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STRATEGIES FOR OPTIMISING SCHEDULE MANAGEMENT DELAYS OF RESIDENTIAL PROJECTS IN CHINA: A CASE STUDY OF YUN YUE DONG FANG PROJECT

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ABSTRACT

Chinese residential developers face complex challenges during the construction process. In particular, schedule management often becomes uncontrolled, leading to delays that hinder timely fund returns and economic losses, and inevitably reputational damage. Grounded in the theory of project progress management, this study uses the Yun Yue Dong Fang (YYDF) project in China as a case in point to explore and rank optimization strategies for schedule management. As a qualitative study, semi-structured interviews were used to gather data from seven project managers from seven participating developers. Participants included key decision makers, such as contractors and supervisors from the study sample. Interview data were coded and analyzed in NVivo for classification and theme extraction. Six key optimization themes were identified, namely optimization in construction, communication, project planning, design, procurement, and funding. The findings highlight strategies applicable to clients and construction units and emphasize the need to strengthen management and control across units and links in the delivery chain. The study also provides a reference value for the management schedule of project progress in Chinese residential development companies. The six strategies identified possess conditional cross-regional adaptability. Although construction projects commonly suffer from management fragmentation and difficulties in resource coordination, the proposed strategies can inform residential development projects in other developing countries or emerging markets after appropriate localization. Overall, this in-depth case study translates theory into practice, providing an empirically derived, ranked set of strategies for mitigating schedule delays, and offers actionable guidance for stakeholders seeking to stabilize schedules, secure cash-flow cycles, and protect corporate reputation.

Keywords: Residential projects, construction process, schedule management delays, optimization strategies.

INTRODUCTION

With the rapid development of China's residential construction industry, there are currently serious problems in project schedule management in the residential construction process. According to the statistics of China's National Bureau of Statistics, China's construction investment from January to December 2023, was 110,913 billion yuan. In particular, the residential investment was 8,382 billion yuan, and the residential investment accounted for 75.6% of the total property investment. This shows that the future property market is still dominated by commercial residential projects. Among the many elements of project management, improving the project schedule as an important part of the project management process can lead to the successful completion of the project and significantly reduce the associated costs (Habibi et al., 2018). Therefore, project schedule management is particularly important for housing development companies. Data from the People's Court Bulletin Network shows that 233 construction companies in China will be declaring bankruptcy in 2023 alone. In addition, more and more small and medium-sized construction companies are choosing to rely on other companies and asset restructuring to survive, which also reflects the importance and urgency of cost management for construction companies.

Many complex issues and challenges arise throughout the lifecycle of a construction project. Among the many issues faced by these projects, schedule optimisation is an important issue (Terzis, 2022; Yu et al., 2023). There are many factors that affect the construction schedule of a project. Time management and deadlines are the top priorities in project schedule management (Delisle, 2019). Despite the proven importance of project schedule management, most construction projects, both in developing and developed countries, still face the problem of neglecting schedule management. This negligence has become a global and long-term problem (Durdyev et al., 2017). Therefore, schedule optimisation of construction projects is particularly important, and project schedule management is the pillar of decision making in project management (Camacho et al., 2018). Meanwhile, a large number of scholars have studied project schedule management and presented a rich research foundation. However, most of the research remains at the theoretical level, and there are few studies on optimisation strategies for actual projects. Therefore, the issue of providing practical applications is still far from being resolved. Moreover, few studies have gone deep into actual project cases to collect first-hand information as project participants and conduct research of actual projects.

In light of the foregoing discussion of project schedule management issues in the construction industry, Taizhou City, Zhejiang Province has been selected as the research site for the present qualitative research on the optimisation strategy of project schedule management. The research objective is to propose optimisation strategies and safeguards for the schedule management of residential construction projects in China. The practical significance of this study is that it will be beneficial for Chinese residential development enterprises to understand the role of the stakeholders who may affect the project schedule in project schedule management. According to the optimisation strategy it is necessary to avoid project schedule risks in advance, and to effectively manage and control the project schedule. At the same time, it is also beneficial for Chinese residential developers to implement upfront optimisation measures to eliminate or mitigate adverse impacts and reduce project development risks.

LITERATURE REVIEW

Project Schedule Management Theory

Through the research of many scholars, the theory of project management has become comprehensive. With the development and expansion of theory, project management has gradually been applied to business development strategies to manage the allocation of limited resources across projects so as to improve business efficiency and corporate competitiveness (Rusnak et al., 2021). The development of a robust Construction Project Schedule (CPS) is one of the main factors influencing the success of construction

projects (Derbe et al., 2020). The Gantt chart was developed and popularised by Henry Gantt between 1910 and 1915 (Gantt, 1913). The emergence of the critical path method (CPM) in 1956 marked the starting point of modern schedule management methods, which have helped to optimize the project execution sequence by identifying the CPM (Yaqin et al., 2023). However, the CPM assumes that the duration of all tasks is certain and lacks sensitivity to uncertainty and risk factors in the actual construction environment, limiting its applicability in dynamic and complex projects (Hendradewa, 2019). To overcome the disadvantage of fixed values for the duration of each work in the CPM, the Project Evaluation Review Technique (PERT) was developed in 1958 by the US Navy's Office of Special Programmes (Astari et al., 2021). PERT improves the ability to handle uncertainty by introducing probability distribution, such as beta distribution, to estimate task duration. However, its practical application in large projects is limited by computational complexity and the lack of modelling of logical relationships between tasks (Duc, 2024).

It was not until 1964 that the former Soviet Union combined years of experience in engineering organisation and management to propose the network planning technique (Gerovitch, 2008; Lamy, 2011). It provides a more systematic methodological support for resource allocation and schedule scheduling. The subsequent development of the Work Breakdown Structure (WBS) (Zecheru & Olaru, 2016), Monte Carlo simulation techniques (Kroese & Rubinstein, 2012) and the Earned Value Method (EVM) (H. L. Chen et al., 2016) further improved the accuracy and systematicness of schedule and cost management, making project management more optimal. In 1984, the Project Management Body of Knowledge was proposed by the Project Management Institute of the United States, and the International Standards Organisation (ISO) used this body of knowledge as a framework and eventually developed the international standard ISO10006 (Quality management systems - Guidelines for quality management in projects) (Jumaa & Khaleel, 2022). Although the above theories and methods occupy a core position in traditional project management, their static modelling and feedback capabilities for actual execution deviations are still insufficient when dealing with challenges such as high complexity, dynamic changes, and multi-party collaboration in contemporary residential construction projects (Liu et al., 2023). This reveals the urgent need to develop more adaptive schedule management strategies to better support the achievement of project goals. Therefore, the present YYDF residential project study through its case analysis and interviews with senior practitioners, has been able to identify and optimize the core strategies for schedule delays, and provide a more operational and forward-looking schedule optimization strategy for Chinese residential projects.

Project Schedule Management Techniques and Tools

This section divides scheduling techniques into the following two categories: traditional methods and modern tools, in order to present their evolution and limitations more clearly. Manual methods that can be used to calculate critical paths and their durations are the network-based CPM and the PERT (Bagshaw, 2021). Network Plan Mapping is an internationally used planning and management method, also known as the CPM or the PERT. It is considered one of the most scientifically advanced methods used as a management tool in the planning and organisation of projects (Rashed & Alnassar, 2021). The CPM is a deterministic method widely used for projects with fixed duration and cost (Akram et al., 2024). On the other hand, the PERT method is used for research projects as it is a probabilistic method with no specified duration or cost (Kenar et al., 2023). Although the CPM and the PERT laid the foundation for project scheduling in the second half of the 20th century, they failed to fully consider factors such as resource constraints, concurrent task conflicts, and external environmental variables that are common in real construction. These methods usually assume that the logical relationship between tasks is linear and static, and lack the ability to respond to multi-project collaboration and rapidly changing requirements (Chaudhary & Meshram, 2025). In addition, the increasing complexity of construction projects has made planning and coordination work dependent on a large amount of paperwork, which has increased the difficulty of management (Kholil et al., 2018).

