Turkish Journal of Civil Engineering, 2025, xxxx-xxxx, Paper xxx, ***Research Article***

Factors Influencing Schedule Management Delays on Residential Projects in China - A Case Study of Yun Yue Dong Fang Project

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ABSTRACT

With the rapid development of China's property industry, residential construction projects face significant schedule delays due to inadequate progress management. It makes it difficult for enterprises to realize the return of funds on time, causing economic losses and reputational damage which brings serious economic losses and loss of corporate reputation. This study aims to identify and prioritize delay factors and propose effective control measures. Qualitative research methods, including semi-structured interviews, are used to collect data from the Yun Yue Dong Fang residential project in China, a case study, and analyze the influencing factors of project schedule management. Like construction, design, materials, finance, communication, non-human elements, planning, and supervision. Results show construction factors (particularly execution efficiency, funding timeliness, and resource allocation) dominate, as evidenced by their highest word frequency in interview coding. Followed by client factors, while the factors related to the design teams, as well as the factors related to the raw material and equipment suppliers have less impact. The study proposes strengthening control through integrated management systems and real-time monitoring, validated by the case study, to mitigate delays. The results of the study provide actionable insights for optimizing schedule management in residential projects as well as the project

Note:
- This paper was received on October 23, 2024 and accepted for publication by the Editorial Board on May 5, 2025.
- Discussions on this paper will be accepted by xxxxxxx xx, xxxx.
- https://doi.org/

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schedule management of residential development enterprises and enhancing enterprise performance.

Keywords: Residential, delay, construction process, project schedule, impact factors.

1. INTRODUCTION

With the rapid development of China's residential construction industry, there are currently serious problems with project schedule management in the residential construction process. According to China's National Bureau of Statistics (NBS), from January to December 2022, China's property development investment reached 13,289.5 billion RMB (approximately €1,637.6 billion). Of this, residential investment accounted for 10,064.6 billion RMB (approximately €1,240.3 billion), representing approximately 75.7% of total real estate investment (Source: National Bureau of Statistics of China). This shows that the future property market is still dominated by commercial housing. 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 residential development companies. Data from the People's Court Bulletin Network indicates that 349 construction companies in China declared bankruptcy in 2022, accounting for roughly 0.36% of the country's total number of 97,938 real estate development enterprises that year. Meanwhile, the total national real estate investment in 2022 fell by 10.0% compared with the previous year (source: National Bureau of Statistics of China). Although the proportion of bankruptcies seems small relative to the size of the industry as a whole. However, 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 project schedule management and cost management for construction companies. This contradiction between rapid industry growth and increasing funding pressures highlights the urgent need to address schedule management inefficiencies, a challenge that is prevalent globally but has unique dimensions in China.

Construction delays are a major obstacle in the construction industry. Various projects face construction delays due to some regulatory or natural reasons. There are many factors that affect the project schedule throughout the project management process, such as external climatic factors, infrastructure condition factors, material and labour cost price factors, as well as internal financial factors, management factors, and contract changes (Singh & Bala, 2018). Time management and deadlines are the top priorities for project schedule management (Delisle, 2019). Despite its proven importance, most construction projects (both in developing and developed countries) still face the problem of neglecting schedule management, which has become a global and long-term issue (Durdyev et al., 2017). This persistent challenge is widely recognized as a global phenomenon in the construction industry, yet the underlying causes remain insufficiently addressed (Ahmed et al., 2022). Meanwhile, a large number of scholars have analysed project schedule management and presented a rich research base. However, most studies remain at a theoretical level. Few studies have delved into actual project cases to collect first-hand information and conduct actual project studies as project participants. Moreover, previous quantitative research, primarily conducted through questionnaires, has focused on identifying delay factors, but

these identified factors show little variation across time and regions, suggesting a critical gap in exploring the root causes of delays (Kim & Bilbao, 2023). Additionally, there is an urgent need to prioritize delay factors and analyze the relationships between them, which remains largely unaddressed in the literature (Ji et al., 2018)**.** Therefore, this study selects Taizhou City, Zhejiang Province as the study area to conduct a qualitative study on the influencing factors of project schedule management and draw research results. The relevance of the findings of this study is that it is beneficial for Chinese residential developers to manage and control project schedules by identifying the key factors and stakeholders that may affect project schedules in project schedule management. At the same time, it is also beneficial for Chinese residential developers to eliminate or mitigate the influence of adverse factors in advance to reduce project development risk. This will ensure the successful completion of the project and improve the project's revenue and market competitiveness.

To address these gaps, the following literature review synthesizes existing research to identify the shortcomings of current research. At the same time, it lays the foundation for the qualitative research of this study, which uses a case study method to explore the delay factors in specific situations. The subsequent chapters will present the results of this study, analyze the specific influencing factors and their importance, and propose practical solutions for Chinese residential buildings.

2. LITERATURE REVIEW

Based on the challenges of project schedule management delays outlined in this study, this section reviewed existing research to identify gaps in project schedule management, particularly as they relate to the Chinese residential sector.

2.1. Theoretical Study of Project Scheduling

Project schedule delays in the construction industry have been a long-standing problem worldwide. With the development and extension of theories, project management is gradually being used in business development strategies to manage the allocation of limited resources among projects to improve business efficiency and competitiveness (Rusnak et al., 2021). Delay can also be defined as a situation where events occur later than expected and are completed later than expected; where action is not taken immediately; or where 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). Despite the advent of new technologies and proposed solutions, delays persist as a significant challenge, with over 85% of large-scale construction projects failing to meet their original timelines, nearly 60% delayed by at least two months, and 14% by a full year (International Construction, 2022). This ongoing issue underscores the need for deeper investigation into its causes and mitigation strategies (Gurgun et al., 2024). Practitioners and researchers of construction projects consider project schedule management as one of the important criteria for successful construction projects (Hamzeh et al., 2020).

