

## Article

# Addressing Individual Perception: Extending the Technology Acceptance Model to the Interim Payment Method in Construction Projects

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**Abstract:** An increasing trend in late payment and nonpayment of construction projects would hinder the sustainable development of projects by impeding progress or causing disputes. Although the interim payment method is a good practice to solve payment-related problems of construction projects, its acceptance rate is low, and studies on it are few. Therefore, this research aims to extend the Technology Acceptance Model (TAM) to understand practitioners' acceptance behavior toward the interim payment method. By adopting TAM, this study established an acceptance model of the interim payment method, which consists of four constructs and 25 indicators, and validated it through 131 survey data collected in Jiangsu Province, China. The results showed that the adoption rate for public projects (17%) was much lower than that of private projects (44.8%). The results revealed that environmental factors, perceived usefulness, and attitude increase practitioners' acceptance, while the perceived ease of use impedes practitioners' acceptance. In addition, the settlement process and pricing method impact the ease of use the most and could be breakthrough points for improvement in the future. Moreover, the perceived usefulness significantly affects practitioners' attitudes but does not affect behavioral intention. This study contributes to the body of knowledge of project management by identifying the key causes of the low acceptance of the interim payment method and provides strategies for further improvement. The findings would help to inform the decision-making in policies, strategies, and incentive schemes to increase practitioners' acceptance in China and worldwide.

**Keywords:** interim payment; technology acceptance model; perceived ease of use; perceived usefulness; SEM; construction finance



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## 1. Introduction

There is an increasing trend in late payment and nonpayment of construction projects in both developed and developing countries. Recent research revealed that 65% of contractors in the UK have experienced slower payments since the start of the pandemic, and a staggering 75% of UK businesses are forced to wait a month beyond their agreed contract terms before getting paid [1,2]. Similarly, a study of eight construction central enterprises in China found that the average collection period and the maximum average cash collection ratio in 2020 were around 150 days and only 5.0%, respectively, indicating a large number of accounts receivable and a large inventory [3]. Late payment would directly impede the progress of projects. In addition, it causes a variety of economic and social problems, such as cash-flow problems of contractors and subcontractors, disputes, and wage arrears to workers [4]. Ramachandra and Rotimi [5] found that 70% of payment

disputes in construction projects were related to progress payments, whereas 75% and 25% were related to interim payments and final payments, respectively.

To solve payment problems, government regulations and new types of payment agreements have been proposed in various countries but have experienced difficulties in application and execution [6–9]. Thus, research was carried out to identify the main causes for late payment and nonpayment of construction projects, and propose mitigation measures from the industry, company, or project levels [4,9,10]. Some recent studies proposed the latest information and communication technologies to mitigate payment issues, such as through blockchain and smart contracts [11–13]. These studies were undertaken in various countries, such as New Zealand [14], Malaysia [15], and China [16]. Additionally, studies found that many contractors choose not to enforce their rights granted in regulations or contracts to preserve their business relationships with the owner [8,17]. This indicates that payment is not only a legal issue but also a business practice [8,16].

To reduce payment problems, mitigation measures for regular periodic payments, such as monthly payments or milestone-based payments, are specified in many standard forms of contracts and are supposed to be effective measures [4]. Compared with mandatory regulation, the interim payment method is a good practice code that can be led by either the policy-makers or the construction associations. The potential success of proposing this method to narrow the above governance gap depends on its ability to effectively influence the perception or shape the behavior of practitioners within the industry. People who do not fully accept an innovation could delay, hinder, underutilize, or even disrupt its implementation [18]. For example, the Ministry of Housing and Urban-Rural Development of the People's Republic of China [19] issued the Work Plan for Project Cost Reform in 2020 to comprehensively implement the interim payment method. However, after two years of promotion, the acceptance of this method is far lower than expected. To solve the payment problems, there is an urgent need to explore the motivational variables influencing the acceptance of this method [8].

In light of the above, this study aims to develop and validate a theoretical model of the user acceptance of the interim payment method in construction projects by taking China as an example. The model extends the Technology Acceptance Model (TAM), which has been frequently used to explain the acceptance behavior of various new technologies and methods [20,21]. The objectives of this study include (1) identifying potential factors influencing the acceptance of the interim payment method in light of TAM; (2) conducting a questionnaire survey in China and validating the theoretical model; and (3) analyzing and drawing conclusions as well as proposing strategies for future improvement. This study will contribute to the body of knowledge on project management by understanding individual practitioners' acceptance processes of the interim payment method. Moreover, the findings of this study would help policymakers, companies, and organizations troubled by payment problems to target redefined policies, incentives, and work strategies. Furthermore, taking China as an example, the empirical research results would be of interest to foreign companies that aim to enter the Chinese construction market in the future. After China accedes to the Government Procurement Agreement (GPA) of the World Trade Organization (WTO) in 2007, more and more public projects in China will be gradually open to international contractors.

## 2. Literature Review

### 2.1. Causes and Countermeasures of Payments Problems

The unique characteristics of construction projects contribute to various payment problems. Different from general spot commodities, construction products are futures that are customized products and need to be gradually supplied in the future. Therefore, an interim payment is a partial payment that equals the actual value of completed and qualified work conducted by contractors over a period of time or after an agreed milestone, taking into account variations, etc. [13]. During the project construction, there are rounds

of applying and verifying interim payments between the contractor and the owner with the help of the consulting enterprise.

Late payment and nonpayment are of the most significant concern. Studies have explored the potential causes and countermeasures for late payment and nonpayment from the project or industry levels. Causes from the owner are often ranked top. The identified important reasons include insufficient funds to make payments [22], poor financial management [9,16,23], the lack of financial resources [9,24], delay in evaluation and certification of interim and final payment [9], and controlling payments to reserve the bargaining power to ensure that the contractor completes a project with due diligence [25]. For public projects, if the project works that are carried out exceed the government budgets, government agencies may not make payment to the contractor until they get the next year's budget [4,12,24]. From the aspect of project management, payment problems lie in works that are not completed correctly or on time, defective construction works, controversial works, rework due to errors, contract changes, and conflicts or disputes among parties involved in the contract [5,12,23]. In addition, slow processing and delay in finalizing variations and final accounts, and poor documentation were also ranked as important reasons [9,16]. For public projects, late payment can also be caused by bureaucratic procedures, such as government audits [4]. From the aspect of the culture, that work first and getting paid later and the perception that late payment is acceptable are also important reasons for payment problems [4,12]. In practice, irregular payments are ranked as a major cause of disputes [26,27].