To meet these challenges, project management software systems have emerged. These modern tools include the following: Microsoft Project (Desai et al., 2023), Primavera P6 (Ninpan et al., 2024), and more

collaborative and visual platforms such as GanttPro, BIM 360, CoConstruct, Open Workbench, DotProject, JIRA and Smartsheet (Desai et al., 2023). These tools can automatically generate critical paths, resource allocation and progress tracking, significantly improving management efficiency. However, although existing scheduling tools have strong functional integration capabilities, they still require manual intervention when facing dynamic progress changes, such as sudden delays and resource mutations, and their intelligence and predictive capabilities are relatively insufficient (Chong et al., 2025). This is especially the case in construction projects, complex supply chain networks and multi-trade collaboration, which often place higher demands on the real-time adaptability of plans.

Project Schedule Management Factors

Delays in construction projects are a global problem and are influenced by a variety of factors. Delay can be defined as a situation when events occur later than expected and are completed later than expected; when action is not taken immediately; or when events occur after the date specified in the contract (Sanni-Anibire et al., 2022). As a long-standing and common problem worldwide, most construction projects suffer from schedule delays due to project schedule management problems (Bajjou & Chafi, 2020). Research shows that although the factors of delay vary across regions and project types, there are always several core factors that frequently appear in delay events and have a substantial impact on the progress of construction projects. Yin et al. (2025) believes that there are many factors that affect the progress of a project, mainly issues such as funding, technology, materials, and human factors. Gunduz and Yahya (2018) proposes that the contribution of these factors to project performance can be evaluated based on the three criteria of "schedule, cost, and quality." However, the latest empirical research points out that among the many contributing factors, financial problems, such as payment delays and poor capital turnover, material shortages and supply chain delays, lack of on-site coordination, and communication barriers constitute the three most frequent and critical factors in construction project delays (Fashina et al., 2021). In addition, Durdyev and Hosseini (2020) have summarized the ten most common factors of Construction Project Delays (CPDs), and these included climatic conditions, poor communication, lack of coordination and conflict among stakeholders, ineffective or improper planning, material shortages, financial problems, payment delays, equipment or plant shortages, lack of experience or qualifications, or capabilities among project stakeholders, labor shortages and poor site management. More importantly, these factors which can delay projects do not occur in isolation, but interact and overlap through systematic paths. For example, funding issues often lead to delays in material procurement and limited mobilization of construction resources, while insufficient site management may amplify the chain effects of these resource allocation obstacles on project progress (Lyneis & Ford, 2007). The out-of-control delays caused by the interweaving of these multiple factors will make it difficult for a single-dimensional management strategy to work. However, most of the existing literature reveals that projects often use quantitative statistics or questionnaire survey methods to discuss delay factors, focusing on impact frequency and the importance of evaluation, and lacks in-depth research on summarizing systematic optimization strategies of actual projects (Xie et al., 2023). Especially in the context of Chinese residential projects, there is still a large research gap on the logical connection between schedule management strategies and implementation effects.

Therefore, the present study is based on a typical residential project in China, adopts a qualitative case study method, collects data through interviews and analyzes them, systematically identifies the factors affecting the schedule, and further proposes an operational optimization strategy covering core links such as construction, communication, design, procurement, and funding. It provides a practical strategic reference for similar residential projects, thereby improving the systematicness and foresight of project schedule management.

Optimization Strategies for Project Schedule Management

Project planning affects the successful completion of a project. This section systematically summarizes eight types of optimization strategies; explains their importance and interactions, and highlights the

importance of optimization strategies in successfully completing a project. There is a strong dependency between the scheduling and planning of construction projects, and being aware of local government regulations. One cannot over emphasize that all construction parties must be aware of these official regulations before starting construction (Faridi & El-Sayegh, 2006). It is important to consider the risk of delay in the contract so that the risk of these contingencies is fairly distributed among the different parties (Le-Hoai et al., 2008). Based on the literature review and field case study results, this study has summarized the eight key optimization strategies for dealing with project delays. These strategies systematically construct the full process path of project schedule optimization from the dimensions of construction, communication, planning, design, procurement, funding, monitoring and future development. The eight specific strategies include the following: construction optimisation strategies; communication optimisation strategies; project planning optimisation strategies; design optimisation strategies; procurement optimisation strategies; project funding optimisation strategies; monitoring optimisation strategies; and future optimisation strategies. These strategies do not exist in isolation, but work together to deal with the problems of uncertainty, complexity and resource conflicts in construction projects through synergy. For example, an efficient communication mechanism can improve the efficiency of information flow between the construction and design stages, thereby reducing rework caused by drawing changes or misunderstandings; and the rationality of the project plan directly affects the procurement progress and the arrangements for on-site construction organization; and if funds are not allocated in a timely manner, even if the design and construction arrangements are reasonable, the project may still fall into a delay crisis. Ling et al. (2009) examined the best project management strategies used in international construction projects in China. Their research found that the top three strategies were as follows: providing high quality responses to perceived changes; effective control of technology transfer risks; and strict adherence to contractual requirements. In addition, timely payment, providing a good information presentation during bidding, timely completion of design, worker motivation and morale, capacity building training, good logistics management (especially about transportation), top management support, and site location were also identified as strategies to mitigate project delays (Banobi & Jung, 2019). Therefore, in the following eight sub-sections, which are based on a large amount of data gathered from the research carried out in the actual study, this article will conduct an in-depth analysis of these eight strategies one by one, aiming to explore their actual application paths, optimization mechanisms and implementation effects, and provide theoretical support and practical guidance for improving the progress management level of China's residential construction projects.

Construction Optimization Strategies

Project schedule performance is better when contractors and external groups, for example, government and suppliers adopt appropriate financial, economic and educational policies (Habibi & Kermanshachi, 2018). Optimising the scheduling of subcontracted projects from the contractor’s perspective can improve schedule performance (Kerkhove & Vanhoucke, 2020). Mostafa et al. (2021) found that faster contractor response saves time and resources, reduces project risk and improves contractor reputation. Hiring competent firms can reduce problems such as poor quality and slow response (Zulkifli et al., 2021). Aibinu and Jagboro (2002) suggest that project delays can be reduced by accelerating on-site activities and granting sporadic allowances. Bakry et al. (2014) suggest a programme compression approach, which involves breaking down processes into smaller units. Meanwhile, off-site construction (OSC) strategies are seen as an alternative to traditional construction methods that can reduce cost and time, and improve safety performance and quality (Mostafa et al., 2020; Zaalouk et al., 2023). Modular construction techniques can improve operational efficiency and product quality while reducing project schedules (Hsu et al., 2019). Developing a robust construction project schedule (CPS) is one of the most important factors for the success of a construction project (Derbe et al., 2020). Khoo et al. (2024) pointed out that through an empirical study of residential construction projects in Malaysia, good site management practices, including site layout optimization, construction waste control and construction path planning, have a significant role in improving construction efficiency. It has become clear that construction optimization strategies play a core role in impacting schedule management positively.

