

Impact of Material Price Volatility on Construction Project Budgets

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Abstract

The construction sector is especially sensitive to price variability in materials, something that can have a major impact on project expenses, schedule, and general fiscal feasibility. In this research, the effect of material price variability on construction project budgets is examined with an emphasis on determining pivotal materials most vulnerable to price variation, determining how such variability impacts cost estimates and financial management, and measuring counterstrategies implemented by construction practitioners to counteract these effects. By way of literature review, case study analysis, and interviews with stakeholders, the study identifies that fluctuating prices of the primary construction materials like steel, cement, and timber tend to cause budget overruns, re-negotiation of contracts, and project delays. The results also confirm that efficient risk management practices, including the application of escalation clauses, adaptable procurement approaches, and instantaneous market analysis, are key to reducing the negative effects of price volatility. This research highlights the necessity of effective cost management and policy measures to promote the resilience of construction budgets against market uncertainty.

1. Introduction

1.1. Background of Material Price Volatility

Price volatility of materials in construction has serious implications for project managers and contractors. Current oscillations, triggered by the COVID-19 pandemic and subsequent supply chain congestion, have triggered volatile cost hikes, with no stability in sight. Contributing factors toward uncertainty include tariffs, trade barriers, and geopolitical tensions, while increased demand from single-family residential projects imposes additional strains on budgets.

These changes in prices affect the feasibility and project timelines, as construction firms experience shortages of materials and rationing. Delays caused by these instances affect labor schedules and deadlines, compelling contractors to adjust quickly without spending much and losing quality.

Budgeting tends to become more challenging as initial projections can immediately become obsolete because of a change in market conditions. Given that the construction industry is highly responsive to economic changes, inflation directly tends to skyrocket costs, especially as building materials directly account for 35% to 60% of all construction costs. The stakeholders need to keep an eye on such price fluctuations.

In order to counter material price volatility risks, there must be proactive management and strategic planning. Including contractual clauses can make distribution of risks among all interested parties, and open communication with suppliers regarding availability and substitutes can offer flexibility when required.

Comprehension of the intricacies of material price volatility and proactive action to eliminate them can result in better financial performance and easier project execution in construction.