Many measures are proposed to mitigate payment problems. From the aspects of legislation, the European Union adopted Directive 2011/7/EU on Late Payment in 2011, which makes late payment less attractive for debtors and compensated the creditor for late payment practices [8]. From the aspect of project management, Peters et al. [4] and Abdul-Rahman et al. [9] suggested training the owner in cash-flow management and investigating the owner's ability to pay. From the aspect of new techniques and tools, blockchain and smart contracts are recently proposed to alleviate payment and related financial problems [11,12]. Using the Bayesian belief network, Wang et al. [16] developed a model to predict the possibility of payment issues, endowing that contractors proactively evaluate if they can afford the payment risks. Nanayakkara et al. [12] explored the suitability of applying blockchain and smart contract technologies to solve payment issues in the construction industry. The findings showed that the application can enhance the traceability of inter-organizational processes and decrease transaction costs. However, these technologies have low efficacy to solve problems, such as cost overruns, payment disputes, and payment hold, which are related to stakeholders' decisions. In addition, the major difficulty in implementing these technologies is not that they are immature but that the developments across the legal, social, and process dimensions are not accompanied [28]. For example, participants are unfamiliar with or unwilling to use them.

## *2.2. Increasing Complexity in the Interim Payment of Construction Projects*

Tracking changes in the interim payment method from a historical perspective can help us to understand the formation of practitioners' behaviors. Taking China as an example has a good advantage. China's national system has gone through several periods of planned economy, planned commodity economy, and socialist market economy. Studying the execution of the interim payment in these processes is easy to show how interim payment changes from simple to complex.

An interim payment is a partial payment that equals the actual value of qualified work completed by contractors over a period of time, taking into account variations, etc. Factors from two aspects will lead to the different workloads of payment application and verification in the construction industry. On the aspect of contract type, payment of lump sum contracts are based on milestone nodes specified in a contract; payments of unit price contracts are not only based on the unit price agreed in a contract, but also based on an accurate measurement that takes a lot of time and effort during the construction [29]. On

the other aspect, payments for significantly defective construction works, disputed works, variation orders, project visas, and other disputed claims usually consume a lot of time and effort to settle [4]. Some even need to be resolved through judicial procedures. Considering the great personnel turnover of the industry, without the timely interim payment, once the relevant personnel leave their position, the successors have great difficulties providing key evidence due to poor documentation and lack of information, easily leading to disputes.

China's construction projects strictly implemented monthly advance payments, monthly interim payments, and completion settlements in the history of China [30]. However, projects with short construction periods and low contract value only implement monthly advance payments and completion settlements. With the increase in the scale of China's capital construction investment, government authorities gradually relax the requirements for not implementing monthly interim payments. The construction period was relaxed from three months in 1953 to six months in 1980, 12 months in 1989, and no requirement in 2004; the contract value was relaxed from 300 thousand RMB in 1980 to 1 million RMB in 1989, and no requirement in 2004 [31]. Accordingly, the owner and the contractor gradually stopped strictly adhering to interim payments.

Moreover, in the past 50 years, before 2003, Chinese construction enterprises used as-built drawings and the Quota valuation method rather than signed contracts as the only basis to calculate payments. The Quota valuation method calculates payments based on government-issued cost-related norms and standards, which are based on full-cost compensation and are relatively stable. Under the administrative management of the government, the owner and the contractor can get full-cost compensation and are equal brothers. In 2003, China started implementing the "Code of valuation with bill quantities of construction works" to be in line with international standards and practices [32]. Thereafter, the owner and the contractor began to use the Bill of Quantity (BQ) valuation method and pay attention to the contracts signed through bidding. In 2004, China issued an important decision on the reform of the investment system to differentiate public investment and private investment under the socialist market economy [33]. With the gradually weakened administrative management, market-oriented management is gradually strengthened. Market factor prices are also gradually fluctuating. In addition, the owner and the contractor have equal civil relations. However, habits and mindsets change very slowly. Even now, a lot has not changed.

In a long run, interim payments made by the owner are only based on rough estimates and have the nature of advance payments. Because of no measurement, the owner intentionally lowers the payment proportion, such as to 60~80%, to avoid overpayment. The lack of real interim payments and improper contract management in the construction phase makes all problems pile up to the completion settlement (Sun et al., 2015), leading to numerous payment problems. Although China has issued many policy documents from 2020 to strengthen stakeholders' performance according to signed contracts and implement the interim payment method, industry acceptance is very low. The Ministry of Finance of the People's Republic of China [34] issued a notice to arbitrarily require that government agencies, institutions, and state-owned enterprises pay no less than 80% of the value of completed projects. However, the notice has low operability and causes another kind of chaos in the industry. The real situation indicates the huge difficulty in returning to this method once giving it up.

Under the market economy, the interaction between the stakeholders changes to a game-based balance. It is well-known that bidding on construction projects and the replacement of contractors mean huge transaction costs. There is process specificity and reversal of bargaining power in construction projects [25]. Once a project starts construction, payment is the bargaining chip for the owner to ensure that the contractor can complete the project with high quality and on time [12,35]. The 60~80% payment proportion is treated as a bargaining chip to help the owner promote the progress of a project [23]. Because of process specificity, project progress is the bargaining chip for the contractor to ensure that the owner can make sufficient payment. Slowing down work is a recommended measure for the contractor to incorporate the risk of late payment or nonpayment [9].

### 3. Conceptual Framework and Hypotheses Development

This study adopted TAM to understand the acceptance processes of the interim payment method. Under the basic framework of TAM, this study identified the critical factors, developed the conceptual framework, and proposed the hypotheses.