Amusan et al., (2018) investigated the factors that influence construction project time and cost performance on construction project sites by evaluating data collected using a Likert

scale questionnaire. Abdul Nabi & El-adaway, (2021) used a multi-stage research approach. The eight most critical factors affecting the cost and schedule performance of modular projects were identified. Acebes et al., (2022) used an analysis of the stochastic and uncontrollable nature of project schedule management. However, traditional scheduling methods often fail to effectively manage delays, a gap compounded by insufficient research targeting these issues (Ma et al., 2015). This limitation has fueled decades of study into delay causes and solutions (Zidane & Andersen, 2018). Moreover, routine schedule assessments struggle to detect delays early, leading to frustrating overruns and cost excesses, particularly in managing rework-intensive tasks, a persistent challenge for project managers (Ma et al., 2019). In addition, the construction industry has the greatest losses in terms of time management and cost management. The impact and contribution of these factors on the actual performance of the project is evaluated based on three criteria: schedule, cost and quality (Gunduz & Yahya, 2018). Compounding these issues, schedule delays remain a practical challenge in project management, with critical delay factors (varying by project scope, domain, and industry) proving difficult to predict and address (Guida & Sacco, 2019; Zaman et al., 2022). At the same time, inefficiencies in contract management, especially payment delays, consistently impede progress (KÜNKCÜ et al., 2023). While these studies lay an important foundation, they tend to ignore the contextual nuances of delays in specific markets (e.g., China), where regulatory, economic, and logistical factors pose unique challenges. For example, studies have highlighted payment delays, design changes and poor subcontractor performance as the main causes, coupled with unique issues such as claims disputes and unreasonable upfront funding requirements from clients (Wang et al., 2018).

In China, delays at all stages of the project have exposed a targeting gap in schedule management. During the design process, poor management and inefficient land acquisition (rooted in bureaucratic hurdles) tend to disrupt the schedule (Weng et al., 2021). The procurement phase is ill-prepared with unreliable agents, exacerbated by low-cost tenders and logistical bottlenecks for equipment and labour (Ji et al., 2018). The construction phase faces poor task planning, inexperienced site supervision and inconsistent progress payments, all of which reflect systemic weaknesses in contractor capacity and supervision (Kim & Bilbao, 2023). These problems are further exacerbated by communication breakdowns and low productivity, which research urges be prioritized in schedule control practices in China (Abdul Nabi & El-adaway, 2021). In addition to internal factors, external pressures such as weather changes and resource shortages add to the complexity, but this aspect remains under-researched relative to contractor-induced delays (Ch et al., 2021). Notably, owner-related delays (e.g., late payments and slow decision-making) account for a significant portion of the problem, highlighting the impact of client-centred project dynamics in China (Yang, 2021). These findings highlight a key gap. While the global literature addresses common delay drivers, China's unique regulatory environment, geographic diversity, and market practices require a more tailored perspective to fully understand and mitigate schedule management challenges. Therefore, it is crucial to explore the factors influencing project schedule management delays through a targeted and in-depth study.

2.2. Construction Factors

Bajjou & Chafi, (2020) evaluated the delay scenarios in the construction industry in Morocco. Statistical analysis showed that rework due to errors in the execution phase of construction

projects, lack of supervision of employees, ineffective planning, and unskilled labour are the main causes of delays. Similarly, identified construction-related delay factors, including rework due to construction errors, lack of trained labour, and poor site management and supervision, echoing these operational challenges while adding delays in decision-making as a critical managerial factor. Lack of manpower skills, shortage of manpower, late delivery of materials, shortage of materials and poor project planning and coordination are identified as the top five causes of contractor-related delays (Alshakhrit et al., 2019). Bhattarai (2023)argued that project contractors lack rationality and science in setting the project schedule, lack of quality control and unscientific risk assessment during the construction process. Islam & Suhariadi (2018) focused on identifying the causes of construction delays in large construction projects in Bangladesh. They found that inexperience of the construction manager, construction errors, poor planning and scheduling, and excessive contractor workload were the most important causes of delays. Adnan et al. (2020) visited construction delays and safety scenarios in Bangladesh and concluded that unskilled labour, accidents at construction sites due to lack of protection, poor construction environment and shortage and breakdown of equipment are the main reasons for delays. Complementing these findings, Cho et al., (2021) highlighted the contractor's equipment availability as another operational factor, reinforcing the role of resource-related issues in exacerbating schedule disruptions.

2.3. Design Factors

Choong Kog, (2018) investigated the common construction delay factors in Portugal, the United Kingdom and the United States. The study found that design errors, delays in amending documents and work approvals, as well as delays in preparing design work, delays in issuing instructions and change orders by the owner were the main causes of delay in these countries. Vacanas & Danezis (2021) through a case study conducted within the construction industry of Cyprus, identified 'consultant errors and lack of information', 'low productivity', 'changes in client requirements', 'contractor financing difficulties', and 'improper project planning' as the primary causes of project delays. Prateepasen & Aumpiem, (2021) examined the delay factors associated with the steel construction industry in Thailand, where material availability, unpublished documents and design changes after completion, poor subcontractor performance, lack of skilled labour and design errors were the main causes.

