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The Impact of Multi-Dimensional Incentives on the Performance of Rail Transit PPP Projects

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Abstract: This study investigates how different types of incentives impact the performance of rail transit PPPs, focusing on their construction and operational phases. By surveying 121 practitioners working in the Chinese rail transit industry, we propose a new classification of incentives (i.e., control-oriented, neutrality-oriented, and recognition-oriented incentives) based on psychological theories to broaden the categorization of "positive" (rewards) and "negative" (punishment) incentives. We further explore how these multi-dimensional incentives influence project performance by surveying another 256 industry professionals. Our findings reveal that (1) in addition to punishments, performance-based payment/bonus, credit ratings, and reputation mechanisms are newly recognized as control-oriented incentives, which can restrain the autonomy of the private sector; (2) control-oriented incentives positively influence project performance in the construction phase where clear, measurable goals are available, but their impact diminishes in the operational phase; (3) recognition-oriented incentives enhance project performance in both construction and operational phases (especially the latter), fostering long-term sustainability; and (4) neutrality-oriented incentives focus on risk allocation and collaboration between public and private sectors, showing a modestly positive effect in the operational phase. As such, the study provides decision-makers in the rail transit industry with valuable insights to enhance project performance effectively when implementing incentive policies.

Keywords: rail transit; public–private partnerships; incentive; key performance indicator

Academic Editor: Pierfrancesco De Paola

Received: 11 November 2024
Revised: 20 December 2024
Accepted: 24 December 2024
Published: 25 December 2024

Citation: Zhu, Z.; Yuan, Y.; Zhang, L.; Zhao, J.; Yuan, J. The Impact of Multi-Dimensional Incentives on the Performance of Rail Transit PPP Projects. *Buildings* **2025**, *15*, 32. https://doi.org/10.3390/buildings15010032

1. Introduction

Performance management has been and continues to be a key to the success of public–private partnerships (PPPs), as it ensures the delivery of quality public services and protects public interests [1]. Traditionally, the performance of PPPs was measured against a range of quantitative and qualitative metrics (pre-defined) such as cost, time, quality, environmental and social impact, and contractual compliance [2]. They aimed to ensure that projects realize their goals and deliver value for money [3,4]. However, as PPPs typically feature significant risk transfer to the private sector, various stakeholders, and long-term contracts (e.g., 30 years), traditional performance management is faced with more and more challenges. For example, Grimsey and Lewis [5] revealed the complex and contentious nature when allocating risks between the public and private sectors. According to Cui et al. [6], consistent funding is problematic because of the potential shortage of public or private financial

resources, especially in long-term projects. Furthermore, Domingues and Zlatkovic [7] argued that disputes over contract interpretation or performance can be costly and time-consuming. These challenges of performance management become more conspicuous in rail transit PPPs [8–10]. In the construction phase, the integration of various technical systems, including civil work, track laying, power supply, signaling, rolling stock, and infrastructure and property development around stations, presents additional complexity in delivering rail transit PPP projects [9,11]. In the operational phase, rail transit PPPs, which serve the daily travel needs of citizens, typically face stringent safety regulations and service standards [8,9,11]. Throughout their life-cycle, rail transit PPPs have historically struggled to achieve profitability, relying heavily on government subsidies, land value capture, and fare revenue recovery to reach financial viability [9]. As a result, incentives have been widely implemented to address such specific performance challenges of rail transit PPPs [12–14]. There are differences between the incentives utilized in rail transit PPPs and other infrastructure PPPs. For example, due to the travel services provision nature, incentives may include the patronage change payment regarding the ridership growth, penalties for failing to run on-time services, or other service quality-based payment (e.g., overall customer satisfaction) [8,12]. Additionally, given the interconnectivity of rail transit systems within cities and the high potential impact of safety incidents on urban mobility, incentives are often designed to uphold high safety standards [11,13], such as penalties for safety breaches and bonuses for exemplary safety performance [15]. In comparison, incentives for other infrastructure PPPs, such as energy PPPs, could be more tied to production targets, cost control, and innovation in energy production or distribution [16].

Despite the widespread implementation of incentives within rail transit PPPs, their impact on project performance sometimes remains ambiguous and ineffective. Generally, incentives can exert dual effects: (1) "positive incentives" (e.g., subsidies, tax reduction/exemption) are designed to improve PPP performance, but not always be able to bring the expected performance improvement [17]; and (2) "negative incentives" (e.g., punishments and penalties) can sometimes be more effective than "positive incentives" in ensuring the performance of PPPs [18,19]. Most existing research attributes this dual impact of incentives to the opportunistic behaviors of the private sector [14,20], and explores multiple influencing factors such as the information asymmetry between the public and private sectors [14,20,21], poorly designed evaluation metrics combined with incentives [12], and the loss of scarcity and exclusiveness of incentives [17]. Therefore, the principal–agent model [20–22], Stackelberg game theory model [18,19,23], and evolutionary game model [17] have been widely applied to study the impact of different incentives on PPP performance and maximize the utility of incentives.

While existing research has touched on the mechanisms of how incentives affect the performance of PPP projects, the current explanations are still inadequate [17]. Most research focuses narrowly on financial outcomes, neglecting broader dimensions of PPP performance such as quality, social welfare, and long-term sustainability. Additionally, despite some studies exploring different types of incentives, the literature predominantly examines financial incentives such as subsidies, performance-based payments, or tax adjustments [17–19,23]. Moreover, relatively few studies account for how the impact of incentives varies across different phases of a project. In order to address the aforementioned gaps, the scope of this paper is to examine the impact of different incentive measures on the performance of PPP projects across different project stages within the context of rail transit PPPs in China. And, we aim to address the following research questions:

Research question (1): Why could both "positive incentives" and "negative incentives" exert dual impacts on rail transit PPPs' performance?

Research question (2): Do incentives have different influences on rail transit PPPs' performance across different stages?

By doing so, the contributions of this study are twofold. First, we provide a deeper understanding of why incentives would have dual effects on project performance by integrating psychological theories from the perspective of the private sector. Second, we broaden the types of incentives in rail transit PPPs, moving beyond the traditional "positive" and "negative" incentives and offering a stage-specific analysis of how they impact project performance, which has the potential to provide a meaningful contribution to the literature and inform practice and policy.

The remainder of this paper is structured as follows: In Section 2, an overview of the relevant literature on rail transit PPPs' performance and incentives is presented, followed by the formulation of research hypotheses. Section 3 describes the methods deployed to address the research questions. Section 4 presents the results on how different types of incentives impact PPP performance across different project phases. Section 5 presents the discussion of the findings, and Section 6 concludes the study.

