Unlocking the Secrets of Successful Knowledge Transfer Among Software Project Managers: A Mixed-Methods Study

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Abstract

Objectives: This study combined qualitative and quantitative sequential exploratory mixed-method approaches to identify the success factors of knowledge transfer effectiveness with software project managers and investigate how these factors impacted knowledge transfer effectiveness. *Methods/Analysis*: The qualitative research component included twelve senior and junior project managers, while the quantitative component involved a cross-sectional survey of 212 completed responses from software project managers. Findings: The results suggested that two influential factors as knowledge providers and knowledge transfer environment had a significant effect on knowledge transfer effectiveness. *Novelty/Improvement*: The research results enhance the operational capability of software project supervision and contribute to the improvement of knowledge transfer for software project managers operating in teams.

Keywords: Knowledge Transfer; Knowledge Transfer Effectiveness; Software Project; Software Project Managers; Mixed-Methods.

1. Introduction

Numerous technological advancements that have a significant impact on human life have surfaced in the contemporary, competitive, and rapidly evolving technological environment. Blockchain technology, virtual reality, artificial intelligence (AI), and the Internet of Things are examples of technologies that fall under this category. Human existence and international commerce are impacted by these developments, which require adjustments to correspond with evolving circumstances [1]. This technological upheaval has compelled many companies to implement digital innovations and promote digital transformation, resulting in increased product sales and profits with streamlined, more effective work processes and improved customer satisfaction [2–4]. To adapt to these changes, companies have modified their strategies, structures, and cultures [5, 6], following the global trend to actively pursue digital transformation at an accelerating rate [7].

This endeavor encompasses a multitude of interconnected undertakings, particularly by leveraging digital technology to revolutionize conventional work procedures that operate on computer software systems and information technology

[8]. The likelihood of success for such software initiatives hinges on efficient management. Every project is unique in terms of budget, schedule, and duration. A project manager is typically responsible for directing, coordinating, and controlling the activities [9] of project team members operating within the set frameworks and standards. Effective collaboration among colleagues and the project director in the execution of their respective duties fosters team unity and enhances operational efficiency [10]. When the project accomplishes its objectives and fulfills the specified criteria, it contributes value to the enterprise and promotes sustained prosperity [11].

Project managers must possess diverse skillsets that encompass effective communication, administration, and leadership. Technical and interpersonal proficiencies are also required to successfully supervise initiatives [12]. These abilities can be developed and improved by project managers through instruction, practical experience, and the transmission of knowledge from more seasoned project managers. Companies must prioritize the administration of knowledge and skills to execute these initiatives [13]. Knowledge management refers to the ongoing procedure of overseeing diverse forms of knowledge by integrating four key facets: technology, company culture, personnel, and processes. By integrating knowledge management systems, companies will fulfill their objectives by acquiring and disseminating knowledge assets, guaranteeing accessibility, and leveraging knowledge to foster future development improvement and opportunity creation [14]. The knowledge transfer phase is the most crucial among the four knowledge management components: generation, representation, accessibility, and transfer of knowledge [15–18]. Knowledge transfer is distinct from general learning and serves the dual purpose of enabling recipients to gain knowledge and further develop their comprehension [19, 20]. Learning empowers the recipients to gain knowledge, allowing companies to develop a competitive edge through implementing an efficient knowledge transfer process [21–23].

The efficacy of competence transfer from headquarters to subunits was investigated regarding the potential consequences of internal and external networks by analyzing eight transfers of identical capabilities [24], while an investigation into how employees of a small high-tech company generated, assimilated, and applied knowledge during their daily work was the focus of a research framework established by Biloslavo and Lombardi [25]. They investigated how organizational factors influenced knowledge transmission within SMEs. Wahba et al. [26] gathered data from the higher educational (HE) sector in the UAE and defined how expatriate faculty members perceived their supervisors' support behaviors in the context of effective transmission of training. In a similar vein, Lindblom and Martins [27] investigated the obstacles associated with cross-functional cooperation between R&D and sales within the framework of a Finnish digital media company. Their investigation focused on how human resources practices facilitated the transfer of knowledge, reduced friction between peers, and optimized the exchanges to drive performance innovation. However, how these influential factors impact the capability of knowledge transfer from the viewpoint of software project managers has not been investigated. The qualitative methodologies emphasized in the literature review included document analysis, inductive multiple-case studies, interpretive approaches via semi-structured interviews, and focus groups.

Numerous quantitative studies have employed cross-sectional designs and provided evidence from positivist perspectives. Empirical data collection through questionnaire surveys and the implementation of structural equation modeling (SEM) are necessary to verify the hypotheses. Anjum et al. [28] probed the impact of ICTs, social interactions, and training on the effectiveness of knowledge dissemination to staff members in public universities, while Bjorvatn & Wald [29] expanded on previous research that concentrated on the consequences of rapidity at the enterprise level and inspected the impact of time constraints on the capability of knowledge transmission at the team level. They investigated the appearance of trust as a mediator, using the perspectives of project teams associated with three public-sector agencies and three industrial associations. Sun et al. [30] conducted a similar investigation into the associations between knowledge-transfer networks and factors influencing construction projects. They conducted a literature review and gathered practical experience from workers in Chinese construction companies to develop a model framework and propose hypotheses. Zhou et al. [20] also assessed the perspectives of both individuals and teams on the primary determinants influencing knowledge transfer in global construction ventures. The efficacy of knowledge transfer among construction laborers in China was later investigated by Zhou et al. [31] by specifically probing the mediating role of laborers' propensity for effective knowledge transfer. An exhaustive framework was introduced by Zhou et al. [32] to inspect the effect of varied factors on the efficacy of knowledge transmission in cross-cultural teams using tacitness and complexity of knowledge, members' willingness, trust, cultural distance, and team identification.

Ren et al. [33] examined the effect of relationship quality among project colleagues on the capability of knowledge transmission by analyzing the influence of organizational structure within the context of the Chinese construction industry, while Mohamad et al. [34] led a research investigation into the correlation between knowledge transfer and supervisory leadership among public department employees in Malaysia, concentrating on the mediating role of the desire to transfer knowledge. A recent study by Deng et al. [35] utilized Exponential Random Graph Models to discern patterns in knowledge exchange among physicians. They considered regional variations when constructing two sub-networks of implicit and distinct knowledge transfer. However, the use of mixed-methods to study quantitative and qualitative data is sparse, although one study investigated the antecedents of training and development practices as an indicator of effective learning in the Vietnamese hospitality sector [36].

Many researchers in various fields have used quantitative, qualitative, and mixed-methods approaches to examine a wide range of themes and aspects of knowledge transfer effectiveness. However, combined qualitative and quantitative sequential exploratory mixed-method approaches have been rarely applied to produce theoretical frameworks of the success factors of knowledge transfer effectiveness with regard to software project managers, especially in Thailand. To fill this research lacuna, this study combined qualitative and quantitative sequential exploratory mixed-method approaches to build a theoretical framework comprising the success factors of knowledge transfer effectiveness for software project managers. The novel idea of this study involves constructing the theoretical framework using a combination of methods to systematically categorize the determinants of knowledge transfer effectiveness among software project supervisors and investigate their impacts to answer the two research questions. RQ1: What are the influential factors that affect the effectiveness of knowledge transfer among software project managers? RQ2: How can those influential factors affect the effectiveness of knowledge transfer among software project managers? The research objectives were to 1) identify the success factors of knowledge transfer effectiveness by software project managers and 2) investigate the impact of these factors on the effectiveness of knowledge transfer. Three influential factors on the effectiveness of knowledge transmission were postulated in light of the literature review as the knowledge recipient, the knowledge provider, and the environment in which the knowledge is transferred. To provide clarification on these three variables, semi-structured interviews and a cross-sectional survey were conducted, with exploratory factor analysis (EFA) utilized to refine the items and establish scales for the influential factors that impacted the efficacy of knowledge transfer by software project managers. Structural equation modeling (SEM) was selected to determine the effect of these three influential factors on the perception of software project managers regarding the efficacy of knowledge transmission.

This paper strengthens the body of knowledge-on-knowledge transfer through the systematic identification of influential factors that impact the effectiveness of the transfer of knowledge in software initiatives. This paper adds to the previous corpus of research as a scholarly contribution by integrating the factors that influence effective knowledge dissemination into a novel software project management framework.

2. Theoretical Background

2.1. Knowledge Transfer

The exchange of information, ideas, and experiences constitutes knowledge transfer [37]. as the process by which information is conveyed from one individual to another [30, 38]. The notion of knowledge transfer was initially proposed by Teece [39] as an essential approach to amassing information. Argote & Ingram [40] defined knowledge transfer as the mechanism by which a specialized understanding is transmitted from one company to another. The definition of knowledge varies but typically comprises the two fundamental processes of knowledge transmission and knowledge reception. Knowledge transfer effectiveness has been evaluated in a variety of ways by numerous researchers. Szulanski [41] defined knowledge transfer as a reciprocal exchange of information between providers and recipients. The knowledge imparted by the sender is assimilated, comprehended, and integrated by the recipient into their preexisting knowledge base. Knowledge transfer consists of two discrete actions. The knowledge distributor first transfers knowledge to the beneficiary, and the recipient then applies the knowledge to enlarge results or produce innovative acumen [42]. Multiple levels of information transmission are possible between organizations, individuals, and other organizations. Knowledge transmission is of the utmost importance because it frequently facilitates information exchange between companies and groups [40, 43]. Knowledge transfer takes place across multiple tiers, including inter-project, intra-project, enterprise-project, and participant-organization-project levels [44–46].

