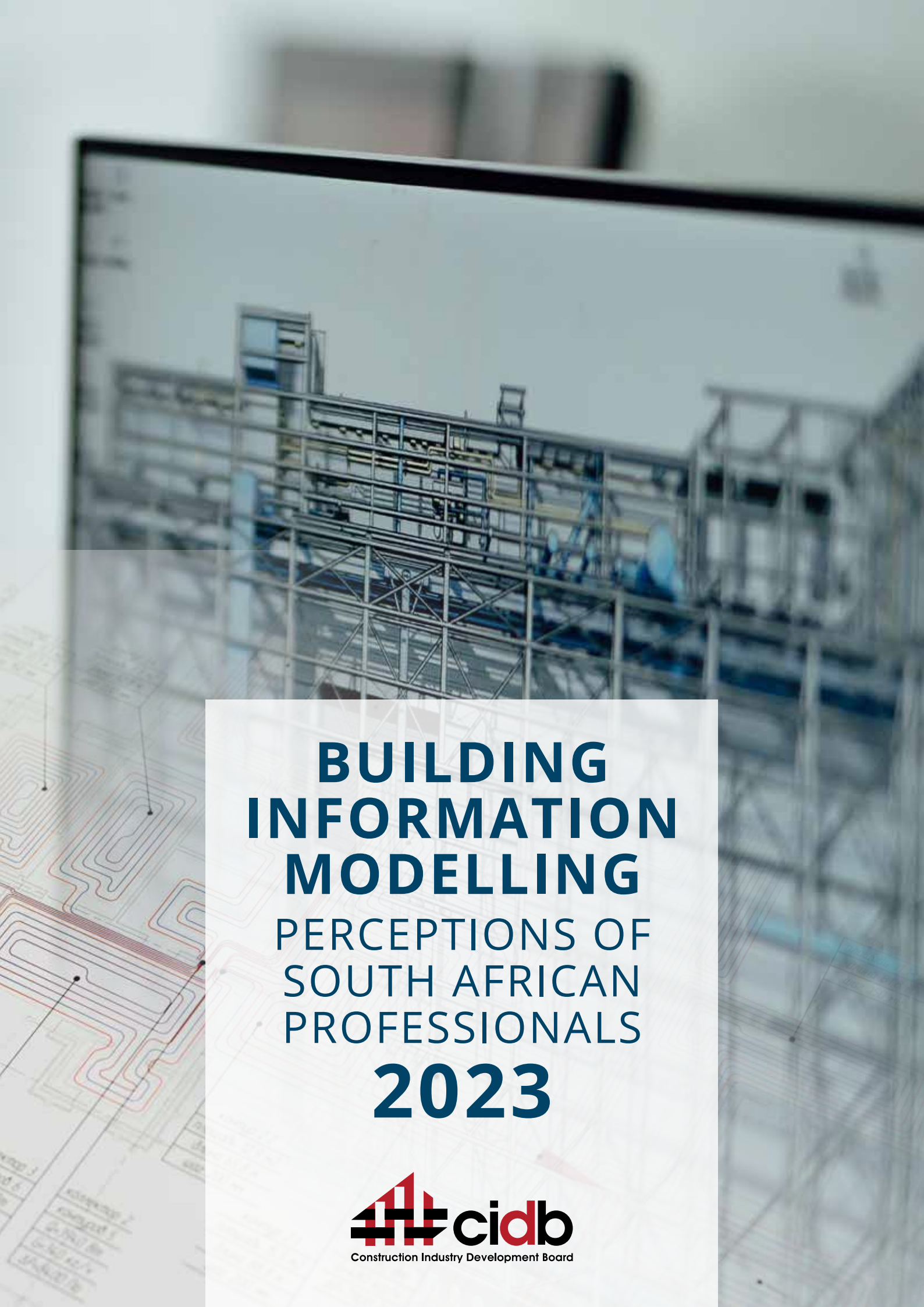


BUILDING INFORMATION MODELLING

PERCEPTIONS OF SOUTH AFRICAN PROFESSIONALS

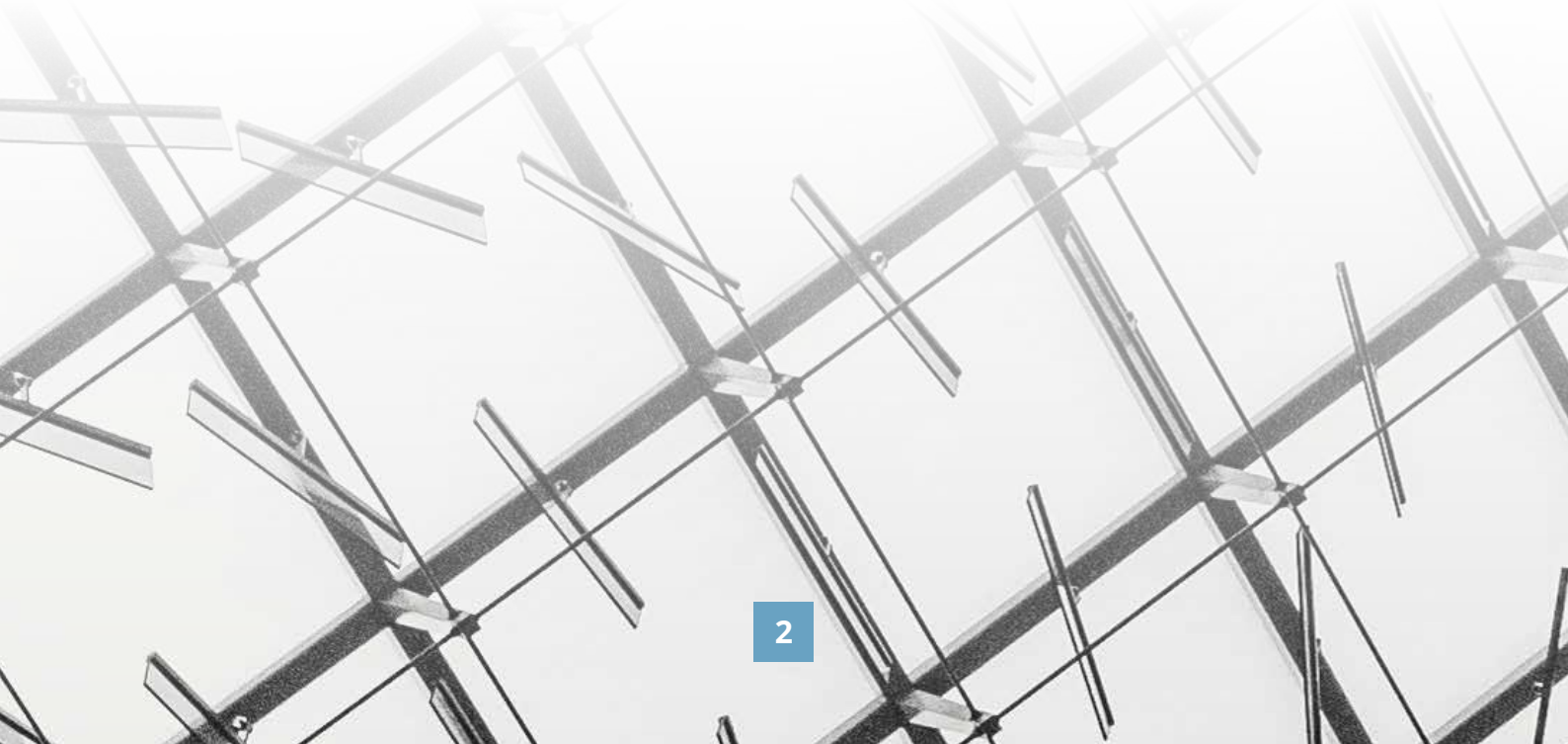
2023

cidb

Construction Industry Development Board

Figures

Tables



Introduction

The construction industry is vital to the economy of any country. It supplies the physical infrastructure that drives the economy and connects geographic locations and peoples' workplaces and homes. It is also a significant employer of unskilled and semi-skilled labour.

