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Quantity Surveyors' Approaches to Minimising Uncertainty and Safeguarding Project Delivery

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Abstract: The unparalleled COVID-19 pandemic had a significant impact on supply chains, resulting in disruptions to construction activities and affecting various professions, including Quantity Surveying. This study aimed to determine the measures taken by the Quantity Surveying profession to minimise risks during the Covid-19 period that facilitated project delivery. The research employed both quantitative and qualitative approaches, involving the distribution of questionnaires and conducting interviews with practicing Quantity Surveyors. The data collected was analysed using the relative importance index for quantitative data and descriptive analysis for qualitative data. The study found that construction risk was the most significant risk, and it had a significant impact on project schedules. The risk mitigation strategy was the most employed risk reduction approach. The results also indicated that cooperation among contractors was crucial in meeting project deliverables.

Keywords: COVID-19, project delivery, quantity surveying, risk management, uncertainty.

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1. Introduction

The COVID-19 pandemic had a profound financial impact on construction projects globally, affecting multiple aspects of the industry. Quantity Surveyors, responsible for managing project costs and ensuring financial control, faced unprecedented challenges during this period. The project disruptions caused by the pandemic included supply chain interruptions, material shortages, labour constraints, project delays, and financial uncertainties (Husien et al., 2021). These challenges impacted various levels of project management, including procurement, site progress, and contractual agreements (Akmam et al., 2021). The disruption of the global supply chain was a significant risk encountered by Quantity Surveyors during the pandemic. Lockdown measures and travel restrictions led to material shortages, increased prices, and delays in material deliveries. To mitigate these risks, Quantity Surveyors had to adapt their procurement strategies and explore alternative supply sources (Akmam et al., 2021).

Moreover, the implementation of health and safety protocols on construction sites posed challenges for Quantity Surveyors. Compliance with social distancing regulations, enhanced sanitation measures, and the provision of personal protective equipment (PPE) resulted in reduced productivity, increased project costs, and potential schedule delays. Quantity Surveyors managed these additional project costs and incorporated them into budget estimates (Bou Hatoum et al., 2021). Quantity Surveyors played a crucial role in closely monitoring project budgets, assessing the financial viability of projects, and implementing cost-saving measures to mitigate risks (Husien et al., 2021). The financial implications of the pandemic, including economic uncertainties, fluctuating exchange rates, and funding constraints increased financial risks for construction projects (ibid).

Also, adopting digital technologies and remote working practices presented risks and challenges for Quantity Surveyors during the pandemic. The use of virtual collaboration tools, online meetings, and remote project monitoring required careful consideration of data security, privacy, and communication challenges (Akmam et al., 2021).

To effectively manage these risks, Quantity Surveyors utilised a range of tactics. Proactive communication with project stakeholders and collaborative decision-making were also vital in navigating the risks introduced by the pandemic (Bou Hatoum et al., 2021). This study, therefore, explores the approaches that Quantity Surveyors adopted to minimise uncertainty and safeguard project delivery during the Covid-19 pandemic period in South Africa. The research question the study seeks to answer is:

What approaches were adopted by Quantity Surveyors to minimise uncertainty and safeguard project delivery during the COVID-19 period in South Africa?

- The study aimed to fulfill the following objectives:
- To identify key risks confronted by the QS profession on projects during the COVID-19 pandemic in South Africa
- To rank these risks according to their severity
- To assess the impact of these risks on projects
- To learn how these risks were mitigated by the QS profession to safeguard project delivery

2. Literature Review

2.1. Uncertainty Related to Project Cost During COVID-19

The COVID-19 pandemic brought significant uncertainty to project costs in the construction industry. The unprecedented nature of the crisis, coupled with disruptions in the global economy and supply chains, made it challenging for quantity surveyors and project managers to estimate and control project costs accurately. The uncertainties associated with project costs during the COVID-19 pandemic have been widely recognised in the literature. Studies have highlighted the financial challenges, increased expenses, and cost overruns experienced by construction projects due to the pandemic (Husien et al., 2021; Akmam et al., 2021). The disruptions in the supply chain, such as material shortages, price fluctuations, and delivery delays, significantly impacted project costs (Husien et al., 2021). Moreover, compliance with health and safety protocols and implementing additional measures to prevent the spread of the virus, such as social distancing and enhanced sanitation, introduced additional costs and uncertainties (Bou Hatoum et al., 2021).

The fluctuations in the economy and financial markets due to the pandemic contributed to uncertainty in project costs. Economic uncertainties, currency fluctuations, and funding constraints made it challenging for quantity surveyors to forecast and control project budgets accurately (Husien et al., 2021). The volatile market conditions and changing cost structures made anticipating and managing financial risks difficult. Quantity surveyors adopted proactive and adaptive strategies to address the uncertainties related to project costs during the COVID-19 pandemic. This included closely monitoring and analysing project budgets, regularly reviewing and adjusting cost estimates, and implementing effective cost control measures (Akmam et al., 2021). Collaboration with project stakeholders, including contractors, suppliers, and clients, became essential to manage and negotiate cost implications (Bou Hatoum et al., 2021). Additionally, quantity surveyors embraced digital technologies and data-driven approaches to improve cost management, enhance project transparency, and mitigate uncertainties (Husien et al., 2021). The COVID-19 pandemic introduced significant uncertainty and challenges in managing project costs in the construction industry.

