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A Study of Factors Influencing Construction Workers' Intention to Share Safety Knowledge

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Abstract: There is a growing body of research on the factors influencing individual knowledge-sharing behavior, but the exploration of knowledge sharing in the construction industry is still in its infancy. Based on the theory of planned behavior (TPB), this paper introduced factors from the social exchange theory (SET) to develop a comprehensive model for exploring the intention of construction workers to share their safety knowledge. Data were collected from a total of 329 construction workers at five sites. Using the structural equation model method, the research model and path hypotheses of this study were analyzed. The results showed that altruism, trust, and reputation positively influenced the construction workers' attitude towards sharing safety knowledge. Attitude, safety training, organizational climate, and knowledge-sharing self-efficacy could increase the construction workers' intention to share their safety knowledge. However, the relationship between workers' attitudes towards safety knowledge sharing and anticipated extrinsic rewards was not significant. Through identifying the factors underlying workers' intention to share safety knowledge in the construction industry, the study helps to further understand the influencing factors and mechanisms of safety knowledge sharing willingness among the special group of construction workers and provides practical implications for engineering managers to strengthen construction safety management from the perspective of knowledge sharing.

Keywords: construction safety management; knowledge sharing; SET; TPB; SEM

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1. Introduction

As a high-risk industry, the construction industry has long been troubled by and has paid increasingly more attention to safety issues. This industry employs around 7% of the world's workforce but is responsible for 30–40% of deaths [1]. The accident Domino theory [2] is the earliest theory to explore the causes of construction safety accidents. This theory holds that up to 88% of accidents are caused by unsafe behaviors. Therefore, the reduction of unsafe behaviors has received the attention of many scholars in the field of construction safety management. These studies can be roughly divided into two categories. The first category [3,4] focused on constructing theoretical models or conducting empirical studies to analyze the factors that lead to unsafe behavior among construction workers, thus deepening the understanding of the mechanisms that generate unsafe behavior. The second category [5,6] was mainly to develop or improve existing methods from the perspective of monitoring unsafe behaviors of workers, thus providing ideas for reducing unsafe behaviors. But very little research focusing on this issue has been conducted from the perspective of safety knowledge-sharing behavior. However, it has been pointed out that one of the main causes of on-site accidents is a lack of safety knowledge [7]. As a group activity, knowledge sharing is an effective way to exchange expertise, experience, and skills through social interaction within the entire organization [8]. Enriching the safety knowledge base of construction workers can effectively reduce the occurrence of construction accidents; therefore, it is of great practical importance to promote the sharing of safety knowledge among construction workers.

Knowledge has always been regarded as a valuable resource. Knowledge management is one of the important tools to help enterprises maintain a competitive edge in the changing environment, and knowledge sharing is considered to be the most critical part [9]. Knowledge sharing means providing knowledge to others and is a conscious action of the knowledge owner. There has been a certain amount of research based on various theories exploring the knowledge-sharing behavior of different groups and their corresponding influences. For example, Hsu [10] explains the factors that affect people's knowledge sharing in the virtual community from both personal and environmental aspects based on social cognitive theory; Wasko [11] uses theories of collective action to examine how individual motivations and social capital influence knowledge contribution in electronic networks; and Yan [12] conducts research on knowledge-sharing behavior in online health communities based on social exchange theory. The studies mentioned above provide valuable insights into knowledge-sharing behavior. However, these research models have rarely been verified and analyzed in the construction industry. Moreover, due to the mobility and aging of construction industry employees, the research on knowledge sharing among construction workers is relatively limited. At present, little is known about knowledge-sharing behavior in the construction industry.

The construction industry is becoming more knowledge-intensive as technology and demands increasingly evolve. Compared with other industries, the practice of organizational knowledge sharing in the construction industry is relatively backward [13]. Although some relevant research has been carried out, there are still several limitations that deserve further exploration. First of all, much of this literature mainly focuses on knowledge sharing among various parties involved in the construction industry [14], the relationship between individual coordination and knowledge sharing in the organization of construction projects [13], and so on. In contrast, research on knowledge sharing with the objective of promoting safety management in the construction industry is relatively limited [15]. Secondly, current research on safety knowledge sharing in the construction industry mostly takes the internet as the main channel for knowledge dissemination, which includes exploring social media such as Twitter to facilitate construction safety knowledge sharing [16] and the use of Web 2.0 to share construction safety knowledge [17]. Despite the convenience and efficiency of such social platforms, the fact is that, due to serious aging and the generally low level of education, many construction workers are not skilled in using informational approaches to improve their safety knowledge reserves. For the current group of construction workers, the sharing of safety knowledge relies more on traditional face-to-face communication. In addition, there are also some studies involving safety knowledge sharing among construction workers, but the influencing factors and mechanisms of this behavior were not explicitly explained. For example, Ni [18] only studies safety knowledge sharing as a mediating variable between satisfaction and safety behavior. The lack of such relevant research has led to the inability of the construction industry management to put forward targeted measures to promote safety knowledge-sharing behavior among the construction workers.