Communication Optimization Strategies

Strategies to optimise communication include establishing information management platforms, improving communication channels and enhancing information sharing (Du, 2023). Existing studies have shown that information islands in construction consulting projects are an important cause of decreased collaboration efficiency and uncontrolled progress. Many construction industries use knowledge management and information technology integration to manage projects in various ways (Rasli et al., 2006). Technological advances are critical for all organisations and many improvements can be achieved through effective IT governance (Henriques et al., 2021). Li et al. (2019) suggest that the most frequently cited strategies include communication and collaboration, effective project planning and control, owner involvement and commitment, and clear goals and objectives. Nguyen (2019) highlights the relationship between customer satisfaction and team behaviour related strategies, such as project planning and organisation, coordination, contractor assurance and empowerment. Yap and Shavarebi (2022) have suggested several strategies to mitigate project delays in Malaysia. These strategies included focusing on project communication and project learning, and focusing on human resource and management issues related to construction industry issues. Ling et al. (2009) showed that there was a significant positive correlation between early acceptance, approval and commitment to schedule, effective control of language barrier risks and better schedule performance.

Project Planning Optimization Strategies

In terms of organisational structure and management levels, segregation of duties and coordination mechanisms can be optimised to increase efficiency and flexibility (Du, 2023). At the same time, Hussain and Mubarak (2021) have proposed that based on organizational relationship theory, the goal cognition consistency and organizational trust of project team members are the antecedent variables that will determine the accuracy of plan execution. They also pointed out that the planning effect depends not only on technical tools, but also on the interpersonal attitudes and cognitive consistency among the team members. The extent of delays can also be reduced through steady and continuous improvement of the project management system (Ajayi & Chinda, 2022). Odeh and Battaineh (2002) suggested the following methods: creating and classifying human resources through proper training; and considering the contractor's competence and experience rather than price when awarding contracts. Tomczak and Jaskowski (2020) proposed a new optimisation approach to deal with project delays by moving some staff from non-critical to critical processes and using additional resources. Riazi et al. (2020), based on a study of the construction industry in Malaysia concluded that most construction problems stem from weak supply chain management systems in organisations. Big data for resource management can minimise resource management problems and thus, reduce profit erosion (Zhao, 2024). In addition, big data analytics can help identify past trends and predict resource conditions (Kusimo et al., 2019). Asadi et al. (2018) presented risk management guidelines and suggested the use of fuzzy modelling for risk management. M.-S. Kim et al. (2018) developed a schedule risk assessment and mitigation model to support investment decisions in construction projects. By developing an integrated schedule framework, project managers can be supported in determining the requirements of each sub-programme and subsequently in using optimal scheduling methods (Varela et al., 2021). Soomro et al. (2019) argued that focusing on an organisation's strategy can help reduce actual schedule delays. Tripathi and Jha (2018) suggested ranking top management capability using measures, such as experience and performance, top management capability, project factors, supply chain and leadership, and effective cost control.

Design Optimization Strategies

By consulting firms to improve the quality of communication between members of the design team, the potential risk of delays in the design phase can be minimised (Habibi & Kermanshachi, 2018). Moreover, managing project approvals during the design phase helps to control costs and time (Abdelalim et al., 2025). Necessary criteria are used to ward off the threat of design errors in order to minimise the magnitude of

other delayed criteria in the later stages of the project (Ajayi & Chinda, 2022). Consideration of constructability at the design stage can minimise errors in material and human resource management. Effective information and management during the implementation phase can lead to better time and cost performance during the construction phase (Habibi & Kermanshachi, 2018). Last but not least, lean construction is defined as a method of designing production systems to minimise wastage of time and materials and create maximum value (J. Kim et al., 2022).

Procurement Optimization Strategies

Material shortages are difficult to completely avoid due to the uncertainty in demand and supply. An effective way to deal with this situation is to maintain an inventory buffer (Lu et al., 2018). Material consolidation can reduce the number of material shipment and schedule disruptions due to local material issues (Nolz, 2021). Using local suppliers can offset the effects of excessive price volatility associated with imported resources while stabilising the local currency (Meglin et al., 2022). Thomas et al. (2005) have divided the work site into the following three zones: semi-permanent external storage, staging areas, and internal storage, in order to address the large amount of time and money wasted due to the mismanagement of materials. The "owner's intention to replace with other materials" may be the reason for owner-related change orders, and the suggested improvement is that "the owner must decide on materials before bidding" (Cheng & Darsa, 2021). Durdyev et al. (2017) have suggested strategies for the Cambodian construction industry, and these included ensuring adequate delivery times for materials at construction sites, providing accurate and comprehensive schedules for site supervisors, and enhancing labour resources. Lean methods can provide standardised workflows for materials and labour resources that directly target construction tasks (Liu et al., 2025). Mathematical modelling of the proposed procurement strategy outperforms the traditional procurement strategy in terms of reduced construction time and overall cost savings (Chen et al., 2023).

Project Funding Optimization Strategies

Banobi and Jung (2019) argued that strategies such as adequate funding and proper scheduling of the project, previous work experience in similar projects, donor influence and close project monitoring can improve the project schedule. The optimisation strategy for project schedule management is to improve schedule management by developing scientific cost control mechanisms and establishing effective forecasting models (Du, 2023). The client should invest enough time and money in preliminary studies to avoid delays in the decision-making process (Habibi & Kermanshachi, 2018). Abdelalim et al. (2025) recognise that cost overruns can be controlled through proper project financing. Soomro et al. (2019) stated that proper financing in construction projects could avoid project delays. A timely payment system contributes to better project performance as it helps to improve workers' morale and productivity (Al Alawi, 2021). However, timely payment is essential to minimise construction delays. Su et al. (2018) recommended floating ownership solutions to prevent delays and conflicts between owners and contractors. Financial support from the government can also improve project performance (Akhmadi & Himawan, 2021).

Monitoring Optimization Strategies

Technical accuracy in the project design planning process, effective project supervision and monitoring, effective project management, and experienced contractors will effectively reduce project delays (Ajayi & Chinda, 2022). Guo et al. (2018) concluded that mandatory supervision is an effective method of controlling project performance. According to Shaikh et al. (2020), project delays can be avoided by enforcing law and order in the organisation, the need for putting in place control measures over the organisational behaviour and attitude of project participants. Muthuveeran et al. (2022) suggest that close project monitoring by project participants helps to identify problems at an early stage. Effective supervision by experienced supervisors who have worked in significant number of projects, can improve project performance by

detecting the need to rework in a timely manner and ensuring that tasks are completed as specified (Ajayi & Chinda, 2022). Kineber (2024) support remote management systems and believe that the integration of new technologies may be the best way to achieve remote site supervision.

Future Optimization Strategies

With the development of technology, construction projects can be managed through the use of Building Information Modelling (BIM) for project schedule risk management (Hossain & Ahmed, 2022; Nafe Assafi et al., 2022). Bataglin et al. (2020) explored a new approach of combining lean manufacturing theory with BIM technology. Assembly construction is also the future direction of the construction industry (Xie et al., 2021). In order to avoid project delays, assembly building has been gradually applied to construction projects (Jin et al., 2020; Wuni & Shen, 2020). Assembled buildings are buildings in which some or all of the components are prefabricated in a factory and then transported to the construction site to be assembled into a complete building (Luo et al., 2021; Yuan et al., 2021). It has therefore, been strongly supported and promoted in countries such as China, Australia and Europe (Li et al., 2022; Zhou & Ren, 2020). In addition, Hafiz et al. (2024) found that in green management practice, green material selection and intelligent construction technology are more conducive to the coordinated implementation of green strategies. Therefore, the future development path of schedule optimization strategy can also be expanded to include green management strategy.