2.4. Material Factors

The most influential cause of material supply shortages and material supply delays was found to be poor material procurement and inventory management systems, along with other potential causes such as the type of material required for the delayed identification (Rahman et al., 2017). Material inventory is critical for organisations (Muniz et al., 2021). Umar, (2018) identified contractual issues, labour issues, unavailability of materials, and lack of coordination between parties as factors contributing to delays in construction projects in Oman. During the course of the project, there may be delays in the supply of materials and other resources, overcapacity or undercapacity of warehouses and on-time shipment of goods (Panova & Hilletofth, 2018). Çavdar et al. (2024) found that poor material quality (e.g., inconsistent performance) can disrupt the supply chain and extend construction timelines. At the same time, material transportation challenges on site further complicate delivery

schedules (Bombar et al., 2023), thereby affecting project progress and causing project delays.

2.5. Financial Factors

In their research on influencing factors and control measures of progress control in engineering projects, Xing et al., (2021) pointed out that there are many factors that affect the project schedule, and the main factors are capital, technology, materials and some human factors. Focusing on financial aspects, they emphasized capital availability as a critical driver of schedule adherence. Asiedu & Ameyaw, (2021) studied cost overruns in construction projects in Ghana. They categorised 'delay in payment for works', 'tendency of the owner to delay project financing', 'delay in processing documents and awarding contracts after tendering' as key financial contributors to delays, with weather-related issues addressed separately below. In addition, Hoque et al., (2023) identified five delay factors contributing to construction delays in Bangladesh: payment delays, with payment delays standing out as a significant financial bottleneck. K.V. et al., (2019) found that financial problems, financial difficulties of contractors, delayed claims and delayed payments by authorities were the main reasons for delays. Cho et al., (2021) found that the top five causes of delay were: contractor's financial capability, owner's financial difficulties, contractor's equipment availability, slow work for completion payment, and poor performance of contractor's subcontractors. Financial capability and payment issues underscore the monetary roots of schedule disruptions. Alsuliman, (2019) conducted a detailed study of construction delay scenarios in Saudi Arabia and concluded that focusing on financial analysis and awarding to the lowest bidder, and delays in granting financial rights to contractors by government agencies were the main causes of delays. Moreover, for private investment projects, 'client's financial problems and payment delays' and 'adverse weather conditions' ranked first (Nafe Assafi et al., 2022).

2.6. Communication Factors

To address the project diversity associated with construction delays, Chen et al., (2019) systematically investigated the causes of delays in grain silo construction projects in China. The top five reasons were 'inexperience of design team', 'miscommunication between contracting parties', 'lack of proper equipment', 'problems with subcontractors' and 'problems with subcontractors' and 'frequent change orders from clients'. Of these, miscommunication stands out as a pivotal barrier to timely coordination among stakeholders. Durdyev & Hosseini (2019) similarly highlighted miscommunication, lack of coordination, and conflicts among stakeholders as critical communication-related delays, though their broader list spans multiple categories addressed elsewhere. While these studies underscore the role of communication breakdowns, they often lack deeper analysis of how ineffective stakeholder interactions amplify delays, a gap warranting further exploration.

2.7. Planning Factors and Supervisory Factors

Yap et al., (2021) through a study of project delays in Malaysia and a ranking of the factors affecting the project by combining the frequency and severity indices of importance, five

main causes were identified: lack of proper planning and scheduling, lack of qualified site management and supervision. This Malaysian study highlights how poor planning and supervision undermine project timelines. The most influential delaying factors are 'poor monitoring of activities' and 'inadequate monitoring of activities' (Hoque et al., 2023). These reflect supervisory deficiencies, a challenge also evident in Bangladesh. Emon (2018) reviewed the factors of construction delays in Khulna division of Bangladesh and found that lack of planning and supervision, and improper implementation of construction laws are the top five causes of construction delays. Emon's findings reinforce the pivotal role of planning and oversight in delay prevention. Overall, these studies underscore the need to address planning and supervisory gaps to enhance schedule management.

2.8. Non-Human Factors

Asiedu & Ameyaw, (2021) studied cost overruns in construction projects in Ghana. 'Excessively bad weather delays project progress' was identified as one of the main reasons for cost overruns. Weather is a factor that affects overall project delays, as weather conditions can disrupt planned activities such as site concreting (Ji et al., 2018). These climatic disruptions, often unpredictable, represent a significant non-human influence on schedules, distinct from human-controlled factors like communication or financing. However, the literature tends to treat weather as a secondary concern, with limited focus on mitigation strategies tailored to such external variables, suggesting an area ripe for critical investigation.

3. MATERIALS AND METHODS

Given the theoretical and practical gaps in the literature, this section details this study's qualitative case study methodology in China to conduct an in-depth investigation into the key influencing factors of project delays. Through the qualitative research method, a more systematic and reasonable elaboration of residential project schedule management can be made, and a new breakthrough can be achieved on the basis of the original scholars' research method, which is conducive to the construction of a more perfect structural system for project schedule planning by other residential development enterprises. Through qualitative research methods, life experiments in social and economic development can be addressed (Starr, 2014). The Yun Yue Dong Fang Residential Project (YYDF Project) is a 1,593-unit residential project to be built by XC Company in Taizhou City, Zhejiang Province, China in 2020. The rationale for choosing a qualitative approach in exploring the factors influencing and ranking the importance of schedule management in the YYDF project in this study was that the study is exploratory in nature, which requires an in-depth understanding of the variables in this study.