The paper was organized as follows: Section 2 introduced the theoretical background and proposed a research model with a description of the hypotheses. Section 3 discussed the methods of this research. The results of the data analysis were provided in Section 4. Section 5 summarized the main findings and discussed the limitations as well as future work.

2. Theoretical Background and Research Model

The research model proposed in this research was based on TPB. Ajzen [19] put forward TPB on the basis of the theory of reasoned action (TRA). Compared with TRA, TPB emphasizes that individual behavior is not entirely influenced by subjective consciousness but also restricted by executive ability and conditions, thus improving the ability to interpret and predict behavior. A person's behavioral intention is influenced by a combination of three elements: individual attitude towards this behavior, subjective norm, and perceived self-efficacy [19]. Attitude is the degree to which an individual feels positively or negatively about a behavior, which represents an overall evaluation. Subjective norms refer to the external pressures that individuals perceive when deciding whether to perform a behavior, which often originate from the organization or groups of people that the individual considers important. Perceived self-efficacy is the perceived confidence that an individual can control and successfully perform a behavior. TPB has a good ability to explain the generation of individual behavior and has been widely applied in various domains [20–22]. Therefore, in this study, TPB was used as a theoretical framework to analyze the factors that influence safety knowledge sharing among construction workers. It is worth noting that although TPB establishes an "attitude-intention-behavior" research framework, it does not explore the antecedents of the attitude and can only explain part of the variance in safety knowledge-sharing behavior. Other factors outside the TPB model can have indirect effects on intention and behavior by influencing attitudes [19]. As Ajzen and Fishbein suggested, some other specific variables can be added to TPB to improve the explanatory power of behavior [23]. Many scholars have introduced a variety of variables to extend the TPB and explored individual behavior in several domains based on these models [20,24,25]. Previous studies [12,21,22] on the factors influencing knowledge sharing can be broadly classified into two categories: personal and environmental factors. The former emphasized more variables such as attitude towards knowledge sharing, perceived usefulness, etc., and its theoretical basis is usually the TPB, or technology acceptance model, while the latter focused more on the influence of external environments such as social organizations and is mostly based on social capital theory and organization theory. However, knowledge-sharing behavior itself can be actually driven by individual factors as well as organizational and social environmental factors, so the influence of both should be considered in the research. Social exchange theory (SET) states that any kinds of social interactions are exchange activities that include benefits and costs, and that individual behavior is driven by the exchange of benefits [26]. For the construction industry, the relationship between workers and firms is also essentially a kind of exchange, where the organization's payments and workers' contributions correspond to benefits and costs. Furthermore, from the perspective of the workers involved in security knowledge sharing, this behavior can be seen as a form of social exchange in a broader sense [27]. In the process, the respondent expends thinking effort and sacrifices knowledge advantage in exchange for receiving prestige increases, bonuses, etc. Therefore, SET can be used to discuss the safety knowledge-sharing behavior of construction workers. The rewards here include not only external rewards, such as material rewards and job promotions, but also non-material rewards that cannot be measured in monetary terms, such as reputation, satisfaction, and trust. The interest factors considered in this study were altruism, trust, reputation, and anticipated extrinsic rewards. These factors were used as antecedent variables for attitudes toward safety knowledge sharing and can be seen as complementary to the individual factors. Among the environmental factors, the influence of organizational climate on individual behavior has been a hot topic for scholars. Organizational climate is an important driver of knowledge-sharing behavior [28]. Kakhki [29] stated that organizational climate occupied a key position in organizational progress and proved that this factor has the most significant effect on employees' knowledge-sharing behavior in his research. Thus, this variable was added to the model. On this basis, safety training was introduced into the model as an environmental factor since the concern of this research is safety knowledge sharing, and safety training is a major way of disseminating safety knowledge in the construction industry. The research model was shown in Figure 1.