In summary, although existing research has achieved many results in schedule management theory, scheduling technology, the identification of influencing factors and optimization strategies, there are still several key research gaps. First, a large amount of literature still focuses on theoretical models and method evaluation, lacking practical research on systematic verification and strategy induction in real project environments; second, current research mostly explores scheduling problems in an isolated variable manner, ignoring the interactive coupling relationship between variables such as finance, communication, resources, and design; third, although some studies put forward optimization suggestions, there is a lack of strategic paths that are feasible and systematic based on actual projects. The present study has focused on Chinese residential construction projects and will address the above shortcomings through a qualitative case study of the YYDF project. Through interviews and other data collection methods, the influencing factors have been systematically identified and as a result, targeted key optimization strategies for project delays have been proposed. These strategies not only have theoretical basis, but their feasibility can also be verified through other cases. Finally, in view of the complexity of Chinese residential projects, this study has proposed practical management strategies that can be directly applied to similar projects, providing a theoretical basis and practical reference for improving the delay management of project schedule.

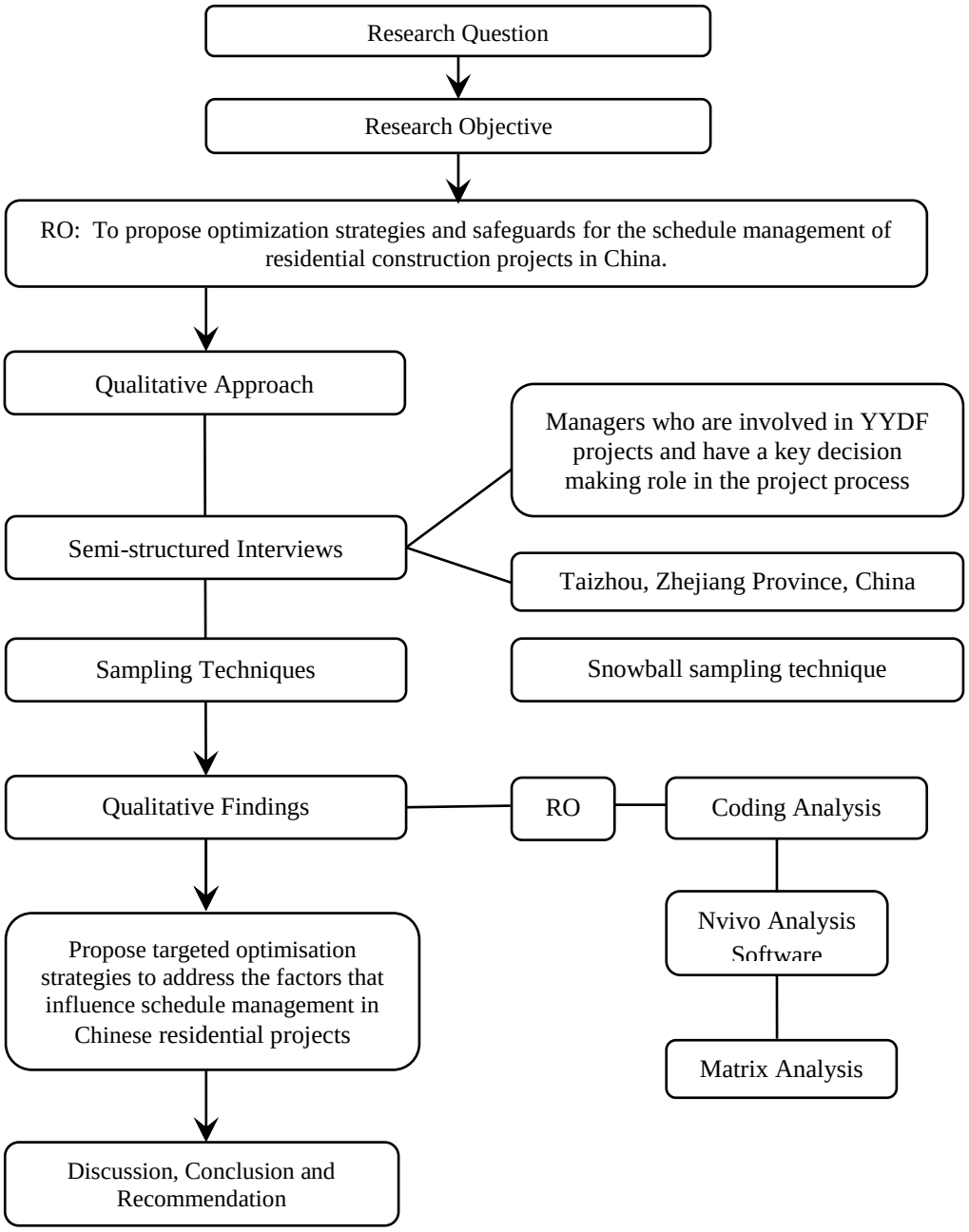
MATERIALS AND METHODS

This study adopts a qualitative research approach to enable a systematic and rigorous examination of schedule management in residential projects. Building on established research methods in prior studies, the qualitative design facilitates deeper elaboration of project progress management and supports the further development of a more structured schedule planning system that may be applicable to other residential development enterprises. Moreover, qualitative enquiry is well suited to investigating socio-economic phenomena in real-life contexts by capturing practices, experiences, and decision-making processes (Tracy, 2019). The YYDF Project is a 1,593-unit residential project to be built by the XC Company in Taizhou City, Zhejiang Province, China in 2020. The present study has adopted a qualitative research approach to explore the optimisation strategies and importance ranking of schedule management in the YYDF project. This approach is justified by the exploratory nature of the research and the need for an in-depth understanding of the study variables.

The research flowchart of this study is developed based on a review of the relevant literature on project schedule management. As shown in Figure 1, in the process of exploring the optimisation strategy of project schedule management in the YYDF, this study first combed through a large amount of relevant literature based on the theory of project schedule management. It then reviewed relevant information on project management, and explored the optimisation strategy of project schedule management based on general projects. The proposed approach is then applied to the YYDF Project, integrating theory with practice. In the present qualitative case study, semi-structured interviews were used to collect data. Then NVivo software was used to conduct coding. Matrix analysis was used to explore the optimisation strategies and order of importance that affect the schedule management of residential construction projects in China.