2. Literature Review and Hypotheses

2.1. PPP Project Performance

The concept of performance originates from business management, encompassing three perspectives: results, behaviors, and a combination of behaviors and results. From the result-oriented perspective, performance refers to the documented outcomes achieved in a particular task or activity within a designated time frame [24]. In the behavior-oriented view, performance is defined as a collection of actions aligned with the objectives of the job or the organization, and should be distinguished from the outcomes [25,26]. From the comprehensive perspective, performance combines both behaviors and results [27,28]. Behaviors are not only a medium for achieving results but are also considered directly as results (the result of mental and physical effort applied for tasks) [29]. In the context of PPPs, the definition of performance remains elusive and subjective because of different value claims, interests, and perceptions of project success from various stakeholders [3,30]. Nevertheless, PPP performance often focuses on both the behaviors and results [31], considering input, process, output, and outcomes [32] from the perspective of each stakeholder.

For effective PPP performance management, performance objectives serve as valuable tools for assessing the strengths and weaknesses of PPPs, and are expected to be fulfilled through the life-cycle of PPPs [3]. Prior studies tend to develop comprehensive frameworks of performance indicators to measure the performance of PPPs against predefined performance objectives [10,33–36]. Quality, cost, time, and value for money remain traditional performance indicators [37–39]. Ahmad et al. [40] identified 10 key performance indicators (KPIs) to achieve an accurate analysis of performance for different stakeholders, including the additional aspects of service delivery, collaboration between organizations, socio-economic impacts, sustainability, etc. Moreover, life-cycle and phase-based perspectives have been considered in combination with KPIs or balanced scorecards (BSCs) to measure PPP performance [32,41–44]. One popular life-cycle perspective incorporates performance at the phases of initiation and planning, procurement, and partnership (such as construction, operation, and maintenance) [42,45,46]. Adopting this view, Liu et al. [46] proposed a performance management system (PMS) supported by a performance prism.

While comprehensive performance goals and indicator systems may be established, fostering long-term trust and cooperation between the private and public sectors in the actual operation of PPPs, and aligning their efforts toward common performance objectives, remains a significant challenge [3]. In this context, the inclusion of well-designed incentives (rewards and penalties) regarding already defined performance indicators in the initial contract, coupled with ongoing performance monitoring, is crucial for the successful delivery of PPP projects [12].

2.2. Incentives for PPP Projects

Incentives are methods designed by organizations to stimulate and assimilate employees' behaviors through appropriate forms of reward ("positive incentives") and punishment ("negative incentives") [47,48]. They can be material/explicit incentives (e.g., salary, benefits, bonuses, and prizes) and non-material/implicit incentives (e.g., honor, autonomy, and recognition) [49]. In PPPs, governments often utilize such incentives as financial incentives, punishments, reputation incentives, and other policy incentives. For example, financial incentives, attributed to "positive incentives", are the most common incentives used in PPPs, providing such as performance-based payment [12], subsidies [19], equity investment and loan guarantees [50], etc. Punishments, regarded as "negative incentives", can be increased taxes, direct penalties, or disqualifications when the private sector is in breach of contract [17–19,51]. Reputation incentives are mostly implicit, such as improving the private sector's image by recognizing rail-transit projects as nationally high-quality [14].

The dual impact of government incentives on PPP projects has been extensively studied. On the one hand, "positive incentives" do not always result in the expected performance improvement, whereas could even have perverse effects. For example, the private sector may deliberately slack on the level of efforts to save costs or not fully disclose their revenues to obtain more subsidies under the incentive of minimum revenue guarantee [18]. Another example is deflated performance manipulation by the private sector to ensure high scores on performance measurement or to avoid unreasonable measurement standards under the incentive of performance-based payment [12]. Yang et al. [17] attribute the side-effect of these "positive incentives" to the loss of scarcity and exclusiveness during the implementation based on the reinforcement theory. On the other hand, "negative incentives" can be particularly effective in supervising the private sector to act in the best interest of the project. By creating a strong deterrent against the private sector's poor performance or unethical behaviors, the addition of punishments into awards can mitigate the governments' risk of exposure to the high transaction costs associated with implementing incentives [12].

The existing research has touched on the dual impacts on rail transit PPP performance, most of which are looking for external reasons, such as ill-designed KPIs chosen to award incentives and/or penalties, lax regulation and tracking of actual performance, and the natural conflicts of interests and information asymmetry between governments and private sectors. However, a significant gap remains in analyzing the internal and underlying reasons from the perspective of the private sector. Therefore, our research aims to examine the real perceptions of incentive measures among private sectors from a psychological view, thus addressing research question (1).

2.3. Theories and Hypotheses

According to Deci and Ryan [52], the self-determination theory (SDT) proposes that individuals are inherently driven to develop and evolve by fulfilling their fundamental psychological needs for competence, autonomy, and relatedness. This motivation can be extrinsic or intrinsic. Extrinsic motivation refers to engaging in an activity primarily for

external rewards or to avoid punishments, closely aligning with the concept of explicit incentives applied in PPPs [53]. In contrast, intrinsic motivation is more closely associated with implicit incentives, driven by internal satisfaction and personal fulfillment [54]. SDT classifies extrinsic motivation into autonomous and controlled motivations. Autonomous extrinsic motivation occurs when individuals engage in an activity for external reasons, but still feel a sense of choice and alignment with their personal goals and values (i.e., the activity is personally meaningful and their engagement is more self-determined) [55]. In contrast, controlled extrinsic motivation occurs when individuals feel pressured or coerced into engaging in an activity due to external factors. This undermines their sense of autonomy and can lead to less sustained effort and satisfaction. According to SDT, tangible rewards such as bonuses, subsidies, and bounties based on performance could also become controlled motivation [52], which differs from their traditionally perceived encouraging nature. This SDT view may explain why some "positive incentives" do not generate expected performance improvement, as they might be perceived as controlling instead of truly inspiring. Therefore, this paper defines incentives which convey autonomy-supportive information and are perceived as motivating by individuals as recognition-oriented incentives. Incentives that convey mandatory information and are perceived as a form of control are considered as control-oriented incentives. Those incentives that fall between recognition- and control-oriented are classified as neutrality-oriented incentives.

However, the negative effect of control-oriented incentives based on SDT might be a little biased. For example, SDT cannot explain why some "negative incentives" can be particularly effective in supervising private sectors to maintain high performance. Hence, the motivated information processing (MIP) theory is introduced to study the underlying mechanisms. Under the MIP theory, the information processing and outcomes within groups are co-affected by two forms of motivation: epistemic motivation (ranging from low to high) and social motivation (from pro-self to pro-social) [56]. Variables like the need for cognition, affiliation, and agreeableness generally lead to high epistemic motivation [57], which is the same as the autonomy-supportive social contexts in SDT. But it is not enough to ensure a high group performance result, because MIP posits that group members encounter a combination of both cooperative and competitive scenarios (corresponding to the relationships between governments and private sectors): the cooperative situation will make members focus on collective outcomes thus lead to pro-social motivation, whereas the competitive situation focuses on pro-self motivation [58], which might lead to selfish behavior, lazy compromising, deception, etc., resulting in low group performance [57]. This MIP view may explain why some "negative incentives" can be particularly effective, as they force the private sector to place more weight on pro-social instead of pro-self behaviors even if their needs for autonomy are not satisfied.