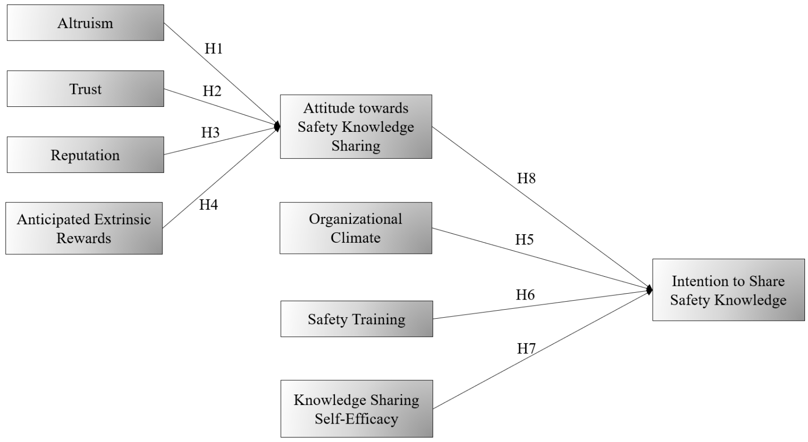

Figure 1. Research Model.

2.1. Antecedent Factors of Attitude towards Safety Knowledge Sharing

2.1.1. Altruism

As an intrinsic motivation for people's behavior, altruism is the extent to which individuals are willing to increase the benefits of others without any apparent benefit to themselves and can be viewed as selfless, unrequited goodwill [30]. Although absolute altruism is rare, relative altruism is more common in society. According to the social exchange theory, some people are helpful by nature. The payoff for this group is to help others, and the benefit is an increase in self-worth. Previous research has shown that this emotional experience, as an intrinsic benefit, positively influences people's attitudes toward knowledge sharing [31]. Driven by altruism, knowledge holders actively share their knowledge and gain satisfaction through this progress. Moreover, this mentality encourages people to think of knowledge sharing as an obligation and responsibility within the work team. This leads to the first hypothesis:

H1. *Altruism has a positive effect on the attitude towards safety knowledge sharing.*

2.1.2. Trust

Trust is a fundamental factor in interpersonal interactions, and it plays an important role in reinforcing knowledge-sharing behavior. Trust is a reflection of the degree of trustworthiness of others. In organizations, it allows people to access and exchange information. People usually think that their knowledge is valuable and important, thus sharing it means losing their competitive advantage. It is human instinct to increase their accumulation and subconsciously doubt the knowledge of others [9]. When participants in the safety knowledge-sharing behavior trust each other, they believe that their knowledge will not be abused, so they are more likely to provide assistance and cooperate with others. And when both parties are vigilant, they will perceive their knowledge-sharing behavior as risky, and their willingness to share safety knowledge will reduce. The higher the level of mutual trust among work team members, the more positive the attitude towards sharing knowledge will be [32]. This leads to the second hypothesis:

H2. *Trust has a positive effect on the attitude towards safety knowledge sharing.*

2.1.3. Reputation

Reputation is an intangible reward. In this study, reputation refers to the good personal image and high personal status of construction workers in their group. Construction workers establish personal reputations by demonstrating, imparting, and sharing the knowledge they possess to gain the recognition and affirmation of others. A good reputation can bring a sense of satisfaction to social life. Through reputation, people achieve and maintain their position in the collective [11]. In the meantime, this process is often accompanied by a certain degree of social privilege. Reputation significantly affects people's knowledge contribution behavior and is a key factor influencing people's participation in knowledge sharing [11]. Individuals will be glad to contribute their knowledge to gain a good reputation. This mentality contributes to a more positive attitude towards knowledge-sharing behavior. This leads to the third hypothesis:

H3. *Reputation has a positive effect on the attitude towards safety knowledge sharing.*

2.1.4. Anticipated Extrinsic Rewards

Social exchange theory and economic exchange theory are the main theories that explain human social exchange activities. According to economic exchange theory, individuals measure their self-interest rationally when making decisions and use it as a guideline for action [9]. People are more willing to engage in safety knowledge sharing when they consider that the compensation they receive is greater than the risks and costs they face [33]. Organizations can provide different forms of extrinsic rewards to encourage people to engage in sharing knowledge, such as bonuses, promotions, and job security [27]. In this research, anticipated extrinsic rewards are defined as workers' perceptions of the extrinsic rewards they could receive for their participation in safety knowledge sharing. Safety knowledge is an invisible asset in people's minds. When there is no clear reward and recognition system, people may not want to proactively share their knowledge. This leads to the fourth hypothesis:

H4. *Anticipated Extrinsic Rewards have a positive effect on the attitude towards safety knowledge sharing.*