Figure 1

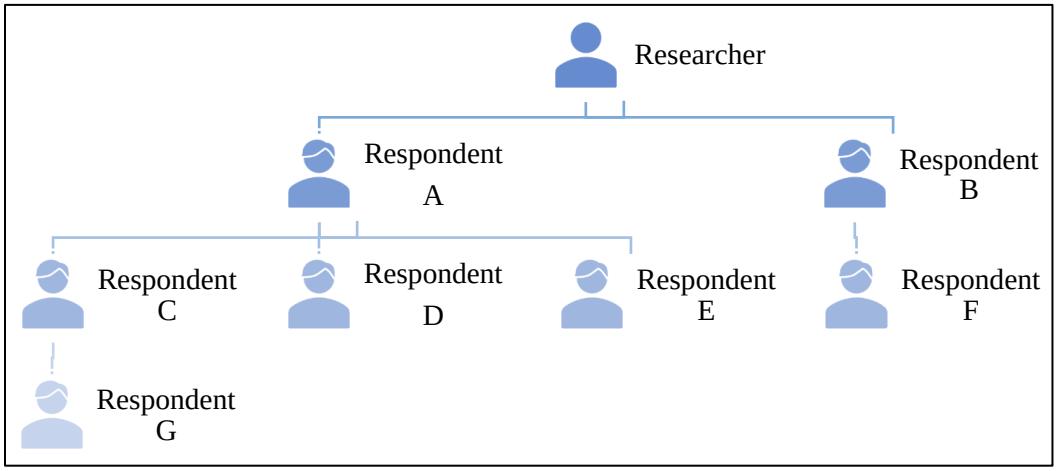
Research Flowchart



In order to obtain the relevant data on schedule management optimisation strategies for residential projects in China, this study uses the YYDF project as a case study. With the help of key case study methodology, the right lessons and experiences will be learned (George, 2019). In the semi-structured interview method, some of the questions are structured and participants are free to introduce new ideas during the interview (Dadzie et al., 2018). Through semi-structured interviews, the researcher can learn about new avenues that were not initially considered (Denny & Weckesser, 2022). Interviews for this study were conducted during June 2024, and the researcher used a 'snowball' sampling method to recruit potential participants. Snowball sampling has many advantages as a network research method for capturing 'hidden populations' (Dragan & Isaic-Maniu, 2022). Snowball sampling can be used as a form of chain referral, whereby existing research subjects recruit other potential research subjects (Navarrete et al., 2022). Key managers in the project unit are the target population for the present qualitative research (Suresh & Annamalai, 2024). As shown in Figure 2, to avoid possible sampling bias, key managers from two different units were contacted and then introduced to other respondents. The final sample included seven respondents.

Figure 2

Snowball Sampling Chart in a Qualitative Research



The inclusion criterion for this study was specifically aimed at selecting staff in the YYDF project, and these were the managers who would play a key decision-making role. Their decisions would influence the progress of the project to a certain extent. In this way, the data collected will be robust and meaningful for the study. The exclusion criteria for this study were people who were not involved in the YYDF project, even if they were in the same client company. Staff who met the above criteria, but did not have five years of experience in the project, and those who could not significantly influence the progress of the project also had to be excluded. The inclusion and exclusion criteria are as listed in Table 1.

Table 1

Inclusion Criteria and Exclusion Criteria for Participation in the Study

Inclusion Criteria	Exclusion Criteria
More than five years of residential project experience	Less than five years of residential project experience
Completed more than two residential projects	Managers without decision-making power
Serving as a key manager in the YYDF project	Managers not involved in the YYDF project

In qualitative research, the actual sample size cannot be determined at the beginning of the study. According to Waycott et al. (2022), the saturation point of research sampling can be reached with as few as 12 and as many as 20 respondents. Additionally, existing researches suggest that data saturation can often be observed after 6 in-depth interviews (Boddy, 2016), and typically 6-7 interviews can capture most themes in a homogeneous sample, achieving around 80% saturation (Guest et al., 2020). Since the last two interviews in the present study contributed minimal new information, it could only confirm that saturation was achieved by the 7th interview, as the subsequent interviews (conducted to assess the amount of new information against a predefined threshold) did not yield significant additional insights (Sharma et al., 2024). As the interviewees in this study were the key leaders of the project, the resulting interview data was more authoritative and persuasive, so when the 7th interview had been conducted, the data was largely saturated with information. The data collected was analysed using NVivo 12. This software improved the accuracy and reliability of the researcher's study analysis (Nowell et al., 2017).

As shown in Figure 3, the YYDF Project has the following characteristics: the selection of cities and land parcels is biased towards second and third tier cities, such as Taizhou in Zhejiang. At the same time, it has typical Chinese residential project characteristics, such as long useful life, high project cost and not easy to relocate, and high project capital turnover. Therefore, the selection of the YYDF project as a case study is of great research significance.

Figure 3

Locations of the YYDF Project Study

RESULTS

As this study is aimed at exploring the optimisation strategies for the schedule management of residential construction projects in China, it is crucial to identify possible sources of delays and risks in order to prioritise and propose targeted optimisation strategies (Muneeswaran et al., 2020). This study has conducted interviews and collected data from seven key managers from key departments, such as construction employers, construction organisations, survey and design organisations, and material and supplier organisations. The profiles of the respondents in the YYDF project are as shown in Table 2.

Table 2

Profile of Respondents in the YYDF Project

Respondents	Positions	Construction Parties
Respondent A	General Project Design Manager	Client
Respondent B	Head of General Contractor	Constructor
Respondent C	Head of Architectural Design Unit	Design team
Respondent D	Main Material Supply Supervisor	Materials and suppliers
Respondent E	Head of Project Finishing Design	Client
Respondent F	Head of Finishing Contractor	Constructor
Respondent G	Head of Interior Design Unit	Design team

The key managers of the YYDF project made suggestions to improve the optimisation strategy in the management of the project schedule. The key information of these suggestions for optimisation was retained and collated, and the data was processed using Nvivo 12 software. The software was used to classify the coding of the suggestions for optimisation, with the input from the participating managers as the first level of coding. The coding analysis was used to further clarify the optimisation strategies and the importance rankings and rationales provided by the corresponding key managers. The suggestions for optimisation from the interviews were sorted out by secondary and tertiary coding to analyse the coding distribution of the optimisation strategies. As shown in Figure 4, the two-level coding relationships of key optimisation suggestions such as construction optimisation, design optimisation, project planning, procurement optimisation, communication optimisation and project financing are obtained. To further clarify the key optimization strategies of this study, and to more specifically reflect the source and basis of each optimization strategy, the following is a compilation of the original responses of key managers from the interview process:

i. Project Funding: Respondent E (the person in charge of project closing design with 10 years of project experience) pointed out that funding issues are an important reason for project delays. *"I think the main thing is still money, because the project is carried out to what extent, the project payment should reach what extent. But now, for example, the construction party or the general contractor advances the money. This has happened before. There are even cases of arrears."* He emphasized that the availability of funds directly affects the progress of the project, especially when the general contractor advances the money or has arrears. This problem is particularly prominent.

ii. Communication Optimization: Respondent C (the person in charge of the architectural design unit) emphasized the importance of communication and believed that many delays are caused by poor communication. *"I think it is very important to communicate with stakeholders and establish effective communication. Because many delays or time delays in the project process are caused by poor and untimely communication, so each unit needs to strengthen communication and coordination."* He suggested that each unit should strengthen communication and coordination to reduce delays caused by information asymmetry.

iii. Construction Optimization: Respondent B (the head of a general contractor with more than 10 years of construction experience) pointed out that construction factors are the most important in affecting project progress, and the current project schedule execution control is unscientific. *"The first part is on-site installation, which requires an experienced construction team to coordinate and arrange the distribution among the existing personnel on site to achieve an uninterrupted and efficient construction plan. At the same time, strict implementation must be carried out in the process, with a pre-planned and pre-made*

construction supervision plan to ensure that the project will not be delayed on the critical route." He emphasized the importance of construction team coordination, plan execution and supervision to ensure that progress on the critical path is not delayed.