Once the classification of incentives is determined, we consider their respective influence on rai transit PPP performance across different stages to address the research question (2). Given that incentives discussed here are implemented in PPPs, the ultimate effect of an incentive shall depend on (1) the relative salience of whether the private sector perceives the incentive as recognition-oriented or as a control-oriented incentive, and (2) the implementation scenario of the incentive during different phases of the project [23,59].

In the construction phase, basic indicators such as schedule, quality, cost, and safety management of PPP performance are given more priority and assessed by specific and quantitative metrics for the successful built-up of rail transit assets [3], which generally needs strict regulation and the supervision of control-oriented incentives such as punishments, performance-based payment [60]. Even though controlled motivation makes individuals feel pressured or coerced, it can monitor the private sector's behaviors according to the established clear performance objectives and restrain it from speculation caused

by pro-self motivation. Furthermore, the private sector faces a strain of cash flow as its profitability outlook or operating capability remains unclear at this phase [61]. In this case, recognition-oriented incentives, such as governments' aids in financing, hold the potential for the private sector to expand their financing sources, improve cash flow management, sustain financial stability, and attract investors [62]. In terms of other recognition-oriented incentives (supposing reputation awards and titles for high-quality projects), both SDT and MIP affirm their positive effects on inspiring individuals. Therefore, we propose the following hypotheses 1, 2, and 3 for the construction phase:

Hypothesis 1. *Control-oriented incentives positively influence rail transit PPP project performance in the construction phase.*

Hypothesis 2. *Recognition-oriented incentive measures positively influence rail transit PPP project performance in the construction phase.*

Hypothesis 3. *Neutrality-oriented incentive measures positively (H3a) or negatively (H3b) influence rail transit PPP project performance in the construction phase.*

For the operational phase, KPIs are gradually transferring priority from the schedule, quality, and cost of construction to fare revenues, safety, public clients' satisfaction with the rail transit service, and sustainability for the sustainable delivery of rail transit services [63,64]. In addition, as projects proceed to the profitable phase, the private sector could play a more independent role and concentrate on its own profits [65]. Implementing financial incentives like performance-based payment/bonuses under the circumstances might breed opportunistic behaviors caused by ambiguous performance measurement metrics [18]. Moreover, excessive punishments might aggravate the private sector's reverse psychology, and hurt their cooperating attitude22 Regarding recognition-oriented incentives, both SDT and MIP affirm their positive effects. For example, the government's positive attitude towards cooperation can encourage the private sector to improve public clients' satisfaction with the rail transit service through various innovative ways [66]. Therefore, we propose the following hypotheses 4, 5, and 6 for the operational phase:

Hypothesis 4. *Control-oriented incentive measures negatively influence rail transit PPP project performance in the operational phase.*

Hypothesis 5. *Recognition-oriented incentive measures positively influence rail transit PPP project performance in the operational phase.*

Hypothesis 6. *Neutrality-oriented incentive measures positively (H6a) or negatively (H6b) influence rail transit PPP project performance in the operational phase.*

Finally, as indicated by the proven interaction effect among performance indicators of PPP projects [35,44], PPP project performance in the construction phase generally provides a guaranteed project management capacity for the later operation. We, therefore, propose the following Hypothesis 7, and develop the hypothetical model in Figure 1.

Hypothesis 7. *PPP project performance in the construction phase positively influences PPP project performance in the operational phase.*

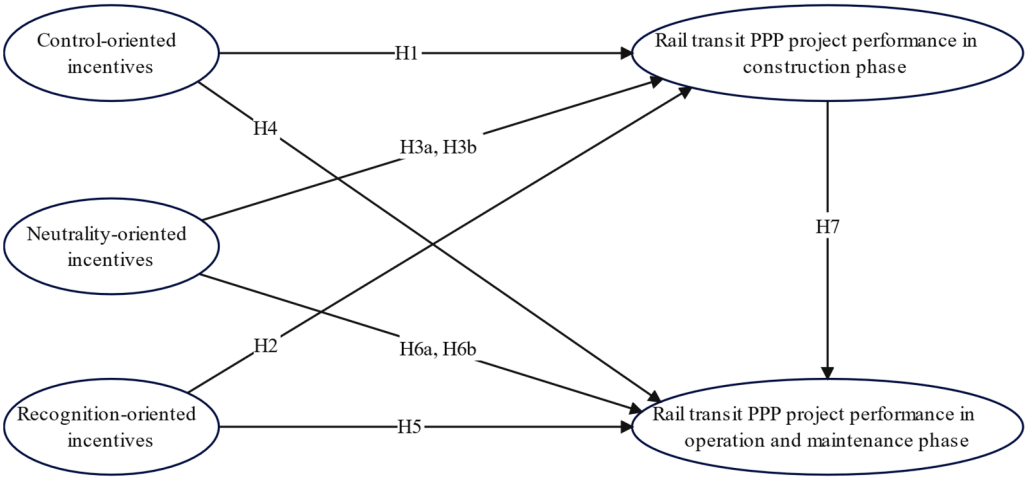

Figure 1. The hypothesized model. Note: H = hypothesis.

3. Research Methods

A quantitative approach was adopted to test the above hypothesized model based on SDT and MIP (Figure 1) [67,68]. Specifically, structural equation modeling (SEM) was selected to validate the hypothesized model because SEM's ability to model complex relationships between the observed and latent variables allows for a precise analysis of how incentives influence performance outcomes over time [69]. By incorporating both direct effects and multiple observed variables into a unified framework, SEM provides a robust analysis that accounts for the intricate dependencies and potential measurement errors within the dataset [70]. The research process was as follows: (1) A life-cycle performance evaluation framework consisting of eight KPIs and an incentive framework consisting of 16 incentive measures for rail transit PPP projects were established based on the existing literature. (2) The incentive framework was further developed to categorize the 16 incentive measures into control-oriented, recognition-oriented, and neutrality-oriented types. This was conducted by using data from 121 questionnaire surveys and the K-Means statistical analysis. (3) The different effects of three types of incentives on PPPs' performance across their life-cycle were tested and verified by structural equation modeling (SEM) using another 256 questionnaire surveys. By doing so, research questions (1) and (2) were addressed.

3.1. Identifying Incentives and Indicators for PPP Project Performance

A total of 16 incentives (Table 1) implemented on rail transit PPPs have been identified from the previous literature, comprising financial incentives, punishments, reputation incentives, and other policy incentives.

From the life-cycle perspective (i.e., construction, operation, and maintenance) [46], 8 KPIs (Table 2) were identified from the existing literature to evaluate rail transit PPP project performance. In the construction phase, KPIs encompass schedule management (PC1), quality management (PC2), cost management (PC3), and safety management (PC4) to assess the project's adherence to the requirements of time, standards, budget, and safety protocols, respectively. Transitioning to the operation and maintenance phase, KPIs are modified to include ongoing cost management (PO1), safety management (PO2), public satisfaction with the service (PO3), and management efficiency and innovation of organizations (PO4), which are crucial for assessing the project's ability to manage substantial operational costs and financial risks while maximizing fare revenue, maintaining high safety standards in complex urban environments, ensuring public satisfaction with

transit services, and fostering continuous innovation and efficiency in organizational management to address the unique challenges of rail transit PPP projects.