2.2. Antecedent Factors of the Intention to Share Safety Knowledge

2.2.1. Organizational Climate

For knowledge sharing, organizational climate is a recognized key driver. Organizational climate refers to a certain attribute that affects the psychological state and even the daily behavior of construction workers in the team. As a common understanding of the team, the organizational climate can not only help individuals better understand the code of conduct but also positively affect the knowledge-sharing activities in the group [34]. The results of a study conducted by Bock et al. [27] show that three aspects of organizational climate—equity, innovation, and sense of belonging—have a significant positive impact on knowledge-sharing behavior. The safety atmosphere of the organization is directly proportional to the safety awareness of its members. The higher the safety awareness of its members, the more likely it is to learn more safety knowledge and techniques to avoid the existing risks, thus effectively increasing the probability of safety knowledge sharing among members. This leads to the fifth hypothesis:

H5. *Organizational climate has a positive effect on the intention to share safety knowledge.*

2.2.2. Safety Training

In the construction industry, safety training, as an essential part of workers' pre-employment, is regarded as a key tool to prevent safety accidents [35]. It mostly refers to the educational activities that aim at enriching the safety knowledge base of construction workers, with safety operation methods and precautions as the teaching content, and last for a relatively short period of time. Safety training can be effective in reducing workers' unsafe behaviors [16]. There are many factors that affect the quality of safety training. More effective training can be carried out by improving the content, increasing the interest of learners, and using more reasonable methods [35]. By conducting a case study on the visualization of safety training, Li [36] suggests that this approach can deepen construction workers' understanding of the causes of accidents. Safety training often represents a kind of standard or requirement. By receiving safety training, construction workers can effectively raise safety awareness, thereby increasing attention to safety risks at work and the frequency of safety knowledge sharing. This leads to the sixth hypothesis:

H6. *Safety Training has a positive effect on the intention to share safety knowledge.*

2.2.3. Knowledge-Sharing Self-Efficacy

Self-efficacy is the self-evaluation of an individual's perceived ability to perform a behavior successfully. It can significantly affect individuals' motivation and behavior [37]. When people share knowledge that is useful to the group, this behavior enhances their confidence in what they are doing and, in turn, increases their sense of self-efficacy. People with high self-efficacy are more likely to perform the behavior in question than those with low self-efficacy [10]. At present, some scholars have extended the research on self-efficacy to the field of knowledge management to explore its impact on knowledge-sharing behavior and propose the concept of knowledge-sharing self-efficacy [10]. Knowledge-sharing self-efficacy is generally expressed as the individual's perception that the knowledge they possess can help solve difficulties at work and positively influence the organization [38]. As an important source of intrinsic motivation, knowledge-sharing self-efficacy has a positive effect on knowledge contribution [9,38]. This leads to the seventh hypothesis:

H7. *Knowledge-sharing self-efficacy has a positive effect on the intention to share safety knowledge.*

2.2.4. Attitude towards Safety Knowledge Sharing

Attitude towards safety knowledge sharing describes the degree of positivity of the feelings that individuals hold about this behavior [39]. Attitude can have a positive impact on knowledge sharing performance [40]. It is an effective mediator between personal factors and the intention to share knowledge [41]. On construction sites, when workers react negatively to safety knowledge sharing, such as when they believe it is meaningless or will diminish their competitive advantage, their intention to share will be weakened by these thoughts. Conversely, a positive attitude toward safety knowledge sharing indicates that workers perceive the behavior as valuable, which in turn stimulates a higher degree of willingness. This leads to the eighth hypothesis:

H8. *Attitude towards safety knowledge sharing has a positive effect on the intention to share safety knowledge.*

3. Research Methodology

3.1. Measurement Development

After proposing the theoretical model, data collection was first carried out using questionnaire method, and then the data were analyzed using SEM. The questionnaire method is a widely used data collection method for exploring factors influencing behavior [32,42–44]. According to the research model, a questionnaire was developed to measure proposed factors that may contribute to safety knowledge sharing intentions among construction workers. Specifically, trust items were adapted from Kankanhalli [38], Hsu [22], and Chiu [42]; organizational climate items from Bock [27] and Liu [43]; items for altruism from Kankanhalli [38] and Hsu [22]; items for anticipated extrinsic rewards from Hung [44] and Bock [27]; reputation items from Yan [12]; safety training items from Liu [43]; items for knowledge-sharing self-efficacy from Kankanhalli [38] and Hsu [10]; items for attitude towards safety knowledge sharing from Bock [27] and Hsu [22]; safety knowledge-sharing behavioral intentions items from Bock [27]. For all items, a five-point Likert scale was used, with anchors ranging from strongly disagree (1) to strongly agree (5).