Despite its importance, the construction industry faces challenges of productivity, efficiency and slow adoption of technology. Building information modelling (BIM) is a transformative technology and benchmark for effectiveness that has been implemented in other economies to manage such challenges.

BIM creates and manages the lifecycle information of a construction project. Key outputs are the building information model and the digital description of every aspect of the built asset. BIM is also a platform for collaboration among project stakeholders and a vehicle for information sharing and management throughout a project's lifecycle.

Study objectives

This study forms part of a larger project to drive BIM infusion into the South African construction industry. Its main aims were to identify the knowledge and perceptions of local industry professionals to BIM and to ascertain how many currently use BIM, what software they use and their BIM experience.

Methodology

The study gathered data using a cross-sectional quantitative method, which was found to be the most appropriate for investigating the BIM perception of built environment professionals in the South Africa's construction industry.

Quantitative data was collected using a convenience sampling approach and structured survey, created in Google Forms, from a sample size of 269 built environment professionals registered with professional bodies under the Council of the Built Environment (CBE). The survey was distributed to all professionals on the register of the South African Council for the Project and Construction Management Professions, the South African Council for the Quantity Surveying Profession, Association of Architects, Engineering Council of South Africa and Consulting Engineers South Africa (CESA). The survey responses were captured and analysed using Excel, and then presented in charts and graphs.

The survey comprised questions pertaining to respondents' academic and professional backgrounds, industry experience and use of various components of BIM, their understanding of BIM and their perceptions of the benefits of and barriers to BIM adoption in the South African construction industry.

FINDINGS

Characteristics of respondents

Educational qualifications and backgrounds

Professionals are the first line of implementation of BIM during the project design phase. BIM implementation requires higher education levels as the practitioner must interpret complex construction drawings. It was, therefore, considered important for this study to assess the qualifications and experience of respondents to establish their credentials to comment on BIM implementation.

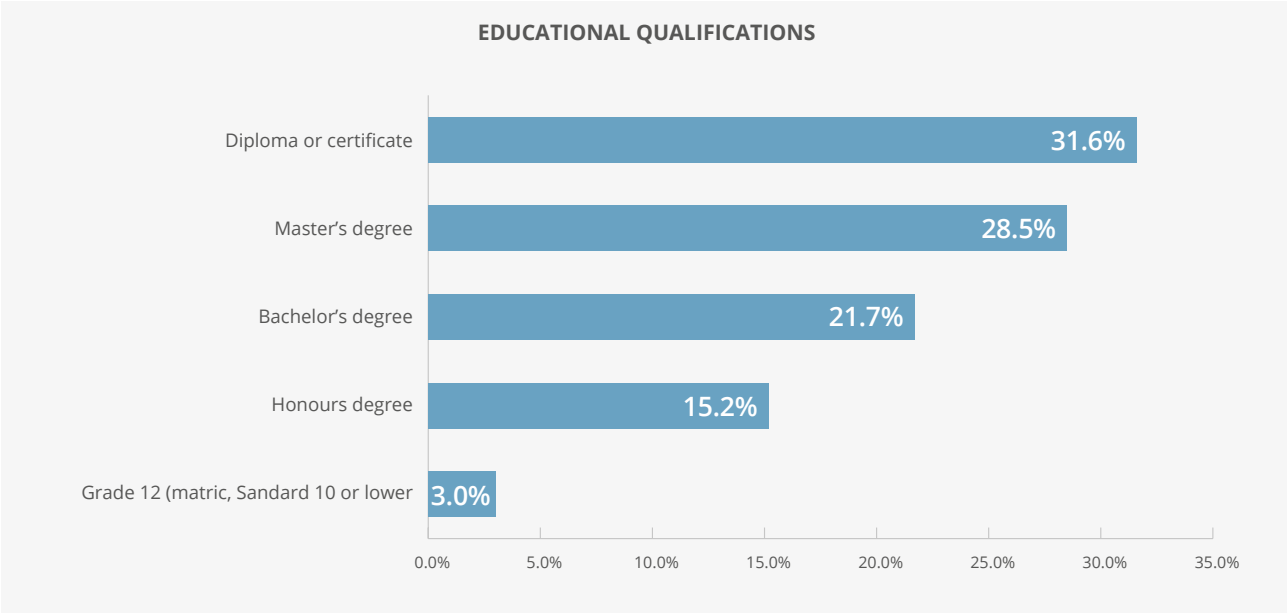


Figure 1: Educational qualifications

Figure 1 shows that most respondents have a post-school qualification diploma or certificate (31.6%), master's degree (28.5%) bachelor's degree (21.7%) or honours degree (15.2%). These findings are consistent with requirements for registration as a professional with the councils of the CBE. It is assumed that respondents with qualifications lower than a matric (3%) may be operating as draughtsmen who registered using the recognition of prior learning provision of the South African Qualifications Authority.

Professional designations

Different countries have shown various BIM diffusion routes, with architects leading with designs. Figure 2 shows that most survey respondents are architects (46%), followed by construction managers and construction project managers (18%), and health and safety practitioners (14%). Civil engineers and BIM practitioners comprise the other major respondents at 10% and 6% respectively. Other participants are quantity surveyors, architectural technologists, draughtsmen, and electrical and mechanical engineers (6%).