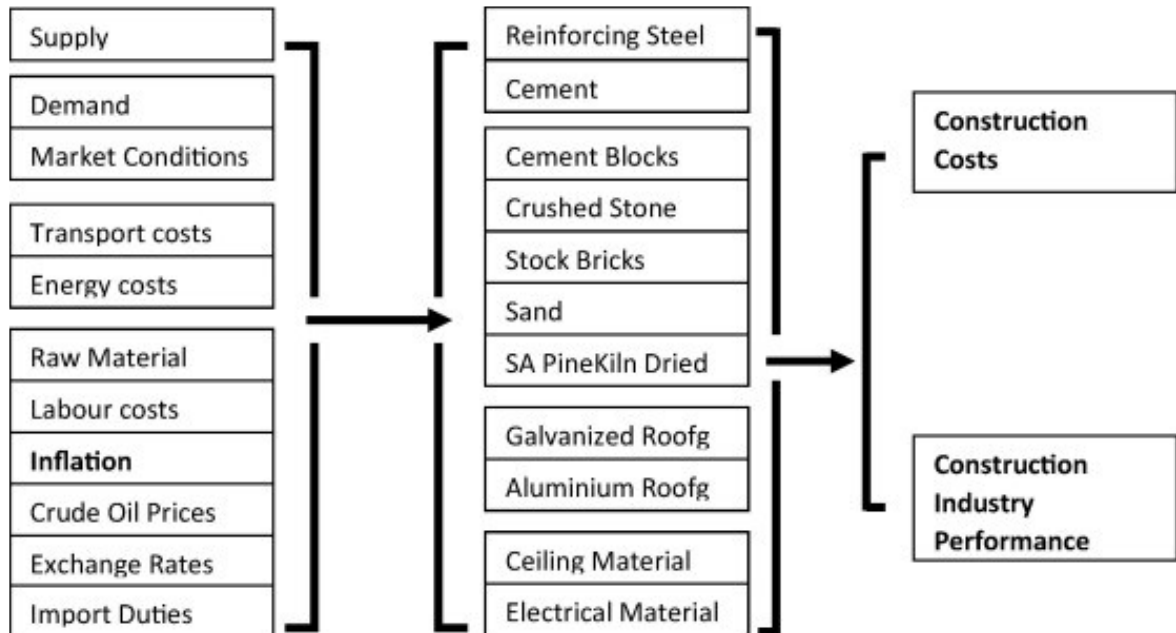


Figure 1

1.2. Significance of Budgeting in Construction Projects

Good budgeting in construction is essential because the cost of materials in construction is unpredictable due to events such as economic inflation, supply chain breakdowns, and geopolitical situations. Good budgets enable stakeholders to prepare for these uncertainties by providing a financial plan for expecting cost increases during the project.

Strategic budgeting is also a risk management strategy because materials usually comprise 35% to 60% of the overall costs. Unexpected price hikes will trigger cost overruns and make projects infeasible, particularly with global supply chain problems and labor shortages that have been brought about by crises such as the COVID-19 pandemic.

Contractors must apply pro-active budgeting strategies, such as frequent reviews of budgets according to market trends and industry index insights. The early involvement of estimators can reduce price volatility risk by taking all the variables into account when budgets are finalized.

Clear contractual terms about financial obligations are crucial for aligning expectations between clients and contractors. Having provisions for coping with price hikes—e.g., provisions for material price escalations—may circumvent disagreements about unforeseen costs. This anticipation enhances stakeholder relations and minimizes delays due to budget renegotiations.

Ultimately, effective budgeting is crucial in addressing challenges arising from volatile material costs in construction works. Through the adoption of sound financial management and ongoing observation of market trends, contractors maximize opportunities to realize project success in the face of uncertainty.

1.3. Goals of the Document

The central purpose of this paper is to investigate the intricate phenomenon of material price volatility in the construction industry and their direct effects on project cost estimation. As projects in the construction industry greatly depend on materials whose prices may change based on various market factors, this paper endeavors to give interested parties such as project managers, contractors, and financial analysts a better insight into these price patterns. By highlighting the volatile tendency of material costs, the present study highlights the need to integrate solid forecasting methods into budgeting models. Another important aim is to determine and assess the major determinants of fluctuations in material prices, including labor shortages and supply chain breakdowns. Accurate knowledge of these factors can enable stakeholders to create strategies that minimize financial risks caused by unexpected cost hikes. Moreover, this paper will make a contribution to what is already out there by compiling historical trends and empirical evidence of material price behavior. Additionally, the research aims to explore efficient ways of gathering and analyzing data related to material price prediction in building projects. Through the use of cutting-edge data-driven methods, this study aims to improve the precision of predictive models guiding budget considerations. Ultimately, the goal is to lay down a paradigm for better decision-making processes that can ensure enhanced budget control and reduce the incidence of cost overruns.

In summary, this paper seeks not only to contribute to scholarly debates on material price volatility but also to provide real-world insights for industry practitioners who are aiming to exercise financial conservatism in the face of uncertain market conditions. These purposes together highlight the importance of an active response to both expected and unexpected variations in material prices over the lifecycle of building projects.



[Figure 2](#)

2. Review of Literature

2.1. Historical Trends in Material Prices

Over the past few decades, prices of construction materials have been very volatile as a result of numerous economic influences and global events. Significantly, since late 2017, costs rapidly increased as a result of trade disputes that raised tariffs on crucial materials, putting upward pressure on inflation caused by the COVID-19 pandemic.

As the pandemic took hold in early 2020, supply chains were severely disrupted, hindering production and delivery while simultaneously increasing demand for home renovations and new projects. This resulted in record prices for essential materials such as lumber and steel, with numerous building products seeing price hikes of over 15% year-to-date by the beginning of 2021. Nonresidential construction input costs increased by a staggering 42.5% between March 2020 and March 2022, as per the Producer Price Index (PPI). Certain materials witnessed even sharper price hikes; steel mill products doubled in price, and some wood categories increased more than 400%. These changes also affected availability of material and resulted in huge delays in the projects because of increased lead times from supply chain problems. Contractors indicated widespread anxiety, and 97% experienced moderate to extreme operational effects in late 2021. The increased cost impacted different kinds of projects, especially residential projects, which had special challenges since homeowners moved quickly to renovate in the post-lockdown period.