Knowledge transfer is defined in this study as the capacity of a software project manager to enhance the efficacy of knowledge transfer by utilizing all acquired skills and knowledge throughout the software project development process. This includes addressing issues related to knowledge flow, cost reduction, and redundancy mitigation in software project management.

2.2. Knowledge Transfer Effectiveness Among Project Teams

Effectiveness in transferring knowledge pertains to the intensity to which the transfer of knowledge is achieved. Collective knowledge transmission is the subject of this investigation. Concurrently, knowledge-transfer efficiency emphasizes the cost-effectiveness and time-saving aspects of the transfer [47]. Pérez-Nordtvedt et al. [47] classified the efficacy of knowledge transmission along four dimensions: the utility of the knowledge, its comprehensibility, its rapidity, and its economy. The efficacy of knowledge transfer has been evaluated through the assessment of knowledge reserve growth, project objective attainment, and technical and managerial capability enhancement [30, 48]. The successful attainment of project objectives and the enhancement of team performance both depend on collaboration and knowledge transfer among professionals hailing from diverse disciplines within project teams [49–51]. Scholars are continually examining diverse viewpoints to enhance the efficacy of information exchange among project team members.

Anjum et al. [28] utilized social interaction theory to scrutinize the factors affecting the effectiveness of knowledge transmission in higher-level educational institutes (HEIs). Using social cognitive theory (SCT), Zhou et al. [31] explored the factors that impacted the effectiveness of knowledge transmission among construction laborers in China. A cross-sectional study design was employed by Mohamad et al. [34] to investigate significant determinants influencing the efficacy of knowledge transmission in public departments of Malaysia. Similarly, Ren et al. [33] scrutinized the effect of institutional structure on the effectiveness of knowledge sharing among groups of a project team as well as the nature of interpersonal connections within the team. Zhou et al. [52] identified and established relationships between the components and results of knowledge transfer in the situation of project environments, while Biloslavo and Lombardi [25] examined critical determinants affecting the effectiveness of knowledge transmission within small high-tech enterprises using qualitative research methodologies. They made substantial contributions to the corpus of knowledge regarding the societal dimensions of knowledge transmission. Zhang et al. [53] identified factors that influenced the efficacy of knowledge dissemination among rural tourism-engaged villagers, while the impact of time limitations on the capability of knowledge dissemination among worldwide project members was examined by Bjorvatn and Wald [29]. Dellestrand et al. [24] recently executed inductive multiple-case research within multinational corporations to examine the impact of embedded actors in internal and external networks receiving sub-units on the efficacy of transfer. Zhou et al. [32] investigated the primary factors affecting the efficacy of knowledge dissemination in global construction initiatives that span cultures. Three distinct levels were utilized to assess these factors as individual factors, collective factors, and knowledge aspects. Lastly, Zhou et al. [20] examined the key factors that impacted knowledge transmission in global construction projects, encompassing both individual and team dimensions.

This study assessed the effectiveness of transferring knowledge in software project management through the evaluation of knowledge flow inclusion, cost reduction, and redundancy problem mitigation. Our theoretical model examined the variables impacting the effectiveness of knowledge transmission within the project environment. Zhao et al. [38] developed a theoretical model for cross-project knowledge transfer by adopting mixed methods research. They empirically tested the model in the context of Chinese IT services firms. Zhang et al. [53] conducted multiple typical case studies to identify the factors influencing knowledge transfer to villagers working in rural tourism. They employed the Decision-Making Trial and Evaluation Laboratory-Maximum Mean De-Entropy-Interpretative Structural Modelling method to analyze a hierarchical structural model of knowledge transfer influencing factors, revealing its roles, hierarchical structure relationships, and influencing paths. Zhou et al. [52] conducted comprehensive research to determine and link the elements and outcomes of knowledge transfer in the project environment by systematically analyzing the relevant literature from the past 20 years.

Zhou et al. [20] examined the key drivers that affected knowledge transfer within international construction projects from both individual and team perspectives by collecting empirical data from people who were participating or had participated in the projects and used structure equation modeling (SEM) to test the hypotheses. Zhou et al. [32] explored the key factors affecting knowledge transfer within cross-cultural teams in international construction projects at three levels, including individual factors, team factors, and knowledge characteristics. A conceptual model and hypotheses were put forward after a literature review and pilot investigation. Their study used structural equation modeling to examine the factors impacting knowledge transfer effectiveness within cross-cultural teams based on the questionnaire data of samples from Chinese international construction projects. However, our study differs from previous research, which established a grounded framework of the factors influencing knowledge transfer in the software project management context. Here, we developed a theoretic model to incorporate the factors influencing the effectiveness of knowledge transfer in software project management by combining qualitative and quantitative sequential exploratory mixed-method approaches. Our model was relevant to an emerging country such as Thailand, where IT and security market size are projected to grow continuously to become the hub of the country's tech industry.

3. Research Methodology

This study combined qualitative and quantitative methodologies as a hybrid approach to expedite the investigation of the research questions. A mixed methods approach guarantees an exhaustive examination of the topic. Determining the factors that impact successful knowledge transmission among software project managers is a novel research area where exploratory and confirmatory inquiries are warranted [54, 55]. A literature review, questionnaire surveys, and semi-structured interviews comprised the mixed-methods design depicted in Figure 1. To probe and identify the crucial factors impacting the effectiveness of knowledge transfer, this investigation integrated qualitative and quantitative methodologies. A quantitative investigation was carried out in Phase 2 to refine and assess the research model built in Phase 1. Structural equation modeling (SEM) was employed, and the model underwent construct validation. An enhanced perception of the factors impacting the efficacy of knowledge transmission among software project directors was attained through the integration of Phases 1 and 2.
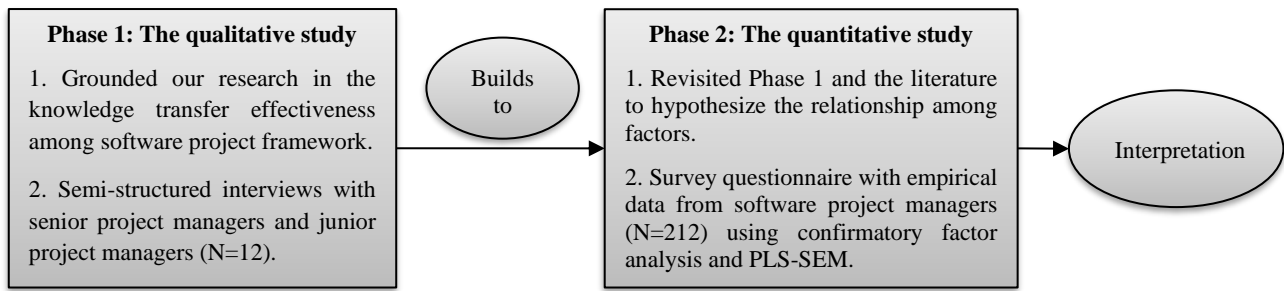
Figure 1. Research design for the sequential exploratory mixed-methods study

3.1. Phase 1 Qualitative Study

The efficacy of knowledge transfer by software project managers was determined in Phase I through the identification of causal factors. To remediate the limitations, this study utilized both qualitative and quantitative methodologies. A literature review was undertaken before commencing the interviews to generate preliminary research questions concerning the variables that influence the efficacy of knowledge transmission among software project managers. Adjustments to the items were made after semi-structured interviews conducted with senior project managers and novice project managers to obtain a range of perspectives and a more comprehensive understanding.

A theoretical framework was developed by integrating the concepts put forward by Zhao et al. [38], Zhang et al. [53], and Zhou et al. [20, 32, 52], concerning the factors that affect knowledge transmission in project environments. The proposed methodology comprised conducting semi-structured interviews with software project managers to gather data and augment our comprehension of the components that impacted the efficacy of knowledge transfer. Six senior project managers (SPM1 to SPM6) and six junior project managers (JPM1 to JPM6) were interviewed between July and August 2022. Table 1 shows the demographic profiles of the twelve key informants.