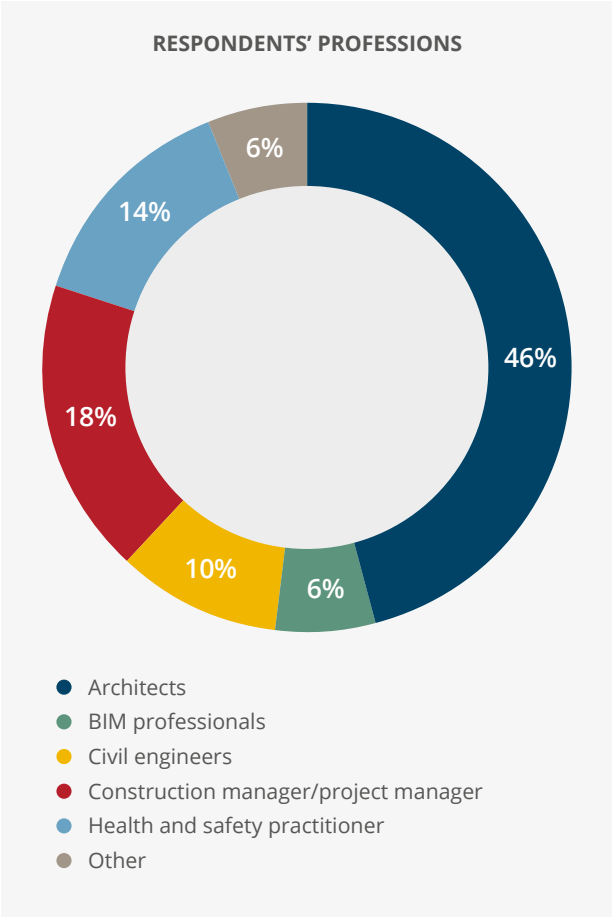


Figure 2: Professions

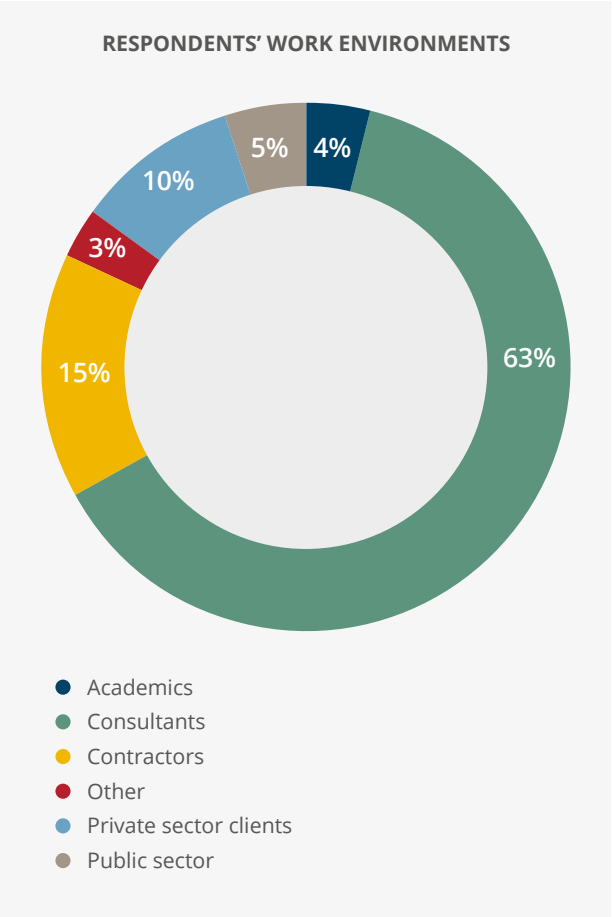


Figure 3: Work environments

The findings reflect the South African construction industry, in which BIM is championed mainly by architects. Notable is the emerging professional designations of BIM professionals, BIM operators and 3D designers reported by the respondents. This shows changing trends as the industry adopts technological innovation.

Work environments

To assess suitability to offer opinions on industry developments, respondents were asked about their work experience. Figure 3 shows that 63% are in professional consulting, 15% are contractors, 10% are private clients, 5% represent public sector client departments public and 4% are academics. The remainder of the study population comprises developers and those employed in multiple sectors (3%).

Notably, 15% of the respondents are self-reported contractors who are registered built environment professionals compared to the many non-built environment professionals listed on the cidb's Register of Contractors. Although a small percentage of the population (5%), the presence of academics among the respondents is noteworthy as registration with professional councils is a prerequisite for teaching in the built environment professional disciplines.

Areas of operation

Learning and innovation are sometimes driven by exposure to other operational climates. Certain large consulting firms in South Africa have both regional and global presences, which may affect their exposure to technological advances in their fields. To assess this, the respondents were asked to share their geographic footprints.

Many respondents work in Gauteng (28%), followed by Western Cape (16%), KwaZulu-Natal (7%) and Eastern Cape (6%). This is consistent with the distribution of the construction economy and the level of activity in the country and indicates that many clients are beginning to use BIM on projects. Forty-five of the 269 professionals work across provinces work in more than one province. In keeping with the local construction economy, the highest cross-provincial-border operations are for Gauteng and Western Cape professionals, with 39 of the 269 operating in both provinces.

South African professionals are also active in the Southern African Development Community (SADC) and international markets. Fourteen respondents reported being active in SADC countries and 15 in both SADC and international markets. This indicates the globalisation of the construction market and the need to keep up with trends and increase the competitiveness of South Africa professionals.

Organisation sizes

Cost is sometimes seen as a barrier to investment. BIM uptake requires significant investment in hardware, software and training which is unfortunately not always feasible, particularly in a shrinking construction market. Company size has been shown to be a factor in BIM adoption locally.

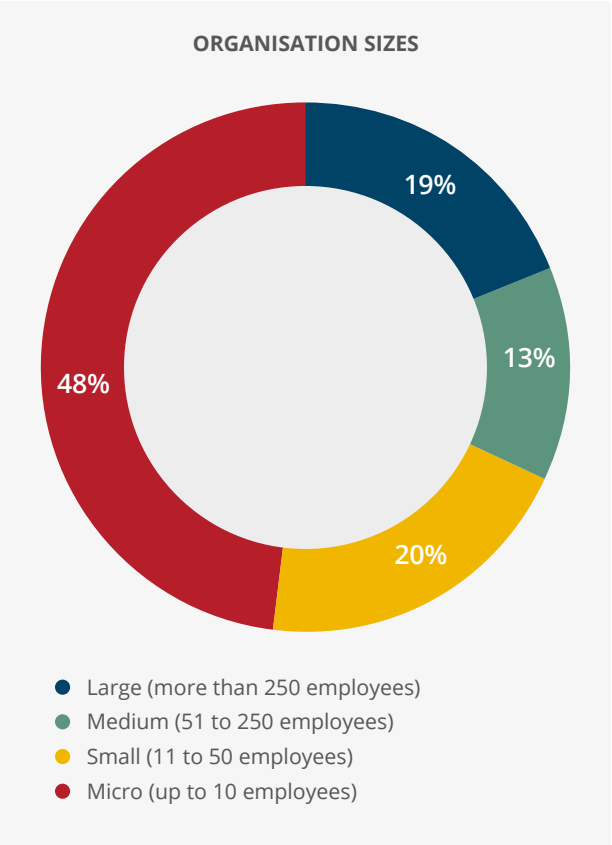


Figure 4: Organisation sizes

Figure 4 shows that most professionals in the survey are employed in microenterprises of up to 10 employees (48%). There is an almost even distribution of small companies (between 11 and 50) and large companies with more than 250 employees, 20% and 19% respectively. Only 13% of the respondents are employed in medium-sized companies (between 51 and 250). The predominance of microenterprises is consistent with CESA and CBE statistics, which show that the professional consulting industry is dominated by small, developing, historically black-owned companies. This reinforces the need to capacitate enterprises and enable them to adopt technology platforms to improve their competitiveness.

BIM

BIM has been used globally for some time, with South Africa a late adopter. The following section reports on respondents' experience of BIM use on projects, number of times the professional has used BIM and overall experience of the concept.

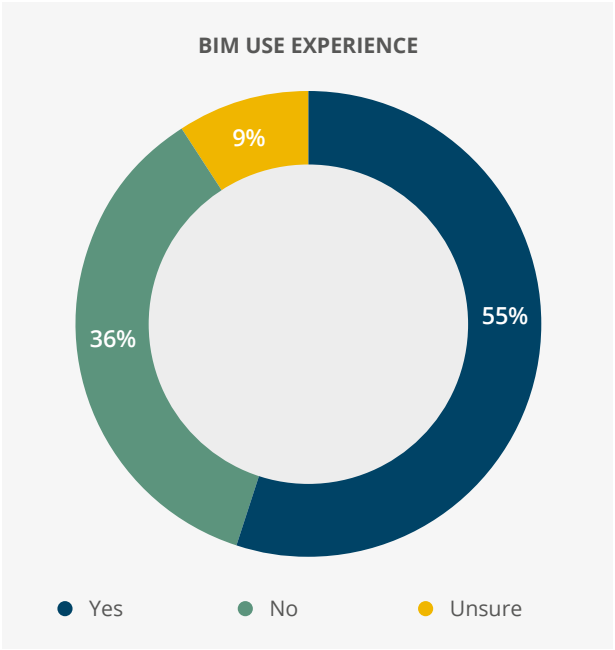


Figure 5: BIM use experience

Use on projects

Figure 5 shows that 55% of respondents had used BIM on their projects, with 36% reporting that they had not and 9% unsure. Respondents were then asked about the number of projects on which they had used BIM.