2.2. Managing Uncertainty

During the COVID-19 pandemic, uncertainties in construction projects were effectively managed through various strategies and measures aimed at mitigating risks and ensuring project continuity. Construction professionals, including quantity surveyors, employed several approaches to address these uncertainties. Contingency planning was undertaken, with project teams developing comprehensive plans to anticipate and manage potential risks and uncertainties. This involved identifying critical project activities, establishing alternative supply chains, and considering various scenarios to ensure adaptability in response to changing conditions (Aibinu et al., 2020).

Enhanced communication and collaboration played a crucial role in managing uncertainties. Effective communication channels were established to facilitate regular and transparent information sharing among project stakeholders. This allowed for timely discussions on challenges and collaborative decision-making to address uncertainties as they arose (Aibinu et al., 2020; Sweis et al., 2021).

Robust risk assessment and management processes were implemented to identify, analyse, and prioritise risks associated with the pandemic. This enabled project teams to develop appropriate risk mitigation strategies, allocate resources accordingly, and monitor risks throughout the project lifecycle (Sweis et al., 2021).

The adoption of digital tools and technologies proved instrumental in managing uncertainties. Virtual collaboration platforms, remote project monitoring systems, and Building Information Modeling (BIM) facilitated effective communication, real-time data sharing, and remote project management, thereby reducing the impact of physical constraints (Abotaleb et al., 2021; Sweis et al., 2021).

Proactive supply chain management was another key aspect. Construction professionals diversified suppliers, explored local sourcing options, and established alternative delivery channels to mitigate the risks of material shortages and delays caused by disrupted global supply chains (Abotaleb et al., 2021; Sweis et al., 2021). Financial planning and flexibility were essential in addressing uncertainties. Quantity surveyors collaborated closely with project stakeholders to reassess project budgets, consider alternative funding options, and renegotiate contracts to accommodate pandemic-related uncertainties.

This facilitated better financial planning, risk sharing, and adaptability to changing financial circumstances (Abotaleb et al., 2021).

Adhering to health and safety guidelines and implementing appropriate measures on construction sites played a significant role in minimising the spread of the virus and mitigating uncertainties related to workforce availability and productivity. Quantity surveyors ensured compliance with health protocols and incorporated additional costs associated with safety measures into project budgets (Sweis et al., 2021). These strategies collectively enabled quantity surveyors and project teams to adapt to the challenges presented by the COVID-19 pandemic, effectively managing uncertainties in construction projects.

2.3. Risk Management Strategies, Minimising Uncertainty and Safeguarding Project Delivery During COVID-19

During the COVID-19 pandemic, Quantity Surveyors have faced contractual disputes and renegotiations to manage the financial implications of the crisis on construction projects. These disputes and renegotiations arose due to disruptions in project timelines, supply chain issues, and unforeseen circumstances. Quantity Surveyors were seized with a crucial role in addressing contractual obligations, resolving disputes (Bou Hatoum et al., 2021; Alsharef et al., 2021), and managing the financial impact of the pandemic. Quantity Surveyors have sought to mitigate the financial risks and ensure the successful delivery of construction projects by renegotiating contracts, revising project scopes, and identifying cost-saving measures.

Quantity surveyors were crucial in minimising uncertainty and safeguarding project delivery during the COVID-19 pandemic (Aibinu et al., 2020). They implemented various strategies to address the challenges and mitigate risks associated with unprecedented circumstances. One key approach was conducting comprehensive risk assessments to identify potential uncertainties and their potential impact on projects. This enabled them to develop proactive risk management plans, incorporating measures to mitigate and respond to the identified risks effectively (Sweis et al., 2021). Quantity surveyors also focused on maintaining effective communication and collaboration among project stakeholders. Clear and regular communication channels were established to facilitate information sharing, decision-making, and problem-solving. By keeping all parties informed about project updates, challenges, and potential risks, quantity surveyors helped maintain alignment and adaptability, minimising uncertainty.

Adapting to digital technologies and remote working became essential for quantity surveyors during the pandemic. They utilised virtual collaboration tools, online meetings, and digital project management platforms to ensure seamless communication and efficient workflow. This allowed for continued project monitoring, progress tracking, and cost control despite physical limitations and remote working arrangements.

Financial planning and budget management were critical aspects of minimising uncertainty (Abotaleb et al., 2021). Quantity surveyors worked closely with project stakeholders to reassess budgets, explore cost-saving measures, and adapt financial plans to the changing circumstances (Abotaleb et al., 2021; Sweis et al., 2021; Husien et al., 2021). They evaluated the feasibility of alternative funding options, renegotiated contracts, and implemented measures to ensure the financial stability of projects.