Table 1. The incentives used in rail transit PPP projects.

No.	Incentives	Explanation	References
1	Assistance in Financing	The government facilitates access to funding, such as bridging loans or partnerships with financial institutions.	[71,72]
2	Business Performance Bonus	Monetary bonuses are awarded for achieving specific business milestones or innovations.	[73,74]
3	Credit Rating and Reputation Mechanism	Implementation of a credit evaluation system that tracks and publicly reports the reputation of project partners.	[74–76]
4	Government's Positive Attitude towards Cooperation	The government demonstrates a collaborative stance through regular communication and mutual respect in project partnerships.	[75,77]
5	Logistical Support	Provision of essential services such as transportation, accommodation, or on-site facilities to project teams.	[78]
6	Other Performance Bonuses	Monetary bonuses are awarded for outstanding achievements in additional performance areas, such as cultural or recreational contributions.	[19,79]
7	Penalties	Financial or contractual penalties are imposed for failure to meet agreed-upon performance standards or deadlines.	[80]
8	Performance-Based Payment	Payments to the private sector are adjusted based on project delivery metrics and performance benchmarks.	[74,81]
9	Policy Support	The government enacts policies such as land-use adjustments or expedited regulatory approvals to facilitate project development.	[8,82]
10	Priority Honor Titles	Titles or distinctions such as "Model Worker" or "High-Tech Enterprise" are awarded to recognize excellence.	[8,21]
11	Revenue Sharing	The private sector is given a share of revenues from secondary sources, such as advertising or property operations.	[8,83]
12	Project Awards	The government supports project applications for prestigious awards like the Luban Award, enhancing industry recognition.	[8,21]
13	Revenue Subsidies	Financial subsidies, such as fare subsidies, are provided to support the financial stability of the project.	[9,84]
14	Risk Sharing	The government takes on specific risks, such as policy change risks, that are beyond the private sector's control.	[82,85]
15	Simplified Approval Process	The government streamlines regulatory approvals, coordinating multiple departments to expedite project timelines.	[86,87]
16	Tax Incentives	Tax relief measures, such as partial exemptions or deferrals, are granted to reduce the financial burden on the private sector.	[88,89]

Table 2. The performance evaluation framework for rail transit PPP projects.

Phase	Code	KPIs	Explanation	References
Construction	PC1	Schedule management	Assesses adherence to the construction timeline, considering delays from various factors such as resources and funding.	[40,90,91]
	PC2	Quality management	Ensures construction meets specified quality and technical standards as per regulations.	[40,90,91]
	PC3	Cost management	Evaluates the effectiveness of budget planning and cost control to enhance project profitability.	[40,90,91]
	PC4	Safety management	Monitors safety practices to prevent accidents and ensure personnel safety, especially in complex or hazardous conditions.	[90,91]
Operation and Maintenance	PO1	Cost management	Focuses on managing operational costs efficiently to maximize fare revenue and maintain financial stability.	[35,91,92]
	PO2	Safety management	Ensures the implementation of safety measures to prevent accidents during operations.	[35,41,90]
	PO3	Public clients' satisfaction with the rail transit service	Measures public satisfaction regarding service quality, punctuality, and overall performance.	[40,91,93]
	PO4	Management efficiency and innovation of organizations	Evaluates efficiency and innovation in management practices and processes to improve organizational performance.	[35,92,94]

3.2. Classification of PPP Project Incentive Measures

A questionnaire survey was designed to investigate the attributes of the initial 16 incentive measures in Table 1. A purposive sampling strategy was employed for data collection as it helped focus on identifying in-service operational staff and project managers working in major private partner companies, such as CRRC Corporation and CSCEC Corporation, which are large suppliers of rail transit PPP infrastructures [95]. Specifically, project managers who assume substantial work experience in rail transit projects and their incentive mechanisms were approached via emails due to their familiarity with the authors. This selection ensured that the participants had knowledge of government incentives and could contribute to the classification of such incentive measures [96]. They were then requested to share the survey within their network to attract wider participation. As a result, 130 responses were received between May and June 2023 among which 121 were deemed valid. Nine responses were discarded due to incomplete or irrelevant information, such as missing critical data or inconsistent answers [97]. The demographic information of the participants is summarized in Table 3. It shows that the majority of them (83.48%) worked in the private sector of rail transit PPPs while the others worked in government bodies (2.48%), research institutions (8.26%), and consulting companies (5.79%), respectively.

The attributes of incentive measures include control-oriented, neutrality-oriented, and recognition-oriented aspects. Control-oriented means the respondent feels the incentive conveys a controlling context that pressures them to think, feel, or behave in specific ways. Recognition-oriented means the respondent feels the incentive could satisfy their competence need, autonomy need, or enhance their intrinsic motivation, internalization,

and psychological well-being. Neutrality-oriented means the respondent feels the incentive has little impact on them [52]. The respondents rate each incentive measure on a scale of 1 to 5, where 1 represents control-oriented, 2 indicates less control-oriented, 3 is neutrality-oriented, 4 indicates less recognition-oriented, and 5 denotes recognition.

Table 3. Demographic information of the first survey respondents (N = 121).

Demographic Variable	Category	Frequency	Percentage (%)
Gender	Male	93	76.86
	Female	28	23.14
Age	Below 30	31	25.62
	30–40	74	61.16
	41–50	14	11.57
	51–60	1	0.83
	Above 60	1	0.83
Education background	High school or below	1	0.83
	Specialized postsecondary college	2	1.65
	Bachelor's degree	69	57.02
	Master's degree	47	38.84
	Doctorate	2	1.65
Years of work or research in infrastructure management	Less than 3 years	21	17.36
	4–6 years	45	37.19
	7–9 years	36	29.75
	10–12 years	16	13.22
	Over 12 years	3	2.48
Type and nature of respondents' work units	Government departments or related public institutions	3	2.48
	Universities or scientific research institutions	10	8.26
	Private sector (state-owned enterprises)	82	67.77
	Private sector (private enterprises)	18	14.88
	Private sector (foreign enterprises)	1	0.83
	Others (consulting firms, financial institutions, etc.)	7	5.79
Job type	Operational staff	43	35.54
	Project junior managers	59	48.76
	Project middle managers	17	14.05
	Project senior managers	0	0.00
	Others	2	65

The mean value of ratings for each incentive measure was obtained and then segmented into clusters using the K-means algorithm on IBM SPSS Statistics 27.0. The K-means algorithm is a widely used technique to cluster data into distinct groups based on similarities between data points [98]. After the first iteration, the deviation distances from initial class center points were 6.609 (control-oriented), 5.878 (recognition-oriented), and 7.087 (neutrality-oriented), respectively. Rapid convergence was achieved after the second iteration, evidenced by the minimal variation in cluster centers, as reflected in the negligible maximum absolute coordinate change of zero [99]. The distances between the final class centers were 33.085 (control-oriented and recognition-oriented), 22.765 (control-oriented and neutrality-oriented), and 11.699 (recognition-oriented and neutrality-oriented). The mean value of each 16 incentives from the survey and the results of the subsequent K-means clustering analysis are shown in Table 4.