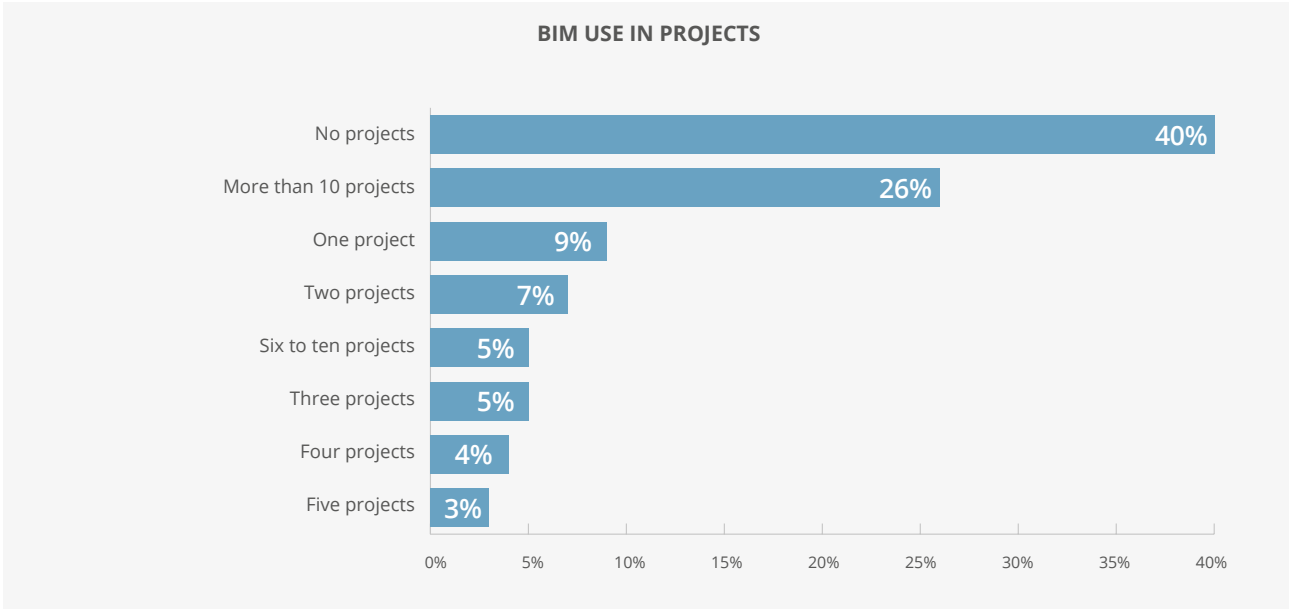


Figure 6: BIM on projects

Experience using BIM on projects

Figure 6 shows that professionals who have used BIM on projects may be considered competent in its use, as 31% have used it on more than six projects (5% on six to nine projects and 26% on 10 or more). A quarter of respondents are relatively new to BIM, having used it on fewer than five projects. Although this reflects BIM filtration in South Africa, more effort is needed to popularise the concept and bring more professionals onto technology platforms.

Use in organisations

For BIM to grow significantly in the country, professional organisations must start adopting it as an operating model to improve efficiency in project delivery and increase return on investment.

Respondents were asked about their organisations' BIM use and reported return on investment. Figure 7 shows that nearly half of the study population (48%) had already adopted BIM in their organisations and 38% had experienced positive returns as a result (Figure 8). The BIM return-on-investment percentage is estimated at between 1% and 15%, with most companies achieving 11% to 15%. Thus, BIM is associated with increased organisational profitability.

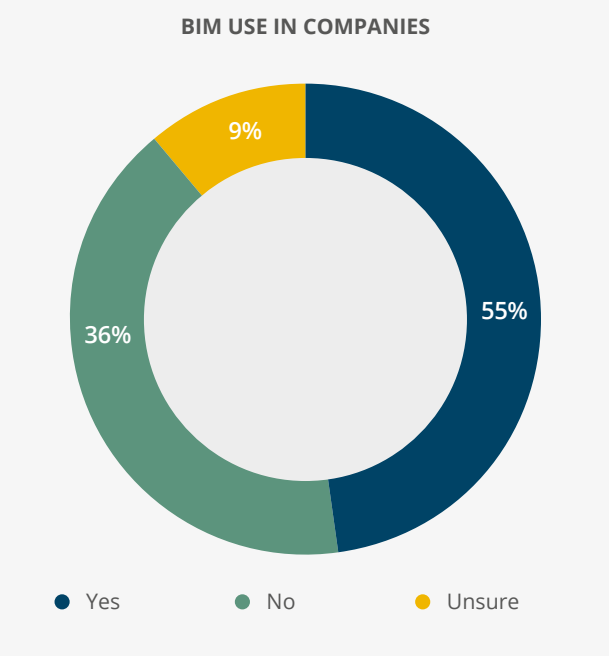


Figure 7: Level of BIM adoption

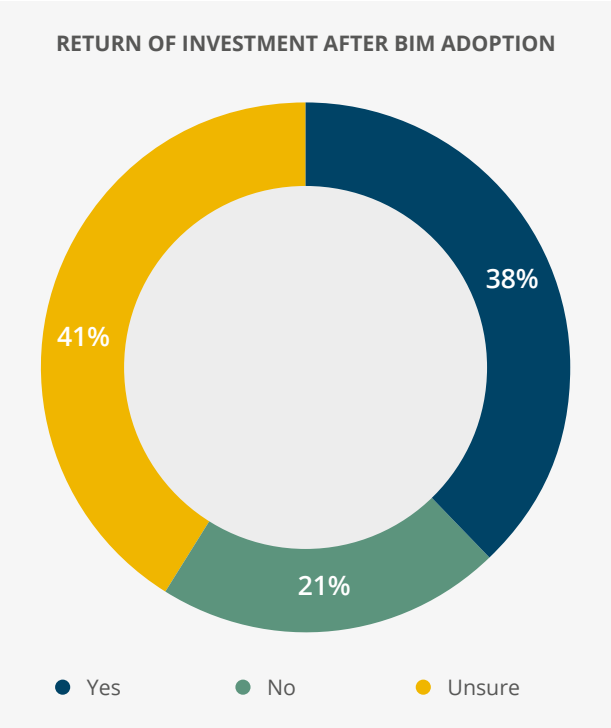


Figure 8: Return on investment after BIM adoption

BIM operation level in South Africa

BIM implementation takes place at different levels, from entry level one with zero use of technology and limited collaboration among project participants, through levels two and three for presentation of designs, to levels four to six, where collaboration among partners increases and more information is embedded in the business information model.

Survey participants were mostly at levels two and three, using technology for design and design sharing (64%). Fifteen percent were at levels four to six, using more advanced modelling tools.

Thirteen percent had adopted BIM at the insistence of clients, while 15% explained that it was part of their internationalisation. Six percent stated the motivation as other project stakeholders' insistence on using BIM, while 5% and 6% respectively cited collaborations based on company size or on project size and complexity.