Table 1. Demographic profiles of the interviewees

No.	Code	Gender	Age group	Education level	Position	Experience in software projects (Years)
1	SPM1	Female	51-60	Master's degree	Senior Project Manager	15
2	SPM2	Female	31-40	Bachelor's degree	Head of IT department	5
3	SPM3	Female	41-50	Doctoral degree	Project Manager	10
4	SPM4	Female	51-60	Master's degree	Project Advisor	25
5	SPM5	Male	51-60	Master's degree	Project Manager	20
6	SPM6	Male	41-50	Master's degree	Project Management Trainer	23
7	JPM1	Male	21-30	Bachelor's degree	Senior Consultant	0
8	JPM2	Male	31-40	Bachelor's degree	Senior Consultant	1
9	JPM3	Female	31-40	Master's degree	Project Manager	3
10	JPM4	Male	21-30	Master's degree	Data Consultant	0
11	JPM5	Female	21-30	Bachelor's degree	Project Management Officer	0
12	JPM6	Male	31-40	Master's degree	Project Management Officer	2

With consent, each interview was recorded. Throughout the interviews, the research objective was established. As postulated in the study, senior and intermediate project managers participated in a collaborative ideation process concerning the determinants and mechanisms that impact the effectiveness of knowledge dissemination among software project managers. Informative and open-ended inquiries served as a guide for this process. Thematic analysis was applied to all transcribed audio recordings to identify preliminary themes and refine the key elements that determined the effectiveness of knowledge transmission [56]. The data were subjected to a deductive analysis by categorizing interview transcripts in accordance with the elements identified in the existing literature. As the process of interpretation advanced, further identifiers were appended to the original items. An inductive analysis was performed in which the initial theme emerged spontaneously from the data, unrestricted by a pre-established framework [56]. Coding the twelve interviews yielded no additional insights, providing support for the concept of theoretical saturation [57]. As shown in Table 2, the analysis identified three initial themes that explained the effectiveness of successful knowledge transfer: knowledge providers, knowledge recipients, and the environment for knowledge transfer.

Table 2. Thematic analysis results

Preliminary Themes	Sub-themes	Representative quotations
Knowledge providers	Level of knowledge and ability in knowledge transfer	Sometimes, project managers are very skilled at their work but struggle to transfer their knowledge to learners. The person who will teach must be able to communicate and convey their thoughts to the learners. It's not just about teaching from textbooks but also about incorporating real knowledge and experiences into the lessons. – JPM1
	Motivation and intention in knowledge transfer	The person who will teach must not be possessive of their own knowledge, nor should they test the learners' level of knowledge. They should listen to the learners' perspectives and be friendly towards them, encouraging open communication without acting superior. – JPM2
	Clear details, categorisation and context of the knowledge	They must make learners feel that they have a problem and want to learn to solve it. They must emphasise hands-on workshops, employing teaching methods, gimmicks and content appropriate for the learners. They must create a good learning environment with a structured teaching sequence and teach in a way that matches the learner's nature. This involves initially fostering a shared emotional connection between the person who will teach and the learner, followed by teaching that doesn't adhere strictly to textbooks but reflects real-world practices. They must tailor the content to suit the learners' context and understand that learning is not solely for exams. – SPM6
Knowledge recipients	Cognitive capacity to assimilate knowledge	They must have a solid background and some foundation or experience working on projects or, even better, have previous experience as a project manager. They should possess logic, methods of thinking and the ability to learn quickly. – SPM6
	Motivation and intention to learn	Not everyone can become a project manager. We have to assess how much the learners want to work in project management. How much do they understand this career field? What is their perspective on this type of work? How motivated are they to learn? Are they ready to face any situation? – SPM1
	Confidence in the knowledge providers	They must respect and accept the person who will teach or be familiar with them beforehand. Otherwise, they might not listen to what is being taught and could even end up challenging the teacher. – SPM4
Knowledge transfer environment	Cultural affinity between the knowledge suppliers and the knowledge receivers	Everyone must adopt the same project management practices without letting culture interfere. This is why the PMI exists: to create standardised guidelines. And if learners respect the teachers, it can help minimise cultural differences. – SPM1
	The level of technology used in the transfer	Having tools and technology to aid in presentations during teaching is very beneficial. Teaching aids like slides, documents and visual representations, rather than just text, along with assessments to ensure understanding between learners and teachers, can make the teaching process easier. – SPM2
	The level of open communication	Those who listen prefer a friendly approach. Open communications make learning easier as everything on our minds can be spoken about. – JPM3

Note: *JPM* represents Junior Project Manager*; SPM* represents Senior Project Manager.

As illustrated in Table 2, the designation 'knowledge providers' pertains to individuals and groups who transfer their expertise, data, experiences, and information concerning software project management. Providers of knowledge must be adept at project management, communication, presentation, and knowledge transmission from multiple vantage points, as well as capable of elucidating the subject matter to the recipients. They must possess the following qualities: willingness to impart knowledge, attentiveness towards knowledge recipients, a desire to foster professional growth in their domain, utilization of appropriate teaching principles and techniques, provision of ongoing instruction and knowledge review, and comprehension of the recipients' foundational knowledge.

The concept of 'knowledge recipients' pertains to individuals or entities who require knowledge. This is accomplished through the exchange of information, data, experiences, and expertise in the field of software project management. Recipients of knowledge must comprehend the material and process their thoughts, accordingly, interact with knowledge providers to confirm comprehension, possess a strong interest in project management, exhibit a motivation to pursue a career in this field, demonstrate a willingness to learn and explore opportunities for experimentation, and establish personal objectives. They must maintain an open mind, engage in ongoing self-improvement and training, and have faith in, regard for, and confidence in the knowledge purveyors.

Lastly, the phrase "knowledge transfer environment" encompasses a range of tangible and ethereal factors that pertain to the knowledge providers and recipients. These factors may include cultural similarities between the two groups. These conditions have both positive and negative impacts on the transmission of knowledge, which in turn affects the efficacy of knowledge transfer in software project management. Culture influences various aspects of knowledge transfer, including the management of individual projects, the extent to which technology is utilized (including the documents, devices, and software used to present, communicate, and assess results), and the degree of open communication (which pertains to direct and transparent communication throughout the knowledge transfer process).

3.2. Phase 2 Quantitative Study

In Phase 2, an online survey employing exploratory factor analysis (EFA) was utilized to refine the items and establish scales for the influential factors that impacted the efficacy of knowledge transfer by software project managers. To evaluate the model, structural equation modeling (SEM) was selected, with construct validation also performed.

● *Method*

During September 2022, software project managers at all hierarchical levels completed an online survey questionnaire utilizing convenience sampling to refine themes, distill items, and determine the robustness of influential elements. After obtaining informed consent, the respondents were asked to complete a survey questionnaire split into two parts. The first part comprised six questions regarding demographic profiles, while the second part comprised 32 questions assessing successful knowledge transfer factors among software project managers using a five-point Likert scale.

The second part included ten questions about knowledge providers, adapted from Bacon et al. [58]; Dong et al. [59]; Glaser et al. [60]; Guvernator Iv & Landaeta [61]; Hatane et al. [62]; Itoe Mote & Karadas [63]; Li & Li [64]; Liu et al. [65]; Moshood et al. [66]; Mote & Karadas [67]; Tshuma et al. [68]; Vaghefi et al. [69]; Zhao et al. [38], nine questions about knowledge recipients, adapted from Authors (2022); Bacon et al. [58]; Dong et al. [59]; Glaser et al. [60]; Hatane et al. [62]; Li & Li [64]; Liu et al. [65]; Moshood et al. [66]; Asatiani et al. [67]; Ouyang et al. [70]; Singh et al. [71]; Vaghefi et al. [69]; Wang et al. [72]; Zhao et al. [38], ten questions about knowledge transfer environment, adapted from Authors (2022); Bacon et al. [58]; Moshood et al. [66]; Ren et al. [73]; Spraggon & Bodolica [74]; Temple & Landaeta [75]; Tshuma et al. [68]; Vaghefi et al. [69]; Vick & Robertson [76]; Wang et al. [72] and three questions about knowledge transfer effectiveness, adapted from Biloslavo & Lombardi [25]; Bjorvatn & Wald [29]; Cheng et al. [77]; Dong et al. [59]; Moshood et al. [66]; Prihadyanti et al. [78]; Ren et al. [48]; Tshuma et al. [68]; Zhang & Xu [79]. All these questions concerned influential factors that impacted knowledge transfer effectiveness among software project managers from Phase 1. A total of 212 returns were received in response to the survey, with 212 considered acceptable. The demographic characteristics of the participants are shown in Table 3.