The research flowchart for this study was developed through a review of relevant literature on project schedule management. As shown in Figure 1, in the process of exploring the influencing factors of YYDF project schedule management, this study firstly based on the theory of project schedule management, combed through a large amount of relevant literature, consulted relevant information on project management, and according to the general project to explore the influencing factors of project schedule management. Then it was specific to the YYDF residential development project, combining theory and practice.

The qualitative research method was used to collect data using the semi-structured interview method in the case study, and then the NVivo software was used to conduct coding and matrix analysis to explore the factors affecting the schedule management of China's residential construction projects and the order of importance.

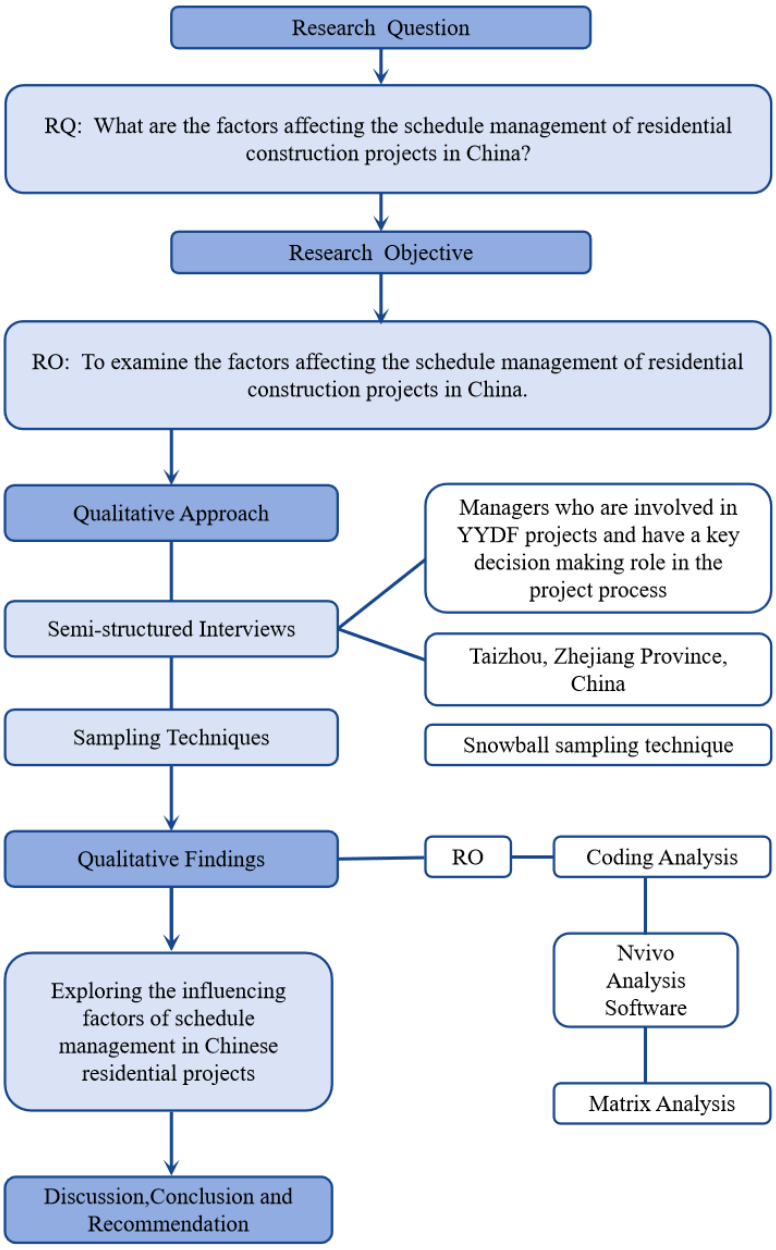

Figure 1 - Research Flowchart

In order to obtain relevant data on the factors influencing the schedule management of residential projects in China, this study used the YYDF project as a case study object. With the help of key case study methodology to learn the right lessons and experiences (George, 2019). There were some data collection techniques such as interviews, questionnaires, etc (Braun et al., 2021). Using semi-structured interview method, some of the questions were structured and the participants were free to introduce new ideas during the interview (Dadzie et al., 2018). Through semi-structured interviews, the researcher can learn about new pathways that were not initially considered (DeJonckheere & Vaughn, 2019). In this study, snowball sampling was used to recruit potential participants.Snowball sampling as a network research has a number of advantages in registering 'hidden populations' (Dragan & Isaic-Maniu, 2022). Snowball sampling can be used as a chain referral with existing research subjects recruiting other potential subjects (Navarrete et al., 2022). The key managers of the units in the project are the target population for the qualitative study (Suresh & Annamalai, 2024). As shown in Figure 2, in order to avoid possible sampling bias, the key managers of two different units were contacted and they in turn introduced the rest of the respondents. The final sample covers the seven main participating units and functional heads in the course of the project.

