the construction and engineering ramifications of these projects are frequently overshadowed by economic difficulties, such as the high costs of construction materials, that have a negative impact on project costs. Cost overruns have been determined as a phenomenon continually plaguing the construction industry in both private and public sectors, and very few projects are completed within cost parameters. This research evaluates the barriers to the use of innovative cost control techniques during the construction phase, and determines the level of cost overruns on construction projects in South Africa; identifies innovative cost control techniques used by construction firms on construction projects; establishes the optimal innovative cost control technique used in the South African construction industry; determines barriers to the use of innovative cost control techniques on projects; and uncovers whether there is a relationship between the level of use of innovative cost control techniques on construction projects and cost overrun.

Questionnaires were the chosen instrument for data collection, and were circulated via Survey Monkey. A total of 123 questionnaires were collected, and they provided the base for the computation of study results. Statistical tools employed in the study included Percentages, Mean Item Score (MIS), and frequency distributions. Innovative cost control techniques identified in the study were Earned Value Analysis (EVA), Last Planner System (LPS), 4D Scheduling, Fuzzy Project Scheduling, Line of Balance (LOB), and Reserve Analysis. Study findings determined that the critical contributors to cost overruns included tight project budgets, project complexity, a high frequency of change orders by clients and financial difficulties encountered by contractors. Perceived barriers to the implementation of cost control techniques in projects by participants included a poor scope definition, a lack of training and technical skill of project personnel, poor understanding of cost analysis and variables involved in cost planning.

Projects cannot meet project objectives, and construction organisations are not making use of the right tools and techniques to monitor and control construction costs. The findings from these objectives have shown that professionals should acquire more knowledge on innovative cost control techniques. This also concludes that they may not be taking advantage of the features of new innovative techniques to tackle complex projects. This, therefore, means that complex projects will continue to experience cost overruns. This study concludes that top management of construction organisations are not training their staff to embrace new technologies and innovation. The relationship between the level of innovative cost control techniques usage in construction projects and cost overrun was determined to be negative. This led to the conclusion that construction professionals are limiting themselves and are not exploring alternative or innovative cost control techniques. They are not focused onproject efficiency and productivity rather than cost overruns.

w: The literature review will be an expansion on, and will provide a more in-depth investigation into, the research question and outlined problems

## 1.10 SUMMARY OF THE CHAPTER

The chapter introduced the research topic and gave an insight into the poor cost control practices being experienced in the construction industry. The background to the research problem, aims and objectives to be achieved, the significance of the study, limitations encountered and structure of the research report were provided. The study will evaluate the barriers to the use of innovative cost control techniques during the construction phase.

Time and c this opinion stating that design changes during the construction phase leads to the rework of alrering performance indices (Najafi and Azimi, 2016: 67). These indices are elaborated on in Table 2.2 with a more detailed description and interpretation of each.

Table 2.12: The performance indices associated with EVA.et al. (2015: 4878), the planning and control of LPS can be summed up in seven stages as shown in Table 2.4.

Table 2. 42: Thems unable to be incorporated into the lookahead window and, therefore, extending the window affords the ability for better control of the workflow (Ballard et al., 2002: 231). Lookahe

Entry into the lookahead is controlled by explosionr manpower (Hamzeh et nder them sound and ready for assignment in the weekly work plan by the last planner (Hamzeh et al., 2012: 26; Lean Construction Institute, 2007: 26).

Weekly work planning, also known as commitment planning, comprises of the highest level of detail before subsequently undertaking work (Hamzeh et al., 2012: 19). It showcases the link between the works of different specialist organisations and drives production procedures (Hamzeh et al., 2012: 19). Through committing to work that can only be implemw uncertainty (Hamzeh et al., 2012: 19). Ebeginning of the week (Koskela et al., 2010: 540; Ballard and Tommelein, 2016: 20). Once the tions in future (Stratton et al., 2010: 4). Over a period of time, the PPC statistics pinpoint where further attention must be paid to attain improved results that can consequently improve learning processes in the project period (Stratton et al., 2010: 4).

### *2.3.2.2 Benefits of using LPS*

Table 2.5 highlights the benefits afforded by the implementation of LPS on construction projects.

Table 2. 53: The benefits of using LPS in construction.

|  |  |  |
| --- | --- | --- |
|  | **BENEFITS** | **DESCRIPTION** |
| 1 | LPS assists in stabilising project-based production systems. |  |
| 2 | LPS enables better proactive control of projects. |  |
| 3 | LPS supports good relationships. |  |
| 4 | LPS shortens waiting times. |  |
| 5 | LPS shortens the project duration. |  |
| 6 | LPS oversees conflicting objectives. |  |
| 7 | LPS reduces contractor costs. |  |
| 8 | LPS conveys bad news promptly. |  |

## 2.4.3 4D SCHEDULING

According to Malsane and Sheth (2015: 54), the lack of progression in the construction sector can be attributed to the fragmented nature of traditional project delivery, which uses 2D CompD CAD drawings is inadequate to maximise collaboration among project participants (Malsane and Sheth, 2015: 54).