Table 3. Demographic characteristics of the participants

Measure	Item	Frequency	Percentage
Gender	Male	110	51.9
	Female	100	47.2
	Not specified	2	0.9
Age	21 to 30 [yrs.]	23	10.8
	31 to 40 [yrs.]	69	32.5
	41 to 50 [yrs.]	96	45.3
	51-60 [yrs.]	20	9.4
	>= 61 [yrs.]	4	1.9
Education level	Undergraduate	79	37.3
	Master	123	58.0
	Ph.D.	10	4.7
Occupation	Private sector employee	171	80.7
	Government official/ State enterprise employee	23	10.8
	Freelancer	13	6.1
	Do-nothing/Pensioner	5	2.4
Work experience	0 to 5 [yrs.]	10	4.7
	6 to 10 [yrs.]	35	16.5
	11 to 15 [yrs.]	49	23.1
	16 to 20 [yrs.]	53	25.0
	21 to 25 [yrs.]	46	21.7
	> = 26 [yrs.]	19	9.0
Experience in software project management	0 to 4 [yrs.]	91	42.9
	5 to 9 [yrs.]	59	27.8
	10 to 14 [yrs.]	34	16.0
	15 to 19 [yrs.]	17	8.0
	20 to 24 [yrs.]	9	4.2
	> = 25 [yrs.]	2	0.9
	Total	212	100

● *Findings*

SPSS 22.0 was used for the exploratory factor analysis (EFA) utilizing the varimax rotation method and principal component analysis. The primary objective of this analysis was to demonstrate the fundamental components of the factors that influenced the efficacy of knowledge transfer in the case of software project management. Items that had cross-loadings or factor loadings below 0.40 were excluded from the analysis. All 32 items were retained because the factor loadings exceeded the threshold of 0.50 [80]. Bartlett's test of sphericity results (p < 0.001) and the Kaiser-Meyer-Olkin (KMO) test result of 0.858 confirmed that the utilization of EFA was appropriate [81]. The findings of the EFA are summarized in Table 4. Four dimensions were identified with an Eigenvalue greater than 1.0 that elucidated 64.097% of the variance and summarized the data accurately. These four dimensions were designed as "Knowledge providers," "Knowledge recipients," "Knowledge transfer environment" and "Knowledge transfer effectiveness".

Table 4. Exploratory factor analysis results

Items	Factor loading			
	Knowledge providers	Knowledge recipients	Knowledge transfer environment	Knowledge transfer effectiveness
KP9 Knowledge providers must categorise the content for knowledge transfer	0.760			
KP10 Knowledge providers must sequence the content in a step-by-step manner for knowledge transfer	0.731			
KP8 Knowledge providers must have clear content details in the knowledge transfer	0.714			
KP2 Knowledge providers must be capable of knowledge transfer	0.676			
KP4 Knowledge providers must possess techniques in knowledge transfer	0.672			
KP6 Knowledge providers must be committed to knowledge transfer	0.644			
KP5 Knowledge providers must have motivation in knowledge transfer	0.572			
KP3 Knowledge providers must be credible	0.557			
KP1 Knowledge providers must have knowledge in what they will transfer	0.534			
KP7 Knowledge providers must consistently transfer knowledge	0.516			
KR9 Knowledge recipients must respect the knowledge providers		0.822		
KR5 Knowledge recipients must be committed to learning		0.780		
KR7 Knowledge recipients must have confidence in the knowledge providers		0.779		
KR8 Knowledge recipients must be in a good relationship with the knowledge providers		0.774		
KR4 Knowledge recipients must be motivated to learn		0.769		
KR2 Knowledge recipients must have a foundational knowledge in project management		0.722		
KR1 Knowledge recipients must possess the ability to learn		0.646		
KR6 Knowledge recipients must learn consistently		0.509		
KR3 Knowledge recipients must engage in questioning and interaction with the knowledge providers		0.455		
KTE1 Knowledge providers and knowledge recipients must have similar cultural backgrounds			0.812	
KTE6 Knowledge transfer must rely on open, direct communication between knowledge providers and knowledge recipients			0.799	
KTE2 Knowledge providers and knowledge recipients must have similar dispositions			0.776	
KTE5 Knowledge transfer must include illustrative images or animations			0.758	
KTE4 Knowledge transfer must rely on technology, such as devices and software			0.699	
KTE8 Knowledge transfer must involve friendly communication			0.693	
KTE10 Knowledge recipients with more experience in software project management will better receive the transfer			0.689	
KTE7 The transferred content must be backed up by logic to demonstrate the origins of the content			0.679	
KTE9 Knowledge transfer must be conducted ethically			0.543	
KTE3 Knowledge providers and knowledge recipients must communicate in the same language, such as Thai or English			0.418	
KEF3 Good knowledge transfer to project managers will help reduce product costs				0.802
KEF2 Good knowledge transfer to project managers will help minimise recurring problems in the project				0.794
KEF1 Good knowledge transfer to project managers will facilitate the circulation of knowledge in project management				0.616

The objective of Phase 2 was to conduct a more in-depth analysis of the critical determinants that impacted the efficacy of knowledge transfer by software project managers following Phase 1. The relevant literature was utilized to construct a research model that demonstrated the influence of relevant factors on the efficacy of knowledge transmission among software project managers. The measurement model underwent construct validation, whereas the structural model utilized structural equation modeling (SEM) to evaluate the validity of the assumptions.

- *Development of the Hypotheses*

The effect of knowledge providers on knowledge transfer effectiveness:

Knowledge transfer is an instance of social interaction. It refers to the mechanism through which information acquired from one supply becomes known to another [82]. The act of software project managers imparting their expertise, skills, and knowledge to others was the conceptual framework for knowledge transfer in this study. Knowledge providers have previously been identified as factors influencing the potency of knowledge transfer from multiple perspectives. Effective supervisory leadership, according to Mohamad et al. [34] and Yaghi & Bates [83], is comprised of two essential elements: guidance, which encompasses the dissemination of task information, expression of ideas, and sharing of training techniques and feedback, which ensures that employee performance is evaluated and includes the communication of performance criteria. To inspire employees to enhance the knowledge transfer processes, the supervisor must foster an atmosphere that promotes constructive criticism and offer sufficient assistance. Alzubi [84] posited a correlation between knowledge leadership and strategy as elements that facilitate knowledge and the efficacy of knowledge transmission. Owusu-Manu et al. [85] identified a positive interrelationship between the effectiveness of knowledge transfer and leadership and knowledge strategy, which functioned as a facilitator of knowledge. Similarly, Mainga [86] highlighted the pivotal role of a transmitting tendency as a basic element of the knowledge transmission process, which improved both the amount and quality of information communicated [30, 48]. Zhou et al. [87] stated that the likelihood of successful knowledge transfer between knowledge providers and knowledge recipients can be increased to promote the efficacy of knowledge transfer. Similarly, in the environment of corporate training, Zhou et al. [20] hypothesized that effective learning processes and intercultural competency impacted knowledge transfer effectiveness in international construction businesses.

Zhou et al. [31] found that knowledge self-efficacy increased the propensity of construction staff to transmit knowledge and positively influenced the success of knowledge transfer. People who have a strong belief in their capacity to solve problems are more likely to take the initiative to educate others as a result of their enhanced certainty regarding the veracity of the information they convey. Zhou et al. [87] and Sun et al. [30] emphasized that enhanced inter-individual communication facilitated more effective knowledge transmission as a consequence of a greater propensity to share information, while Zhou et al. [87] argued that the level to which knowledge providers are willing to convey their expertise impacted the feasibility of knowledge transfer operations. Knowledge providers who are enthusiastic strive diligently to convey knowledge through explanations and consolidate their expertise. Enhancing the quantity and quality of knowledge concurrently increases the probability that it will be conveyed and received by the intended recipients. Research by Phung et al. [88] revealed that people who possess a strong sense of knowledge self-efficacy are more likely to acknowledge the value of their expertise and, as a result, are more motivated to impart that expertise, while Ren et al. [48] posited that trust can eliminate dishonesty, reduce suspicion, and foster efficiency. The establishment of trusting relationships can motivate individuals with knowledge to share their expertise and enhance the faith of those receiving the knowledge in their capacity to comprehend the information [87]. Studies by Ren et al. [48], Sun et al. [30], Ni et al. [89], and Zhou et al. [87] supported the notion that trust relationships are crucial for facilitating the exchange of knowledge among project teams. Lastly, Ren et al. [73] revealed that the level of readiness to share knowledge by knowledge providers had a substantial effect on the efficacy of comprehensive, transparent, and exhaustive internal communication. Therefore, hypothesis 1 was posited as:

H1: *Knowledge providers positively influence knowledge transfer effectiveness.*

The impact of knowledge recipients on knowledge transfer effectiveness:

Academic researchers have predominantly focused on beneficiaries when examining corporate knowledge transfer because the efficacy of knowledge transfer is dependent on the recipients' motivation to enhance their capabilities and boost their efficiency [90]. Bashir & Long [91] stated that individuals who possessed a profound sense of affiliation and company loyalty were more likely to exhibit motivated behaviors with respect to training. In the same vein, Xie et al. [92, 93] stated that individuals who demonstrated a strong commitment to learning through deliberate resource allocation and knowledge transmission strategies were more decisive in facilitating the assimilation and transfer of information. Zhou et al. [87] posited that individuals who were exposed to information and possessed a strong desire to gain new knowledge were more likely to enlist in knowledge transfer initiatives and seek assistance in transferring knowledge, thereby ultimately augmenting the efficacy of knowledge transfer. People who possess a high level of knowledge self-efficacy exhibit a notable propensity for learning initiative and a desire to augment their knowledge, thereby enhancing the efficacy of information transfer. Similarly, for effective knowledge transmission, according to Phung et al. [88] and