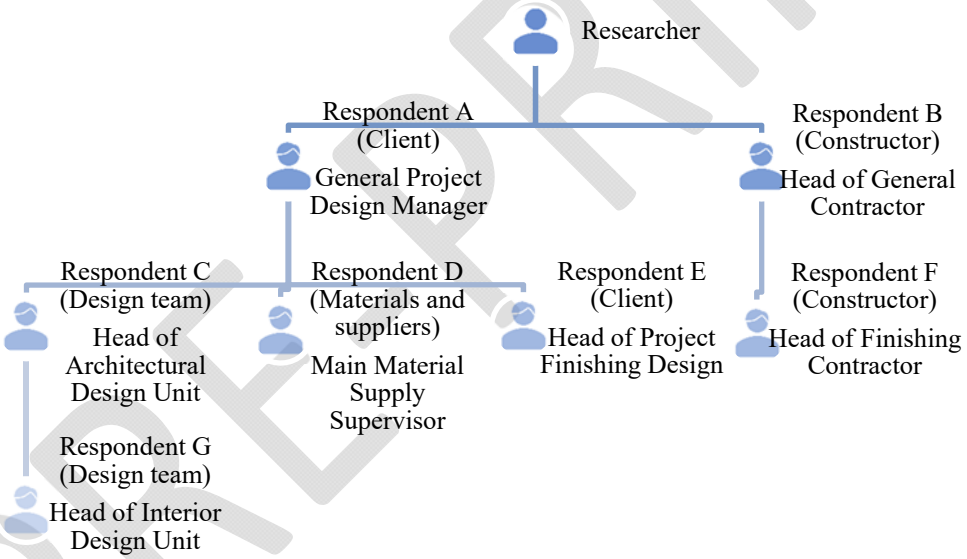

Figure 2 - Snowball Sampling Charts in Qualitative Research

In qualitative research, the actual sample size cannot be determined at the beginning of the study. According to Hennink & Kaiser, (2022), a saturation point in research sampling can be reached with as few as 12 participants and no more than 20 participants. As the interviewees in this study were all key leaders in the project, the resulting interview data was more authoritative and persuasive, and therefore the data was largely saturated with information when 7 was reached. Additionally, existing research supports 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 this study contributed minimal new information, this research confirmed 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)**.** The data collected was analysed using thematic analysis supported by NVivo 12. This software improves the accuracy and reliability for the researcher's research analysis (Nowell et al., 2017). The YYDF project has the following characteristics: the selection of cities and parcels was biased towards second and third tier cities such as Wenling, Taizhou, Zhejiang Province, China , as shown in Figure 3. At the same time, it has typical Chinese residential project characteristics such as long life, high project cost and not easy to move, and high project capital turnover. Therefore, the selection of the YYDF project as a case study has great research significance.

Figure 3 - YYDF Project Location Study

To ensure that the qualitative data collected through semi-structured interviews accurately reflect reality and minimize respondent bias, this study adopted several strategies. Firstly, as noted by Coleman (2022), the selection of interviewees is crucial; therefore, only individuals with extensive experience and professional expertise in project management were chosen. Secondly, the interview questions were deliberately phrased in neutral terms, avoiding leading language to ensure that respondents could express their views freely and objectively, while the interview data were cross-validated with official project documents, project reports, and progress reports to enhance the rigor of the data analysis (Cole, 2024). Moreover, to encourage honest responses, the research team explicitly informed participants of the study's academic and impartial nature prior to the interviews, and assured them of the anonymity and confidentiality of their responses, thereby effectively reducing the influence of social desirability bias (Hung et al., 2024). Finally, the use of digital audio recordings with complete transcriptions (where feasible, professional transcription services) along with member checking to confirm the accuracy of data interpretation (Saunders et al., 2018), further contributed to the study's methodological robustness. Overall, these multi-faceted measures significantly reduced the likelihood of respondent bias and ensured the reliability and validity of the qualitative data presented in this investigation.

4. RESULTS

This section presents the relevant data collected using semi-structured interviews as a tool on YYDF residential projects and analyses the results of these interviews using qualitative research methods. As this study explores the factors that affect the schedule management of residential construction projects in China. Therefore, it is crucial to identify the possible sources of delays and risks in order to prioritise them (Muneeswaran et al., 2020). This study interviews and collects data from seven key managers from key departments such as construction employers, construction organisations, survey and design organisations, and material and supplier organisations, as shown in Table 1.

Table 1 - Attribute information of respondents

Respondents	**Professional background**	**Experience**	**Number of projects**
Respondent A	Master of Architecture	22 years	>50 (Project investment greater than 200 million, (approximately €25.4 million)
Respondent B	Bachelor of Civil Engineering	26 years	>100
Respondent C	Master of Architecture	18 years	>50
Respondent D	Bachelor	14 years	>50
Respondent E	Master of Architectural Design	11 years	>10 (Large-scale urban landmark projects)
Respondent F	Bachelor	15 years	>30 (Greater than 5,000 square meters)
Respondent G	Bachelor of Interior Design	7 years	>20 (Design to delivery; more than 50 design projects)

Table 2 - YYDF case study key data (Source: project construction logs and inspection reports)

Problems	**Data**
Planned versus actual schedule	Planned: 105 days, Actual: 105 days, Delay: 0 days (localised delays made up by cross construction)
Delay in progress payments	Amount: 1.2 million RMB (approximately €0.15 million), Delay: 4 days

Number of days of inclement weather unavailability	4 days (impact of typhoon in July-August 2022)
Design Changes	Yes (some materials were not constructed according to the plan, replacement: 160,000 RMB (approximately €20,500); partial construction was not implemented according to the design plan, impacting 3 days)
Non-compliant design	None
Building inspections resulting in rework or stoppages	Yes (rework: 2 days, cost: 100,000 RMB (approximately €12,800)
Materials rejected for substandard quality	Yes (wood veneer, quantity: 100 ㎡, replace)
Supplier provides unsuitable or incorrect materials	Yes (black glass, quantity: 10 ㎡, impact: 2 days)

At the same time, Table 2 shows data on project delays in the YYDF case, covering such aspects as schedule, payment, weather, design and materials. Although there were localized delays, the project was completed on time through cross construction of multiple trades day and night to ensure timely completion.