#### 3.1. Critical Factors

This study first summarized the potential influencing factors and their measurements, followed by a pre-survey interview with five industry experts in the Jiangsu province of China to check the suitability of these factors and their measurements. The experts have worked in the construction industry in cost-related work for more than 10 years. Through the survey, some factors and some measurements were deleted or added. For example, the factor of using behavior was deleted because all experts believed that the application of this method is rare. In addition, the relevant stakeholders were divided into the owner, contractor, consulting enterprise, and others. Therefore, questions for measuring the perceived ease of use and the perceived usefulness should be distinguished from different stakeholders. The finalized factors and their measurements are summarized in Table 1.

##### 3.1.1. Environmental Factors

Environmental factors refer to the extent to which practitioners believe that the external environment can facilitate the implementation of the interim payment method. Overall, the legislation and the payment culture are identified as critical factors [4,24]. In practice, government regulations or policies reflect the guidance on the future development of the industry. In addition, the actual use or recommendations from peers implies the social influence and the need for future competition among peers or enterprises [21]. The support from seniors or managers and customer requirements are direct demands for the adoption of this method. Because there is a power imbalance among businesses in the construction industry [8,25], the owner often determines the implementation model of a project.

##### 3.1.2. Perceived Ease of Use

Perceived ease of use refers to how easy it is for practitioners to adopt the interim payment method, indicating the effort expectancy of the user [21]. Compared with the settlement of the as-built drawing-based method, if this method and related procedures are easier to learn, practitioners will have the motivation to change their existing working routine. The practitioners' perception of the ability and willingness of their enterprises represents the assessment of their colleagues' abilities. There must be plenty of qualified personnel or experienced employees to perform this method [4,36]. The ability of the owner to prepare sufficient capital and make interim payments is vital for a successful payment [9]. The sufficient and qualified cost management personnel of the contractor ensures the correct application, which is the first step of interim payments [4]. As the party often works for the owner, if the consulting enterprise's personnel, such as the quantity surveyor, can verify the interim payment, they will recommend this method to the owner to avoid cost overrun or payment-related problems [36,37]. In addition, if the utilization rate of this method is increasing, enterprises will take the initiative to change their working routine and accept this method to meet business needs and improve their competitiveness [21].

**Table 1.** Major motivational variables and their measurements.

Factor	Code	Measurement	Reference
Environmental factors (EF)	EF1	Promotion policies of the government prompt me to use the interim payment method.	European Commission [8], Expert interview in 2021, Howard, et al. [21], Peters, et al. [4]
	EF2	The actual use or recommendations from peers prompt me to use the interim payment.	
	EF3	The support from seniors or managers prompts me to use the interim payment.	
	EF4	The client's requirement forces me to use the interim payment.	



Table 1. Cont.

Factor	Code	Measurement	Reference
Perceived ease of use (PEOU)	PEOU1	The pricing method of the interim payment method is simpler than that of the as-built drawing-based method.	Im, et al. [38], Howard, et al. [21]
	PEOU2	The settlement process of the interim payment method is simpler than that of the as-built drawing-based method.	
	PEOU3	The requirements for workability are lower in the interim payment method.	
	PEOU4	With the increase in utilization rate, the interim payment method becomes easier to use.	
	PEOU5	The interim payment method can be easily learned.	Expert interview in 2021, Peters, et al. [4], Abdul-Rahman, et al. [9], Nayan, et al. [36], Wang, et al. [16]
	PEOU6	My company is able to prepare the project funds and make payments according to the interim payment amount (owner).	
		I am able to apply for progress payment using the interim payment method (contractor).	
		I am able to verify the progress payment made by the interim payment method and suggest the owner adopt the interim payment method (consulting enterprise).	
Perceived usefulness (PU)	PU1	My company or I have the ability to apply the interim payment method (other enterprises).	Nanayakkara, et al. [12], Kennedy [27]
		The interim payment method can bring the company extra value because it can accurately control the cost and match the cost with the progress and quality of the project (owner).	
		The interim payment method can help us to timely obtain progress payments matching with project progress and cost expenditure (contractor).	Ansah [23], Odeyinka and Kaka [39], Euginie [40]
		Undertaking projects with the interim payment method can improve the cost consulting capability and bring the company or me more business and profits (consulting enterprise).	
	PU2	Applying the interim payment method can improve the workability/work experience/cost control ability etc. (other enterprises).	Howard, et al. [21], Nayan, et al. [36]
			Im, et al. [38]
Attitude (AT)	AT1	It is a good idea to use the interim payment method.	Expert interview in 2021
	AT2	Using the interim payment method makes my work more fulfilling and meaningful.	
	AT3	Using the interim payment method makes my work process more interesting.	
	AT4	Using the interim payment method is necessary.	
	AT5	Compared with other settlement methods, I prefer the interim payment method.	
Behavioral intention (BI)	BI1	I want to try the interim payment method in future projects in the next 36 months.	Howard, et al. [21]
	BI2	I expect that my future projects will adopt the interim payment method in the next 36 months.	
	BI3	I plan to use the interim payment method in future projects in the next 36 months.	

### 3.1.3. Perceived Usefulness

Perceived usefulness refers to the degree to which practitioners believe that the adoption of the interim payment method will bring them benefits, indicating the performance expectancy of this method [21,42]. From the owner's perspective, this method can accurately match the cost with the progress and quality of the project and avoid cost overruns caused by poor estimating [12]. From the contractor's perspective, this method can help timely obtain interim payment matching with project progress and cost expenditure. The contractor often borrows working capital, which must be repaid on time. Late payment or nonpayment can result in increased finance charges or more borrowing of the working capital [23,39,40]. From the consulting enterprise's perspective, the implementation

of interim payment can improve the company's cost consulting ability and bring more business and profit [38]. At the construction industry level, implementing this method can bring benefits such as reducing disputes, reducing repetitive work, and improving settlement efficiency [26,27,41]. Considering the great personnel turnover of the industry, the interim payment ensures a timely measure of the completed works and fixes the pieces of evidence related to the interim payment to reduce disputes [40]. Otherwise, once the relevant personnel leave their position, the successors have great difficulties providing key evidence due to poor documentation and lack of information.