To safeguard project delivery, quantity surveyors also prioritised compliance with health and safety regulations. They implemented rigorous health and safety protocols on construction sites to protect the well-being of workers and minimise the risk of virus transmission. By ensuring a safe working environment, they helped mitigate uncertainties related to workforce availability, productivity, and potential disruptions due to health-related issues. Overall, quantity surveyors demonstrated resilience, adaptability, and effective risk management strategies during the COVID-19 pandemic to minimise uncertainty and safeguard project delivery.

2.4. Risk Management Theory

Risk management theory plays a crucial role in understanding and addressing project risks during the COVID-19 pandemic. The theory provides a structured framework for identifying, assessing, and mitigating risks that arise in the context of project management. In the context of COVID-19, risk management theory helps project managers and stakeholders navigate the unique and unprecedented challenges brought about by the pandemic. It assists in identifying and evaluating risks associated with factors such as supply chain disruptions, labor shortages, health and safety concerns, regulatory changes, and economic uncertainties (Klucka et al., 2021; Husien et al., 2021).

The theory emphasises the importance of proactive risk identification and assessment to anticipate potential impacts on project objectives. It encourages project teams to consider the likelihood and severity of risks and prioritise their response accordingly. For example, risks related to delayed material deliveries or workforce availability may require different mitigation strategies compared to risks associated with changing government regulations or public health measures.

Risk management theory also highlights the significance of effective risk mitigation strategies tailored to the specific circumstances of the COVID-19 pandemic. This may involve developing contingency plans, diversifying supply chains, implementing health and safety protocols, adjusting project schedules, or exploring alternative approaches to resource management.

Additionally, the theory emphasises the need for ongoing risk monitoring and evaluation during the project lifecycle. As the COVID-19 situation evolved, new risks emerged, and existing risks changed in nature or magnitude. Continual monitoring allows project teams to adapt their risk mitigation strategies and make informed decisions in response to evolving circumstances, like the use of online tools (Akmam et al., 2021).

Furthermore, risk management theory underscores the importance of communication and collaboration among project stakeholders. Effective communication facilitates risk information sharing, promotes transparency, and enables timely decision-making. Collaboration allows for the pooling of expertise and resources to develop comprehensive risk management plans and implement appropriate risk response strategies. By applying risk management theory to project risk during the COVID-19 pandemic, project managers proactively identified and addressed potential challenges, enhanced project resilience, and improved the likelihood of successful project delivery.

2.5. Theories for Managing Risk and Uncertainty During COVID-19

Several theories and frameworks can be applied to manage uncertainty and risk during the COVID-19 pandemic on projects. These theories provide valuable insights and guidance for project managers in navigating challenges and minimising the impact of uncertainties. Some notable theories include the Uncertainty Management Theory (UMT), which focuses on understanding how individuals and organisations perceive and respond to uncertainty. UMT emphasises the importance of information processing, communication, and decision-making in managing uncertainty effectively (Brashers, 2001). Applying UMT during COVID-19 involved actively seeking and disseminating information, fostering open communication channels, and adapting decision-making processes to address emerging uncertainties.

Another theory applicable to the management of uncertainty and risk during the pandemic is the Risk Management Theory (RMT). The theory provides a structured framework for identifying, assessing, and mitigating risks. It involves a systematic approach to understanding potential risks, evaluating their likelihood and impact, and developing risk response strategies (Loosemore et al., 2006). Applying risk management theory during COVID-19 involves proactive risk identification, assessing the unique risks posed by the pandemic, implementing appropriate risk mitigation measures, and continuously monitoring and adapting risk management strategies. These two theories provide a foundation for understanding and managing uncertainties and risks during the COVID-19 pandemic.

3. Research Methodology

3.1. Research Philosophy

This research adopted a pragmatic philosophical perspective that is not associated with any particular philosophical framework or reality. Pragmatism emphasises the utilisation of mixed methods research, which combines quantitative and qualitative approaches, for conducting inquiries (Cresswell, 2014). According to Sanders et al. (2019), this approach acknowledges the presence of miscellaneous viewpoints and recognises that a single perspective cannot fully grasp the complexities of a subject. Therefore, it advocates for the exploration of multiple realities.

In this study, a mixed methods approach that incorporated both qualitative and quantitative methods was employed. The decision to use a mixed methods approach was based on the understanding that each method has its own limitations and biases. By integrating both types of data, the weaknesses of one approach can be offset by the strengths of the other (Creswell, 2014).

3.2. Population and Sampling

For participant selection, a purposive sampling technique was utilised for the study. In this approach, the researchers used the criteria of selecting quantity surveyors who were active during the COVID-19 period, managing or involved in projects. The quantity surveyors that participated in the study were identified through the LinkedIn platform and some were known to the researchers.

These quantity surveyors were best able to answer the research questions that were posed to them. 30 participants were purposively sampled from a larger population of quantity surveyors. The sample size of 30 was deemed representative of the targeted population.