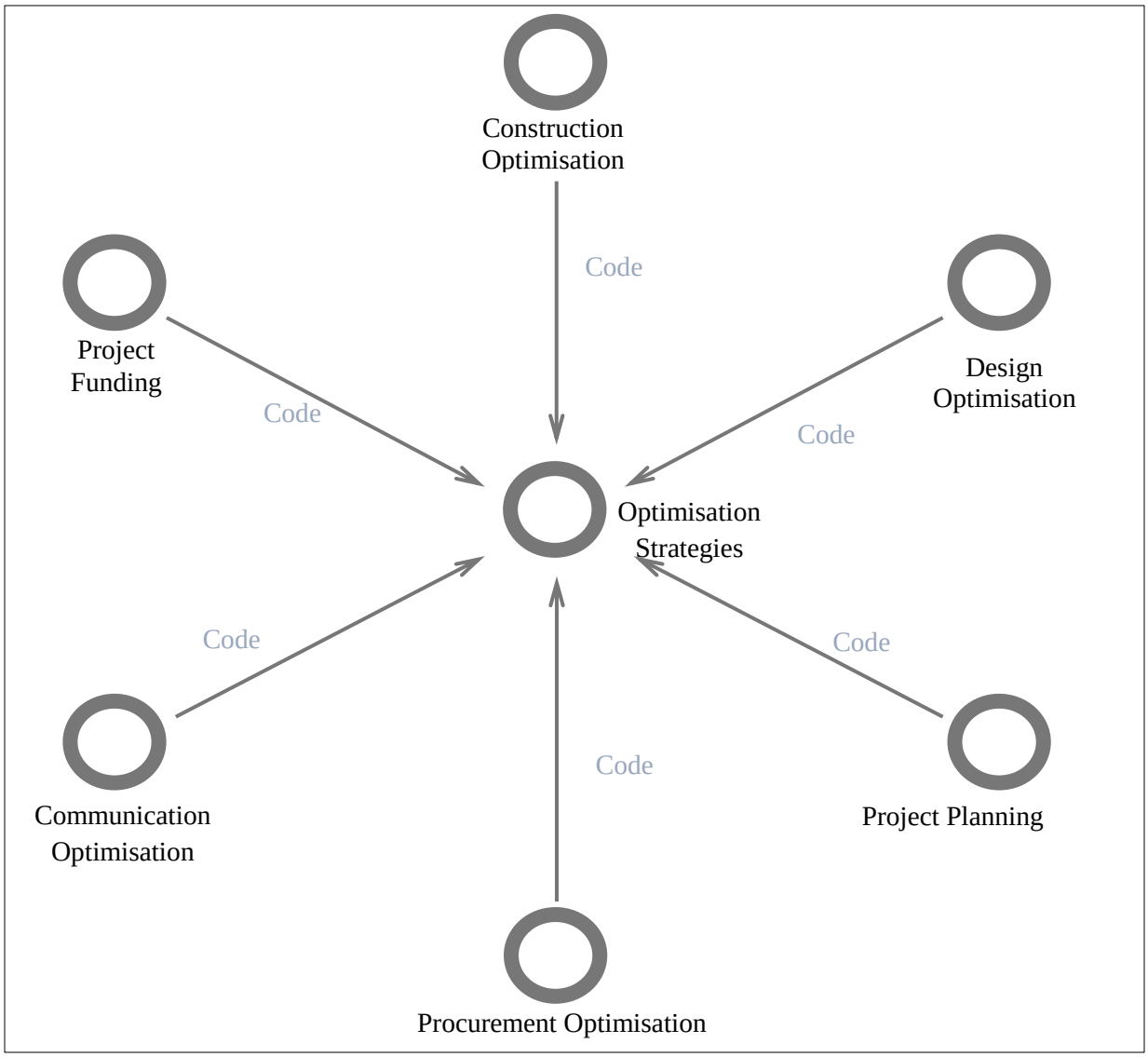
iv. Procurement Optimization: Respondent B further mentioned that unreasonable resource management is also an important reason for project schedule management problems, especially in the procurement link. *"The second is procurement, well, procurement is divided into two aspects, one is the procurement of personnel labour, the procurement of talent, according to the local market environment, as early as possible in advance to arrange your optimal labour. Then the materials, machinery and equipment from where to plan."* He suggested arranging the best labour according to the market environment in advance, and rationally planning the procurement sources of materials and equipment to optimize resource allocation.

v. Design Optimization: Respondent F (head of the finishing contractor) mentioned the impact of errors in the design stage on the project schedule. *"I think the main reason for this problem is that when there is a large error between the design drawings and the on-site situation, it will be a big problem when design changes or additional drawings are needed."* He pointed out that the discrepancy between the design drawings and the on-site situation will lead to design changes or additional drawings, which will affect the project schedule. It is necessary to improve accuracy and efficiency in the early survey and design stages.

vi. Project Planning: Respondent E emphasized the importance of project planning and believed that a clear plan is crucial to project schedule management. *"I think the first thing is to clarify the project goals, and then make a clear and detailed project plan. Because a clear plan will have a guiding role in the subsequent project process. And supervise each node on time, and then ensure that the time schedule of each link can meet the standard, then the entire progress management will be qualified."* He suggested clarifying the project goals, making detailed plans, and supervising each node in a timely manner to ensure that the overall management of progress meets the standards.

Figure 4

Diagram of the YYDF Project Optimization Strategy Relationship



The above interview analysis provides a basis for identifying key optimisation strategies. To further translate the interview findings into clear optimisation measures, this study extracts specific optimisation strategies based on the coding results. As shown in Figure 5, the coding distribution and classification ratio of these strategies reveal that the construction optimization suggestions account for the largest proportion. The specific optimization strategies mentioned in the case include the following: optimizing construction management by clarifying project personnel arrangements; organizing experienced construction teams and formulating construction supervision plans; preparing optimal configurations of labor and equipment in advance; accurately providing material information of each supplier, and preparing risk plans for each construction process; improving communication efficiency by communicating with each unit in advance and establishing an effective communication mechanism; strengthening project planning by clarifying project goals and plans; optimizing procurement processes by accurately communicating required materials and formulating risk plans; improving design management by reducing design changes; and optimizing project financing by clarifying project costs. These strategies provide specific guidance for the schedule management of the YYDF project.

Figure 5

Coding Comparison of the YYDF Project Optimization Strategy

<table>
<tr><td colspan="2">Optimization Strategies for Project Schedule Management</td></tr>
<tr><td>Construction Optimization

● Define project staffing arrangements.
● Organize experienced construction team and develop construction supervision plan.
● Procurement of optimal labor, machinery and equipment, etc., in advance.
● Provide accurate information on dimensions, quantities, workmanship practices, etc., of each supplier.
● Prepare all risk plans for each construction process.</td><td>Communication Optimization

● Advance communication and interface between departments to complete work on time.
● Establish effective communication.</td></tr>
<tr><td>Project Planning

● Clarify project objectives and plans.</td><td rowspan="2">Procurement Optimization

● Communicate accurately about the materials needed for the project and plan for risks.</td></tr>
<tr><td>Design Optimization