Ngo et al. [94], employees must acquire external information and be receptive to learning with collaborators. Phung et al. [88] observed that individuals with a greater propensity to engage in the dissemination of their expertise often had a higher level of knowledge self-efficacy. The notion that individuals with high self-efficacy are capable of imparting their expertise was also validated by Cao et al. [95] and Ibrahim & Heng [96]. People may also become less inclined to divulge information. Ren et al. [73] stated that trust can inhibit deceit, reduce suspicion, and promote cooperation, while Zhou et al. [87] asserted that relationships founded on trust increase the propensity of those imparting knowledge to transmit it and the confidence of those receiving it to accept it. Consistent with this concept, Ren et al. [73], Zhou et al. [87], and Sun et al. [30] all concluded that trust relationships within project teams are crucial for the transmission of knowledge. Previous studies have shown that trust is essential for people to feel comfortable when sharing information with one another [30, 31, 97]. Trust relationships enhance recipients' perceptions of the information source while simultaneously reducing expenses and enhancing the efficacy of knowledge transmission. The effectiveness of information transfer and the quality of social interactions both contribute to the improvement of knowledge transfer outcomes through interpersonal communication [98, 99]. Furthermore, Probodha & Vasanthapriyan [100] found that attitude and trust are both significant determinants of knowledge sharing. Therefore, hypothesis 2 was posited as:

    H2: *Knowledge recipients positively influence knowledge transfer effectiveness.*

    The effect of the knowledge transfer environment on knowledge transfer effectiveness:

The environment for the transfer of knowledge may change an individual's sense of learning opportunities and benefits, thereby influencing their desire to study. Support from managers or supervisors, learning culture, perceived organizational support, encouragement for learning, and team support constitute the knowledge transfer environment [36]. Chung et al. [77] identified learning transfer, declarative knowledge, training reactions, and job performance as outcomes that exhibited a positive correlation with learning motivation. Team support was found to be positively correlated with both the desire to learn and training transfer in the workplace [101]. To facilitate knowledge transmission for training development, Han et al. [36] demonstrated that job quality and team support were critical, while Ren et al. [73] postulated that the inclination of workers towards closed-group dynamics improved their preference for socializing with people who shared comparable familial or geographical connections. This fostered the establishment of common values and facilitated the interchange of knowledge among personnel. Cultural differences can complicate or obstruct the successful transmission of information, according to Goswami et al. [102], while Ni et al. [89] asserted that colleagues from diverse nationalities, ethnicities, or cultural backgrounds can hinder the flow of knowledge. Corporate culture can either facilitate or impede the dissemination of knowledge, contributing to the overall success of the project [73, 84, 87, 89]. An organizational culture that provides incentives for personnel to generate and disseminate knowledge is imperative. Gunasekera & Chong [103] emphasized the importance of fostering a corporate environment that encouraged construction workers to exchange information and collaborate to resolve issues. Alzubi [84], Ni et al. [89], and Owusu-Manu et al. [85] concurred with the notion that a "no-blame culture" must be established within a project environment and also emphasized the significance of promoting knowledge sharing among team members. A culture that exerts influence can dampen egocentrism and foster a spirit of knowledge dissemination among its constituents. This enhances members' motivation to learn and prevents them from experiencing embarrassment by highlighting their knowledge deficiencies. Goswami et al. [102] proposed that the process of knowledge transmission is relatively uncomplicated between people of similar cultural backgrounds. Divergences in values and the absence of universally accepted standards were emphasized as potential causes of knowledge ambiguity, thereby impeding the exchange of knowledge. Wijaya et al. [104] posited that enhancing fundamental operational functions, including communication and transaction recording, to optimize the efficacy of knowledge transmission requires the effective implementation of information technology. A positive correlation was identified by Mohamad et al. [34] between the feedback environment and knowledge transfer within public organizations. A similar notion was proposed by Alzubi [84], who identified a correlation between information technology and alternative facilitators of knowledge that enhanced the efficacy of knowledge transmission. Furthermore, Chung et al. [77] identified learning transfer, declarative knowledge, training reactions, and job performance as outcomes that exhibited a positive correlation with learning motivation. Similarly, Zhou et al. [87], Ren et al. [73], and Sun et al. [30] suggested that trust and reciprocal relationships had a positive effect on both the inclination to share knowledge and the effectiveness of knowledge transmission. Therefore, hypothesis 3 was posited as:

    H3: *Knowledge transfer environment positively influences knowledge transfer effectiveness.*

4. Results

PLS-SEM was used to assess the robustness of the structural and measurement models. Smaller sample sizes and fewer distributional assumptions are required for PLS-SEM to estimate route models containing numerous constructs and latent variables [105, 106]. PLS-SEM also permits the execution of cause-and-effect relationship models by incorporating latent variables [105]. Thus, PLS-SEM was suitable for our research, with data analyzed utilizing SmartPLS 4.0.

4.1. Common Method Bias

A comprehensive collinearity test was carried out to assess the presence of common method bias (CMB), as suggested by Kock [107]. Construct values ranged from 1.488 to 1.854, with internal variance inflation factors (VIF) lower than the crucial threshold of 3.3. Thus, the model was considered to be free from CMB [107].

4.2. Measurement Model

The validity and reliability of the components were evaluated using confirmatory factor analysis (CFA). The standardized factor loadings for all constructs in Table 5 surpassed the acceptable threshold of 0.7. Cronbach's α and composite reliability (CR) values for each construct exceeded 0.7, whereas the average variance extracted (AVE) value surpassed 0.5. Results suggest that the measures of convergent validity and reliability were adequate [105, 108]. Discriminant validity was verified in compliance with the Fornell-Larcker criterion (Table 6). The correlation between each pair of constructs in Table 5 was determined to be subject to the square root of the average variance extracted (AVE) for the claimed constructs, in accordance with the Fornell-Larcker criterion [108].

Table 5. Results of the reflective measurement models

Latent variables	Indicators	Convergent validity			Internal consistency reliability		
		Loading	Indicator reliability	AVE	Cronbach's Alpha	Composite reliability (rho_a)	Composite reliability (rho_c)
		>0.7	>0.5	>0.5	0.60-0.90	0.60-0.90	0.60-0.90
Knowledge Providers (KP)	KP10	0.820	0.672				
	KP4	0.739	0.546				
	KP6	0.736	0.541	0.621	0.847	0.846	0.891
	KP8	0.802	0.643				
	KP9	0.840	0.705				
Knowledge Recipients (KR)	KR4	0.844	0.712				
	KR5	0.909	0.827	0.705	0.792	0.841	0.877
	KR6	0.760	0.578				
Knowledge Transfer Environment (KTE)	KTE7	0.814	0.662				
	KTE8	0.839	0.704	0.658	0.740	0.744	0.852
	KTE9	0.780	0.608				
Knowledge Transfer Effectiveness (KEF)	KEF1	0.834	0.696				
	KEF2	0.819	0.671	0.681	0.768	0.777	0.865
	KEF3	0.822	0.676				

Table 6. Discriminant validity and collinearity statistics (VIF)

Construct	VIF	KP	KR	KTE	OKT
Knowledge Providers (KP)	1.854	*0.788*			
Knowledge Recipients (KR)	1.783	0.553	*0.840*		
Knowledge Transfer Environment (KTE)	1.488	0.419	0.349	*0.811*	
Knowledge Transfer Effectiveness (KEF)	1.587	0.512	0.357	0.419	*0.825*

4.3. Structural Model

The predicted correlations in the suggested model were checked after confirming the measurement model's validity and reliability. To evaluate the predictive accuracy, the coefficient of determination (R^2) was computed, as illustrated in Figure 2. The R^2 values for the dependent constructs exceeded 0.25, with the model demonstrating a moderate capacity for predicting the endogenous components [105]. Following the SmartPLS recommendations [109], the model fit was evaluated by computing the Standardized Root Mean Square Residual (SRMR), with a well-fitting model indicated by an SRMR score of 0.070.
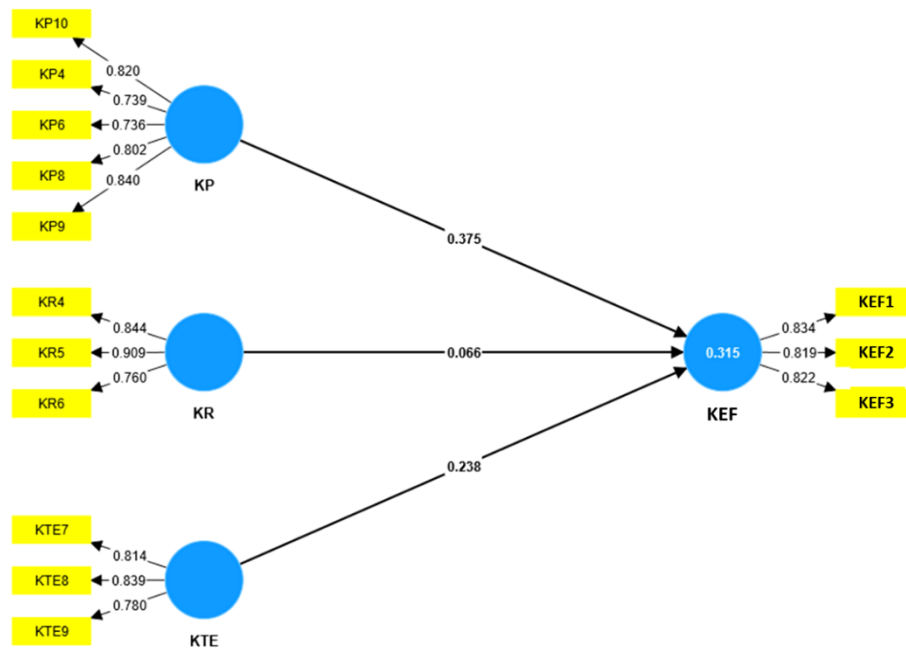
Figure 2. Structural model results