Table 1. Summary of the research process

Research process	Qualitative	Quantitative
Data collection	In-depth interviews	Questionnaires
Population	Quantity surveyors	Quantity surveyors
Selection criteria	Quantity surveyors active during pandemic	Quantity surveyors active during pandemic
Sampling	Purposive	Purposive
No. of participants	Four participants	Fifteen participants
Data analysis	Descriptive	Relative Importance Index
Mixed method process	Sequentially	Sequentially

3.3. Data Collection Method

A mixed method combining qualitative and quantitative methods was utilised to collect data for the study. To gather data, the study utilised in-depth interviews for the qualitative data collection tool and questionnaires were utilised for the quantitative data collection tool.

Creswell (2014) categorised mixed methods designs into sequential and concurrent designs. In sequential designs, either qualitative or quantitative data is collected in different stages, with one stage preceding the other. In contrast, concurrent designs involve the simultaneous collection of both types of data (Castro et al., 2010). In this study, a concurrent method was employed, where data collection occurred simultaneously through administering questionnaires and conducting interviews. The number of participants that were invited to respond to questionnaires was 25 and five participants were invited to take an interview. Both the interviews and questionnaire distribution happened concurrently, resulting in a total of 30 participants invited to participate in the study. There was a total of four interviews conducted out of the five and only 15 respondents completed the questionnaires, giving a total of 19 study participants.

3.4. Profile of Participants

Data was first collected using a questionnaire and 15 participants responded. This was then sequentially followed by interviews which were conducted using MS Teams with four participants, to ensure the safety of research team from COVID-19. The profile of participants from interviews and questionnaires is outlined below. Data was collected from participants located in Johannesburg between September to October 2021.

Table 2. Participants' profile

	Designation	Experience (yrs)	Education level
Interview Participants			
P1	Quantity Surveyor	10	Bachelors
P2	Senior Quantity Surveyor	15	Bachelors
P3	Quantity Surveyor	12	Honours
P4	Senior Director: Quantity Surveyor	15	Bachelors
Questionnaire Participants			
P5	Quantity Surveyor	8	Honours
P6	Quantity Surveyor	10	Bachelors
P7	Quantity Surveyor	7	Bachelors
P8	Senior Director: Quantity Surveyor	20	Bachelors
P9	Senior Quantity Surveyor	18	Bachelors
P10	Senior Director: Quantity Surveyor	25	Bachelors
P11	Senior Quantity Surveyor	16	Honours
P12	Quantity Surveyor	8	Masters
P13	Quantity Surveyor	10	Honours
P14	Quantity Surveyor	8	Masters
P15	Senior Director: Quantity Surveyor	25	Bachelors
P16	Senior Quantity Surveyor	17	Honours
P17	Quantity Surveyor	9	Masters
P18	Quantity Surveyor	10	Honours
P19	Quantity Surveyor	12	Masters

3.5. Data Analysis Method

Two different approaches were employed to analyse the data collected from the questionnaires and interviews: the Relative Importance Index (RII) for quantitative data and descriptive analysis for the qualitative data.

The Relative Importance Index (RII) is a method used to assess the relative significance or importance of different variables or factors in a quantitative dataset. It involves assigning numerical weights to each variable based on the responses received in the questionnaire. The RII was calculated by dividing the mean score of each variable by the sum of all mean scores across all variables (Peña et al., 2014). This index helped determine the relative importance of each variable in relation

to the research objectives. The higher the RII value for a particular variable, the greater its importance in influencing the outcome.

On the other hand, descriptive analysis was employed for qualitative data. This approach involved systematically examining and summarising the qualitative data collected from interviews. It focused on identifying and describing patterns, themes, and insights that emerged from the qualitative data. This analysis involved categorising and organising the data, extracting key information, and providing a detailed description of the findings. It aided in uncovering commonalities, differences, and significant aspects within the qualitative data, which provided a rich understanding of the research topic.

By utilising the RII for quantitative data and descriptive analysis for qualitative data, this study was able to extract meaningful insights and understand the strategies adopted by Quantity Surveyors to minimise uncertainty and ensure project delivery during the COVID-19 pandemic. These analysis methods allowed for a comprehensive examination of both the quantitative and qualitative aspects of the data, providing a holistic view of the research findings.

4. Discussion and Analysis

To explore the strategies employed by Quantity Surveyors to mitigate uncertainty and ensure successful project delivery amidst the challenges posed by the COVID-19 pandemic, this study examined the data from the results of questionnaires and interviews to identify recurring themes and patterns. The identified themes are presented and discussed in detail below, shedding light on the strategies adopted by Quantity Surveyors in response to the prevailing circumstances.

4.1. Identification, Ranking and Categorisation of Risks

Many risks were identified from the questionnaires. The study findings indicate that Quantity Surveyors faced three dominant risks. These risks are ranked based on their severity of impact from the perspectives of the participants. Table 2 below outlines the risks and their ranking below. Construction risk was ranked 1 with a weighted mean of 39, whereas Project Execution risk was ranked second with a weighted mean of 41. Thirdly, the Pricing risk was ranked 3 with a weighted mean of 34. The abovementioned risks were the top three ranked risks in terms of this study's findings.