Semi-structured interview data was collected from key managers in the YYDF project and the results of the interview data were collated and summarised. The key drivers of progress management were retained and the data were processed using nvivo12 software to code and classify the drivers, using the participating managers' department as the first level of coding, and the interview data were coded and analysed. This multi-level coding approach aligns with qualitative methods used to uncover delay factors in construction projects, building on prior efforts to systematically categorize influences on schedule performance (Abdul Nabi & El-adaway, 2021; Ma et al., 2015). A total of four main influencing factors related to the client, six main influencing factors related to the designer, four main influencing factors related to the design team and three main influencing factors related to the material and equipment suppliers were derived. A total of 17 factors were identified as having a significant impact on residential projects. In order to further clarify the influencing factors and the corresponding key managers (e.g. Client, Constructor, Design Team, etc.) of the interview data results and their significance and appropriateness, the interview data was collated through secondary coding and tertiary coding, and the coding of the influencing factors was analysed. The secondary coding of the key influencing factors such as construction factors, design factors, financial factors, material factors, non-human factors, communication factors, planning factors and supervision factors were derived, showing that these factors influence the schedule management of the project. As shown in Figure , which shows the categorization and percentage relationship of these key influencing factors, construction factors have the greatest influence on project schedule management. In addition to these key secondary categorized factors influencing project schedule management, the tertiary coded influencing factors show in detail the relationship of the secondary factors influencing project schedule management.

<table>
<tr><th colspan="3">Influences on project schedule management</th></tr>
<tr><td colspan="2">Construction Factors

• Construction unit workmanship is lacking .
• Construction unit progress management and coordination is not scientific enough.
• Procurement of machinery and materials for construction.
• The construction has the longest lead time with uncertainties.
• Inexperience of the construction unit and failure to implement the project plan.
• Unreasonable arrangement of personnel and equipment required for construction.</td><td>Design Factors

• Unclear design requirements.
• Design changes.
• Design effect adjustment.
• Inadequate design drawings.
• Design drawings do not match site conditions.</td></tr>
<tr><td>Financial Factors

• Funding planning was problematic.
• Project payments were not made in a timely manner.</td><td rowspan="2">Non-Human Factors

• Weather and Epidemics.</td><td rowspan="2">Communication Factors

• Poor communication between units.</td></tr>
<tr><td>Material Factors

• Untimely supply of materials.</td></tr>
<tr><td></td><td>Planning factors

• The project is not well planned.</td><td>Supervisory factors

• Regulatory failure.</td></tr>
</table>

Figure 4 - Comparison of Reference Points for Coding Impact Factors for the YYDF Residential Project

The semi-structured interviews with the respondents of the YYDF project and the analysis of the data obtained from the interviews revealed that Respondent A identified construction factors, communication factors and external factors as the main factors affecting the project schedule. Respondent B identified construction factors, design factors, material and supplier factors as the main factors affecting the project schedule. Respondent C identified construction factors, planning factors, supervision factors, financial factors and external factors as the main factors affecting the project schedule. Respondent D identified construction factors and financial factors as the main factors affecting the project schedule. Respondent E identified planning factors, construction factors, design factors, communication factors and financial factors as the main factors affecting the project schedule. Respondent F identified design factors, construction factors, financial factors and

material factors as the main factors affecting the project schedule. Respondent G identified planning factors, material factors, financial factors and construction factors as the main factors affecting the project schedule.

The secondary and tertiary coding of the data was collated and analysed to derive the coded word frequencies of the key influencing factors, which were then analysed to derive the ranking and influence relationships of the influencing factors. As shown in Figure , the percentage coverage of the word codes written for the influencing factors. The highest word frequency was for construction factors with 16.2%, followed by design factors with 11.7%, material factors with 3.7%, financial factors with 3.5%, communication factors with 1.9%, non-human factors with 1.6%, planning factors with 1.1% and supervision factors with 0.8%. It can be seen that the construction factors affect the efficiency and progress of the implementation of the project progress plan, and the quality and construction factors consume most of the resources in the whole project process, i.e., they have the greatest impact on the project progress. Collectively, the results indicate that construction factors consistently emerged as the most frequently cited influence across respondents, followed by design and financial factors, while planning and supervision factors were less prominent, a pattern that echoes the critical role of execution-related activities in schedule management, as identified in prior studies (Amusan et al., 2018; Gunduz & Yahya, 2018). In addition, the consistent findings from the respondents' interviews - where construction factors repeatedly emerged as the main influencing factor - highlight the complex interplay between the technical and managerial aspects of project execution. Guida & Sacco (2019) and Zaman et al. (2022) support this observation, suggesting that an integrated management strategy that addresses the interplay between factors is critical for effective delay mitigation.