Due to the relatively low literacy level and limited comprehension ability of the workers, an expert review was organized to evaluate the descriptions of questionnaire before the pretest. Four experts from the construction industry were invited, including two professors in civil engineering and two experienced project managers. According to their suggestions, some adjustments were made to the questions so that the questionnaire was more logical and reasonable while still being easy to understand. Afterwards, a pretest in which a total of 72 construction workers participated was performed. Their experience enabled them to provide reliable feedback on the validity of the questionnaire. Cronbach's α was used to measure the consistency of the questionnaire structure. For each variable and the entire questionnaire, Cronbach's α was greater than the recommended value of 0.7. The final questionnaire, shown in Table 1, contained 31 questions, of which 5 were related to personal information.

Table 1. Summary of measurement scales.

Construct	Measure	Mean	SD	Loading	SMC
Altruism (Cronbach's α = 0.918)					
ALT1	I am willing to help others	3.53	1.15	0.828	0.686
ALT2	I am willing to share my safety knowledge with others	3.57	1.08	0.879	0.772
ALT3	I feel happy by sharing my safety knowledge to help others solve problems	3.56	1.07	0.849	0.721
ALT4	It is worthwhile to devote some time and energy to helping others	3.60	1.10	0.883	0.78
Trust (Cronbach's α = 0.884)					
TRU1	I trust my workmates	3.73	1.06	0.897	0.804
TRU2	I believe my workmates will share their safety knowledge as much as possible	3.66	1.04	0.866	0.748
TRU3	I believe that my workmates will not deliberately violate the construction safety regulations	3.78	0.99	0.782	0.611
Anticipated Extrinsic Rewards (Cronbach's α = 0.883)					
AER1	If I share my safety knowledge, I will get corresponding financial rewards in return	3.36	1.05	0.849	0.72
AER2	If I share my safety knowledge, I will have a greater chance of promotion	3.42	1.12	0.862	0.743
AER3	When there is an economic return, it will make me more willing to share my safety knowledge	3.40	1.12	0.83	0.69
Reputation (Cronbach's α = 0.881)					
REP1	Sharing safety knowledge can improve my reputation among my workmates	3.82	1.07	0.855	0.734
REP2	When I share safety knowledge with my workmates, I will be praised by them	3.84	1.02	0.873	0.758
REP3	When I share safety knowledge with my workmates, I will get their respect	3.89	0.98	0.805	0.646
Organizational Climate (Cronbach's α = 0.918)					
OC1	My workmates and I have a harmonious relationship and a strong sense of teamwork	3.75	1.07	0.845	0.713
OC2	My organization treats me and others fairly	3.76	1.08	0.815	0.664
OC3	There are very eye-catching safety slogans on the construction site where I work, and there are signs to warn about the accident situation	3.63	1.06	0.835	0.696
OC4	My organization encourages us to put forward different ideas on the problems	3.67	1.08	0.827	0.684
OC5	My superiors care about the work and life of me and my workmates	3.67	1.09	0.837	0.703
Safety Training (Cronbach's α = 0.918)					
ST1	The safety training content of my organization can help me skillfully deal with the safety problems encountered in daily work	3.49	1.15	0.869	0.756
ST2	I will actively participate in safety training and relevant discussions	3.48	1.12	0.817	0.667
ST3	My organization often organizes safety training	3.47	1.16	0.861	0.743
ST4	I like the safety training method of my organization	3.50	1.16	0.871	0.759
Knowledge-sharing self-efficiency (Cronbach's α = 0.876)					
KSSE1	I think I can provide valuable safety knowledge to my workmates	3.71	1.10	0.846	0.717
KSSE2	The safety knowledge I shared will be helpful to my workmates	3.64	1.10	0.848	0.719
KSSE3	I can express my views clearly	3.71	1.05	0.819	0.671
Attitude toward Safety Knowledge Sharing (Cronbach's α = 0.828)					
ASKS1	I think it is good for me to share safety knowledge with others	3.60	1.10	0.751	0.558
ASKS2	I like to share safety knowledge with my workmates	3.74	1.04	0.819	0.69
ASKS3	I have positive views on safety knowledge sharing	3.70	1.03	0.786	0.606