Table 4. K-means clustering results of incentive measures.

No.	Incentive Measure	Pre-Clustering Mean Value	Assigned Cluster	Distance from Cluster Centroid
1	Policy support	3	Neutrality	7.776
2	Simplified approval process	3.033	Neutrality	7.157
3	Tax incentives	3.992	Neutrality	7.548
4	Assistance in financing	4.041	Recognition	6.872
5	The government's positive attitude towards cooperation	4.579	Recognition	5.793
6	Risk sharing	3.041	Neutrality	7.051
7	Revenue subsidies	3.934	Neutrality	7.051
8	Priority honor titles for project companies and their employees	4.388	Recognition	5.878
9	Performance-based payment	1.413	Control	7.272
10	Business performance bonus	1.512	Control	5.628
11	Other performance bonuses	2.008	Control	8.202
12	Penalties	1.364	Control	6.609
13	Revenue sharing	3.901	Neutrality	6.342
14	Project awards	3.893	Neutrality	7.464
15	Credit rating and reputation mechanism	1.463	Control	6.007
16	Logistical support	3.223	Neutrality	7.087
Average score		3.049		

Based on the clustering results from Table 4, 16 incentive measures were divided into three clusters: control-oriented, neutrality-oriented, and recognition-oriented. Further adjustments were made based on the nature of the incentives. For instance, the incentives related to government support that go beyond obligatory duties but reflect a positive cooperation attitude (incentive 14 and incentive 16) were reclassified from neutrality-oriented into the recognition-oriented category based on the principle that a good cooperative attitude is founded on the government's recognition of effective actions by the private sector. The final categories of incentives for the rail transit PPP project are shown in Table 5.

Table 5. Framework of categories of incentives for rail transit PPP project.

Category	Code	Incentive Measures
Control-oriented	A1	Performance-based payment
	A2	Business performance bonus
	A3	Other performance bonuses
	A4	Penalties
	A5	Credit rating and reputation mechanism
Neutrality-oriented	B1	Policy support
	B2	Simplified approval process
	B3	Tax incentives
	B4	Risk sharing
	B5	Revenue subsidies
	B6	Revenue sharing
Recognition-oriented	C1	Assistance in financing
	C2	The government's positive attitude towards cooperation
	C3	Priority honor titles for project companies and their employees
	C4	Project awards
	C5	Logistical support

3.3. Impact of Incentives on Rail Transit PPP Performance

A second questionnaire survey was conducted to gather data for the primary SEM analysis shown in Figure 1. Similarly to the first survey, a purposive sampling method was used to ensure that participants had knowledge of government incentives and could contribute to understanding the impact of these incentives on the performance of rail transit PPPs [96]. There were some overlaps in the participants between the two rounds of the survey, which is common as large rail transit companies are limited. Additionally, due to the trust and reputation established from the first survey, the second survey successfully recruited 256 valid responses between July and August 2023. The demographic information of the participants is summarized in Table 6, which shows that the second survey included more experienced respondents, with 45.3% having 7–9 years of experience in infrastructure management or research, as well as managers in higher positions. Moreover, given that 88.7% of the respondents in the survey were male, due to the current working status in the construction industry, an independent sample t-test was performed to determine if there are significant differences in the impacts perceived by the male and female respondents. The results indicated no significant differences between the two genders across all the test variables ($p > 0.05$).

Table 6. Demographic information of the second survey respondents (N = 256).

Demographic Variable	Category	Frequency	Percentage (%)
Gender	Male	227	88.7
	Female	29	11.3
Age	Below 30	29	11.3
	30–40	145	56.6
	41–50	70	27.3
	51–60	8	3.1
	Above 60	4	1.6
Education background	High school or below	2	0.8
	Specialized postsecondary college	4	1.6
	Bachelor's degree	178	69.5
	Master's degree	66	25.8
	Doctorate	6	2.3
Years of work or research in infrastructure management	Less than 3 years	16	6.3
	4–6 years	60	23.4
	7–9 years	116	45.3
	10–12 years	36	14.1
	Over 12 years	28	10.9
Affiliation type	Government departments or related institutions	4	1.6
	Efficient or scientific research institutions	14	5.5
	Social capital (state-owned enterprises)	187	73.0
	Social capital (private enterprises)	45	17.6
	Others (consulting firms, financial institutions, etc.)	6	2.3
Job type	Operational staff	35	13.7
	Project junior managers	155	60.5
	Project middle managers	46	18.0
	Project senior managers	8	3.1
	Others	12	4.7

Secondly, based on their experiences, the participants were requested to indicate the degree of impact of control-oriented, recognition-oriented, and neutrality-oriented incentives (Table 5) on enhancing rail transit PPPs' performance through a 16-item scale. For instance, under control-oriented incentives, 'How significant do you think performance-based payment can enhance rail transit PPP project performance?' was asked (A1 in Table 5)). This significance was rated using a 5-point Likert scale ranging from 1 (slight impact), 2 (moderate impact), 3 (significant impact), 4 (very large impact) to 5 (extremely large impact). Similarly, the impact of items A2–5 (control-oriented incentives), B1–6 (neutrality-oriented incentives), and C1–5 (recognition-oriented incentives) of Table 5 were evaluated.

Thirdly, the participants were requested to indicate the degree of impact of incentives on enhancing rail transit PPP project performance in the construction phase and performance in the operation and maintenance phase (Table 2) through an 8-item scale. For instance, in terms of performance in construction, 'How significant do you think the performance indicator—the project schedule in construction phase would be affected by incentive measures?' (PC1 in Table 2). This significance was rated using a 5-point Likert scale ranging from 1 (slight impact), 2 (moderate impact), 3 (significant impact), 4 (very large impact) to 5 (extremely large impact). Similarly, the impact of items PC2-4 (performance in construction) and PO1-4 (performance in operation and maintenance) of Table 2 were evaluated.

Finally, several analytic techniques were employed to process the collected data. First, IBM SPSS Statistics 27.0 was utilized to calculate Cronbach's alpha values, assessing the reliability of the measurement scales [100]. IBM SPSS AMOS 28.0 was employed to evaluate the structural validity of our measures through a series of confirmatory factor analyses (CFA) [70]. Second, IBM SPSS Statistics 27.0 was applied to conduct correlation analyses and generate descriptive statistics for the study [101]. Lastly, all the effects hypothesized in hypotheses 1, 2, 3, 4, 5, 6, and 7 were examined by establishing SEM in IBM SPSS Statistics 27.0.