The structural model results are depicted in Figure 2. A significant proportion of the suggested relationships contained statistical values. Knowledge Providers (KP) and Knowledge Transfer Environment (KTE) exhibited statistically significant positive impacts on Knowledge Transfer Effectiveness (KEF), confirming hypotheses H1 and H3. The interaction effect of Knowledge Recipients (KR) on Knowledge Transfer Effectiveness (KEF) was not significant ($\beta = 0.066$, $t = 0.880$, $p = 0.379$) and did not support H2. Test results for the hypotheses are displayed in Table 7.

Table 7. Test results of the hypotheses

Hypothesis	Path	Path coefficient	Standard deviation	T statistics	P values	Results
H1	KP → KEF	0.375*	0.073	5.140	0.000	Supported
H2	KR → KEF	0.066	0.075	0.880	0.379	Not supported
H3	KTE → KEF	0.238*	0.063	3.771	0.000	Supported

* $p < 0.001$

5. Discussion and Implications

5.1. Discussion

Knowledge providers, knowledge recipients, and the knowledge transfer environment were the three facets of effective knowledge transfer identified qualitatively in Phase 1 to answer Research Question # 1. Two influential factors had a positive impact on the knowledge transfer effectiveness of software project managers, according to our empirical findings from Phase 2 to answer Research Question # 2. The findings of the structural model suggested that knowledge providers exert the most significant positive influence on the efficacy of knowledge transfer, followed by the environment for knowledge transfer. One notable observation was that the recipients of knowledge do not significantly impact the efficacy of knowledge transfer.

This finding indicated that knowledge providers were the most critical determinant of knowledge transfer effectiveness, as perceived by the sample group of software project managers with expertise in software project management. Knowledge providers must categorize the content for knowledge transfer, followed by knowledge providers must sequence the content in a step-by-step manner for knowledge transfer, and knowledge providers must have clear content details in the knowledge transfer, as the top three loading score indicators.

This result is in line with the work of Park et al. [110], Salamon et al. [111], and Mohamad et al. [34] and indicated that constructive supervisory encouragement had a positive effect on trainees through the promotion of knowledge-sharing, training technique exchange, and idea exchange. Knowledge enablers, including knowledge leadership and transfer strategy, have a significant influence on the success of knowledge transfer, as claimed by Alzubi [84]. Owusu-Manu et al. [85] revealed significant positive associations between the effectiveness of knowledge transfer and leadership and knowledge strategy, which function as facilitators of knowledge. Zhou et al. [20] suggested that the training mechanism utilized by knowledge providers impacted the efficacy of knowledge transmission within the realm

of corporate training. The willingness of knowledge providers to impart their particular knowledge is a crucial element in determining the achievement of knowledge transfer operations, as stated by Zhou et al. [87]. To enhance the quality and quantity of information transmitted, knowledge providers who possess a strong inclination towards knowledge transfer employ their specialized knowledge and furnish comprehensive explanations to enhance the likelihood that their knowledge will be transmitted and received by the recipients.

A knowledge transfer environment should be established that encourages learning and exchange among seasoned software project managers. Knowledge transfer must involve friendly communication, followed by the transferred content must be backed up by logic to demonstrate the origins of the content, and knowledge transfer must be conducted ethically as the top three higher loading scores. This result concurred with Ren et al. [73], who found that individuals with comparable professional backgrounds, geographical origins, or blood relatives were more likely to interact in closed-group settings. Such interactions foster mutual understanding and facilitate the exchange of information. Gunasekera and Chong [103] argued that fostering an open work culture to transfer knowledge facilitated personal engagement in knowledge-sharing initiatives and enabled the resolution of challenges via inter-individual communication. Similarly, Mohamad et al. [34] identified a positive interrelationship between the feedback environment and knowledge transfer [30, 73, 87]. The effectiveness and inclination to transfer knowledge are both positively impacted by trust and reciprocal relationships. Mainga [86] underscored the value of cultivating a "no-blame culture" in a project setting as a means to promote the sharing of expertise among team participants. Lastly, Owusu-Manu et al. [85] and Alzubi [84] established a significant positive interrelationship between the effectivity of knowledge transfer and company culture and ethics.

By contrast, the influence of knowledge receivers on the efficacy of knowledge transfer was found to be insignificant, reflecting that knowledge recipients who have a high cognitive capacity to assimilate knowledge, motivation and intention to learn, and confidence in the knowledge providers were not correlated with an increase in knowledge transfer effectiveness. This phenomenon was attributed to a multitude of factors. Anjum et al. [28] indicated training as the determining element that significantly and positively correlated with successful knowledge transmission, while Tran & Pham [112] proposed that learning moderated the association between employee participation and knowledge transfer efficiency, with a stronger correlation observed at higher company levels. Bjorvatn & Wald [29] found that time constraints hindered the efficiency of knowledge transfer in teams, while Sun et al. proved that the knowledge distributor-receiver connection was crucial for understanding how project elements impact knowledge transfer performance. [30]. The effectiveness of knowledge transfer can be greatly diminished by the knowledge receivers.

5.2. Theoretical Implications

At the start of the study, two research questions were posited as:

RQ1: What are the influential factors that impact the effectiveness of knowledge transfer among software project managers?

RQ2: What are the influential factors that impact the effectiveness of knowledge transfer among software project managers?

The variables that influenced knowledge transfer in the project domain were incorporated into the theoretical model with guidance from the investigations of Zhang et al. [53], Zhou et al. [52], Zhou et al. [20], Zhao et al. [38], and Zhou et al. [32]. Conducting a comprehensive examination of relevant scholarly works allowed the discovery of new variables that impacted the efficiency of knowledge transfer by software project managers and clarified how these variables contributed to the deterioration of the efficacy of knowledge transmission. Further investigations should be conducted to ascertain whether any additional factors significantly affect the efficacy of knowledge transfer in the perspective being examined, beyond the knowledge providers and knowledge transfer environment, both of which demonstrated noteworthy positive impacts [113]. The results of this research demonstrated that knowledge transfer effectiveness was associated with the knowledge provider-environment relationship, with a predictive coefficient (R^2) of 0.315. The value of 31.50% of the observed variability in the dependent variable was attributed to the factors investigated in this study. In other words, variables that were not taken into application in this study could account for an additional 68.50% of the variance. For example, the temporary nature, time urgency, transmit willingness, receive willingness, trust relationship, project-project transfer channels, and project-enterprise transfer channels were sourced from the research of Zhou & Deng [114], exposure to project-level knowledge transfer from the study of Duva et al. [115], and the moderating role of learning orientation on the relationship between job rotation, cross-functional interfaces, and decision participation on knowledge transfer from the investigation of Wu & Ding [116].

5.3. Practical Implications

Project managers and other relevant staff may make use of the practical research implications in software project management. Our findings suggested that knowledge providers had the most significant positive effect on the effectiveness of knowledge transfer, followed by the knowledge transfer environment. Software project managers and

related personnel must prioritize knowledge providers. These individuals transfer their experiences, data, information, and expertise regarding software project management to individuals and groups that need this knowledge. Categorizing the content for knowledge transfer by knowledge providers using the higher factor loading values should be the primary focus. The content should also be sequenced in a step-by-step manner for knowledge transfer and have precise content details. The establishment of a conducive knowledge transfer environment encompassing both tangible and intangible factors that influence the knowledge providers and recipients would be beneficial. Establishing an atmosphere conducive to knowledge transfer through amicable communication—identifying—the index with outstanding factor loading and substantiating the provenance of the transferred content with logical backtrack will influence knowledge transfer between providers and recipients in software project management in both positive and negative ways. Knowledge transfer must be conducted ethically. Knowledge transfer that adheres to the aforementioned guidelines will increase transfer effectiveness, including facilitating the circulation of knowledge in project management, reducing project costs, and minimizing recurring problems in the project.