● Reduced design changes.</td></tr>
<tr><td></td><td>Project Funding

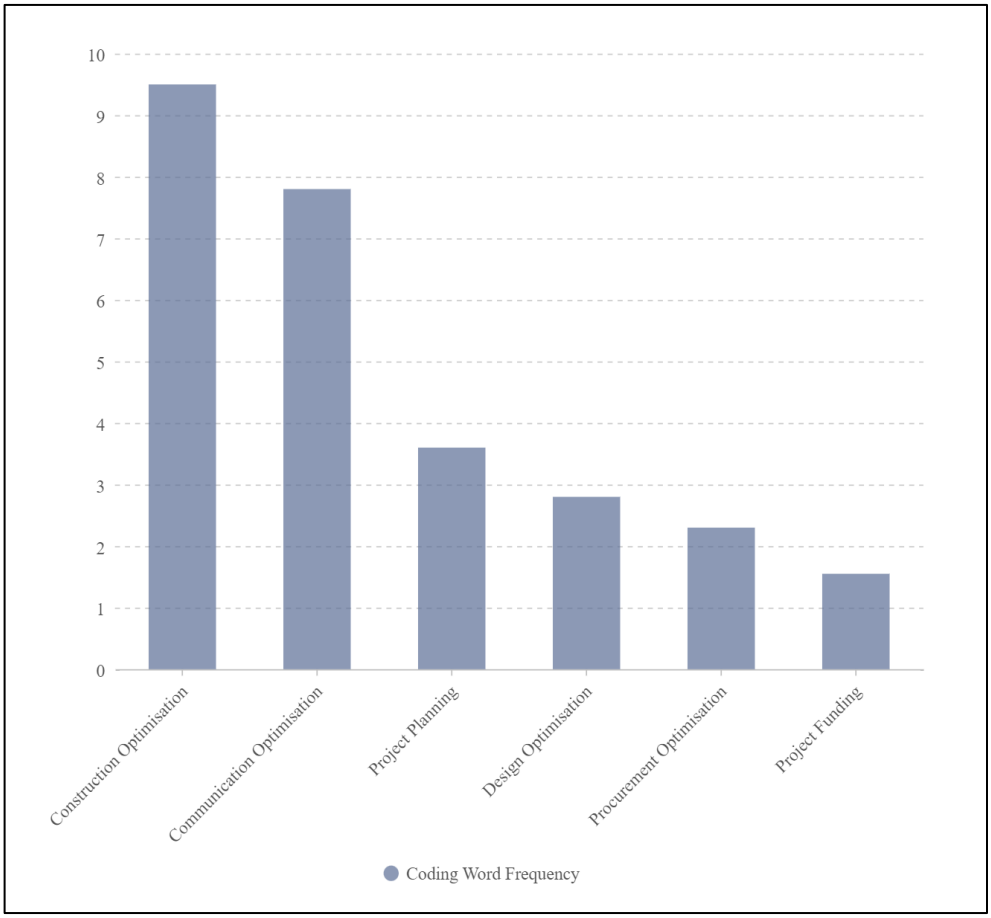
● Clarify project costs.</td></tr>
</table>

In order to further analyze the importance and impact of optimisation strategies from a quantitative perspective, this study conducted word frequency statistics on the encoded optimization suggestions. The relevant results are as shown in Figure 6.

The coded word frequencies of the optimisation strategies were sorted and analysed to derive the following order and influence relationships. The highest word frequency is Construction Optimisation with 9.5%, followed by Communication Optimisation with 7.8%, Project Planning Optimisation with 3.6%, Design Optimisation with 2.8%, Procurement Optimisation with 2.3% and Project Finance Optimisation with 1.55%. It is easy to see that in the order of importance of coded word frequencies, construction optimisation recommendations are the most important and have the greatest impact on project schedule management. This is followed by communication suggestions. The word frequency analysis shows that construction optimization suggestions play a dominant role in project schedule management, and their importance is further verified by the data from the qualitative research. Therefore, the implementation of optimisation strategies for project schedule management can be based on the importance ranking of the existing optimisation strategies. In order to better optimise the project schedule management, the implementation of optimisation strategies, resource optimisation and optimisation strategies are implemented according to the importance ranking of the existing optimisation strategies. In order to optimize project schedule management more effectively, it is recommended to gradually implement corresponding optimization strategies in terms of priority of construction optimization, communication optimization, project planning optimization, design optimization, procurement optimization and project financing optimization, combined with resource optimization measures.

Figure 6

Word Frequency Coding for the YYDF Project Optimization Strategy



DISCUSSIONS

The development process and project schedule management of any residential development project is complex. Therefore, it is particularly important to explore the optimisation strategies present in project schedule management and rank their importance. As shown in Table 3, the optimisation strategies were derived from the interviews of the seven interviewees. From the findings, it evident that construction optimisation, communication optimisation, project planning, design optimisation, procurement optimisation, and project funding are the key optimisation strategies for project schedule management. The frequency with which each strategy was mentioned indicates stakeholders' awareness of its importance. Construction optimization was mentioned by five of the seven respondents, making it the most recognized strategy. This highlights its critical role in managing the duration of residential projects; this is most likely because site operations and efficiency have a direct and obvious impact on schedule management. Communication optimization was mentioned by four respondents, highlighting its importance in coordinating stakeholders and maintaining clear workflows at all stages. Project planning, design optimization, and procurement optimization were mentioned by three respondents, indicating that they play an important but secondary role in the scheduling process. Although project funding was only mentioned by two respondents, it is still critically important, especially because it has the potential to facilitate or hinder timely procurement and construction.

Table 3

YYD Project Optimization Strategies

Optimisation	A	B	C	D	E	F	G	Total
Construction Optimisation	√	√		√		√	√	5
Communication Optimisation	√		√		√	√		4
Project Planning		√	√		√			3
Design Optimisation	√	√					√	3
Procurement Optimisation		√		√			√	3
Project Funding			√			√		2

Based on the data provided by the respondents, it is worth noting that more than half of the respondents mentioned construction optimisation and communication optimisation, and that construction optimisation was mentioned most often. This suggests that construction optimisation is seen as the most important optimisation strategy. Respondent C and Respondent E have similar views and both consider communication optimisation and project planning to be the most important optimisation strategy. Respondent D and Respondent G have similar views and both consider construction optimisation and procurement optimisation as the most important optimisation strategy. Respondent C and Respondent F have similar views and both consider communication optimisation and project financing to be the most important optimisation strategies. Respondent A and Respondent E, as clients, need to be involved in all communication throughout the project and therefore, believe that communication factors are the most important to optimise during the project.

Respondent B, as a representative of the general contractor, expressed his views on construction optimization, communication optimization, project planning, and procurement optimization. This reflects the perspective required by construction units when dealing with schedule issues and the complex factors affecting the construction process, thereby highlighting the key role of construction optimisation strategies. The respondents' views focus mainly on the internal factors affecting the project, which can be optimised through human control. External factors were rarely mentioned as force majeure factors. Although they have a potential impact on the project, respondents generally believe that the probability of occurrence is low. Nevertheless, appropriate risk assessment and emergency response strategies are still essential, especially for large projects with long construction periods and complex stakeholder networks.

It is worth noting that the six strategies identified through the interviews are not completely consistent with the eight categories summarized in the literature review. Specifically, the strategies proposed by the interviewees include the following: construction optimization, communication optimization, project planning, design optimization, procurement optimization, and project financing. However, the monitoring optimization strategy and future optimization strategy mentioned in the literature were not mentioned by any of the interviewees in this study. This inconsistency may be due to the difference in perspective between practitioners and scholars. Project practitioners usually focus more on operational, internal, and immediate challenges that can be directly managed on site, such as improving contractor coordination or funding security, while academic research tends to take a broader and longer-term optimization perspective. Table 4 shows the specific manifestation of this difference. Table 4 lists the confirmation of various optimization strategies in the literature review and case studies, as well as the subjective evaluation of their importance by the interviewees. For example, construction optimization and communication optimization were both confirmed in the literature and interviews, and ranked first and second with a mention rate of 9.5% and 7.8% respectively, highlighting their key positions that are widely recognized in practice. Construction

optimization is regarded as the primary strategy to advance progress, while communication optimization is regarded as the core factor to promote collaboration among all parties. Project planning optimization and design optimization were mentioned relatively less frequently (3.6% and 2.8%, respectively), but respondents noted that they were particularly important in the early stages of a project to help prevent rework. Procurement optimization (2.3%) was considered key to ensuring that materials were supplied on time, while project funding optimization (1.55%) was highlighted by clients as being closely related to funding flow and project continuity. In contrast, monitoring optimization and future optimization, two strategies that have been widely discussed in the literature, were not mentioned by any of the respondents. Monitoring optimization strategies, including performance feedback systems and key performance indicator-based supervision, are often implemented at a higher organizational level or in the post-project phase, which may explain why they were overlooked by respondents. Similarly, future-oriented optimization strategies, such as integrating predictive analytics or resilience planning, represent a more strategic management direction and may not have been widely adopted in the daily management of construction projects. This gap reveals an important insight; while practitioners are more focused on current operational efficiency, theoretical models emphasize continuous improvement and the long-term sustainability of projects. Bridging this gap is critical in advancing project schedule management practices in China's residential construction industry. Future research can further explore how to transform the monitoring mechanisms and forward-looking tools emphasized in the theoretical perspective into actionable strategies in practice to improve the overall robustness and adaptability of project schedule management.