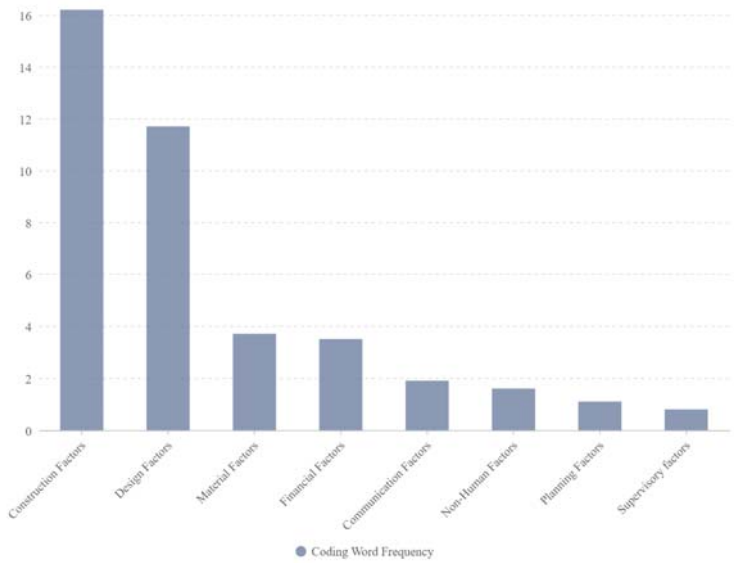

Figure 5 - YYDF Residential Project Influencing Factors Word Code Writing Word Frequency Ranking Chart

In summary, the analysis of the semi-structured interviews identified 17 key factors affecting schedule management, with construction factors exerting the most substantial influence (16.2%), as evidenced by their high word frequency and consistent mention across all seven respondents. Design factors (11.7%) and material factors (3.7%) also featured prominently, particularly among respondents from design and supplier-related roles, while financial and communication factors showed moderate influence. Non-human factors (1.6%), including external risks, align with the stochastic elements noted in construction delays (Acebes et al., 2022), though they ranked lower alongside planning (1.1%) and supervision (0.8%) factors. These findings, derived from multi-level coding and quantitative word frequency analysis, provide a structured ranking of delay factors specific to the YYDF residential project, highlighting the relative significance of execution-phase elements over preparatory or oversight processes**.** In order to better optimise the project schedule management and optimisation strategy measures, the resource optimisation and protection measures can be adjusted according to the importance ranking of each influencing factor.

5. DISCUSSION

After deeply analyzing the interview data and identifying the specific influencing factors of the YYDF project, this section discusses these key influencing factors in depth. The influencing factors of any residential development project are complex. Therefore, it is particularly important to explore the influencing factors present in project schedule management and rank their importance. As shown in Table 3, the key factors obtained by the seven respondents after the interviews. From the results of the survey, it can be seen that construction factors, design factors, material factors, financial factors, communication factors, non-human factors, planning factors, supervisory factors are the key factors for project schedule management.

Table 3 - YYDF Project Influencing factors

Factors	A	B	C	D	E	F	G
Construction Factors	√	√	√	√	√	√	√
Design Factors		√	√		√	√	√
Material Factors	√	√			√	√	√
Financial Factors		√	√	√	√	√	√
Communication Factors	√			√	√		
Non-Human Factors	√		√		√	√	
Planning Factors		√	√		√	√	√
Supervisory Factors			√				

Based on the data of the respondents it was learnt that every respondent mentioned construction factors. This shows that construction factors are considered to be the most

important influencing factors. Among them, Respondent C, Respondent E, Respondent F and Respondent G have similar views and all of them believe that construction factors, funding factors and planning factors are the most important influencing factors. More than half of the respondents believe that the funding of the project determines whether the project can be completed on time and also whether the project can be completed successfully. Respondent A and Respondent E, as clients, need to be involved in all communication of the project throughout the process, so they believe that communication factors influence the project schedule. Respondent B and Respondent F, as contractors, believe that design changes will have a major impact on the project schedule. This is because a change would mean stopping the existing work to make adjustments to the design changes. The respondents' views focus mainly on the internal factors that affect the project and that can be optimised through human control. External factors, while affecting the project, are less likely to occur and are force majeure. Examples include severe weather, major epidemics and political changes. However, they still require an appropriate risk assessment and contingency plan. These findings are consistent with the broader context of construction projects in China, in which internal factors such as construction efficiency and funding delays often mask external risks. For example, China's strict land acquisition policies and complex bureaucratic approval processes tend to exacerbate delays in the planning and construction phases, which distinguishes this study from findings in less regulated environments (Wang et al., 2018). In addition, compared to countries with more homogeneous climates in Western studies. China's diverse geography, ranging from seismic zones in the south-west to monsoon-prone coastal areas, further complicates project progress (Weng et al., 2021). Aydemir et al. (2024) responded to environmental disruptions such as typhoons by proposing structural solutions. These contextual differences highlight the need for tailored risk management strategies that take into account both China-specific institutional and geographic factors.

As mentioned above, most of the respondents believe that construction factors, financial factors and planning factors are the main causes of delays in housing projects, which is in line with the results of the study of significant influencing factors by (Durdyev & Hosseini, 2020). Arantes & Ferreira, (2020) review and analysis of the construction project identified six root causes revealed by an analysis of influencing factors: poor planning, poor consultant performance, inefficient site management, owner influence, bureaucracy and substandard contracts. In this regard, Respondent D's view that construction and financial factors are the main influencing factors is consistent with the findings of (Sanni-Anibire et al., 2022) . Bhattarai (2023) and Yap et al., (2021) argues that contractor reasons are the biggest factors causing project delays. Mahmoud, (2020) ranked contractor, consultant and resource-related performance factors first, second and third, while in this study, construction factors were also the most influential factors. K.V. et al., (2019) found that financial issues were the main cause of project delays, which is consistent with the funding factors in this study. Chen et al., (2019) and Abdul Nabi & El-adaway, (2021) identified the main causes of project delays as inexperience of the design team, poor communication between contracting parties, lack of appropriate equipment, problems with subcontractors, and frequent changes in orders by the client. This finding is consistent with the results of the influencing factors in this study. In terms of external factors, Asiedu & Ameyaw, (2021) concluded that excessively bad weather is one of the main causes of project cost overruns. Nafe Assafi et al. (2022) and Bajjou & Chafi, (2020) concluded that bad weather and client's financial problems are the main factors causing project delays. The results of this study show that external factors such as bad

weather are one of the main factors affecting project schedules, but the most important influence comes from the internal construction factors of the project.