6. Conclusions

Knowledge transfer is crucial for companies to remain profitable. Project teams are transient and disband after achieving their objectives. Knowledge transfer in project teams is more difficult than in companies because of time and resource restrictions. Previous studies focused on qualitative or quantitative studies to investigate the influential factors concerning the effectiveness of knowledge transfer and identify how influential factors can affect knowledge transfer effectiveness from the perspective of software project managers. However, combined qualitative and quantitative sequential exploratory mixed-method approaches have rarely been applied to study the success factors of knowledge transfer effectiveness by software project managers, especially in Thailand. Therefore, this mixed-methods study unlocks the secrets of successful knowledge transfer among software project managers, intending to bring university knowledge to society. The purpose of this research was to 1) analyze the factors that influence the knowledge transfer effectiveness of software project managers and 2) evaluate the impacting factors of knowledge transfer effectiveness. To properly examine the two research questions, this study used a mix of methodology designs that included both qualitative and quantitative approaches. First, the qualitative research comprised a literature review, semi-structured interviews, and questionnaire administration. Effective knowledge transfer was determined by three preliminary themes derived from the thematic analysis of the qualitative study as knowledge providers, knowledge recipients, and the environment for knowledge transfer. A quantitative inquiry was then conducted to develop the research model. The investigation of the measurement model was performed using structural equation modeling (SEM), while the structural model underwent construct validation. Finally, the findings suggested that knowledge providers significantly influenced the effectiveness of knowledge transmission, followed by the knowledge transfer environment. By contrast, the recipients of knowledge did not contribute significantly to the efficacy of knowledge transfer.

However, this research had some limitations. This paper examined the efficacy of knowledge transfer among software project administrators in Thailand. Therefore, it is crucial to exercise prudence when applying the results of this research as a standard. The possible impacts of demographic and cultural differences on the varied viewpoints and expectations of software project managers regarding the effectiveness of knowledge transfer must also be taken into account.

The research results refute the assumption that knowledge recipients have a positive influence on knowledge transfer efficacy, and this needs further examination. Utilizing a qualitative research method by conducting in-depth interviews or other appropriate methods from the sample group can also uncover, expand on, and deepen the understanding of data related to why software project managers do not focus on the factor of knowledge recipients. Researchers can also utilize demographic data to study the relationships between variables such as different genders, ages, educational backgrounds, occupations, work experience, or experience in software projects to determine whether these variables affect knowledge transfer effectiveness.

7. Declarations

7.1. Author Contributions

7.2. Data Availability Statement

7.3. Funding

7.4. Institutional Review Board Statement

The study was conducted in accordance with the Declaration of Helsinki and approved by the Research Ethics Review Committee for Research Involving Human Subjects: The Second Allied Academic Group in Social Sciences, Humanities, and Fine and Applied Arts at Chulalongkorn University (COA No. 183/2564, September 15, 2021).

7.5. Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

7.6. Declaration of Competing Interest

The authors declare that there is no conflict of interests regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely observed by the authors.

8. References

[1] Mhlanga, D. (2023). The Fundamental Strategies that will Drive Higher Educational Sector Towards Digital Transformation in Industry 4.0. Emerging Science Journal, 7(Special issue 2), 125–134. doi:10.28991/ESJ-2023-SIED2-010.

[2] Erhan, T., Uzunbacak, H. H., & Aydin, E. (2022). From conventional to digital leadership: exploring digitalization of leadership and innovative work behavior. Management Research Review, 45(11), 1524-1543. doi:10.1108/MRR-05-2021-0338.

[3] Chowdhury, A. Z., & Jomo, K. S. (2020). Responding to the COVID-19 pandemic in developing countries: lessons from selected countries of the global south. Development, 63(2), 162-171. doi:10.1057/s41301-020-00256-y.

[4] Tomičić-Pupek, K., Furjan, M. T., Pihir, I., & Vrček, N. (2023). Disruptive Business Model Innovation and Digital Transformation. Business Systems Research, 14(1), 1–25. doi:10.2478/bsrj-2023-0001.

[5] Mishra, D. B., Haider, I., Gunasekaran, A., Sakib, M. N., Malik, N., & Rana, N. P. (2023). "Better together": Right blend of business strategy and digital transformation strategies. International Journal of Production Economics, 266, 109040. doi:10.1016/j.ijpe.2023.109040.

[6] Zoppelletto, A., Orlandi, L. B., Zardini, A., Rossignoli, C., & Kraus, S. (2023). Organizational roles in the context of digital transformation: A micro-level perspective. Journal of Business Research, 157, 113563. doi:10.1016/j.jbusres.2022.113563.

[7] Kunene, N., & Mapulanga, P. (2023). A survey of transformational leadership traits for South African academic libraries in Gauteng province, South Africa. Library Management, 44(1/2), 1-16. doi:10.1108/LM-04-2022-0025.

[8] Ananyin, V. I., Zimin, K. V., Lugachev, M. I., & Gimranov, R. D. (2021). Statistical sustainability of a digital organization. Business Informatics, 15(1), 47–58. doi:10.17323/2587-814X.2021.1.47.58.

[9] Gonçalves, M. L. A., Penha, R., Silva, L. F., Martens, C. D. P., & Silva, V. F. (2023). The relationship between project management and digital transformation: Systematic literature review. Revista de Administracao Mackenzie, 24(4), 230075. doi:10.1590/1678-6971/eRAMR230075.en.

[10] Papadonikolaki, E., Krystallis, I., & Morgan, B. (2022). Digital Technologies in Built Environment Projects: Review and Future Directions. Project Management Journal, 53(5), 501–519. doi:10.1177/87569728211070225.

[11] Carujo, S., Anunciação, P. F., & Santos, J. R. (2022). The Project Management Approach. A Critical Success Factor in Digital Transformation Initiatives. Economics and Culture, 19(1), 64–74. doi:10.2478/jec-2022-0006.

[12] Badewi, A. (2022). When frameworks empower their agents: The effect of organizational project management frameworks on the performance of project managers and benefits managers in delivering transformation projects successfully. International Journal of Project Management, 40(2), 132–141. doi:10.1016/j.ijproman.2021.10.005.

[13] Robu, D., & Lazar, J. B. (2021). Digital transformation designed to succeed: Fit the change into the business strategy and people. Electronic Journal of Knowledge Management, 19(2), 133–149. doi:10.34190/EJKM.19.2.2411.

[14] Quintas, P., Lefrere, P., & Jones, G. (1997). Knowledge management: A strategic agenda. Long Range Planning, 30(3), 385–391. doi:10.1016/s0024-6301(97)90252-1.

[15] Alam, S., Zhang, J., Muhammad, S., Ali, A., & Khan, N. (2023). The mechanism of knowledge management process toward minimizing technical risks under green implementation network: a direct and configurational approach. Journal of Manufacturing Technology Management, 34(6), 937–960. doi:10.1108/JMTM-03-2023-0085.

[16] Al-Dmour, A., Zaidan, H., & Al Natour, A. R. (2023). The impact knowledge management processes on business performance via the role of accounting information quality as a mediating factor. VINE Journal of Information and Knowledge Management Systems, 53(3), 523–543. doi:10.1108/VJIKMS-12-2020-0219.

[17] González-Ramos, M. I., Guadamillas, F., & Donate, M. J. (2023). The relationship between knowledge management strategies and corporate social responsibility: Effects on innovation capabilities. Technological Forecasting and Social Change, 188, 122287. doi:10.1016/j.techfore.2022.122287.

[18] Zaid, A., Sleimi, M., Saleh, M. W. A., & Othman, M. (2023). The mediating roles of knowledge transfer and supply chain quality management capabilities on organisational performance. VINE Journal of Information and Knowledge Management Systems, 53(6), 1041–1064. doi:10.1108/VJIKMS-12-2020-0226.

[19] Ghorbankhani, M., & Rossi, F. (2023). Intrinsic and strategic complementarity of research and knowledge transfer activities as determinants of knowledge transfer management: evidence from public research organisations. Journal of Technology Transfer, 48(4), 1386–1412. doi:10.1007/s10961-022-09970-w.

[20] Zhou, Q., Deng, X., Hwang, B.-G., Mahmoudi, A., & Liu, Y. (2023). Integrating the Factors Affecting Knowledge Transfer within International Construction Projects: Individual and Team Perspectives. Journal of Construction Engineering and Management, 149(11), 4023117. doi:10.1061/jcemd4.coeng-13299.

[21] Jung, H. (2023). Is Knowledge Management Vital for Competitive Advantage, Innovation, and Company Success? Organizational Cultures, 23(1), 39–51. doi:10.18848/2327-8013/CGP/v23i01/39-51.

[22] Wang, J., Wang, Y., Liu, O., & Chong, W. K. (2023). Unleashing Continuous Improvement and Competitive Advantage Through BP-Driven Knowledge Management Processes. Journal of Global Information Management, 31(1), 1–19. doi:10.4018/JGIM.330309.

[23] Wu, D., & Liu, E. (2023). The influence of competitive personality on rationalized knowledge hiding among Chinese employees. VINE Journal of Information and Knowledge Management Systems, 7. doi:10.1108/VJIKMS-01-2023-0007.

[24] Dellestrand, H., Holm, U., & Lindahl, O. (2023). Moving beyond the transfer dyad: Exploring network influences on transfer effectiveness. International Business Review, 32(2), 101950. doi:10.1016/j.ibusrev.2021.101950.