4. Results

4.1. Reliability, Validity, and Descriptive Analysis

As shown in Table 7, the value of Cronbach's alpha for each construct is greater than the acceptable threshold of 0.6 [102]. Next, the results of CFA indicated good construct validity of the latent factors underlying the items on surveys (χ^2 = 701.951; df = 237; χ^2/df = 2.962 < 3 [103]; GFI = 0.827 > 0.8 [104]; RMR = 0.028 < 0.05 [105]; RMSEA = 0.088 (90% C.I.) < 0.1 [106]; PGFI = 0.653 > 0.5 [107]; PNFI = 0.594 > 0.5 [108]). The mean (M) values ranged between 3.574 and 4.500, and the standard deviation (SD) values were between 0.496 and 0.818 (Table 7), showing moderate spread and variability of the data [109]. The skewness values fell within an absolute range of three, and kurtosis remained within an absolute range of 8, indicating an approximately normal distribution [103].

4.2. Correlation Analysis and Hypothesis Test

Table 8 presents the correlation statistics for the preliminary verification of whether there is a mutual influence relationship between the latent variables of this study. All the incentives were positively correlated with the PPP project performance in both the construction phase (control-oriented incentives: r = 0.587, p < 0.01; neutrality-oriented incentives: r = 0.347, p < 0.01; recognition-oriented incentives: r = 0.607, p < 0.01) and the operation and maintenance phase (control-oriented: r = 0.522, p < 0.01; neutral-oriented: r = 0.419, p < 0.01; recognition-oriented: r = 0.609, p < 0.01).

Table 7. Results of reliability, validity, and descriptive analysis.

Latent Variables	Observed Variables	Standardized Loading Coefficient	Means	Standard Deviations	Skewness	Kurtosis
Control-oriented incentives (α = 0.664; M = 4.079; SD = 0.432)						
	A1	0.162	4.418	0.608	−0.526	−0.616
	A2	0.733	4.020	0.556	−1.094	6.464
	A3	0.637	4.047	0.673	−0.990	3.249
	A4	0.505	3.980	0.743	−1.008	2.178
	A5	0.648	3.930	0.711	−0.824	2.024
Neutrality-oriented incentives (α = 0.735; M = 4.139; SD = 0.390)						
	B1	0.446	4.500	0.601	−0.875	0.357
	B2	0.692	4.035	0.496	−0.507	3.657
	B3	0.570	4.102	0.637	−0.272	0.161
	B4	0.638	4.074	0.606	−0.248	0.542
	B5	0.615	4.086	0.614	−0.460	1.232
	B6	0.432	4.035	0.603	−1.096	5.136
Recognition-oriented incentives (α = 0.605; M = 3.986; SD = 0.425)						
	C1	0.244	4.402	0.625	−0.548	−0.611
	C2	0.482	4.039	0.545	−0.266	1.577
	C3	0.646	3.617	0.818	0.117	−0.185
	C4	0.658	4.023	0.613	−0.836	3.904
	C5	0.612	3.848	0.775	−0.749	1.108
Rail transit PPP project performance in construction phase (α = 0.721; M = 4.012; SD = 0.462)						
	PC1	0.608	4.336	0.598	−1.176	5.909
	PC2	0.680	4.043	0.569	−1.023	5.945
	PC3	0.625	4.055	0.723	−1.150	2.960
	PC4	0.617	4.047	0.605	−1.731	8.895
Rail transit PPP project performance in the operation and maintenance phase (α = 0.668; M = 3.873; SD = 0.451)						
	PO1	0.550	4.008	0.509	−0.347	2.381
	PO2	0.589	3.574	0.710	0.298	−0.372
	PO3	0.574	3.926	0.637	−0.944	3.368
	PO4	0.624	3.984	0.674	−0.755	2.406

Table 8. Correlation coefficient among variables.

Variables	1	2	3	4	5
1. Rail transit PPP project performance in the construction phase	1				
2. Rail transit PPP project performance in the operation and maintenance phase	0.571 **	1			
3. Control-oriented incentives	0.587 **	0.522 **	1		
4. Neutrality-oriented incentives	0.347 **	0.419 **	0.433 **	1	
5. Recognition-oriented incentives	0.607 **	0.609 **	0.611 **	0.442 **	1

Note: ** $p < 0.01$, two-tailed.

Finally, SEM was conducted to test the hypothesized relations among the latent variables. Firstly, the results indicated that our hypothesized SEM model fit the data well (x^2/df = 2.972 < 3 [103]; RMSEA = 0.088 (90% C.I.) < 0.1 [106]; RMR = 0.028 < 0.05 [105]; PGFI = 0.657 > 0.5 [107]; PNFI = 0.597 > 0.5 [108]). Secondly, the hypothesis test (Figure 2) shows that hypotheses 1, 2, 5, and 6 were empirically supported while hypotheses 3, 4, and 7 were rejected. To sum up, in the construction phase, control-oriented incentives have

the strongest positive impact ($\beta = 0.527$, $p < 0.01$), ensuring accountability and measurable performance outcomes. Recognition-oriented incentives also contribute positively by motivating stakeholders ($\beta = 0.471$, $p < 0.01$), while neutrality-oriented incentives show little effect ($\beta = -0.142$, $p > 0.05$, n.s.). In the operation and maintenance phase, recognition-oriented incentives have the most significant and positive impact ($\beta = 0.618$, $p < 0.01$), fostering collaboration and long-term performance. Neutrality-oriented incentives turn out to show minor effects ($\beta = 0.227$, $p < 0.01$), providing stability and risk mitigation. Control-oriented incentives lose their effectiveness and can even have negative effects on performance ($\beta = -0.173$, $p > 0.05$, n.s.).

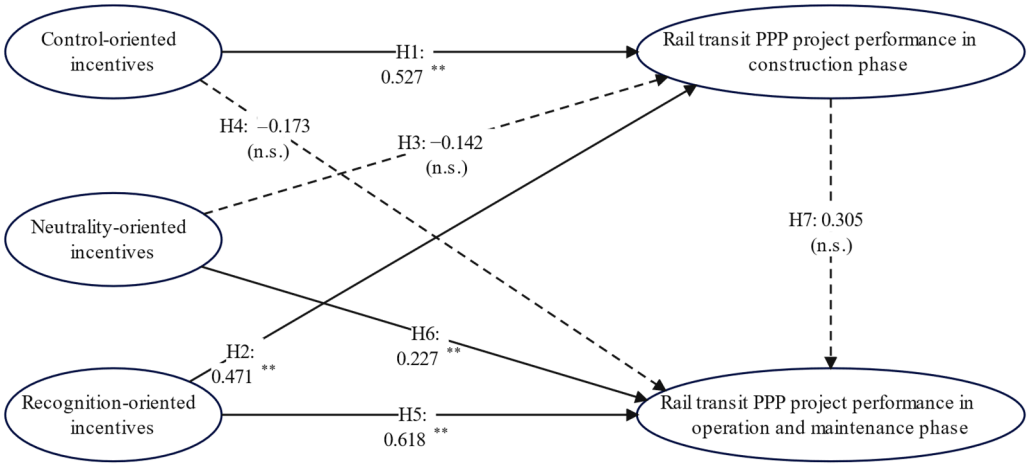

Figure 2. Results of SEM. Note: Solid lines represent significant path coefficients, while dashed lines indicate non-significant ones. All path coefficients are standardized. ** $p < 0.01$, two-tailed.