#### 3.1.4. Attitude

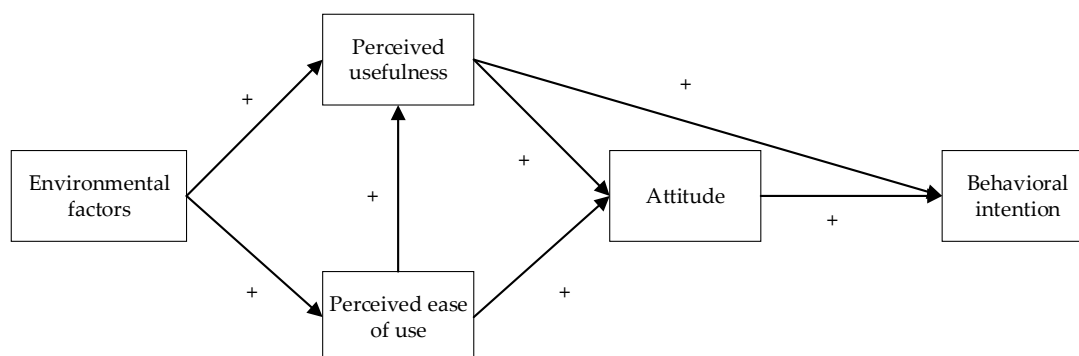
Attitude refers to the individual's positive or negative feelings about the implementation of the target behavior [43]. Attitude shapes one's behavioral intention to use a technology or method [44]. According to the pre-survey, this study found that the personnel who is capable of using this method preferred to use it. The positive or negative psychological attitude of practitioners towards this method is used to moderate their experience and voluntariness [21]. Two beliefs which are perceived usefulness and perceived ease of use are essential for one's attitude toward the usage of the method [44]. Moreover, considering that good motivation will result in better job performance, attitude affects user behavioral intention [21].

#### 3.1.5. Behavioral Intention

Behavioral intention is the behavioral tendency of practitioners to use the interim payment method in future construction projects. Behavioral intentions are divided into three categories, which are trying to use, expecting to use, and planning to use, indicating the intensity of the employee's behavioral intention [21].

### 3.2. Conceptual Framework and Hypotheses Development

TAM was proposed by Davis [44] based on the Theory of Reasoned Action (TRA). The model not only shows the major motivational variables influencing the use of technology or method but also reveals the causal relationships between the motivational variables and the use. Known as a robust acceptance theory, TAM has been widely used to explain users' adoption behavior of technology, techniques, and methods. In terms of the acceptance of techniques and methods, Di Marco et al. [45] adopted TAM to study the impact of students' acceptance of the blended learning method; Liu et al. [46] proposed an extended TAM model to study the influence of residents' psychological factors on their adoption of green housing. TAM is suitable for this study because the interim payment method is a technique or management method to secure the timely payment and smooth cash flow of construction projects [4]. Based on the classical TAM, this study developed the conceptual framework for the acceptance of the interim payment method in construction projects, as shown in Figure 1.



**Figure 1.** Conceptual framework of the acceptance of the interim payment method.

The foundation of TAM is a series of concepts that clarifies and predicts people's behaviors with their beliefs, attitudes, and behavioral intention [47,48]. TAM replaces many of TRA's attitude measures with the two technology acceptance measures, which are ease of use and usefulness. In addition, similar to TRA, TAM assumes that when someone forms an intention to act, they will theoretically be free to act without limitation [47]. In addition, several studies proposed an extension of the original TAM by adding external variables [48]. Considering the above, four major motivational variables, which are environmental factors, perceived usefulness, perceived ease of use, and attitude, have potential impacts on the behavioral intention of the acceptance of the interim payment method. This study did not include using behavior because the acceptance and use of this method currently are very low in China. In light of the above, this study proposed the following hypotheses.

**Hypothesis 1 (H1).** *Environmental factors positively impact the employees' perceived ease of use of the interim payment method.*

**Hypothesis 2 (H2).** *Environmental factors positively impact employees' perceived usefulness of the interim payment method.*

**Hypothesis 3 (H3).** *Employees' perceived ease of use of the interim payment method positively impacts their perceived usefulness of this method.*

**Hypothesis 4 (H4).** *Employees' perceived usefulness of the interim payment method positively impacts their attitude towards this method.*

**Hypothesis 5 (H5).** *Employees' perceived ease of use of the interim payment method positively impacts their attitude towards this method.*

**Hypothesis 6 (H6).** *Employees' perceived usefulness of the interim payment method positively impacts their intention to implement this method.*

**Hypothesis 7 (H7).** *Employees' attitude towards the interim payment method positively impacts their intention to implement this method.*

## 4. Research Method and Data Presentation

### 4.1. Sampling and Measurements

This study used a structured questionnaire survey to solicit the opinions of practitioners in the construction industry. The questionnaire survey has been widely used to collect professional views [49,50]. Before the formal survey, three industry experts who have more than 15 years of experience in cost management reviewed the questionnaire for refinements, minimizing any structural weaknesses or deficiencies in the instrument. The questionnaire consists of three parts. The first part aims to collect background information on the respondents. The second part aims to evaluate the acceptance rate of this method in Chinese construction projects. The last part aims to measure the factors by asking about the practitioners' perception of the description of the factors. All factors were measured with a seven-point Likert scale (1 = strongly disagree; 7 = strongly agree).

The population of this study consisted of all professionals in the construction industry of Jiangsu Province, China. Jiangsu Province is very representative because the total output value of the construction industry in Jiangsu Province has been the first in China for 16 consecutive years. This study used the cluster sampling method that belongs to probability sampling [50]. In cluster sampling, the entire population is divided into four clusters that are the owner, the contractor, the consulting enterprise, and other types of enterprises. Then, the questionnaires were first distributed to enterprises belonging to these clusters and then randomly distributed to employees of these enterprises. The survey adopted a combination of online and offline methods. The online survey is based on the Questionnaire



Star platform, and the offline survey is conducted through face-to-face individual survey. Three criteria were used to screen invalid responses: the time to complete the questionnaire is less than 120 s (for the online survey), the number of participating projects is unreasonable (such as more than 100 or 0), and the answers to all questions are almost the same. Through 16 months of data collection from May 2020 to August 2021, a total of 166 responses were received. After deleting 35 invalid responses, 131 valid questionnaires were used for the following analysis. The effective response rate of the questionnaire is 78.92%. A sample size of 100 or more is recommended for Structural Equation Modelling [51,52].