Most common software used in South Africa

Globally, many software packages are used for BIM, with Autodesk Revit and AutoCAD the most widely used. In South Africa, Autodesk Revit is the most utilised by 42%, while AutoCAD is used by 31% of the study respondents. Other software used includes Google SketchUp (8%), Graphisoft ArchiCAD (11%) and Navisworks, Bentley Building Suite and others (8%).

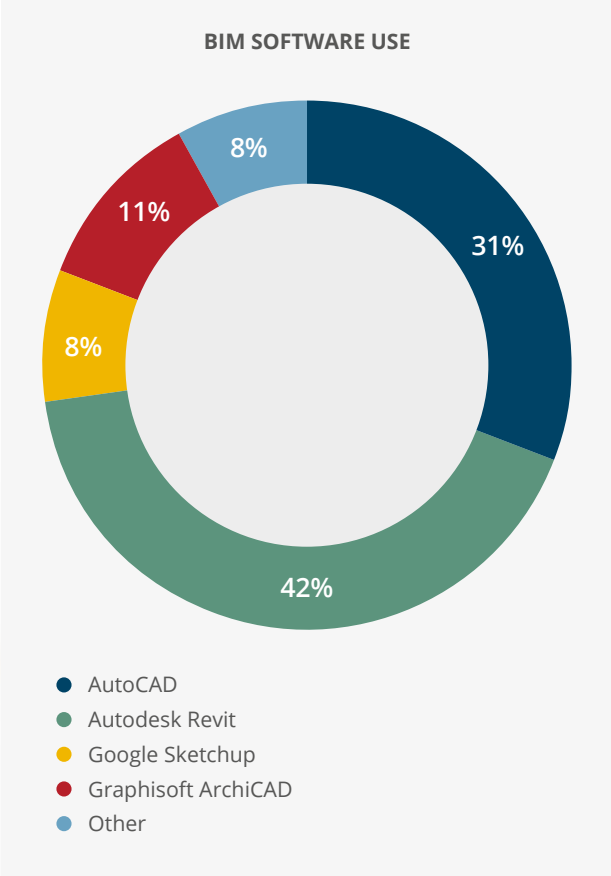
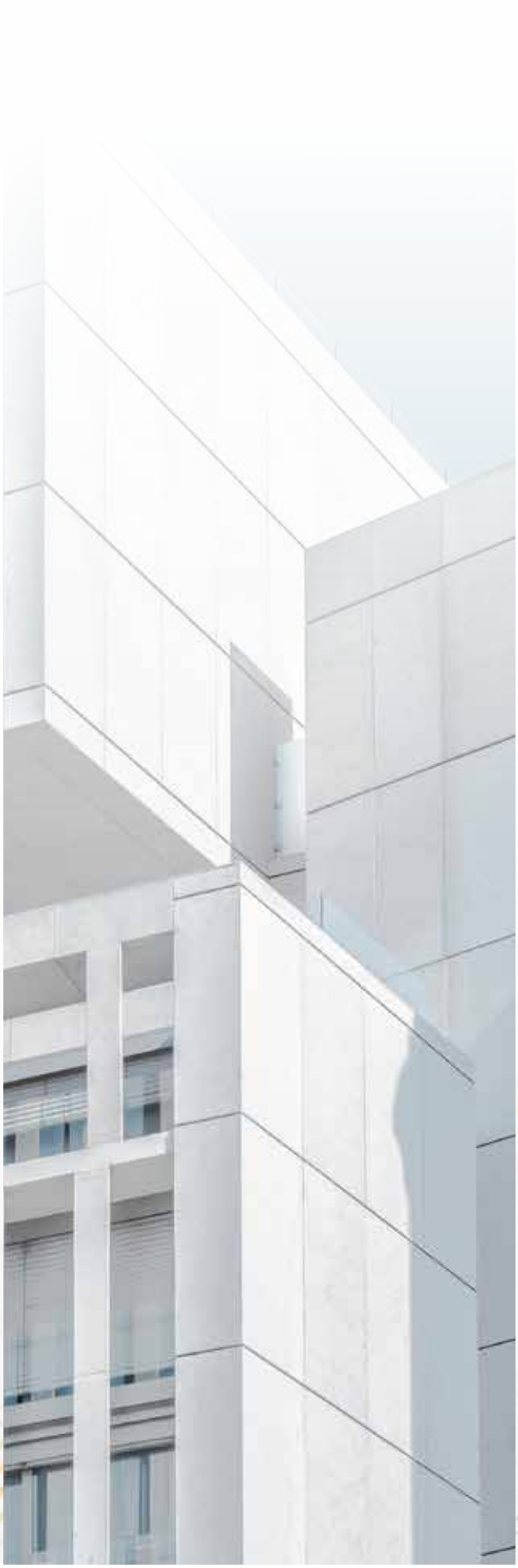


Figure 9: Most-used BIM software



BIM ADOPTION PROJECTIONS

Stakeholders yet to adopt BIM were asked about their readiness. Figure 10 shows that 12.2% plan to adopt BIM within months, 8.5% in the next year and 10.7% within two years. Some 6.7% reported that they plan to introduce it only in the next decade. These may be the same respondents who reported they would adopt BIM in their practices only if it were legislated or demanded by clients.

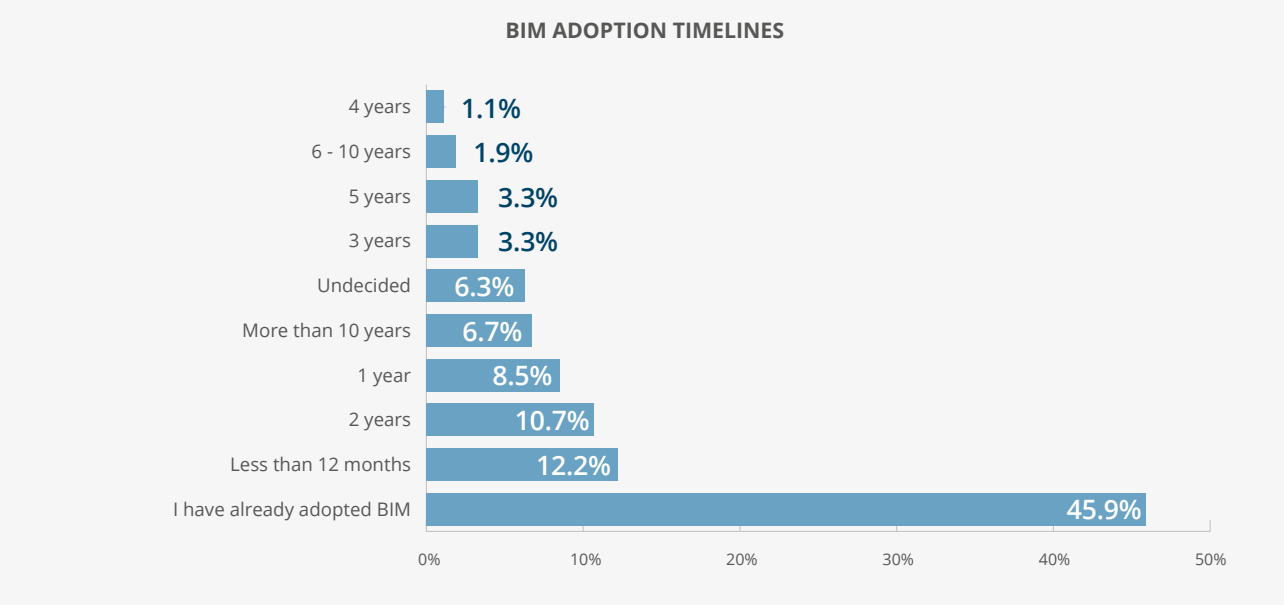


Figure 10: Projected BIM adoption timelines

Proposed BIM champions in South Africa

For new technologies to thrive, they must either be championed by credible players who can show their benefits or be legislated, giving participants no choice. Respondents were asked to name their preferred champion for BIM adoption in South Africa (Figure 11).