5. Discussion

5.1. The Attributes of Incentive Measures

The classification results reveal that the private sector perceives incentives differently (see Table 5). Consistent with SDT, control-oriented incentives not only refer to penalties (A4), but also tangible rewards based on performance including performance-based payment (A1), business performance bonus (A2), and other performance bonuses (A3) were all recognized by the respondents as control-oriented incentives, as they condition the receipt of rewards on meeting specific performance criteria [74]. Unexpectedly, the credit rating and reputation mechanism (A5) was also recognized as a control-oriented incentive (discussion presented later). The classification results provide an answer for the first part of research question (1)—the dual effect of "positive incentives": while these incentives are expected by government policymakers to play positive roles, they are perceived by the private sector as controlling rather than genuinely inspiring, thus possibly leading to bad sequent behaviors [59]. For example, reducing their real current performance to smooth high performance standards in the future is caused by the rachet effect (in the principal–agent relationship, an agent's strong performance or reputation leads the principal to raise future expectations and targets) [74].

Neutrality-oriented incentives (B1–B6) show a congruous balance between the interests of the public and private sectors without the pressure of overly controlling or disproportionately rewarding one party over the other. Policy support and simplified approval processes (B1, B2) reduce bureaucratic barriers, making it easier for the private sector to participate in rail transit projects [110]. Risk sharing, revenue subsidies, revenue sharing, and tax incentives (B3–B6) focus not on recognizing or rewarding superior performance but on addressing the inherent uncertainties and financial risks associated with

large-scale rail transit projects, where both parties share the risk and have their interests safeguarded [8,9,82].

Consistent with SDT, incentives (C1–C5) share a common recognition-oriented focus that fulfills individuals' intrinsic needs for competence, relatedness, and autonomy, either directly or indirectly. Assistance in financing (C1) and logistical support (C5) enable autonomy by providing the necessary resources and infrastructure to allow project companies to operate more effectively [111]. The government's positive attitude towards cooperation (C2) and logistical support (C5) contribute to a collaborative environment that nurtures positive relationships between the public and private sectors. Priority honor titles for project companies and their employees (C3), and project awards (C4) validate the efforts and achievements of the project companies and their employees [112].

The different attributes of credit rating and reputation mechanism (A5) and priority honor titles for project companies, their employees, and projects (C3, C4) provide insights into the dual nature of reputation mechanism within the context of PPP projects. A reputation mechanism refers to the use of the track record, credibility, and historical performance of both the public and private sectors to influence behavior and foster trust [14]. The private sector is often eager to strive for a good reputation, as it not only brings social acknowledgment but also enhances market competitiveness during bidding [74]. Therefore, reputation mechanisms are often assumed to be recognition-oriented (e.g., C3 and C4). However, when reputation and credit ratings are tied directly to performance evaluations (A5), they transition from being motivational tools to instruments of control [74]. In this scenario, the private sector is pressured to maintain a high reputation to avoid negative consequences, such as losing future business opportunities, and might become more cautious and conservative, reducing risk but potentially limiting creativity and innovation.

5.2. The Effects of Incentive Measures

The results of SEM provide answers to research question (2)—distinct characteristics of these three incentive categories lead to varying impacts on rail transit PPP performance at different project stages (see Figure 2).

Control-oriented incentives have a significantly positive impact on performance in the construction phase ($\beta = 0.527$, $p < 0.01$), consistent with the MIP theory. In line with research [73,79,113], the performance-based payment in rail transit PPPs is a key element of contracts, since it directly links rewards and abatements (penalties) to the achievement of performance milestones and defines risks transferred to the private sector. According to Li et al. [74], coupling reputation supervision with performance-based payment can help the government evaluate the performance of the private sector more accurately, thus reducing the incentive cost of the government. Hence, the finding can provide an answer to the second part of research question (1)—the dual effects of "negative incentives": although control incentives may impair autonomy, they act as a deterrent against delays or substandard behavior, and opportunistic behaviors for performance rewards [73,74,114], being especially effective in rail transits' construction environments, where clear, measurable goals are paramount (such as on-time delivery or budget compliance).

While control-oriented incentives were observed to lose efficiency on performance in operation and maintenance ($\beta = -0.173$, $p > 0.05$, n.s.), according to Gordon et al. [12], in some Metro contracts, most of the risk was placed on the operator, with a cap on the quality bonuses (limiting government payout), but no cap on penalties (meaning the operator could face significant financial risk if performance was poor). In addition to the naturally low passenger flows and fares of some metro lines, control-oriented incentives further discourage the private sector. Moreover, performance-based payment could lose efficiency due to the unclear evaluation methods for qualitative operational performance indicators

such as service quality [12], the incentive coefficients are fixed instead of dynamic [73,79], etc., opening the way for performance deception by self-seeking private sectors for a higher bonus, thus exerting negative effects on PPP projects [18].

Neutrality-oriented incentives were observed to have a negative but not significant impact on performance in the construction phase ($\beta = -0.142$, $p > 0.05$, n.s.), whereas they demonstrated a significantly positive impact on performance in the operational phase ($\beta = 0.227$, $p < 0.01$). The limited role of neutrality-oriented incentives during construction suggests that policy support, simplified approval processes, and tax incentives may not directly address the immediate goals of construction, such as timely completion, cost efficiency, and quality assurance. During construction, projects tend to prioritize control-oriented incentives that offer clear, measurable outcomes tied to performance milestones, such as penalties for delays or bonuses for meeting deadlines [38]. While in the operational phase, the focus shifts to sustaining long-term performance indicators such as service quality, sustainability, and financial stability [115]. Neutrality-oriented incentives become more valuable in this phase by fostering collaboration and mitigating risks over a longer timeframe [35,116].

Recognition-oriented incentives were empirically supported to have a positive impact on performance in both the construction ($\beta = 0.471$, $p < 0.01$) and operation phases ($\beta = 0.618$, $p < 0.01$), in line with SDT and MIP. Notably, recognition-oriented incentives demonstrate superior positive effects (0.618 **) compared to both the control-oriented (-0.173, n.s.) and neutrality-oriented incentives (0.227 **) in the operation phase. The operation phase often spans decades, during which the private sector is responsible for the day-to-day functioning and maintenance of the rail transit system, involving coordinating various elements such as scheduling, maintenance, customer service, safety, and regulatory compliance. The result suggests that the private sector places a higher value on incentives that provide collaboration, acknowledgment, and support in this phase to go through difficulties.

5.3. Practical Implications

Our findings empirically evidence that the ultimate effect of an incentive depends on the relative salience of whether the private sector perceives the incentive as recognition-oriented or as control-oriented, and its implementation scenario (e.g., project stage).