Engineers and architects typically generate fragmented CAD drawings for clients and contractors that lack cost and schedule integration and typically pose problems resulting in errors, project delays and cdback to estimate constructions costs, constrn does not offer this type of analysis. Table 2.6 describes the information provided by contractor building models that includes detailed building information, temporary components, specification information associated with each building component, analysis data related to performance levels and

Table 2. 46: Information provided by building models

|  |  |
| --- | --- |
| **INFORMATION PROVIDED** | **DESCRIPTION** |
| Detailed building information. |  |
| Temporary components. |  |
| Specification information associated with each building component. |  |
| Analysis data related to performance levels and project requirements. |  |
| Design and construction status. |  |

Source: Eastman et al. (2008: 212).

Table 2. 57: The benefits of using 4D scheduling

|  |  |
| --- | --- |
| **BENEFITS** | **DESCRIPTION** |
| Visual communication. | 4D simulations allow planners to visually communicate planned construction processes to stakeholders (Basu, 2007: 2; Swallow and Zulu, 2019: 8; Malacarne et al., 2018: 140, 147). Non-technical senior stakeholders that typically greenlight the projects get an understanding of the project scope, the expected times for project completion and manner in which current operations are likely to be impacted by construction activities (Basu, 2007: 2). |
| Collaboration of stakeholders. |  |
| Logistics on site. |  |
| Revealing spatial constraints and coordination of trades in confined spaces. |  |
| Schedule and construction progress monitoring. |  |
| Settling claims and disputes. |  |
| Anticipation of safety hazards. |  |
| Improved coordination of contractors. |  |

### *2.3.3.4 4D scheduling benefits*

Table 2.7 shows that the various benefits afforded by 4D scheduling to construction firms are visual communicationg real world demands for project scheduling (Maravas and Pantouvakis, 2011: 62). Probabilit 85; Ammar, 2019b: 3). If there is a shortfall in the output of work required, adjustments can be made accordingly to increase the work progress rate (Pai et al., 2013: 89; Ammar, 20ssified as fixed and variable; variable risks are those events that will take place bund Grant, 2005: 90). Zulkefli et al. (2018: 345) showcased that EVA was still in its infancy in the Malaysian construction industry in a survey conducted to obtain the perception and enablersn, with frequencies of 12 and 20 respectively. This indicates that the majority of respondents worked in GB and CE organisations with cidb grade 1 and 2.

### *4.2.1.2 Educational background of respondents*

The study sought to establish the educational background of study participants, and the results are reflected in Figure 4.1. The majority, or 33.93%, of respondents hold a Bachelor’s degree. This was followed by Matric certificate holders at 30.36% and N4-6/NTC4-6/Certificate/Certificate-diploma with less than Grade 12 at 23.21%. 14.29% of respondents are Master’s degree holders and 0.89% hold a PhD. The results reveal the diversity of qualified professitives.

Table 4. 1: cidb grade and specialisation of study participants.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **GRADE** | **GENERAL BUILDING (GB)** | **CIVIL ENGINEERING (CE)** | **ELECTRICAL ENGINEERING WORKS-INFRASTRUCTURE (EP)** | **SPECIALIST CONTRACTOR (SQ)** | **SPECIALIST CONTRACTOR (SO)** | **SPECIALIST CONTRACTOR (SH)** | **MECHANICAL ENGINEERING (ME)** | **TOTAL NUMBER** | **%** |
| 1 | 11 | 12 | 1 | 1 | 1 | 1 | - | 27 | 30.00 |
| 2 | 21 | 20 | - | 3 | 1 | - | 1 | 46 | 51.11 |
| 3 | 2 | 3 | - | - | - | - | - | 5 | 5.56 |
| 4 | 2 | 1 | - | - | - | - | - | 3 | 3.33 |
| 5 | 3 | 1 | - | - | - | - | - | 4 | 4.44 |
| 6 | - | - | - | - | - | - | - | - | - |
| 7 | - | - | - | - | - | - | - | - | - |
| 8 | - | - | - | - | - | - | - | - | - |
| 9 | 1 | 4 | - | - | - | - | - | 5 | 5.56 |
| **TOTAL** | 40 | 41 | 1 | 4 | 2 | 1 | 1 | 90 |  |
| % | 44.44 | 45.56 | 1.11 | 4.44 | 2.22 | 1.11 | 1.11 |  |  |

Figure 4. 1: Educational background of respondents.

### *4.2.1.3 Designated position in organisation*

The designated positions of respondents in their respective organisations are identified in Figure 4.2. The majority of rrs, contractors and a contracts manager. Quantity surveyors represented 11.76% and architects and site engineers verse array of construction professions were represented in the study.

### *4.2.1.4 Area of expertise*

The area of expertise of respondents is presented in Figure 4.3. It indicates that the majority (38.84%) of professionals had buher areas of expefied by respondents included geotechnical engineering, property development, mining

Figure 4. 2: Number of employees in organisation.

### *4.2.1.7 Year of establishment of organisation*

The year of establishment of respondents’ organisations is presented in Figure 4.6. The majority of organisations (38,94%)20% came into being after 2010. The