After analyzing the data, this study selected an engineering consulting enterprise (hereafter named Enterprise A) in Jiangsu Province to conduct the post-survey interviews. Enterprise A is one of the leading consulting enterprises in Jiangsu Province and has successful experience in implementing the interim payment method. The purpose of the post-survey interviews is to verify the survey findings and help accurately explain the results.

#### 4.2. Descriptive Results of Collected Data

The statistical results of the survey are shown in Table 2. The proportion of males (61.07%) and females (38.93%) is reasonable because male employees are more than female employees in China's construction industry. More than half of the responses are from employees of the consulting enterprise, followed by the number of employees from the owner and the contractor. In the construction industry, the consulting enterprise undertakes a large part of the cost-related work. As for work experience, respondents with 5–15 years of work experience accounted for the largest proportion (57.25%). Moreover, the survey requires the respondents to include people with (69.47%) and without (30.53%) relevant interim payment experience. In a nutshell, the response to the survey can be used for further analysis.

**Table 2.** Profiles of respondents and companies.

Category	Classification	Frequency	Percentage
Gender	Male	80	61.07
	Female	51	38.93
Work experience (year)	1–5	37	28.24
	5–10	48	36.64
	10–15	27	20.61
	15–20	11	8.40
	≥20	8	6.11
Company type	Owner	27	20.61
	Contractor	26	19.85
	Consultant	65	49.62
	Others	13	9.92
Projects involved	1–5	46	35.11
	6–10	43	32.82
	11–15	10	7.63
	16–20	8	6.11
	≥20	24	18.32
Interim payment experience	Yes	91	69.47
	No	40	30.53

## 5. Acceptance Analysis and Model Evaluation

### 5.1. Acceptance Rate Analysis

The analysis results of the acceptance rate of the interim payment method in China are shown in Table 3. The adoption rate for public projects (17.0%) was much lower than that of private projects (44.8%).

**Table 3.** The acceptance rate of the interim payment method in China.

Project Type	Proportion of Projects (%)	Adoption Rate (%)
Public project	56.9	17.0
Private project	43.1	44.8
Total	100	-

This result is consistent with Peters et al. [4] and the European Commission [8], that payment problems are more often experienced in public projects than in private projects. Private projects have more motivation to implement this method because the majority of them are real estate development projects. The owner or developer not only attaches importance to cost control but also to the early completion of a project. According to the post-survey interviews, the payment mechanism adopted by private projects is very similar to but is not the real interim payment method. Taking the unit price contract as an example, the developer uses timely interim payments to encourage the general contractor to complete the project as soon as possible; the developer also uses key milestone payments to control the construction progress. However, the interim payment amount is not calculated based on the accurate re-measurement according to the standard measurement method and contract terms but also be a roughly estimated amount with the nature of advance payments. Re-measurement is only performed after project completion and is based on as-built drawings.

### 5.2. Measurement Model Evaluation

The partial least squares-structural equation modeling (PLS-SEM) method was chosen for this study because it can properly handle non-normal datasets and small sample sizes [53]. PLS-SEM was first lauded for its prognostic superiority [53] and has gained significant interest in various disciplines, including civil engineering and business research [54,55]. The analysis results of the measurement model obtained using Smart PLS 3.0 are shown in Tables 4–6 following the reporting practices in confirmatory factor analysis [56]. During the evaluation, this study excluded the measurement items of PEOU5 and PU1 because their loadings are much lower than 0.5 and their variances are very large, indicating unacceptable indicator reliability.

**Table 4.** Measurement model evaluation.

Factor	Code	Loading	T Statistic	Cronbach's Alpha	AVE	CR	Mean
Environment factors (EF)	EF1	0.879	29.847	0.880	0.735	0.917	5.294
	EF2	0.828	15.860				
	EF3	0.875	28.119				
	EF4	0.847	30.968				
Perceived ease of use (PEOU)	PEOU1	0.815	4.302	0.862	0.646	0.901	3.620
	PEOU2	0.915	5.159				
	PEOU3	0.705	3.010				
	PEOU4	0.795	3.600				
	PEOU6	0.774	3.419				
Perceived usefulness (PU)	PU2	0.807	17.116	0.853	0.694	0.901	5.155
	PU3	0.822	22.062				
	PU4	0.869	34.602				
	PU5	0.833	26.201				
Attitude (AT)	AT1	0.883	36.619	0.926	0.772	0.944	5.231
	AT2	0.863	32.712				
	AT3	0.849	23.700				
	AT4	0.884	37.118				
	AT5	0.914	41.775				
Behavioral intention (BI)	BI1	0.929	57.071	0.935	0.885	0.959	5.208
	BI2	0.943	74.663				
	BI3	0.950	83.686				

**Table 5.** Correlation matrix and the square root of AVE of factors.

Code	AT	BI	EF	PEOU	PU
AT	<b>0.879</b>				
BI	0.811	<b>0.941</b>			
EF	0.740	0.606	<b>0.857</b>		
PEOU	0.066	0.026	−0.026	<b>0.804</b>	
PU	0.790	0.578	0.661	0.120	<b>0.833</b>