Table 3. Identified risks and their ranking

Risks	Weighted Mean	RII	Rank
Construction risk	39	0.71	1
Project execution risk	41	0.68	2
Pricing risk	34	0.62	3
Resource risk	34	0.62	4
Organisation risk	35	0.58	5
Estimating risk	37	0.57	6
Project management risk	34	0.57	7
Statutory compliance risk	31	0.56	8
Information risk	30	0.55	9
Design risk	19	0.35	10

In the context of this study, the above results suggest that participants highly placed Construction Risk as it relates to loss and exposure on the project. The COVID-19 disrupted routine, and participants indicated that they knew that there would be losses incurred as the projects were exposed to a lot of uncertainties. They indicated that there were time, cost, and skill-related uncertainties that had a detrimental effect on most projects. The changes were beyond everyone's control and affected pricing, resources, and estimating of all the risks. The ranked risks categories encompass the uncertainties related to the construction process itself, such as delays, quality issues, safety concerns, and unexpected events that had to be incorporated to ensure project delivery. It is a fundamental risk that influences the overall success of a construction project and can have significant implications for costs, timelines, and client satisfaction.

4.2. Project-Related Risks Navigated by Quantity Surveyors During COVID-19

From the risks identified, the interview results further gave direction on how Quantity Surveyors navigated each of the top five risks during COVID COVID-19 period. Amid the COVID-19 pandemic, Quantity Surveyors faced various risks inherent in their job. According to the findings of this research, the experts who participated in the study encountered multiple risks such as construction-related uncertainties, challenges in project execution, uncertainties in pricing, resource management risks, and difficulties in accurate estimation. What made the situation intricate was the simultaneous occurrence of these risks, necessitating their diligent focus and attention. This situation presented a unique challenge for Quantity Surveyors as they had not previously encountered the simultaneous occurrence of these specific risks during their work, as everything

became uncertain. It was an unprecedented scenario that demanded their adaptability and careful handling in navigating the complexities arising from these various risks. Results from interviews are further discussed below indicating how risks were navigated by Quantity Surveyors.

4.2.1. Construction risk

In terms of the construction risk, Quantity Surveyors indicated that the health and safety of construction workers and project stakeholders were at risk due to the contagious nature of the virus. Quantity Surveyors had to ensure that appropriate safety protocols, such as social distancing measures, use of personal protective equipment (PPE), and sanitisation practices, were implemented on construction sites to mitigate the risk of COVID-19 transmission and factor in revised health and safety plans and costs that had time and cost implications. This posed a risk to construction activities as construction sites worked on figuring out how to manage workers on construction sites and the impact of reduced labour and production on sites. These posed threats to the completion of construction projects and delivery deadlines. One quantity surveyor interviewed elaborated that "*This was a novel territory to navigate but it became manageable because every stakeholder involved in the project was susceptible to COVID-19, no one was immune. So, there was an implicit understanding from all stakeholders that delays, and additional costs incurred were legitimate, it was just the veracity of these that had to be managed*" – P1, P2 and P3. Another participant highlighted that: "*We understood that this was a risk no one could avert, we simply had to figure out how to work our way around it to make the construction sites workable again in a safe manner and no matter what cost*"- P4. Construction risk presented itself in many forms during the COVID-19 period and included health and safety issues, project delays, increases in material costs, and delays in deliveries, threatening completion of project.

4.2.2. Project execution risk

The study's findings indicated that Quantity Surveyors encountered challenges in executing projects during the COVID-19 period, specifically due to various constraints that arose during this period. These constraints included the implementation of social distancing measures, which affected effective communication between project stakeholders, as well as shortages of materials and extended lead times for material delivery. These challenges had financial implications that Quantity Surveyors had to address and manage. The participants advised that "*the execution of projects was severely affected by supply chains that became unreliable*" – P2 and P3. Another added that "*The additional unplanned costs threatened project execution and delivery*" – P4.

To navigate these risks associated with project execution in the construction industry, it was found that Quantity Surveyors supported flexible project management approaches. This entailed closely coordinating with all stakeholders involved on virtual platforms, regularly reviewing and revising project plans as needed to factor in the changes and implementing alternative strategies to overcome obstacles or adapt to changes in project requirements caused by the pandemic. Furthermore, Quantity Surveyors provided advice on the financial implications of such changes. They assisted in assessing the cost implications of implementing alternative strategies, determining the impact on project budgets, and making recommendations on mitigating financial risks. Quantity surveyors highlighted that their active involvement in discussions pertaining to these threats and utilising their expertise for cost control benefitted project teams in managing the financial aspects of construction projects amidst the uncertainties brought about by the pandemic.

4.2.3. Pricing risk

The findings revealed that Quantity Surveyors encountered significant pricing risks and there was a general price uncertainty within the construction industry. The pricing risks were primarily attributed to the volatile market conditions and disruptions in the supply chain. One participant added that "*the pricing schedules we had in the beginning were primarily thrown off as costs kept rising and delays impounding projects*" – P1As a result, Quantity Surveyors had to navigate through several challenges to manage pricing uncertainties effectively. One of the key risks they faced was the fluctuating market conditions. The pandemic caused significant fluctuations in demand and supply dynamics, leading to rapid material costs and pricing changes. Quantity Surveyors indicated that they closely monitored the market trends and remained updated with the latest pricing information to ensure accurate cost assessments and budget estimations for construction projects.