Table 1. *Cont.*

Construct	Measure	Mean	SD	Loading	SMC
Intention to Share Safety Knowledge (Cronbach's α = 0.922)					
ISSK1	I plan to share my safety knowledge with my workmates in the near future	3.30	1.20	0.871	0.754
ISSK2	In the future, I will share my safety knowledge with my workmates more frequently	3.40	1.12	0.922	0.848
ISSK3	I am willing to participate in the discussion about safety knowledge among my workmates	3.28	1.21	0.889	0.788

3.2. Data Collection

To test these hypotheses, an investigation was carried out. The researchers selected a total of five projects under construction owned by three construction companies in Nanchang, Jiangxi Province, China, for data collection. The collection methods included both online and offline. A total of two rounds were conducted. The online collection was carried out by first contacting the project manager, explaining the purpose as well as the importance of the study, and providing the questionnaire to solicit participation. Then, researchers commissioned the project manager to release the QR code of the electronic questionnaire to the workers. To improve the response rate, two weeks after the release, follow-up calls were made to encourage workers to participate. After the online survey, a second round of data collection was conducted by visiting project sites and distributing paper questionnaires to encourage participation from workers who did not respond during the online process. The beginning of the questionnaire explained the purpose of this study and guaranteed confidentiality. The data collection process lasted from 7 September to 7 October, and 363 questionnaires were received. After excluding 34 invalid questionnaires (including cases where the completion time was too short or all answers were the same), a total of 329 complete and valid questionnaires were used for data analysis. A reliable estimation of the proposed path hypothesis is already possible when the sample size is 150–200 and above [45]. The sample included 270 men and 59 women, with a general age concentration of 30–50 years old, accounting for 57.5%. Most of the respondents had worked for 5–20 years, indicating that the majority of respondents in the sample had more extensive work experience. The demographic information of the sample is listed in Table 2.

Table 2. Demographic profile.

Measure	Items	Frequency	Percent/%
Gender	Male	270	82.1
	Female	59	17.9
Age	Under 25	35	10.6
	25–30	58	17.6
	31–40	94	28.6
	41–50	95	28.9
	51–60	46	14.0
	61–65	1	0.3
Education	Primary school or below	51	15.5
	Junior high school	125	38.0
	High school	58	17.6
	Junior college or above	95	28.9
Length of Service	<5 years	74	22.5
	5–10 years	93	28.3
	11–20 years	94	28.6
	21–30 years	53	16.1
	>30 years	15	4.6

Table 2. *Cont.*

Measure	Items	Frequency	Percent/%
Type of Work	Carpenter	55	16.7
	Steelworker	52	15.8
	Erector	27	8.2
	Mason	41	12.5
	Decorator	20	6.1
	Installer	15	4.6
	Mechanic	26	7.9
	Electrician	44	13.4
	Handyman	49	14.9

3.3. Method of Analysis

The structural equation model (SEM) was chosen as the data analysis method for this research. As a multivariate data analysis technology, SEM integrates measurement and analysis into one for examining the causal relationships between latent and observed variables. Since its introduction, SEM has been applied in several different fields [46–48]. In general, SEM contains two parts: the measurement model, which describes the relationship between the observed and latent variables, and the structural model, which mainly describes the relationship between the individual latent variables. Compared to other scientific statistical methods, SEM allows the latent variable to contain more than one observed variable. This method has the ability to process multiple dependent variables at the same time and allows for measurement error in both the independent and dependent variables, which makes the measurement model more flexible and the results more plausible. The data were analyzed using a two-step approach suggested by Anderson and Gerbing [49], which first analyzes the measurement model and then tests the structural relationships among latent variables. Specifically, confirmatory factor analysis (CFA) was applied to assess the reliability and validity of the measurement model, while the degree of model fit and the hypotheses were estimated in the structural model. In this research, the corresponding SEM was established using AMOS 26.0.

4. Results and Data Analysis

4.1. Measurement Model

The measurement model was tested by CFA, and the related results are shown in Table 1, in which reliability was tested with Cronbach's α values, and all of those above the recommended value of 0.7 indicated good reliability. In addition, item reliability was checked by calculating the squared multiple correlation (SMC), and the SMC value of all items exceeded the threshold of 0.5 [50]. The convergent validity of the constructs was examined using the guidelines proposed by Fornell and Larcker [51]: (1) all indicator loadings should be significant and exceed 0.7; (2) construct reliability should exceed 0.8; and (3) average variance extracted (AVE) by each construct should exceed the variance due to measurement error for that construct (i.e., AVE should exceed 0.5). For this model, factor loadings ranged from 0.747 to 0.921, all above the benchmark of 0.7. The composite reliabilities of the structure ranged from 0.829 to 0.923, and AVE values were all above 0.5, ensuring convergent validity. The correlations between structures were presented in Table 3, in which the values on the main diagonal were the square roots of the AVE of each construct, and each value exceeded the correlation coefficients between this construct and any other construct. Therefore, the discriminant validity results were acceptable [51].