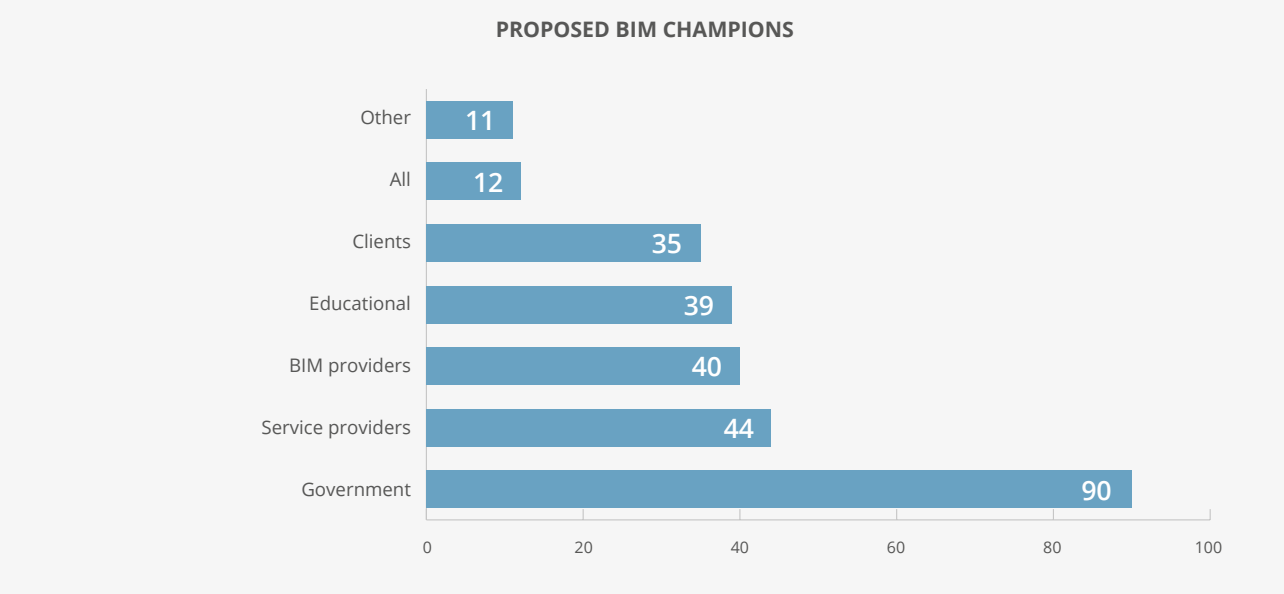


Figure 11: Proposed BIM champions in South Africa

Many respondents believed that the government sector, namely Department of Public Works and Infrastructure, CBE and the cidb must champion BIM adoption. Other potential champions suggested were service providers, namely consultants and contractors, followed by BIM providers — both software vendors and organised BIM communities — and clients. Very few participants said BIM adoption was the responsibility of all construction role players, while others wondered why BIM must be championed at all.

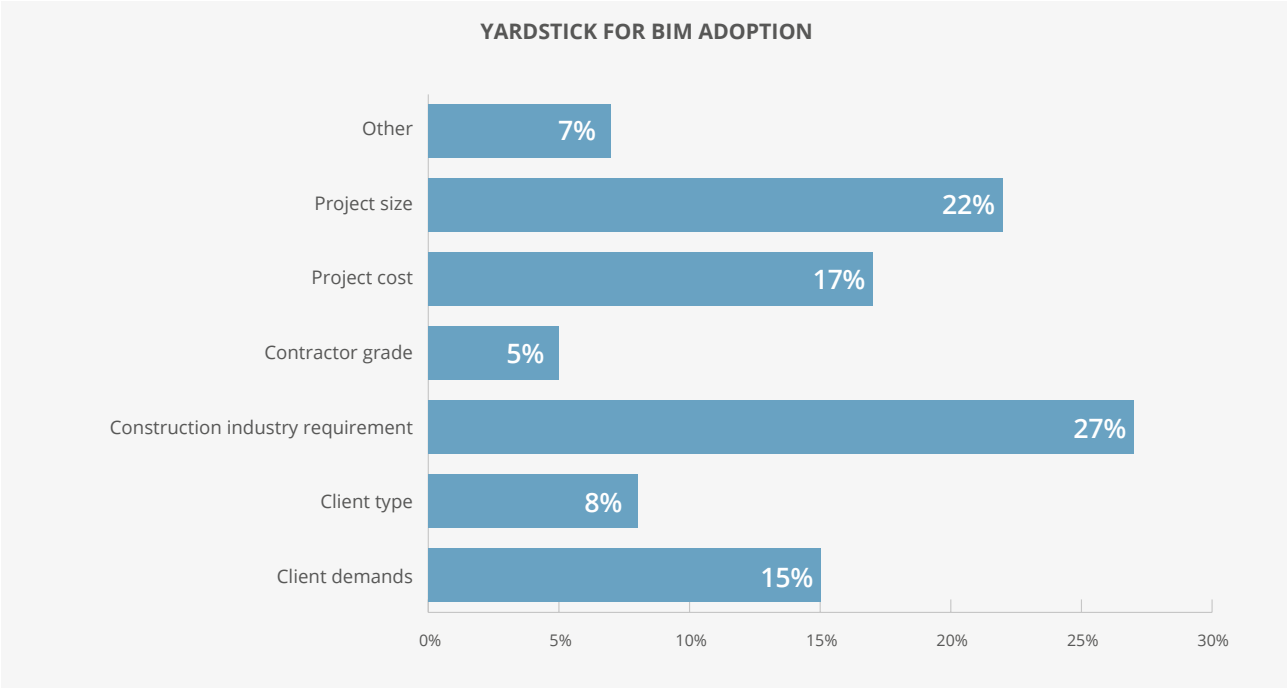


Figure 12: Yardstick for BIM adoption

BIM adoption yardstick

Those surveyed were given a list of conditions and asked what they considered a good yardstick for BIM adoption on projects. As seen in Figure 12, 27% opted for industry requirements and 22% for project size. Also important were project cost and client demand (17% and 15% respectively). Very few regarded as primary yardsticks the recommended literature criteria such as project complexity, need for collaboration, productivity and cost effectiveness — these were raised by only 7% of those polled.

These findings show that consultants appreciate the value of BIM to information management and, therefore, rate project cost and size very important determinants for BIM adoption. Also noteworthy is that construction industry guidelines are rated very highly, indicating that the industry is compliance-driven and participants will always strive to comply, irrespective of cost.

PERCEPTIONS OF AND CONSTRAINTS TO BIM ADOPTION

The study looked at professionals' perceptions of the benefits and constraints to BIM adoption. A survey using a five-point Likert scale, to elicit responses that may have a significant impact on BIM penetration locally.