Though some of the material prices did soften by the early part of 2022, most continued to be higher than pre-pandemic levels. Continued geopolitical tensions and ongoing inflation indicate prices are likely to settle at new equilibrium levels instead of reverting back to former norms.

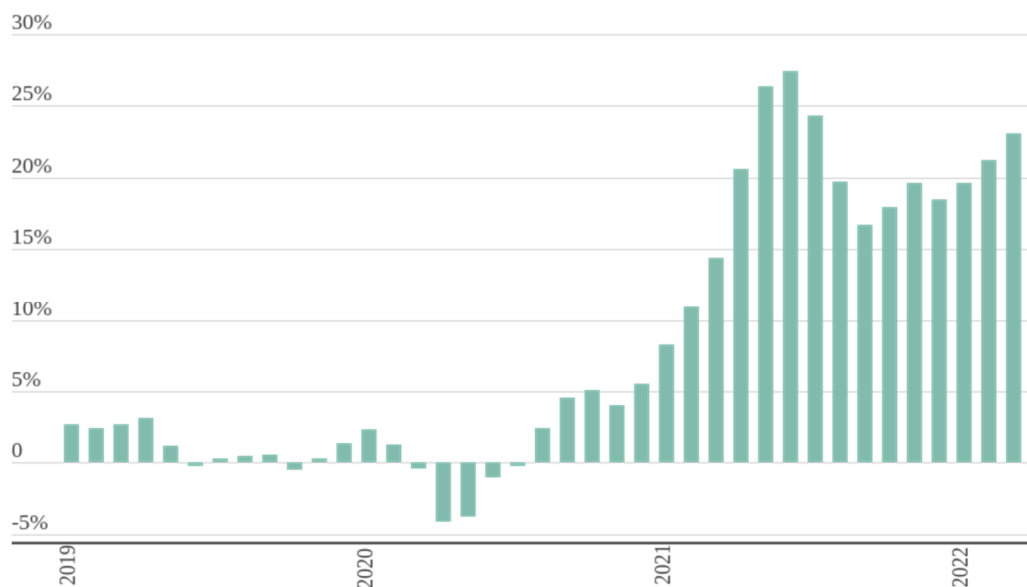


Figure 3

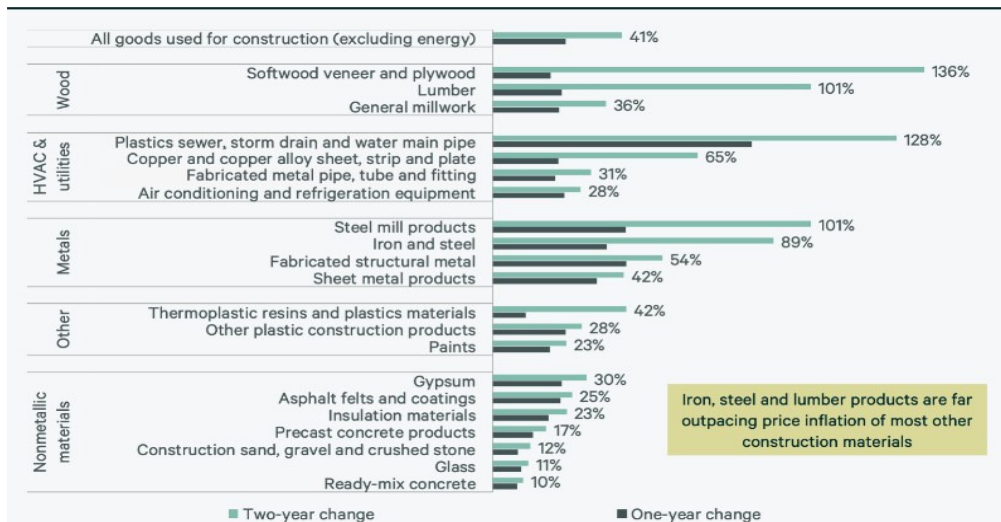


Figure 4

Material	Last 6 months	Last month
Lumber	57%	4%
General millwork	11%	1%
Fabricated structural metal	11%	0%
Machinery and equipment	8%	1%
Sand, gravel and stone	6%	1%
Gypsum	6%	2%
Ready-mix concrete	4%	0%
Thermoplastic resins and plastics materials	-7%	-2%
Iron and steel	-4%	-1%