In addition, the disruptions in the supply chain posed a significant pricing risk. Restrictions, lockdowns, and reduced production capacities during the pandemic caused delays and shortages in the availability of construction materials. Quantity Surveyors engaged in negotiations with suppliers and contractors to mitigate potential price escalations or material shortages. One participant indicated that "*we had several iterations and negotiations to attempt to manage prices and some were reluctant to fix prices*" – P4. With strong communication channels and proactively seeking alternative suppliers or materials, they aimed to stabilise costs and ensure a smooth flow of materials for ongoing projects. To manage the pricing risk effectively, Quantity Surveyors implemented various strategies. They conducted regular cost assessments and updated their project budgets accordingly to reflect the changing market conditions. This allowed them to track and manage any deviations in pricing and identify areas where cost savings could be achieved.

Furthermore, Quantity Surveyors played a crucial role in negotiations with suppliers and contractors. They leveraged their expertise in pricing analysis and market knowledge to engage in discussions to secure competitive pricing, manage risks, and ensure the availability of necessary materials for construction projects.

4.2.4. Resource risk

The findings revealed that the COVID-19 pandemic exacerbated issues concerning the availability and adequacy of resources, particularly labour, and skills, on projects. Some laborers were reported to express skepticism about the existence of the COVID-19 disease, leading to reluctance in adhering to site protocols such as wearing masks and sanitising. The labourers'

disbelief in COVID-19 posed a significant risk to the spread of the disease on site, prompting management to implement additional precautionary measures. Enforcing strict adherence to health and safety protocols, including wearing masks and sanitising, became crucial to protect the workforce and prevent potential outbreaks. Those who continued to ignore the protocols were reported to have been removed from the sites, resulting in disruptions and a strain on project resources, impacting the overall project delivery timeline. One participant highlighted how "*some sites struggled dealing with labour that did not believe COVID-19 was real and were later kicked off sites due to non-adherence and this further put a strain on labour shortages and project delivery*" – P4.

The one significant aspect of resource risk was the occurrence of labour shortages. Restrictions, lockdowns, and health concerns reduced labour availability within the construction industry. Quantity Surveyors indicated that they navigated through this shortage of skilled workers, which posed a threat to project timelines and overall project execution. One participant narrated that "remember the construction industry in labour intensive and if continuous labour shortages or labour non-adherence to COVID protocols are experienced, this will bring the project to a standstill" – P1. The unavailability of skilled labour resulted in project delays, reduced productivity, and compromised quality. Additionally, skill gaps became more pronounced during the pandemic. Some specialised skills required for construction projects were in short supply due to travel restrictions or limited access to training and development opportunities.

Findings revealed that workforce planning was adopted on sites to manage the resource risk effectively. This entailed closely monitoring labour requirements and proactively seeking to allocate resources according to project needs. There was a strong focus on identifying critical areas that required attention and proactively assessing resource availability to these areas to optimize resource allocation.

Exploring alternative sourcing options was another strategy adopted by Quantity Surveyors. They sought to diversify their sources of labour and expertise by considering subcontracting, collaborating with different contractors or agencies, or exploring remote working arrangements. This allowed them to mitigate the impact of resource shortages and ensure a consistent supply of skilled labour.

4.2.5. Estimating risk

During the COVID-19 pandemic, Quantity Surveyors encountered challenges in accurately estimating project costs and timelines due to the unprecedented uncertainties it brought. Some indicated that "*more than usual buffers were added to estimates to cover uncertainty*" – P3. Quantity Surveyors implemented various strategies and measures to effectively address the estimating risk during this period. Whereas another added that "*we needed to cover the level of uncertainty in our estimates which was very high*" – P2.

Firstly, they relied on data-driven estimation techniques to enhance the accuracy of their projections. By leveraging historical data, industry benchmarks, and market trends, they were able to make more informed estimations. Analysing past project data and considering industry knowledge allowed Quantity Surveyors to incorporate relevant factors and trends into their estimates, improving the reliability of cost and timeline projections.

Thorough risk assessments were a crucial aspect of estimating risk during the pandemic. Quantity Surveyors conducted comprehensive assessments to identify and evaluate potential risks and uncertainties that could impact project costs and timelines. They considered various factors, such as supply chain disruptions, labour shortages, regulation changes, and health and safety requirements. They were better equipped to develop mitigation strategies and contingency plans by proactively identifying these risks. It highlighted that "*these risks came at a premium*" – P4

Incorporating contingency plans was another key approach utilised by Quantity Surveyors. They included contingency allowances in their estimates to account for unforeseen circumstances and potential changes that could occur during project execution. Another added that "*estimating unforeseen events or risks does not do justice to project costs but it had to be done*" – P1. These contingency plans acted as buffers to manage unexpected events, reduce the likelihood of cost overruns, and mitigate potential delays.