However, while these findings are consistent with the global literature, they have a different focus due to the specific context of China. For example, Wang et al. (2018) emphasize 'claim difficulties' and 'unreasonable advance funding requirements by clients' as unique causes of delays in China's construction industry, due to its unique contractual and financial regulatory framework. In contrast, studies in regions such as the Middle East or Europe tend to prioritise contractor inefficiency or material shortages over these institutional factors (Sanni-Anibire et al., 2022). Similarly, Ji et al., (2018) point out that the problems of miscommunication and low productivity are more pronounced in this context in China than in developed economies with a stable labour force, exacerbated by rapid urbanization and reliance on migrant workers.

To address these identified issues, this study proposes practical recommendations to improve schedule management in residential projects in China. Given that construction factors are the main cause of delays, it is recommended to implement integrated project management solutions that leverage new technologies such as Internet of Things (IoT), Artificial Intelligence (AI), and Building Information Modeling (BIM). For example, the adoption of real-time site management tools such as IoT monitoring systems can improve construction efficiency and reduce delays due to poor site supervision, in line with global best practices (Gurgun et al., 2024). The use of BIM can prevent design conflicts and minimize changes (Kim & Bilbao, 2023), and establishing a strong communication platform that integrates stakeholders (clients, contractors, designers, etc.) is crucial, thus addressing the issues raised by respondents B and F. Meanwhile, integrated supply chain management software can ensure timely delivery of materials, addressing logistics inefficiencies in the Chinese context (Weng et al., 2021). As highlighted by respondent D, regulatory reforms as well as streamlining payment processes (e.g., reducing bureaucratic delays in progress payments) can alleviate funding-related frustrations (Wang et al., 2018). Meanwhile, implementation of collaborative platforms such as cloud-based project management tools can improve stakeholder coordination to address communication challenges noted by respondents A and E (Ji et al., 2018). Weather-related disruption contingency plans can be enhanced by adopting standardized risk assessment methodologies from other regions and tailored to China's diverse geographic environment (Zaman et al., 2022). The use of tools such as project management software such as Microsoft Project 2019 can enable precise scheduling to address planning deficiencies highlighted by respondents (Yang, 2021). Finally, training programs for site supervisors can improve the quality of supervision and reduce the risk of delays (Ch et al., 2021). These solutions combine technological innovation with contextual adaptation to provide a comprehensive study of the problem of optimizing project schedule delays in China's unique environment**.**

6. CONCLUSIONS AND RECOMMENDATIONS

The purpose of this study is to explore the influencing factors of residential project schedules in China and to rank their importance. This study was orientated towards the application of the research theory to real projects and was one of the few studies in the international arena that focuses on the direction of schedule management in Chinese residential projects. In

response to the research question 'What are the factors affecting the schedule management of residential construction projects in China?', this study clearly identified and ranked the key influencing factors. The study identified 17 key factors that influence schedule management in Chinese residential projects. The analysis showed that construction factors account for 16.2%, followed by design factors (11.7%), material factors (3.7%), financial factors (3.5%), communication factors (1.9%), non-human factors (1.6%), planning factors (1.1%), and supervisory factors (0.8%). Interview coding yielded that the highest word frequency was construction factors, which means that constructor's influence on the efficiency of construction schedule execution, the time of construction funds availability, and constructor's influence on various resource inputs during the construction process were the most important, i.e., they have the greatest impact on the project schedule. Reducing and improving schedule delays is critical to the success of construction projects in any country (Melaku Belay et al., 2021). Project delays can be significantly reduced by selecting contractors with qualified financial backgrounds and credentials, improving the management skills of contractors, and devoting resources and efforts to the most frequent factors (Abbasi et al., 2020; Durdyev, 2021; Fashina et al., 2020). Therefore, by using the project impact factor analysis methodology, companies can develop targeted measures to manage risk and increase profitability and market competitiveness.

Although this study made some contributions to schedule management of residential development projects in China, it still had limitations. For example, this study was limited by the use of a single data collection method using field surveys, which may lead to single method bias and data that is not suitable for other countries or other types of projects. Additionally, while the study focused on identifying key factors affecting schedule delays, it did not delve into the specific barriers faced by small and medium-sized construction firms in developing economies. Future research could delve deeper into these barriers and provide more comprehensive information. In addition, methodological limitations prevented providing longitudinal insights into the evolution and long-term impact of delay factors; future research could address this issue using a longitudinal approach. To enhance theoretical and practical innovations, future research could also develop novel schedule management frameworks or methods applicable to various residential projects. In Moreover, incorporating advanced emerging technologies such as IoT or Digital Twins or AI or BIM or irtual Reality (VR) (Bozkurt et al., 2024) into schedule management models and discussing the constructability and applicability of these models would greatly enrich future research and contribute significantly to the theory and practice of the field. Therefore, future research subjects could tend to be pluralistic and increase the diversity of research methods. For example, could leverage methods like Structural Equation Modeling (SEM) to uncover complex interrelationships among factors (Özen et al., 2024), or fuzzy PIPRECIA to calculate impact factors (Stević et al., 2022). In this way, a more in-depth and comprehensive study of the factors affecting the project schedule can be carried out.

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