Figure 5

2.1. Influence of Project Budgets from Earlier Studies

The constant material price fluctuations have long been a major problem for the construction sector, significantly impacting project budgets and timelines. Studies have indicated that such price fluctuations lead to significant budget overruns, with materials constituting 60-70% of direct project expenses. For example, in the COVID-19 pandemic, prices of major materials such as steel and timber skyrocketed—increases of more than 400%, according to some reports—putting unforeseen financial pressure on developers and contractors. Volatility makes budgeting a challenge, with stakeholders finding it harder to fulfill their own financial commitments. Construction professionals tend to complain that price volatility happens so rapidly that there is not enough time for adequate contingency planning. A survey performed by the U.S. Chamber of Commerce determined that a staggering 97% of contractors found themselves with moderate to severe

effects from the variable cost of materials on their companies' operations. This experience highlights the dramatic challenges that come with uncertain prices for crucial materials like steel and wood.

In addition, external pressures such as tariffs also compound these problems. As new tariffs loom, most companies are revising contracts to reflect terms that account for possible price hikes from market fluctuations. This precautionary tactic serves to reduce risk but also indicates a recognition of the persistent uncertainty of material prices.

Studies in this field reveal a general agreement that better material management is essential in order to reduce delays and budget overruns due to erratic prices. An algorithm that predicts delays due to material issues illustrates how systematic techniques can result in successful outcomes in project management plans under such unpredictability.

Overall, existing literature stresses the need for effective risk management measures in construction projects, as material prices remain prone to volatility. By incorporating findings of existing literature in planning and executing future projects, stakeholders can learn to cope better with the issues while striving towards more stable budgeting results amid volatile costs.

2.1. Key Factors behind Material Price Fluctuations

The volatility of material costs in the building industry stems from a delicate mix of different factors. Centrally is the precarious supply-and-demand balance that dictates trends in the market. As construction activity rises, demand for the materials usually outpaces available supplies, causing spikes in prices. On the other hand, during economic recessions or situations of diminished demand, suppliers cut prices to dispose of excess supplies, which fuels this price volatility.

Geopolitical influences also contribute to these cost fluctuations. Political instability may interfere with established supply lines, leading to shortages and increased costs. Global events over the past few years have shown us this, where trade restrictions or sanctions have led to sudden spikes in costs for critical materials such as steel and concrete.

Besides, there are environmental considerations. Natural disasters can suspend production and interrupt transportation systems, with far-reaching impacts on the availability of resources. Disruptions to this system tend to create sudden and volatile price increases as desperate suppliers vie to fulfill pressing needs in the wake of inclement weather.

Inflationary forces add another layer of difficulty to the material cost landscape. Chronic inflation affects not just raw materials' prices but also labor costs, and it creates a ripple effect that affects project budgets. The higher the inflation level, the more contractors' purchasing costs increase, which are notoriously difficult to forecast against long project horizons.

Speculation in the market adds a further degree of complexity to such price shifts. Traders often respond to apparent scarcity or future demand that is expected but not yet present, rather than existing conditions in the market, increasing uncertainty for construction managers who have to create credible budgets.

Lastly, innovations in technology also impinge on pricing dynamics. Advances like engineered timber offer substitute solutions that could dampen classic market variability by encouraging more stable pricing when standard materials are volatile.

In short, comprehension of these key drivers—interplay between demand and supply, geopolitical stability, environmental factors, inflation rates, speculation, and technological innovation—is essential for construction players who want to steer through the predicaments created by material price volatility in their projects.

3. Research Methodology

3.1. Data Collection Methods

Data collection for the study entailed the use of a mix of historical data analysis, expert interviews, and sector-wide surveys. Historical information on material prices was collected from different databases and industry reports to give an overall picture of price trends over time. This encompassed records of prices for fundamental building materials such as steel, cement, and aggregates from credible sources such as government publications, industry associations, and commercial databases.

As part of the historical information, consultations were conducted with seasoned practitioners in the industry, such as project managers, contractors, and estimators. These meetings were meant to provide qualitative information on what influences material prices and how price volatility impacts the budget of projects. The experts provided information based on their experiences on price changes and how such changes have affected their decision-making for various projects.