Table 3. Correlations and AVE.

Construct	AVE	CR	ALT	TRU	AER	REP	OC	ST	KSSE	ASKS	ISSK
ALT	0.74	0.919	**0.86**								
TRU	0.722	0.886	0.39	**0.85**							
AER	0.718	0.884	0.22	0.13	**0.85**						
REP	0.714	0.882	0.55	0.51	0.23	**0.84**					
OC	0.692	0.918	0.32	0.37	0.22	0.53	**0.83**				
ST	0.731	0.916	0.30	0.41	0.18	0.36	0.31	**0.85**			
KSSE	0.702	0.876	0.43	0.54	0.33	0.49	0.42	0.46	**0.84**		
ASKS	0.618	0.829	0.45	0.52	0.21	0.52	0.32	0.28	0.39	**0.79**	
ISSK	0.799	0.923	0.27	0.34	0.17	0.35	0.38	0.40	0.41	0.36	**0.89**

ALT = Altruism; TRU = trust; AER = Anticipated Extrinsic Rewards; REP = Reputation; OC = Organizational Climate; ST = Safety Training; KSSE = Knowledge-Sharing Self-efficiency; ASKS = Attitude towards Safety Knowledge Sharing; ISSK = Intention to Share Safety Knowledge.

4.2. Structural Model

For a research model with a good fit, chi-square normalized by degrees of freedom (χ^2/df) should not exceed 3 [52]; goodness-of-fit index (GFI) [53] and adjusted GFI (AGFI) [54] should exceed 0.8; incremental fit index of improved NFI (CFI) and normalized fit index (NFI) should be greater than 0.9 [52]; and root-mean-square error of approximation (RMSEA) should be lower than 0.05 [55]. For the current structural model, χ^2/df was 1.079 (χ^2 = 437.121), GFI 0.924, AGFI 0.907, CFI 0.995, NFI 0.941, and RMSEA 0.016. As shown in Table 4, all fitness indexes of the model exceeded recommended values, indicating that there was a suitable fit between the model and the measured data.

Table 4. Model fit index summary.

Index	Results	Recommended Value	Suggested by Authors
χ^2/df	1.079	<3	Bentler and Bonett (1980) [52]
GFI	0.924	>0.8	Seyal et al. (2002) [53]
AGFI	0.907	>0.8	Scott (1995) [54]
CFI	0.995	>0.9	Bentler and Bonett (1980) [52]
NFI	0.941	>0.9	Bentler and Bonett (1980) [52]

The collected data were further used to examine the hypothesized relationships among latent variables in the structural model. Figure 2 shows the standardized path coefficients. Among all paths, the *p* values of 2 paths were less than 0.001, 5 paths' less than 0.01, while that of 1 path was not significant at the level of 0.05. The results suggested that trust had a significant and positive impact on the attitude towards safety knowledge sharing (β = 0.324, t value = 4.75), supporting Hypothesis 2. At the same time, the path between safety training and the intention to share safety knowledge was significant (β = 0.213, t value = 3.456), which supported Hypothesis 7. Altruism (β = 0.18, t value = 2.683) and reputation (β = 0.236, t value = 3.135) significantly affected attitude, providing support for Hypotheses 1 and 4. Also, the results showed that the attitude towards safety knowledge sharing (β = 0.176, t value = 2.808), organizational climate (β = 0.189, t value = 3.12), and knowledge-sharing self-efficacy (β = 0.162, t value = 2.359) had significant effects on the intention to share safety knowledge; thus Hypotheses 5, 6, and 8 were supported. Contrary to expectations, an insignificant path was shown between anticipated extrinsic rewards and the attitude towards safety knowledge sharing (β = 0.073, t value = 1.313). Hence, Hypothesis 3 was not supported.

