIVE COPING AND WELLBEING

Other studies have reported instances of temporary wellbeing with maladaptive coping. Therefore, the hypothesised relationship that there is a non-significant relationship between maladaptive coping and subjective wellbeing may be attributed to several factors. However, long term effects of maladaptive coping affect wellbeing. Individuals reporting subjective wellbeing may report feeling good because of maladaptive coping strategies which have been used to temporarily alleviate effects of workplace stressors. Coping - both adaptive and maladaptive - pertains to the alleviation of stress response and some workers have reported smoking cannabis as beneficial. However, the associations of many other with subjective wellbeing and coping remain unexplored. Where reported, there are not significant findings and only correlations^{[45],[46],[47]}.

CONCLUSION AND RECOMMENDATIONS

The current study assessed common mental disorders, coping and wellbeing of the construction workforce in South Africa. It is noteworthy to acknowledge the limitations of the current study. The sampling type used in the study faces challenges associated with self-report questionnaires such as response bias, social desirability, introspective ability, understanding and limitations with rating scales. A mixed method study could be used to gain in-depth understanding of the challenges faced by workers. Further, the use of other scales such as the Patient Health Questionnaire-9 (PHQ-9) paired with the WHO-5 may reveal symptoms of depression among the population. The current study assessed common mental disorders, coping and subjective wellbeing of the construction workforce in South Africa.

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Table 1 Components of expenditure

Component	Expenditure
Cleaning works	40,9
Mechanical Services	37,7
Building Works	13,6
Civil Works	7,8
Total	100,0
Source ¹	

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