Surveys of a broader segment of the construction sector were also undertaken to gather quantitative data. These surveys queried participants regarding their experiences with volatility in material prices, budgeting response to volatility, and efficacy of risk management methods employed in their projects. The integration of qualitative input from expert sessions and quantitative data from surveys provided more comprehensive insight into material price volatility's impact on construction budgets.

Data cleaning was instrumental in ascertaining the validity of the information obtained. Historical data received thorough cleansing measures to correct for missing values or variations in reporting formats. Normalization procedures were also used where need be to ensure a common ground for comparison across datasets.

As a whole, it allowed for the intensive examination of construction material price volatility by combining historical patterns and present practices seen across the industry.

3.2. Analysis Techniques Used

Throughout this research, numerous analytical methods were utilized to determine the impact of material price fluctuations on construction project budgets. Causal modeling was the main method utilized, and it combined supervised machine learning models to support predictive analysis. Historical material cost data, combined with supporting economic indicators, were used as input features for such models. Using this method enabled the detection of patterns and trends that drive price volatility.

Preparation of data was also a vital step here, incorporating sensitive preprocessing of past data to remove noise, correct missing values, and make it uniform through normalization. Feature engineering was also significant, where key variables were chosen to refine model accuracy. Standardization was one technique used to deal with features with different scales.

The choice of suitable algorithms was based on dataset size and model interpretability. Supervised machine learning methods, such as Multiple Linear Regression (MLR) and Artificial Neural Networks (ANN), were explored. MLR is usually preferred due to its simplicity, whereas ANN is appreciated for its ability to identify nonlinear relationships in complex datasets.

Once the models were trained through techniques such as gradient descent or stochastic optimization, model performance needed to be measured. This meant implementing cross-validation methods to determine generalizability by repeatedly splitting datasets into training and validation sets. Measures such as Mean Absolute Error (MAE) and Root Mean Square Error (RMSE) were employed to measure prediction accuracy.

Outside of one-point point predictions that are deterministic, others have turned towards probabilistic forecasts to better account for price forecast uncertainties by predicting ranges or intervals that capture likely potential variability in the cost of materials. This recognizes that one-point forecasts won't adequately capture the risk borne by variability in material costs.

In addition, continuous tracking and analysis of market trends are advisable across project lifecycles. Through learning from local contractors and using historical project data combined with industry cost indices, estimators can create educated strategies that dynamically adjust to changing market conditions.

4. Objective of the Study

The objective of this study is to investigate the intricate problems of material price fluctuations in the construction industry and how they affect project budgets. As material costs form a major percentage of total project costs, the research hopes to ascertain the primary drivers behind these price fluctuations—i.e., interruptions in worldwide supply chains, inflationary pressures, and demand dynamics shifts. Through a close analysis of historical evidence and pertinent case studies, this research seeks to shed light on how these variables have influenced project budgets and timeliness throughout history. In addition, this study aims to come up with realistic solutions for project managers and contractors to both anticipate and handle material cost variations. These solutions will involve new budgeting methods incorporating contingency funds in the case of price hikes, how to negotiate with suppliers to get more stable prices, and determining alternative materials that are still of high quality but offer costs savings.

Moreover, the research will provide constructive suggestions supported with empirical data to help construction professionals make adjustments in their budgeting processes under conditions of uncertainty.

By improving material pricing mechanism knowledge and its implications for financial provisioning in construction ventures, this study will enhance decision-making potential among stakeholders.

By means of close scrutiny of information obtained from different projects across the globe, this study aims not only to identify the risks given by material price volatility but also intends to determine effective avenues for risk management in construction projects.

5. Materials and Methods

5.1. Types of Materials Examined

This research performs an in-depth examination of different construction materials in order to uncover the intricacies of their price volatility and the resulting implications on project budgets. The following materials are examined: those basic materials that are crucial in construction like steel, concrete, wood, glass, and insulation materials. Steel is frequently put into the limelight for the integral purpose it serves in giving structural strength and for its important contribution to overall construction expenses. Concrete is also examined for its pricing volatility, which is often driven by supply chain factors and regional procurement strengths. Wood plays a significant role in most projects, particularly in domestic construction, where it is used both structurally and for its appearance. Prices can fluctuate drastically as a reaction to demand in the marketplace and external events such as wildfires or legislation governing forest logging. Glass items are also researched for their pivotal functions in contemporary building design and energy efficiency but are vulnerable to prices impacted by global trade wars and shifts in manufacturing processes.