**Table 6.** Cross-loadings for individual measurement items.

Code	EF	PEOU	PU	AT	BI
EF1	<b>0.879</b>	−0.054	0.498	0.649	0.534
EF2	<b>0.828</b>	0.011	0.578	0.673	0.531
EF3	<b>0.875</b>	0.034	0.611	0.607	0.466
EF4	<b>0.847</b>	−0.089	0.565	0.609	0.552
PEOU1	−0.066	<b>0.815</b>	0.048	0.01	−0.029
PEOU2	−0.022	<b>0.915</b>	0.128	0.071	0.014
PEOU3	−0.087	<b>0.705</b>	0.095	0.005	−0.036
PEOU4	0.064	<b>0.795</b>	0.082	0.082	0.031
PEOU6	−0.013	<b>0.774</b>	0.098	0.07	0.092
PU2	0.547	0.149	<b>0.807</b>	0.634	0.448
PU3	0.564	0.170	<b>0.822</b>	0.629	0.461
PU4	0.560	0.089	<b>0.869</b>	0.702	0.536
PU5	0.531	−0.007	<b>0.833</b>	0.665	0.477
AT1	0.738	−0.048	0.747	<b>0.883</b>	0.683
AT2	0.605	0.094	0.651	<b>0.863</b>	0.616
AT3	0.581	0.123	0.674	<b>0.849</b>	0.682
AT4	0.671	0.002	0.720	<b>0.884</b>	0.712
AT5	0.651	0.124	0.678	<b>0.914</b>	0.850
BI1	0.618	−0.011	0.556	0.788	<b>0.929</b>
BI2	0.547	−0.001	0.515	0.722	<b>0.943</b>
BI3	0.543	0.084	0.556	0.775	<b>0.950</b>

In Table 4, the loadings of all measurement items are greater than 0.5, indicating acceptable indicator reliability [57]. The values of Cronbach's alpha and composite reliability (CR) of each factor are over 0.7, ensuring the reliability of internal indicators within each factor [58,59]. The values of the average variance extracted (AVE) are above 0.5, ensuring convergent validity [60]. In Table 5, the square root of the AVE of each factor is higher than its correlation with other factors. In Table 6, each measurement item has the highest loading on the corresponding factor. The discriminate validity of the factors is satisfactory. Overall, the results indicate that the measures have adequate reliability and validity.

### 5.3. Structural Model Evaluation

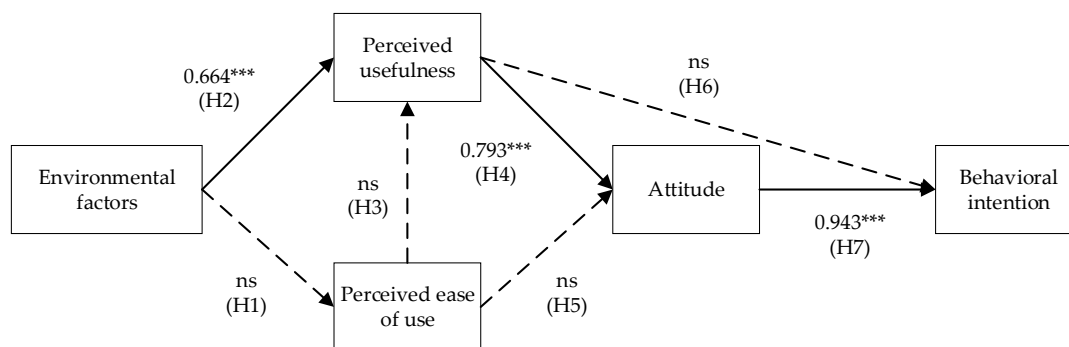
Before evaluating the structural model, this study checked the collinearity issues. The variance inflation factor (VIF) quantifies the extent of correlation between one predictor and the other predictors in a model and diagnoses collinearity. The VIF values of all factors are less than the cutoff of 5, indicating that variables are moderately correlated in this study [61].

Table 7 shows the indices' values for evaluating the explanatory power and predictive ability of the proposed structural model. First, the coefficient of determination ( $R^2$ ) was used to evaluate the explanatory power of the structural model. Without considering the value for PEOU, the  $R^2$  values of latent variables were around 0.5, indicating a moderate explanatory power. Moreover, Stone-Geisser's  $Q^2$  was used to evaluate the predictive ability of the structural model. Without considering the value for PEOU, the  $Q^2$  values of other latent variables were all above 0, indicating a good predictive ability [62,63].

**Table 7.** Structural model evaluation results.

Factor	R <sup>2</sup>	Stone-Geisser's Q <sup>2</sup>
EF	/	/
PEOU	0.001	−0.000
PU	0.455	0.305
AT	0.625	0.475
BI	0.668	0.581

Figure 2 shows the structural model evaluation results. As can be seen from the figure, only three paths are statistically significant because the  $p$ -values of these paths are less than 0.05. The results indicated that, at the current stage, the impact of environmental factors on the perceived usefulness, the impact of the perceived usefulness on the attitude, and the attitude on the behavioral intention in the industry are all statistically significant. It is worth noting that all paths to or from the perceived ease of use are statistically insignificant. According to the results, to accurately evaluate the explanatory power and predictive ability of the proposed structural model, the value of PEOU was not considered when calculating the R<sup>2</sup> and Q<sup>2</sup>.

**Figure 2.** Hypothesis testing results. Note: \*\*\*  $p < 0.01$ , ns refers to not significant.

## 6. Discussion

### 6.1. Impeding Effect of Difficulty in Use

All paths related to the perceived ease of use (PEOU) were statistically insignificant (rejecting H1, H3, and H5). In addition, the mean of the scoring results of PEOU factors is only 3.62. The rejection of H1 means that the environmental factors did not significantly impact PEOU. Moreover, the rejection of H3 and H5 indicates that the low PEOU cannot significantly impact practitioners' perceived usefulness and attitude. Therefore, the ease of use of this method must be improved first in the future. Among the measurement items of PEOU, PEOU 1 (factor loading = 0.815) and PEOU 2 (factor loading = 0.915) received the highest factor loadings. The results alert that the pricing method and settlement process of this method is the top most important to the ease of use. According to the results and the post-survey interviews, the complexity of the settlement process is even more daunting to industry practitioners than the pricing method. When preparing or verifying the interim payment, cost engineers need to not only calculate the progress payment according to the contract terms but also confirm the responsibility, do measurements, and make payments for the variation orders, claims, price adjustments, and other matters. Particularly, the cost management of variations and claims often leads to many rounds of bargaining and meetings [4,9,35]. In addition, the use of unqualified or inexperienced personnel to resolve payment issues often leads to additional meetings [4]. Compared with the settlement based on as-built drawings at the completion stage, interim payments mean more workload during construction, implying extra transaction costs.