Table 1 points to the belief that BIM is here to stay and will enable real-time collaboration among project parties, improving benefits for all industry stakeholders. It also shows that by facilitating better communication, BIM will improve productivity. The professionals opined that a South African BIM standard is required and that BIM adoption must be mandatory for all government projects, with an incentive offered for early adopters.

Others feel that BIM is synonymous with 3D computer-aided design (CAD) and encourages laziness among professionals. Concerns were raised that BIM will delay construction project management, hamper effectiveness and take over professionals' jobs.

Table 1: BIM perceptions among professionals

BIM perception	Mean	Ranking
BIM is about real-time collaboration among project parties	3.91	1
BIM is beneficial to all stakeholders	3.89	2
BIM facilitates the construction process	3.88	3
BIM will improve industry productivity	3.87	4
A South African BIM guideline is required for easy adoption	3.82	5
BIM will stand the test of time	3.75	7
A South African BIM standard is required for easy adoption	3.74	8
There should be an incentive for BIM adoption	3.52	10
BIM is only for new construction projects	2.15	18
BIM hinders effective project management	2.14	19
BIM can be used only on large projects	2.13	20
BIM is just a synonym for 3D CAD drawings	1.81	27
BIM will take over my job	1.80	28

Constraints

Respondents identified the major constraints to BIM adoption as costs of hardware and software and a general lack of BIM understanding in the industry, coupled with a scarcity of BIM skills (Table 2). It was mentioned that uneven adoption rates will perpetuate transformation challenges as not all professionals will have the resources to invest in BIM. Unwillingness to adopt innovations and general industry resistance to change were also cited as possible hindrances. Overall, though, respondents were very optimistic about the future of BIM, given its potential to improve information management and productivity. None of the identified constraints is viewed as insurmountable.

Table 2: Challenges to BIM adoption

Challenges	Mean	Rank
Cost of BIM software	4.00	1
Lack of BIM understanding	3.93	2
Lack of BIM skills readiness	3.92	3
Lack of BIM skills training	3.82	5
Cost of BIM hardware	3.81	6
Lack of skilled BIM operators	3.76	7
Cost of skilled BIM operators	3.70	12
Lack of South African BIM guidelines	3.64	14
Industry's resistance to the fourth industrial revolution	3.51	18
Low industry technological capability	3.48	20
Weak innovation culture	3.48	21
Lack of software infrastructure	3.44	22
Data security issues	3.15	28

Benefits

Improved coordination of construction project documentation was cited as the most significant benefit (Table 3). Other positives mentioned included improved design visualisation, better information management, greater collaboration and ease of information retrieval. Design management and communication among project team members were also mentioned as positive outcomes of BIM use.

Table 3: Professionals' perceptions of BIM benefits

BIM benefits	Mean	Ranking
Improves coordination of construction project documentation	4.17	1
Improves design visualisation	4.12	2
Improves information management	4.06	3
Improves collaboration	4.04	4
Eases retrieval of information	4.01	5
Improves communication among project team members	3.97	6
Improves design management	3.94	7
Improves project management	3.91	8
Improves productivity	3.89	9
Improves asset monitoring	3.89	10
Enhances project knowledge management	3.86	11
Enables analysis of potential failure	3.82	12
Facilitates cutting-edge infrastructural developments	3.81	13
Enhances project stakeholder management	3.79	14
Improves cost efficiencies	3.70	15
Promotes competitiveness	3.60	16
Ensures compliance management	3.58	17
Ensures timely delivery of projects	3.58	18
Increases profitability	3.56	19
Improves data security	3.45	20

Professionals' perceptions of BIM readiness

Respondents believe structures currently available in the industry could facilitate BIM adoption. Professionals, it was stated, are aware of BIM and certain organisations already have BIM-competent individuals in their employ. They were, however, neutral on the availability of software and hardware support, with many not being convinced that South African professionals are motivated to adopt BIM. They were also very clear that there is a paucity of training opportunities for BIM adoption for professionals and a lack of policies to support the change.

The observations in Table 4 imply that BIM's adoption as a practice needs a concerted effort to develop country-specific guidelines and policies, initiate training and capacitation of all professionals in practice and provide support for software acquisition across the industry to avoid economic bias.

Table 4: Professionals' perceptions of BIM readiness

BIM readiness	Mean
Professionals are aware of BIM	3.69
My organisation has BIM-competent personnel	3.16
There is adequate hardware support for BIM adoption	3.15
There is adequate software support for BIM adoption	3.15
Professionals are motivated to adopt BIM	3.09
Organisational structures are being reviewed to adopt BIM	2.91
There is continuous BIM training for professionals	2.87
Clients are demanding BIM on their projects	2.64
There are adequately trained BIM professionals in the South African construction industry	2.56
The pre-qualification process insists on BIM	2.51
There are supporting policies for BIM adoption	2.45

Conclusions

The South African construction industry needs to adjust its business approach if it is to become productive and efficient, and live up to the infrastructure delivery expectations of clients and communities. It must also align with international best practices and embrace technology to remain competitive, improve productivity and quality, and contain infrastructure delivery costs.

Resistance to change and reluctance to introduce new technologies are challenges for most developing countries, even though technological advances cannot be halted. Technological risk aversion hinders the productivity and competitiveness of local construction companies and increases infrastructure delivery costs across the country.

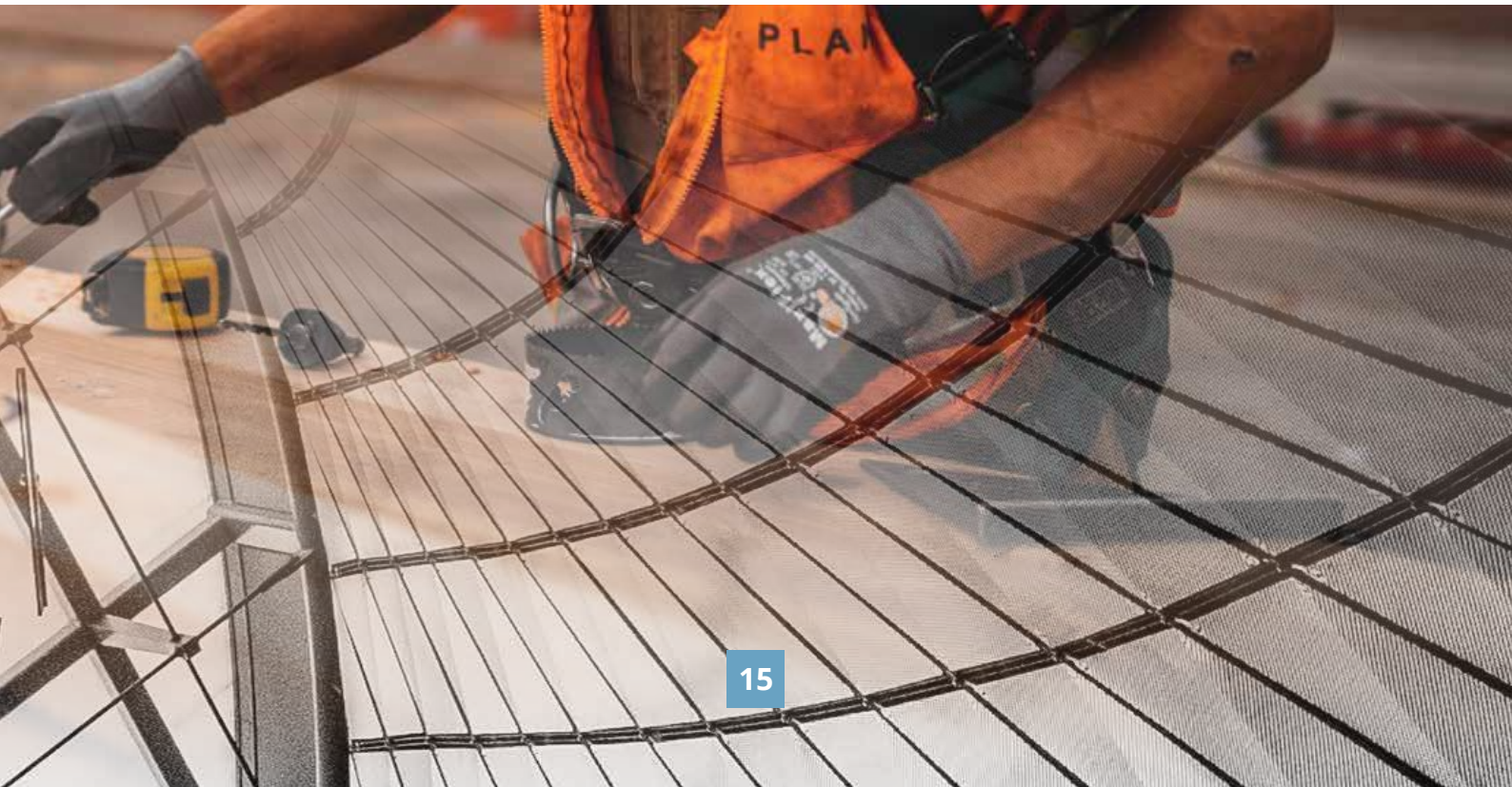
To help the sector prepare for innovation it is imperative to understand the knowledge and perceptions of role-players. This will be gauged through the opinions and readiness of professionals, contractors and client departments before wholesale recommendations are made to legislate use of technology. This study assessed the BIM readiness of professionals to understand how they can be helped to adopt BIM and act as catalysts for a focused industry adoption strategy.