The same incentive can be perceived by the private sector as control-oriented or the opposite in different projects depending on factors such as project goals, stakeholder dynamics, and implementation practices. These shifting perceptions highlight the need for governments to regularly investigate how incentives are viewed by the private sector and adjust their design and implementation accordingly [61]. For example, if an incentive, such as performance-based payments, is perceived as control-oriented, governments can introduce flexibility by adjusting performance targets [73], refining evaluation methods [12], or coupling these payments with supportive policies (e.g., logistical assistance or risk-sharing mechanisms) to mitigate the feelings of excessive control. If the same incentive is perceived as recognition-oriented, it can be emphasized as a tool to promote innovation, collaboration, and long-term commitment [94]. For example, linking performance-based payments to the public acknowledgment of achievements or awards can reinforce their motivational value [21].

The perception of incentives may also change across different phases of a project (e.g., construction vs. operation). Governments should dynamically adapt their implementation strategies to suit the evolving needs of each phase [14,22]. For instance, during the construction phase, control-oriented incentives can positively influence project outcomes. However, in the operational phase, these incentives may discourage innovation and autonomy if perceived as overly rigid. To address this, governments can adjust performance standards

and evaluation methods over time. For example, in the early operational phase, setting lower performance thresholds can accommodate the private sector's initial instability while minimizing the risk of excessive profit-taking [19]. In the mid-to-late operational phase, governments should implement balanced incentive designs, such as placing caps on both bonuses and penalties, to ensure fairness and maintain long-term private sector engagement [8]. Conversely, stakeholders should prioritize the use of recognition-oriented incentives throughout the project life-cycle. For example, the public recognition of exceptional operational performance, combined with supportive policies (e.g., logistical assistance), can help private stakeholders overcome challenges and maintain service excellence [22]. In terms of neutrality-oriented incentives, they should be used as complementary measures rather than as the primary drivers of performance in the construction phase. During the operational phase, public entities can leverage these incentives to maintain strong partnerships and support the private sector in addressing ongoing operational challenges [75]. For example, risk-sharing mechanisms can help balance financial uncertainties, such as fluctuating ridership levels or revenue shortfalls, ensuring private entities remain committed to maintaining high service standards [89].

5.4. Generalizability Caveats

While this study offers valuable insights into the role of incentive measures in rail transit PPPs, it was conducted in the Chinese context. Therefore, we clarify the generalizability caveats of the findings in relation to (1) the effects of debates on the scope of the government [117], (2) the effects of performance volatility [118], and (3) the effects of limited government resources [119].

Firstly, the results may be different under other circumstances of market conditions as survey evidence is typically gathered in a short period of time [95]. For example, the increasing complexity and heightened uncertainty due to recent geopolitical events (e.g., the Ukraine war) triggered the discussion on the degree of their governments' intervention in private sector activities [117], which might alter the way neutrality-oriented incentives (such as risk-sharing mechanisms or government subsidies) are perceived. Private companies may perceive these incentives as more reliable and valuable safeguards from governments due to the instability of the market. Consequently, such incentives may be seen as more positively impactful on the performance of rail transit PPPs compared to the results in Figure 2.

Secondly, another important factor to consider is the volatility of performance metrics chosen to award incentives or penalties, which significantly impacts the effect of incentives [12,120]. According to [18], governments should design incentives that engage private investors based on their profitability outlook. Predictable performance metrics help private investors better evaluate their profitability outlook. Based on the evaluation, private investors might view PPPs as more valuable, leading to a greater willingness to invest in such projects [118]. Conversely, in projects with higher performance volatility, the effectiveness of incentive measures might be diminished, as stakeholders may perceive the risks associated with these projects to be higher or conduct opportunistic behaviors [18].

Thirdly, the role of government resources in supporting PPP projects may affect the effectiveness of incentives. In jurisdictions where governments face fiscal challenges or constraints, such as those experiencing debt-ceiling standoffs [119], even well-designed incentives may not be effective if the government lacks the resources to implement or sustain them. Private companies may perceive these incentives as less valuable or riskier due to the potential for reduced government credit [84]. This could lead to the negative effects of control-oriented incentives, which may manifest differently than the results shown in Figure 2, as public entities may struggle to meet their contractual obligations.

Consequently, the perceived reliability and effectiveness of these incentives could diminish, influencing both the private sector's behavior and the overall success of the project.

Therefore, we suggest that future research should explore how these factors influence the implementation and effectiveness of incentives in rail transit PPPs under varying conditions.

6. Conclusions

Public–private partnerships (PPP) projects have become increasingly relevant, especially given the emerging market economies. Despite the widespread implementation of incentives within rail transit PPPs, their impact on project performance sometimes remains ambiguous and ineffective. This study combines the SDT and the MIP from the discipline of psychology to examine the private sector's real perceptions regarding three dimensions of incentives—control-oriented, neutrality-oriented, and recognition-oriented, thus analyzing how different incentives influence PPP project performance from a life-cycle perspective.

The re-classification results of 16 incentives challenge the "positive" nature of some financial incentives by demonstrating that performance-based payment/bonuses were perceived as control-oriented incentives by the private sector. We also examine the dual attributes of reputation incentives, with credit rating and reputation mechanism recognized as control-oriented incentives while priority honor titles as recognition-oriented incentives. Furthermore, our SEM results empirically evidence that the ultimate effect of an incentive depends on the relative salience of whether the private sector perceives the incentive as recognition-oriented or as control-oriented, and its implementation scenario (e.g., project stage). Although control-oriented incentives restrain autonomy, they positively influence project performance during the construction phase, where clear, measurable goals are paramount. In addition, recognition-oriented incentives significantly enhance project performance in both construction and operational phases (especially the latter), fostering long-term sustainability. Finally, neutrality-oriented incentives focus on risk allocation and collaboration between the public and private sectors, showing a modestly positive effect in the operation phase.

These findings unearth the nature of incentives in rail transit PPP projects, enrich the extant literature on incentive mechanisms, and provide practical recommendations for policymakers. Nevertheless, there remain limitations and areas for further research, as survey evidence is typically gathered in a short period of time and in the Chinese context. Moreover, as SDT and MIP limit the impact of incentives on the extrinsic and intrinsic motivation of individuals and groups, future lines of inquiry can examine the potential mediating roles of the private sector's motivations and subsequent behaviors to assess whether they partially or fully mediate the relationship between incentives and project performance in rail transit PPPs.

Author Contributions: Conceptualization, Z.Z. and J.Y.; methodology, Z.Z., L.Z. and J.Y.; validation, Y.Y.; formal analysis, Z.Z. and L.Z.; investigation, Z.Z. and L.Z.; resources, Z.Z. and J.Y.; writing—original draft preparation, Y.Y.; writing—review and editing, J.Z.; visualization, Z.Z.; supervision, J.Y.; project administration, J.Y. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the National Natural Science Foundation of China, grant number 72072031.

Data Availability Statement: The original contributions presented in the study are included in the article; further inquiries can be directed to the corresponding author.

Acknowledgments: This research appreciates the valuable contributions of all participants who generously shared their insights during the two surveys, making this study possible.

Conflicts of Interest: Author Zheng Zhu was employed by the company CRRC Urban Transport Planning and Design Institute Co., Ltd. The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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