To deal with the interim payment, cost engineers need to not only know the cost valuation method, but also have professional knowledge of the contract, law, construction

technology, etc., which is more complex [12]. An analysis of the education level of China's cost engineer shows that the vast majority of college training is prepared for the budget estimate at the bidding stage, emphasizing more on the measurement and valuation based on the Quota valuation method; little training is provided for the process settlement and final account at the construction stage. This emphasizes more on contract performance and interim payments based on the signed contract. The lack of qualified personnel or the use of inexperienced employees may lead to payment problems [4], or defer all problems to completion settlement. Therefore, future cost engineer education should strengthen the integration of cost, contract, project management, law, etc. [16].

The high factor loading of PEOU 4 (0.795) is a good sign because it implies that if the utilization rate increases in the future, practitioners believe that it will be easier to use. In the construction industry's digital transformation process, cost engineer/quantity surveyors encounter huge opportunities and challenges in leveraging advanced technologies to simplify the pricing method and settlement process. For example, quantity takeoff using building information modeling (BIM) can be used to help make cost estimations of construction projects when bidding. Automated payment and contact management by integrating BIM and blockchain-based smart contracts are also proposed [64]. Of course, there are still disputes in the industry about the accuracy of automatic quantity takeoff using BIM and its basis for commercial transactions because most of the industry still uses manual measurement as the basis for settlement. By the way, some of the current cost valuation methods are inconsistent with trading habits. To improve it, more trading habits were considered in China's recently published draft new version of the BQ valuation method [65]. Therefore, future research should strive to conduct in-depth research on exploring the processes and works that can be automated and intelligently treated from the perspective of cost professionalism and trading habits.

In addition, China's future policy should provide more concrete operational guidance on the ease of use of this method. Although China has issued many related policies to promote the interim payment method in the past three years, few policies emphasize the practical guidance on the ease of use of this method, especially on the pricing methods and settlement process. This may be the most important reason for little improvement in the acceptance of this method. More research should direct to these aspects to support the reform of the construction industry and the materialization of related policies.

## 6.2. Incentive Effect of Perceived Usefulness

The perceived usefulness significantly influences practitioners' attitudes (accepting H4) but insignificantly influences their behavioral intention (rejecting H6). Except for PU1, the factor loadings of measurement items are greater than 0.8, and PU 4 received the highest factor loadings of 0.869. All results indicate that the performance expectation of this method is high. PU1 was excluded according to the measurement model evaluation. This should be further analyzed because PU1 was highlighted during the survey. The analysis results of the mean and independent sample t-tests of the data from the owner, consulting enterprise, and contractor are shown in Table 8.

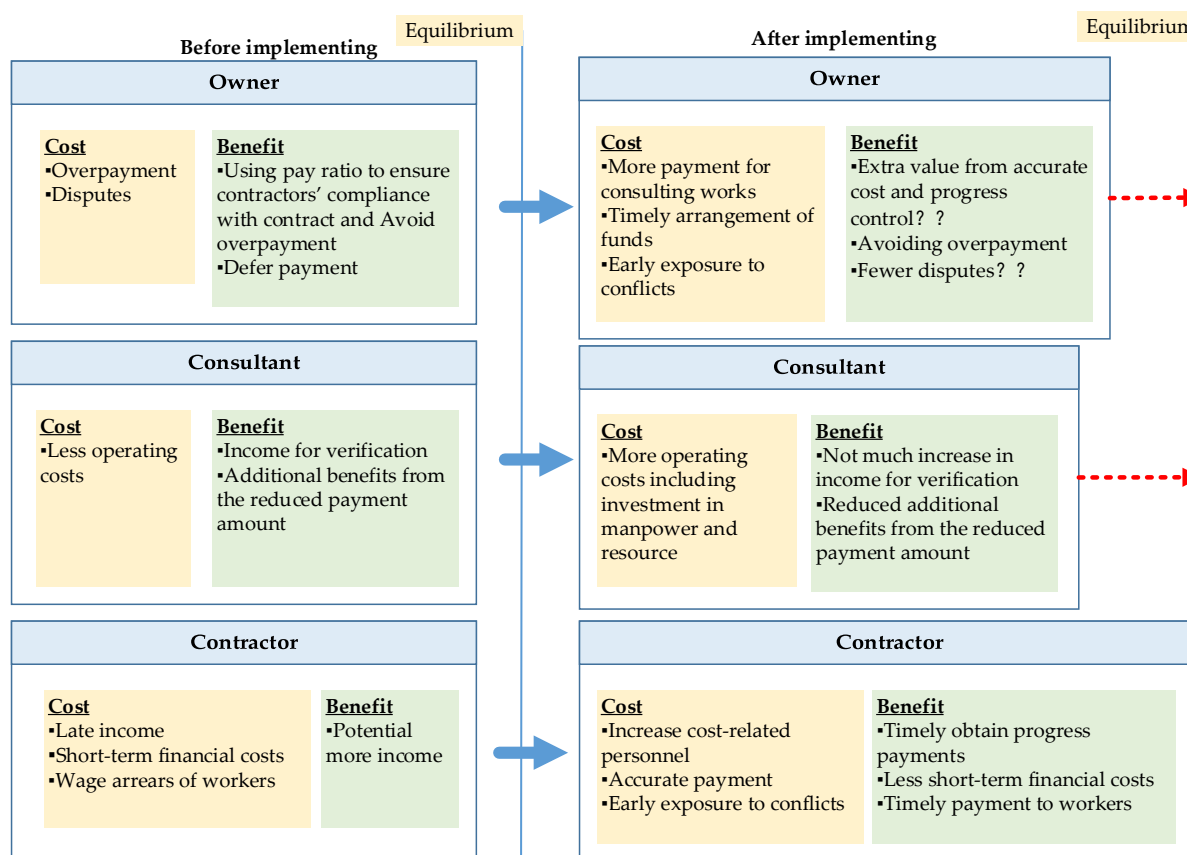
**Table 8.** Analysis results of PU1 among different parties.