Table 4

Comparison of Optimization Strategies in the Literature and Case Studies

Strategy categories	Literature review	Case Studies	Review
Construction optimization	√	√	9.5% Most
Communication optimization	√	√	7.8% Second most
Project planning	√	√	3.6% Some respondents think it is important, especially in the early stages
Design optimization	√	√	2.8% Respondents believe it helps prevent rework
Procurement optimization	√	√	2.3% Seen as critical to on-time material supply
Project funding	√	√	1.55% Customers stressed that funding is closely tied to project continuity
Monitoring optimization	√		Not mentioned
Future optimization	√		Not mentioned

As has been mentioned above, construction optimisation is considered to be the most important optimisation strategy. Its importance lies in directly shortening the construction period and reducing the high costs caused by on-site delays. For example, modular construction technology can significantly improve efficiency. Communication optimization is a close second priority because it can effectively reduce rework and coordination errors caused by information asymmetry, especially in residential projects involving multiple parties.

Khoo et al. (2025) pointed out in their analysis of green site management trends in Malaysia that in residential projects that are highly dependent on resource allocation, construction and procurement optimization has the most direct impact on schedule performance. To reduce project delays in the construction industry, owners should select the most qualified contractors with strong financial backgrounds, identify and phase the project according to their financial resources, and determine an effective financial payment plan (Abbasi et al., 2020a). Meanwhile, the use of BIM has become a more effective solution (Abbasi et al., 2020b). The development of integrated algorithmic models allows real-time monitoring of project progress against a dynamic schedule (Egwim et al., 2021; Gondia et al., 2020; Parsamehr et al., 2023; Yaseen et al., 2020). Due to the complexity and uncertainty of construction projects, many different objectives need to be considered simultaneously. The multi-objective optimisation (MOO) perspective for solving project management problems has attracted much attention and has become an inevitable trend (Banihashemi et al., 2021; Guo & Zhang, 2022). Assembled buildings have the advantages of fast construction, cleanliness and environmental protection, and appear to be the main means to achieve the development of industrialised construction in the future (Xie et al., 2021). Work Breakdown Structure (WBS) is used to divide a project into smaller parts, each of which can be handled more easily. If there is a significant delay in the work schedule, the work plan can be changed quickly to improve management of the project schedule (Cerezo-Narváez et al., 2020; Raden et al., 2020). Combining the results of this study with the research of existing scholars, project schedule management can be optimized in terms of the following aspects:

i. Strengthen control over the execution of the construction progress programme and monitor it through regular and ad hoc meetings.

ii. Strengthen the management and control of the contractor's various resource inputs and develop and review a clear resource planning programme.

iii. Strengthen the management and control of the construction manager's skills and experience and assess the construction manager prior to the project, and review and assess from time to time during the project.

iv. Review the project construction organisation plan and conduct site inspections from time to time.

v. Ensure that both the client and contractor have adequate construction funds when the project is tendered.

vi. Select experienced project managers and team members to form the project management team.

vii. Develop project permit plans and optimise the permit process to improve the efficiency of project management decisions.

viii. Select experienced construction personnel and supervisors, and conduct occasional appraisals of them.

ix. Strengthen design progress control and design team evaluation before, during and after project construction.

x. Supervision units improve the project management mechanism and optimise the professionalism and stability of supervision personnel.

xi. Strengthen the control and evaluation of suppliers, supervisors and other units, and establish a mechanism for advance planning.

CONCLUSION, IMPLICATIONS, LIMITATIONS AND FUTURE RESEARCH DIRECTIONS

This study aims to explore and prioritize optimization strategies for project schedule management in residential projects in China. The goal of this research is to apply research theory to real-world projects. Existing research has proposed numerous schedule management tools and models to improve project schedule management. However, given the complexity of the construction industry, most studies have inefficient practical applications, and systematic optimization strategies tailored to the Chinese residential construction context remain insufficient. Based on a case study of the YYDF project, this study has been able to identify the following six key optimization strategy themes for project schedule management in China: construction, communication, project planning, design, procurement, and financing. Strategies related to construction optimization accounted for the largest proportion, indicating that prioritizing construction as the core strategy, closely supporting communication, and supporting planning/design, procurement, and financing is more conducive to improving project schedules. Reducing and improving schedule delays is crucial to the success of construction projects in any country (Solomon et al., 2021). By leveraging the optimization strategies identified in this study, project managers can minimize project delays and ensure on-time completion.

Theoretically, this study expands project schedule management research by shifting the focus from individual tools to empirically based optimization strategies tailored to residential projects in emerging markets. In practice, this study provides a prioritized implementation path, starting with the implementation of construction process optimization and formalized communication mechanisms. Furthermore, planning/design checkpoints and milestone monitoring are established, supply and logistics are locked in early, and resource security is reinforced through milestone-linked funding arrangements. Where feasible, digital monitoring is used to strengthen critical path and deviation warnings. Therefore, by applying the methods and optimization strategies presented in this study, companies can not only significantly improve project schedule management efficiency and on-time project completion, but also increase revenue and market competitiveness. Importantly, while this study focuses on residential projects in China, its core strategies have extra polable value after local adaptation. Common challenges such as inefficient construction, communication delays, and imbalanced resource allocation are also prevalent in residential projects in other countries. Therefore, the optimization strategies presented in this study can provide reference and inspiration for projects in different regions and institutional environments.

While this study is seen as being able to contribute to the understanding of schedule management in residential development projects in China, it still has some limitations. First, the data sources are mainly single cases (YYDF) and obtained through semi-structured interviews. As such, the findings may have limited external validity. Second, the importance ranking based on coding reflects perceived significance rather than causal effects. Third, the sample size is small and the method is single, which may lead to single-method bias and selection bias. Therefore, future research projects should try to be more diverse, increase the sample size, and enhance the diversity of research methods to improve the robustness and reliability of the research. For example, for commercial buildings, methods such as fuzzy PIPRECIA (pivot pairwise relative criteria importance assessment) have been used to calculate impact factors (Stević et al., 2022). In terms of availability of other research methods, mixed methods, for example, the Delphi method, and the AHP (Analytical Hierarchy Process), DEMATEL (Decision Making Trial and Evaluation Laboratory), and PIPRECIA can be used to triangulate the rankings. Moreover, longitudinal or quasi-experimental designs can be used when feasible to estimate the causal effects of these strategies on key schedule KPIs, such as on-time completion, rework time, and approval cycle. In addition, future research can also consider how to integrate modern information technologies, such as artificial intelligence, big data analysis, and BIM (Building Information Modelling) into schedule management optimization strategies to improve prediction accuracy and decision-making efficiency. This will provide project managers, especially those working on complex projects, with more real-time and accurate decision-making support, helping them to identify potential risks and make timely adjustments. Furthermore, cross-cultural and cross-national research is

expected to provide more comparative perspectives and insights on scheduling management in different regions of the world, especially since the adaptability and implementation effectiveness of management strategies may vary significantly across different economies and market environments.

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