Insulation products are part of this investigation due to their significance when ensuring buildings meet energy efficiency requirements, as various types of products on the market carry different cost considerations. The study cites that all of these products can represent a high percentage—very frequently between 30% and 40% of overall project expenses—meaning that changes in their prices can have huge budget impacts.

Additionally, the research investigates how various types of projects (commercial vs. residential) can impact material selection and budgeting plans. The differences based on project classification uncover the intricacies in managing the costs of materials in various construction contexts.

Through an extensive analysis of these materials, this study seeks to identify patterns of volatility that can enhance forecasting methods for budgeting allocations in construction projects.

5.1. Project Types in the Study

The study takes into account a broad selection of project types in order to fully analyze how changes in material prices impact construction budgets. The most important categories are residential, commercial, industrial, and healthcare developments. Residential projects include single-family dwellings, multifamily dwellings, and mixed-use establishments. Such projects are frequently considerably influenced by trends in material costs because they rely heavily on local marketplace influences and consumer tastes.

On the business side, projects include buildings like office space, shopping malls, and business parks. Such builds typically must comply with certain zoning regulations and operational expenses that can greatly differ with location and project scale. The intricacies involved in such projects make cost management even more challenging, as it calls for accurate estimates of permits, inspections, and environmental studies.

Industrial construction projects such as manufacturing plants, warehouses, and distribution centers are included in the category. These projects are most likely to be affected by price volatility through global supply chain forces. Specialized materials commonly cause more likelihood of cost overruns than typical residential or commercial construction.

Healthcare construction has only recently begun to attract more attention as it has special needs. Medical facilities and hospitals require cutting-edge material that must meet stringent health codes yet face volatile prices on must-have items like steel and concrete. Rising material prices resulting from soaring demand for these rapid expansions in healthcare during health crises only add to the uncertainty within healthcare. By analyzing these diverse project types, the research aims to uncover patterns regarding how price volatility affects budgeting strategies across various sectors, while also emphasizing challenges specific to certain industries that may require customized financial solutions. This approach seeks to improve the understanding of the obstacles faced by contractors and stakeholders who must navigate the unpredictable terrain of construction material costs.

6.Results and Discussion

6.1Summary of Findings on Cost Impacts

The random volatility of material price movements has profound impacts on costs associated with building projects and affects both budgets and schedules. Unanticipated spikes in material prices can result in significant hikes in total project cost, frequently resulting in budget overruns. Confronted with escalating costs, contractors are confronted with a difficult dilemma: to either absorb the extra fees or pass them on to their customers. Sopping up these added costs can tightly constrict profit margins, restraining a firm's ability to finance additional projects or add more employees. On the other hand, transferring these expenses to customers may make new builds less attractive, which could then diminish market demand. The effects of postponed material deliveries are just as damaging. Supply chain loss can lead to significant delays in projects, imposing extra financial burdens as construction firms pay more for labor and equipment rentals in prolonged schedules. These delays not only increase current costs but also lower client satisfaction and harm a contractor's reputation.

Evidence indicates that the economic pressures from material shortages and rising costs can hamper good project management. Overruns in costs often result in lower productivity in labor and make administrative processes like profit-and-loss reporting for stakeholders more complicated. These issues automatically increase tensions between project teams and subcontractors, which adversely influence overall work quality.

In order to offset the risks of volatile material prices, numerous companies are increasingly incorporating escalation clauses into contracts. By enabling price change-adjusted adjustments, such clauses ensure equitable sharing of financial risks between customers and contractors. Moreover, embracing robust procurement practices—such as bulk buying and effective waste management—can help stabilize budgets against surprise price increases.

In conclusion, continued volatility in material costs poses many challenges that have the ability to interfere with construction operations at multiple stages. Companies need to remain alert with their financial projections and implement good risk management strategies so that they can navigate this complicated scenario effectively.

6.2. Implications for Project Management Practices

Amidst the unpredictable tides of material pricing, project management methodologies must need to develop to effectively manage the complexities and risks associated with these fluctuating costs. A proactive mentality is essential. Nurturing open communication among all stakeholders—contractors, suppliers, and clients—fosters a collaborative environment where risks can be discussed freely and contained. These interactions set the stage for forecasting obstacles and developing strategies particularly aimed at managing price volatility, thus reducing its blowback on project budgets and schedules.