Factor	Mean			t-Test Significance		
	Owner (O)	Consulting (QS)	Contractor (C)	O-QS	O-C	QS-C
PU1	5.96	5.06	5.46	0.040	0.100	0.689

The owner gave the highest score, followed by the contractor and the consulting enterprise. Moreover, the means of the owner and the consultant enterprise are statistically different. To reveal the underlying reason, this study conducted in-depth discussions with experts and Company A. Finally, it was found that this is caused by the potential payoffs under the choice of game strategies of all parties in the current construction industry in



China. This study summarized the potential costs and benefits for each party before and after using this method, as shown in Figure 3.



**Figure 3.** Comparison of payoffs before and after using the interim payment method.

Before using the interim payment method, there is no real measurement and payments are based on rough estimation. When making payments, the owner uses the pay ratio as a bargaining chip to ensure the contractor's compliance with the contract, avoid overpayment, and defer payments as much as possible. When applying for payments, the contractor pretends not to be so professional and applies for more payment. When verifying payments, the consulting enterprise can not only obtain income for verifying the contractor's payment claim but also obtain additional benefits from the reduced payment amount through the verification. These payoffs and strategies lead to a game equilibrium and lead the industry to a vicious circle and a dilemma of numerous disputes.

The current policies promoting this method are inclined to the contractor but can change the costs and benefits for all parties, leading to disequilibrium. From the owner's perspective, using this method can bring extra value such as ensuring successful project delivery and avoiding overpayment. However, this extra value is uncertain, and not easy to get an intuitive and objective evaluation from the perspective of the project itself. When using this method, the owner has to pay more costs for the extra salary of internal cost-related personnel or more consulting fees. From the consulting enterprise's perspective, implementing this method means more workload and more investment in manpower and resources. However, the consulting fees in China currently are too low. There are many reasons such as the owner's low evaluation of the consulting services and the lack of a mechanism for the owner and the consulting enterprise to share value increase. Therefore, the consulting enterprise is doomed to have no motivation to adopt this method. Although this method brings more benefits, the contractor and the owner both are afraid of early exposure to conflicts and breaking the cooperation relationship in advance.

The rational starting point for improvement is a change in the motivation of upstream parties [5] by considering their benefits and costs. For example, ways to evaluate the extra value to the owner should be first explored. For the extra value, this study suggests referring to the 7th edition of PMBOK. A system's focus on value delivery changes the perspective from one of governing projects to focus on the value chain that links those and other business capabilities to advancing organizational strategy, value, and business objectives [66]. In addition, the carrot and stick incentive and punishment mechanism could be adopted. Praising and publicizing participants in projects successful in implementing this method, and increasing the punishment for payment problems caused by lack of interim payment can be considered. Moreover, measures to improve the service capability and remuneration rate of the consulting enterprise should be considered. The extra value can only be generated on the basis that the consulting enterprise has the capability of using this method. After giving it up for many years, the consulting enterprise should re-cultivate its interim payment ability such as through learning experience from successful projects and standardizing services to reduce operating costs [67]. Furthermore, a benefit-sharing mechanism between the owner and consulting enterprise should be proposed. In addition, other strategies can focus on changing the vicious competition in the contracting market. The rules of bidding competition should be changed to let the owner choose a contractor who is competitive in price and believable in providing quality service rather than just the price [68]. The trust established through long-term cooperation can reduce the transaction costs caused by bargaining between the owner and the contractor.

### 6.3. Incentive Effect of Environmental Factors and Attitude

The environmental factors have a significant incentive effect on the perceived usefulness (accepting H2) but an insignificant effect on the perceived ease of use (rejecting H1). Thus, future policies should focus on concrete operational guidance on ease of use. The measurement items EF1 and EF3 have the highest factor loadings of 0.879 and 0.875, respectively. Compared with the client's requirements, the support from the seniors or managers will directly facilitate the relevant cost-related personnel to learn and use this method.

The current attitude has a significant incentive effect on behavioral intention (accepting H7). It is very gratifying that the factor loadings of measurement items are relatively high, implying practitioners' positive attitudes towards this method. Many practitioners commented that implementing this method makes their work more meaningful and makes them feel more successful because they can essentially contribute to the cost and project management instead of wasting time in repetitive work and inefficient and lengthy bargaining meetings.

## 7. Conclusions and Recommendations

### 7.1. Conclusions

This study established an acceptance model of the interim payment method by extending TAM and validated it through survey data collected in Jiangsu Province, China. The survey results first showed that the adoption rate for public projects (17%) was much lower than that of private projects (44.8%). Moreover, the results revealed that environmental factors, perceived usefulness, and attitude currently have significant incentive effects on practitioners' acceptance, while the perceived ease of use has an impeding effect. In addition, the settlement process and pricing method have the greatest impact on its ease of use. Furthermore, the perceived usefulness significantly affects practitioners' attitudes but does not affect behavioral intention. Further analysis of the difference in the perceived usefulness of the main parties revealed that the game strategies and payoffs of each party before and after using this method lead to the perception of unrewarded and additional workload to existing work processes. To break the illusion of no reward, adjusting game strategies and payoff distribution, exploring the evaluation of extra value, and proposing sharing mechanism of the extra value should be considered.

### 7.2. Theoretical and Practical Contribution

This study first contributes to the body of knowledge of project management by identifying the motivators and impediments to the acceptance of the interim payment method and providing strategic suggestions for its improvement. The ineffectively solved and continuously existing payment problem is not only a practical problem but also a theoretical problem. Through theoretical analysis, this study demonstrates the critical causes of government failure (policy failure) and market failure (payment problems and disputes) in terms of the interim payment method. The results can help to redefine policies, strategies, and incentive schemes to increase practitioners' acceptance in China and worldwide.

### 7.3. Limitations and Recommendations

First, the lack of depth interviews with experts about the cost and benefits distribution of implementing the interim payment method in the early stage of the study hinders the deeper discussion on this aspect. Second, due to COVID-19 epidemic restrictions, the sample size of this study is relatively small, affecting the representativeness of the results to some extent.

According to the results of this study, future research can focus on the following aspects: (1) exploring ways to improve the ease of use of this method; (2) exploring ways to evaluate the extra value by using this method; and (3) proposing a benefit-sharing mechanism between the owner and consulting enterprise.

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