Additionally, Quantity Surveyors maintained open communication and collaboration with project stakeholders. By actively engaging with contractors, suppliers, and clients, they sought insights and input to validate their estimations. This collaborative approach helped gather diverse perspectives, leverage expertise, and ensure that estimations considered various viewpoints and factors that could impact costs and timelines.

Overall, Quantity Surveyors addressed estimating risk during the COVID-19 pandemic by employing data-driven techniques, conducting thorough risk assessments, and incorporating contingency plans. These proactive measures allowed them to adapt to the uncertainties of the pandemic, enhance the accuracy of their estimations, and mitigate potential cost overruns or delays in construction projects.

4.3. Impact of these Risks on Project Delivery

The following subsections describe the nature of the impact of the identified risks on project delivery.

4.3.1. Impact of construction risk

The participants indicated that the primary problem faced by construction sites was Health and Safety. The health and safety of construction workers and project stakeholders was at risk due to the contagious nature of the virus. The impact of this risk on construction projects was a dearth of human resources available for work. Additionally, the restrictions of human resources to work delayed projects further. This resulted in time, cost, quality, and safety implications on site requiring it to be closely monitored. Despite ensuring that appropriate safety protocols, such as social distancing measures, use of personal

protective equipment (PPE), and sanitisation practices, were implemented on construction sites to mitigate the risk of COVID-19 transmission, there was a negative impact on projects due to delays and cost overruns. Additionally, contractual and legal risks threatened the completion of some projects. The participants indicated that "*they handled higher volumes of contractual disputes and legal challenges than usual arising from the pandemic*" – P1, P2, P3 and P4. These included issues related to force majeure clauses, project extensions, payment delays, and variations in project scope.

4.3.2 Impact of project execution risk

The results of the study revealed that during the COVID-19 pandemic, project execution risk significantly impacted all construction sites. Participants indicated that they faced challenges with communication and coordination of projects due to restrictions and social distancing measures. One cited that "*sites became very difficult to manage during this period*" – P1 and another added that "*it was not business as usual on sites and this severely affected costs*" -P3. Supply chain disruptions caused delays and shortages of construction materials. Labor shortages and skill gaps hindered project productivity, while health and safety concerns required additional protocols. Changes in project requirements and overall uncertainties posed further challenges. Effective management involves proactive risk mitigation, collaboration with stakeholders, and adaptability in project planning.

Overall, project execution risk during the pandemic had a profound impact on Quantity Surveyors. They navigated communication challenges, supply chain disruptions, labor shortages, health and safety considerations, changes in project requirements, and uncertainties. They implemented risk mitigation strategies, collaborating with stakeholders, and adapting project plans to address the unique circumstances of the pandemic, to minimise project execution risk.

4.3.3. Impact of resource risk

Without appropriate supply chains, projects struggled to reach completion. The pandemic led to disruptions in the global supply chain, affecting the availability and timely delivery of construction materials and equipment. Quantity Surveyors faced the risk of project delays or cost escalation due to shortages, price fluctuations, or the need to source materials from alternative suppliers. "*It was too many delays that had to be managed at the same time*", added participant – P4. Stakeholder Communication and Coordination: Effective communication and coordination with various stakeholders, including clients, contractors, and subcontractors, were vital to managing construction risks during the pandemic. Quantity Surveyors needed to ensure clear and consistent communication to align expectations, address concerns, and maintain project progress despite the challenges.

4.3.4. Impact of pricing and estimating risks

Quantity Surveyors faced pricing uncertainties during the COVID-19 pandemic as market conditions fluctuated and supply chains experienced disruptions. They had to closely monitor market trends, conduct regular cost assessments, and engage in negotiations with suppliers and contractors to mitigate potential price escalations or shortages of construction materials. "*There were many order cancellations, order delays and price fluctuations we experienced*" – P2. Managing pricing risk was crucial for accurate budgeting and cost control throughout the project, requiring adaptability and proactive measures to address the dynamic market conditions.

Concerning estimating risk, participants indicated encountering difficulties in accurately estimating project costs and timelines due to the uncertainties brought about by the pandemic. They indicated that they employed data-driven estimation techniques, conducted thorough risk assessments, and incorporated contingency plans to account for unforeseen circumstances. By leveraging historical data and industry knowledge, they aimed to make more informed projections and mitigate potential cost overruns or delays. Effective management of estimating risk involved proactive planning, flexibility, and a comprehensive understanding of the unique challenges posed by the pandemic.

4.4. Mitigating Strategies to Minimise Uncertainty and Impact, and Safeguard Project Delivery

Additional themes were formulated from data emanating from both questionnaires and interviews summarised into five themes discussed below addressing strategies utilised to minise uncertainty and impact to project delivery:

4.4.1. Adoption of virtual platforms during social distancing restrictions to ensure continuity of project meetings

Quantity Surveyors utilised virtual platforms to facilitate project meetings and ensure continuity during social distancing restrictions caused by the pandemic. Additionally, they embraced digital tools and software to improve cost estimation accuracy, project monitoring efficiency, and communication streamlining. The adoption of effective cost management practices, including resource optimisation and budget monitoring, allowed Quantity Surveyors to mitigate financial risks. They also emphasised collaboration and communication with project stakeholders, engaging in negotiations, revising payment schedules, and seeking mutually beneficial solutions to address the financial impact of the pandemic, and these engagements were carried out virtually to ensure project continuity.