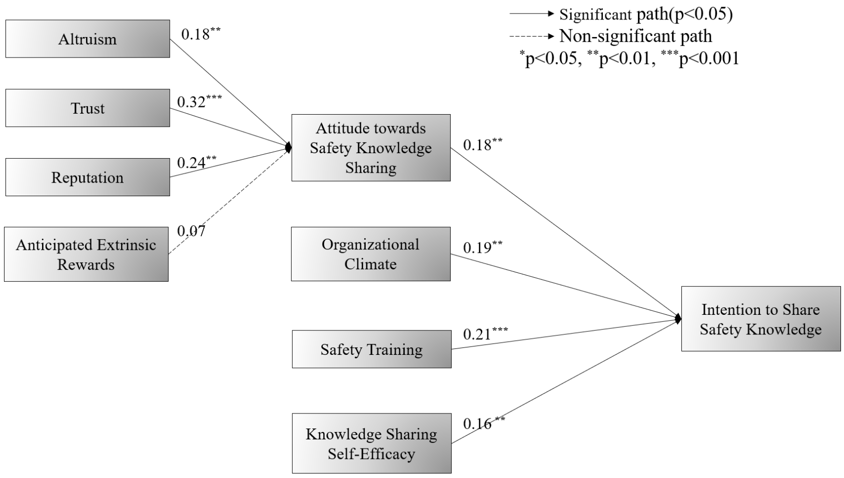

Figure 2. SEM analysis of the research model.

5. Conclusions

5.1. Findings and Implications for Practice

As front-line participants in construction projects, construction workers' safety knowledge has a direct effect on construction safety. However, research on construction workers' safety knowledge sharing is limited to some extent. This study proposed and analyzed an extended model based on TPB, which helped to understand construction workers' safety knowledge-sharing behavior. The main findings of this research are as follows:

(1) Three factors—altruism, trust, and reputation—all had positive effects on the attitude towards safety knowledge sharing, of which trust had the most obvious influence compared to the other antecedent variables of attitude. This result is consistent with the studies of some previous scholars [56,57]. One possible reason for the role of trust being so evident to the construction worker group is that workers responsible for similar works are always allocated to the same team. This grouping unit is like the concept of class within the school, and the workers' relationship in a team is always more united. This kind of relationship leads to a higher level of trust, which positively influences attitudes towards safe knowledge-sharing behavior.

(2) Contrary to the research expectation, anticipated extrinsic rewards did not have a significant effect on attitudes towards safety knowledge sharing. This result was consistent with several previous studies [58]. One plausible explanation for this result is that in China, the climate of material rewards for safety knowledge sharing is actually not prominent. The absence of this atmosphere may make workers, even when faced with this incentive condition, mentally believe that it is a false promise. In addition, the sharing of safety knowledge among workers is more of an empirical reminder than a systematic and comprehensive explanation every day. The essential motivation for this kind of communication is mainly management requirements and friendships rather than money. Therefore, whether there are extrinsic rewards or not, workers will still communicate with each other in this regard due to their work needs. For Chinese workers, who are paid by the day, systematic sharing of safety knowledge takes both time and effort. If there are differences in perceptions of the reward system between managers and workers, and if extrinsic rewards cannot cover the cost of workers sharing knowledge, such kinds of rewards can instead become disincentive. Natu [59] stated that incentives based on endogenous motivation can more effectively shape people's behavior, which is also supported by the results of this study.

(3) Among the direct influences on workers' intention to share safety knowledge, safety training had the most significant effect. During the offline survey, researchers found that the frequency of safety communication among workers was relatively low, and some workers had a fluke mentality for safety operation and thought that as long as it did not affect the final result, there was no need to pay attention to safety details. On

the one hand, this mentality is due to the poor safety quality of the workers themselves; on the other hand, it is because workers focus more on their tasks, hoping to compress the time costs of each task within the working time calculated by day; therefore, insufficient attention is paid to safe construction. Safety training is an important tool to effectively enhance the safety awareness of workers. Thus, it is suggested that engineering managers can strengthen safety training in terms of frequency, duration, and quality.

5.2. Limitations and Suggestions for Further Research

Although the findings provided some useful insights into safety knowledge sharing among construction workers, there were still some limitations.

(1) Due to the limitations of research time and human and financial resources, the sample areas and enterprise types selected during the survey were relatively singular, which resulted in certain limitations of survey data. Meanwhile, some workers with very low literacy levels were unable to fill out the questionnaire, and the omission of this part may also cause some possible bias in the data, so further research is needed to verify the universality and applicability of the findings.
(2) The sample used in the study contained workers from different projects and companies, which may cause bias in the estimations. Therefore, future research on the impact of this part is necessary.
(3) The results showed a significant impact of trust on workers' attitudes toward safety knowledge sharing. Hsu [10] proposed the concept of multistage trust in his research. Hence, the different stages of trust development could be expanded in the future to explore their impact.
(4) The research indicated the important role of safety training in terms of the intention to share safety knowledge. Future research can be conducted around mediators of safety training affecting workers' intentions to contribute safety knowledge and explore the impact mechanism.

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