The study identified the different perspectives, opinions and experiences of professionals and highlighted the perceived barriers to and the benefits of BIM adoption in the South African construction industry. The most prevalent BIM tools used were identified, with Autodesk emerging the main software supplier in South Africa.

An emergence of local BIM professionals was noted. The survey also revealed the cost of hardware and software, and the provision of education and training, among biggest constraints to BIM adoption. Professionals already using BIM showed good returns on investment and this could prompt others to follow suit.

The study shows that private and public sector consultants are aware that BIM is the future of project management. Many believe that BIM must be driven by software vendors, who must also provide BIM education to end-users and other stakeholders.

The recommendations of the study are presented in the following section and will be used to canvass support for BIM and the development of suitable standards and guidelines.

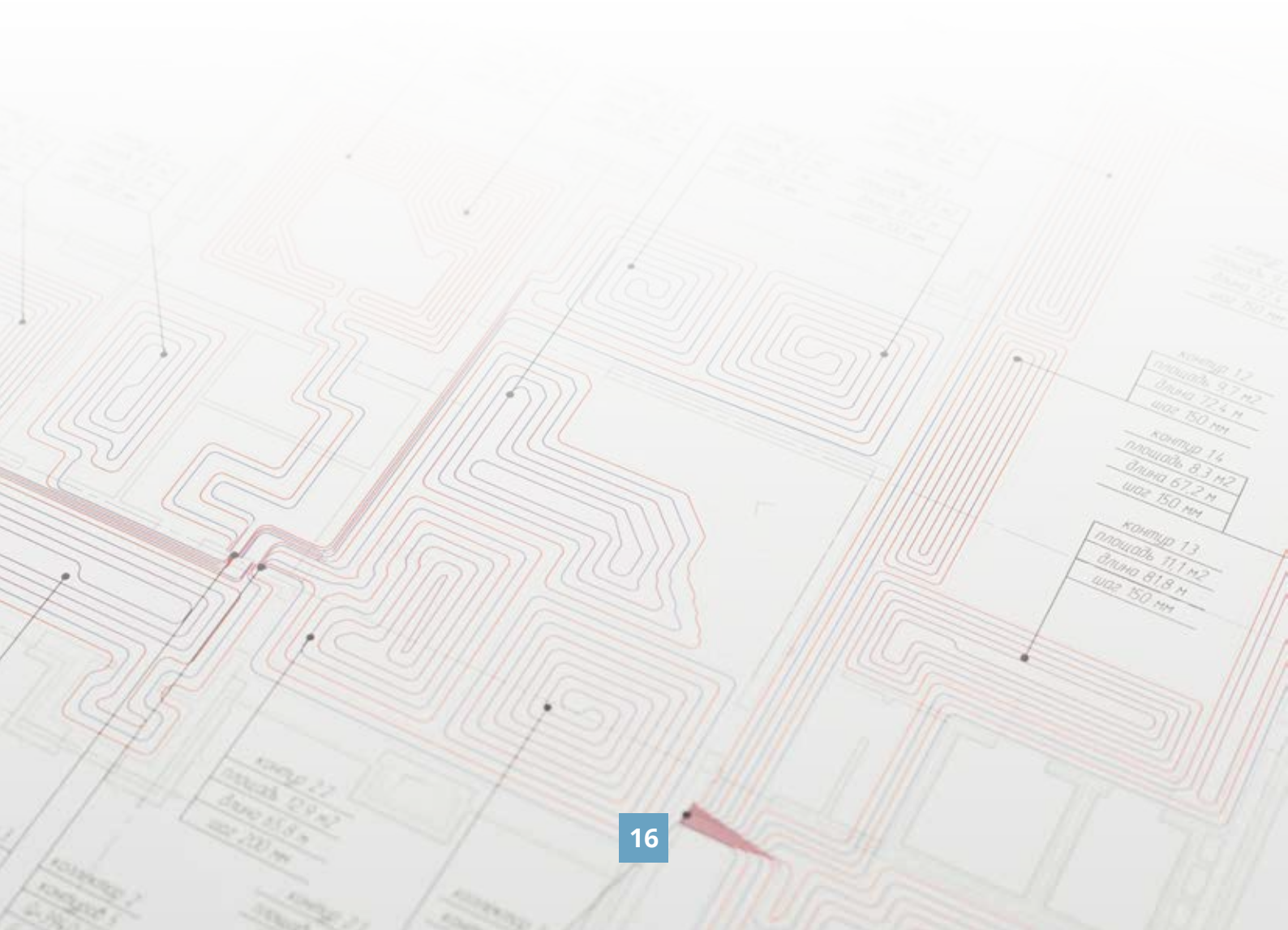


Recommendations

To support BIM implementation and bring the industry to an appropriate technological level, the cidb must develop a framework that includes timelines for the development of different BIM components. Based on literature studies and experiences from other economies, this framework must:

- Develop a change management strategy for the industry to gear up for BIM adoption.
- Define an implementation maturity model for the local industry.
- Define project metrics for implementation.
- Develop and publish industry standards and guidelines.
- Support the development of training standards and definition of competency levels for BIM operators.
- Develop guidelines for hardware and software requirements.
- Develop and publish data security guidelines and principles for implementers.
- Support the development of a BIM community of practitioners.

This study — the first stakeholder assessment of BIM knowledge and readiness — surveyed professionals in both public and private sectors. Two further studies will document the perceptions and readiness of contractors and client departments ahead of initiating change management to phase in BIM for infrastructure delivery.



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