Flexibility is another pillar of successful project management in this dynamic environment. Construction managers need to encourage flexibility by coming up with contingency plans that include substitute materials and flexible project timelines. This may involve locating alternative materials or adjusting construction schedules to factor in supply chain disruptions. Phased project completion may also help decongest pressure at moments when necessary materials are in short supply, so teams can focus on less affected areas. In addition, accurate prediction of material requirements is critical to saving on costs. Contractors should base their procurement plans on thorough project descriptions that include potential waste and scope changes. Through the right quantities in advance, they can avoid runaway costs associated with overbuying or the loss of time due to shortages. Scenario planning is a valuable tool for contractors to manage price volatility. By simulating different cost scenarios and possible supply chain disruptions, contractors can acquire the insight to make informed decisions about material acquisition and budget changes.

In the matter of contractual contracts, it is important that contracts be unequivocal as to how risks relating to material cost variations are to be managed. This may include terms such as risk-sharing policies among contractors and clients or tying up material prices with market indices for a more adaptive response to fluctuations.

In summary, integrating these strategic approaches with project management practices not only reinforces resistance to market volatility but also creates increased confidence among all the stakeholders participating in construction projects.

6. Summary and Conclusion

Material price fluctuations pose a key challenge to the construction industry, impacting different aspects of project management. These price variations are determined by a number of factors, such as economic recessions, political instability, and supply chain problems. Hence, stakeholders increasingly find it difficult to properly plan and estimate project finances.

An important aspect of managing these price movements is creating contractual arrangements that will specifically lay out how risks are distributed between all the parties touched by the project. The use of measures like escalation clauses on materials and change-in-law provisions can assist contractors in safeguarding themselves from unforeseen cost escalations triggered by market behavior or tariff changes. Further, proactively setting in motion such interventions as signing up for early buying contracts and hoarding required material can prove potent safeguards against the economic uncertainty borne of volatile pricing. The need for flexibility in material choice is also critical. Venturing into substitute materials can result in huge savings while enhancing responsiveness to shifting market trends. Innovative material use in projects that excel generally exhibits greater compliance with budgeted plans and are less likely to exceed deadlines, emphasizing the need for building teams to be aware of upcoming developments in material availability.

In addition, keeping communication lines open between all interested parties is important during times of price instability. Keeping customers up to date about possible cost overruns can create trust and facilitate joint problem-solving, ultimately resulting in better project results.

Overall, successfully addressing the issues presented by material price volatility calls for an integrated method that involves detailed planning, intelligent contracting, aggressive procurement, and effective communication. By embracing these methods, construction professionals are able to handle risks effectively while keeping projects within cost limits.

7. Recommendations for Further Research

Future research should explore the complex dynamic of material price volatility in construction, specifically looking at how different variables are related to each other. One promising area of research is the creation of predictive models incorporating not only past pricing dynamics, but also current market fluctuations and economic signals. These new models have the potential to fundamentally improve decision-making in project management and financial planning.

Furthermore, it is important to analyze how particular geopolitical variables affect material prices, examining how trade policies, tariffs, and political instability can lead to price fluctuations. A regional or country-level

comparison might show methods in which local economies respond to insulate themselves from world price volatility.

Another potential research area is the evaluation of the different strategies contractors use to deal with budget overruns due to price volatility in materials. This may involve case studies comparing the benefits of developing long-term relationships with suppliers with a diversified procurement strategy. In addition, the use of technology in buying—e.g., using blockchain for greater transparency or artificial intelligence for accurate demand forecasting—can dramatically minimize risks due to supply chain disruptions.

Additionally, future research must investigate algorithmic approaches to forecasting delays and cost overruns associated with material problems. Developing user-friendly programs as a result of this study would allow for more streamlined on-site management and allow for proactive project adjustments during execution.

Lastly, analyzing the psychological impacts of material price fluctuations on all parties involved—project managers, clients, and contractors—may provide useful insight into risk perception and decision making in the construction sector. Knowledge on these psychological factors can make training programs more effective at preparing professionals with good strategies for coping with uncertainties in material prices.

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