4.4.2. Efficient risk assessment, contract management, and dispute resolution strategies to mitigate risks

Quantity surveyors employed efficient risk assessment methodologies, diligently managed contracts, and implemented effective dispute resolution strategies to mitigate risks effectively. Through conducting comprehensive risk assessments, they identified potential hazards and vulnerabilities within projects, allowing them to develop proactive measures and contingency plans. Through meticulous contract management, quantity surveyors ensured that all contractual obligations were met, minimising the likelihood of disputes arising. In the event of disputes, they employed various resolution strategies, such as negotiation, mediation, or arbitration, to reach fair and amicable settlements. By employing these measures, quantity surveyors played a crucial role in minimising risks and ensuring the successful completion of projects. Quantity Surveyors

played a crucial role in negotiations with suppliers and contractors. They leveraged their expertise in pricing analysis and market knowledge to engage in discussions to secure competitive pricing, manage risks, and ensure the availability of necessary materials for construction projects.

4.4.3. Contingency planning by quantity surveyors during covid 19

During the COVID-19 pandemic, Quantity Surveyors implemented contingency planning as a crucial measure to address estimating risk. They incorporated contingency allowances in their cost estimations to accommodate unforeseen circumstances and potential changes during project execution. By including this buffer, Quantity Surveyors aimed to effectively manage unexpected events and cost variations, minimising the risk of cost overruns and ensuring projects stayed within budget. The adoption of contingency planning played a vital role in maintaining financial stability and project success amidst the uncertainties brought about by the pandemic.

4.4.4. Resource disruptions or supply chain challenges on projects

The findings revealed that Quantity Surveyors explored alternative sourcing options and actively engaged in negotiations to mitigate pricing risks caused by supply chain disruptions. The participants highlighted the importance of maintaining strong communication channels and seeking alternative suppliers or materials to stabilise costs and ensure a consistent flow of construction materials. Additionally, Quantity Surveyors implemented resource management strategies, including workforce planning and skill development initiatives, to overcome labour shortages and skill gaps. The study emphasised the adaptability of Quantity Surveyors in seeking alternative procurement strategies and considering local sourcing options to address supply chain disruptions and mitigate the impact of material cost increases. Overall, the findings revealed the proactive measures Quantity Surveyors took to manage risks and ensure the successful execution of construction projects amidst the uncertainties of the pandemic.

4.4.5. Adaptability and resilience when managing uncertain project plans

During the COVID-19 pandemic, Quantity Surveyors demonstrated remarkable adaptability and resilience in managing uncertain project plans. They swiftly adjusted their approaches, incorporating new strategies and techniques to address the challenges posed by the ever-changing circumstances. Quantity Surveyors remained flexible, actively monitoring and analysing market trends, supply chain disruptions, and health and safety regulations. Their resilience shone through as they proactively developed contingency plans, conducted thorough risk assessments, and collaborated closely with stakeholders to navigate the uncertainties. Their ability to adapt to new information, make informed decisions, and modify project plans accordingly exemplified their strength and professionalism in effectively managing projects amidst the uncertainties brought about by the pandemic.

5. Conclusion

The study employed a mixed methods approach to investigate the strategies employed by Quantity Surveyors in mitigating uncertainty and ensuring the successful delivery of projects in South Africa. Through this mixed methods approach, the study successfully identified a range of approaches including i) adoption of virtual platforms during social distancing restrictions, ii) effective risk management, contract management and dispute resolution strategies, iii) resilience and adaptability, 1v) resource management and contingency planning were used by Quantity Surveyors to minimise uncertainty and safeguard project delivery. These findings contribute to the existing knowledge base in the field and can inform practitioners and stakeholders in making informed decisions and implementing effective risk management strategies in construction projects.

In conclusion, the COVID-19 pandemic had a significant financial impact on construction projects. Quantity Surveyors faced various challenges, including disruptions in supply chains, increased costs, and project delays. However, through effective cost management practices, alternative procurement strategies, collaboration, and leveraging technology, Quantity Surveyors were able to mitigate the financial impact and navigate the complexities of the pandemic. The limitation of this study is that a small qualitative sample was utilised which limits generalisability. The data was also collected in one area in Johannesburg, the results of a larger population sample in different locations may provide different results. It is suggested that a further study with a bigger sample be conducted in the same context to validate the results of the study.

Author Contributions

Pride Ndlovu contributed to the conceptualization, review, investigation, data collection, draft preparation, manuscript editing, methodology, analysis, and validation. James Rotimi contributed to project administration, methodology, draft preparation, review, and manuscript development. Thanuja Ramachandra contributed to draft preparation and manuscript editing. All authors have read and agreed with the manuscript before its submission and publication.

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