[25] Biloslavo, R., & Lombardi, R. (2021). Knowledge transferring and small and medium enterprise's (SME's) effectiveness: emerging insights and future directions. Business Process Management Journal, 27(6), 1747–1774. doi:10.1108/BPMJ-10-2020-0441.

[26] Wahba, K., Kyriakidou, N., & Astley, J. (2021). Transfer of training: An effective tool of knowledge application. Global Business and Economics Review, 25(3–4), 273–291. doi:10.1504/GBER.2021.118703.

[27] Lindblom, J., & Martins, J. T. (2022). Knowledge transfer for R&D-sales cross-functional cooperation: Unpacking the intersections between institutional expectations and human resource practices. Knowledge and Process Management, 29(4), 418–433. doi:10.1002/kpm.1726.

[28] Anjum, R., Khan, H. H., Bano, S., Nazir, S., Gulraiz, H., & Ahmed, W. (2021). A Latent Factor (PLS-SEM) Approach: Assessing the Determinants of Effective Knowledge Transfer. Journal of Asian Finance, Economics and Business, 8(2), 851–860. doi:10.13106/jafeb.2021.vol8.no2.0851.

[29] Bjorvatn, T., & Wald, A. (2020). The impact of time pressure on knowledge transfer effectiveness in teams: trust as a critical but fragile mediator. Journal of Knowledge Management, 24(10), 2357–2372. doi:10.1108/JKM-05-2020-0379.

[30] Sun, J., Ren, X., & Anumba, C. J. (2019). Analysis of Knowledge-Transfer Mechanisms in Construction Project Cooperation Networks. Journal of Management in Engineering, 35(2), 4018061. doi:10.1061/(asce)me.1943-5479.0000663.

[31] Zhou, S., Qin, L., Zhang, J., & Cao, X. (2023). Research on the influencing factors of knowledge transfer among construction workers based on social cognitive theory. Engineering, Construction and Architectural Management, 30(4), 1768–1786. doi:10.1108/ECAM-07-2021-0621.

[32] Zhou, Q., Chen, S., Deng, X., & Mahmoudi, A. (2023). Knowledge transfer among members within cross-cultural teams of international construction projects. Engineering, Construction and Architectural Management, 30(4), 1787–1808. doi:10.1108/ECAM-09-2021-0838.

[33] Ren, X., Xu, J., Hao, Y., & Wang, S. (2023). The effectiveness of relationship quality on knowledge transfer in project teams: the roles of project organizational structure. Kybernetes. doi:10.1108/K-10-2022-1394.

[34] Mohamad, N. I., Sanusi, S., & Raja Hisham, R. R. I. (2023). Implementing Change in Public Organisations: The Effects of Motivation to Transfer as a Mediating Factor in the Relationship between Supervisory Leadership and Knowledge Transfer. Academic Journal of Interdisciplinary Studies, 12(6), 187–202. doi:10.36941/ajis-2023-0163.

[35] Deng, Z., Deng, Z., Liu, S., & Evans, R. (2023). Knowledge transfer between physicians from different geographical regions in China's online health communities. Information Technology and Management, 1-18. doi:10.1007/s10799-023-00400-3.

[36] Han, J. W., Nguyen, T. T. M., Hua, S. M., & Pham, T. H. (2023). Organizational learning through training effectiveness: evidence from the hospitality industry in Vietnam. Learning Organization, 30(5), 532–553. doi:10.1108/TLO-03-2022-0036.

[37] Tasselli, S. (2015). Social Networks and Inter-professional Knowledge Transfer: The Case of Healthcare Professionals. Organization Studies, 36(7), 841–872. doi:10.1177/0170840614556917.

[38] Zhao, D., Zuo, M., & Deng, X. (Nancy). (2015). Examining the factors influencing cross-project knowledge transfer: An empirical study of IT services firms in China. International Journal of Project Management, 33(2), 325–340. doi:10.1016/j.ijproman.2014.05.003.

[39] Teece, D. J. (2004). Technology and technology transfer: Mansfieldian inspirations and subsequent developments. Journal of Technology Transfer, 30(1–2), 17–33. doi:10.1007/s10961-004-4355-x.

[40] Argote, L., & Ingram, P. (2000). Knowledge transfer: A basis for competitive advantage in firms. Organizational Behavior and Human Decision Processes, 82(1), 150–169. doi:10.1006/obhd.2000.2893.

[41] Szulanski, G. (1996). Exploring internal stickiness: Impediments to the transfer of best practice within the firm. Strategic Management Journal, 17(Suppl: Winter), 27–43. doi:10.1002/smj.4250171105.

[42] Davenport, T., & Prusak, L. (1998). Learn how valuable knowledge is acquired, created, bought and bartered. Australian Library Journal, 47(3), 268–272. doi:10.1080/00049670.1998.10755852.

[43] Nesheim, T., & Smith, J. (2015). Knowledge sharing in projects: Does employment arrangement matter? Personnel Review, 44(2), 255–269. doi:10.1108/PR-11-2013-0203.

[44] Argote, L., & Fahrenkopf, E. (2016). Knowledge transfer in organizations: The roles of members, tasks, tools, and networks. Organizational Behavior and Human Decision Processes, 136, 146–159. doi:10.1016/j.obhdp.2016.08.003.

[45] Mahura, A., & Birollo, G. (2020). Transferring Knowledge Within and Among Projects: A Public Sector Project-Based Organization. Academy of Management Proceedings, 2020(1), 13129. doi:10.5465/ambpp.2020.13129abstract.

[46] Mueller, J. (2012). Knowledge sharing between project teams and its cultural antecedents. Journal of Knowledge Management, 16(3), 435–447. doi:10.1108/13673271211238751.

[47] Pérez-Nordtvedt, L., Kedia, B. L., Datta, D. K., & Rasheed, A. A. (2008). Effectiveness and efficiency of cross-border knowledge transfer: An empirical examination. Journal of Management Studies, 45(4), 714–744. doi:10.1111/j.1467-6486.2008.00767.x.

[48] Ren, X., Deng, X., & Liang, L. (2018). Knowledge transfer between projects within project-based organizations: the project nature perspective. Journal of Knowledge Management, 22(5), 1082–1103. doi:10.1108/JKM-05-2017-0184.

[49] Wei, Y., & Miraglia, S. (2017). Organizational culture and knowledge transfer in project-based organizations: Theoretical insights from a Chinese construction firm. International Journal of Project Management, 35(4), 571–585. doi:10.1016/j.ijproman.2017.02.010.

[50] Buvik, M. P., & Rolfsen, M. (2015). Prior ties and trust development in project teams - A case study from the construction industry. International Journal of Project Management, 33(7), 1484–1494. doi:10.1016/j.ijproman.2015.06.002.

[51] Zhang, P., & Ng, F. F. (2012). Analysis of knowledge sharing behaviour in construction teams in Hong Kong. Construction Management and Economics, 30(7), 557–574. doi:10.1080/01446193.2012.669838.

[52] Zhou, Q., Deng, X., Wang, G., & Mahmoudi, A. (2022). Linking elements to outcomes of knowledge transfer in the project environment: Current review and future direction. Frontiers of Engineering Management, 9(2), 221–238. doi:10.1007/s42524-022-0195-3.

[53] Zhang, R., Ji, C., Zhao, W., & Chen, Z. (2024). Analysis of the Factors Influencing the Knowledge Transfer to Villagers Working in Rural Tourism: a Multiple-Case Study in China. Journal of the Knowledge Economy, 15(1), 3551–3599. doi:10.1007/s13132-023-01255-3.

[54] Creswell, J., & Creswell, J. D. (2018). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches (5th ed.). Sage publications. doi:10.1002/nha3.20258.

[55] Venkatesh, V., Brown, S. A., & Sullivan, Y. (2016). Guidelines for conducting mixed-methods research: An extension and illustration. Journal of the AIS, 17(7), 435-495. doi:10.17705/1jais.00433.

[56] Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative Research in Psychology, 3(2), 77–101. doi:10.1191/1478088706qp063oa.

[57] Saunders, B., Sim, J., Kingstone, T., Baker, S., Waterfield, J., Bartlam, B., Burroughs, H., & Jinks, C. (2018). Saturation in qualitative research: exploring its conceptualization and operationalization. Quality and Quantity, 52(4), 1893–1907. doi:10.1007/s11135-017-0574-8.

[58] Bacon, E., Williams, M. D., & Davies, G. (2020). Coopetition in innovation ecosystems: A comparative analysis of knowledge transfer configurations. Journal of Business Research, 115, 307–316. doi:10.1016/j.jbusres.2019.11.005.

[59] Dong, J., Lai, X., & Zhao, D. (2022). How incentive affects knowledge transfer performance in corporate user community: The mediating roles of users' transfer willingness and ability. Managerial and Decision Economics, 43(6), 2249–2260. doi:10.1002/mde.3522.

[60] Glaser, M., Blake, O., Bertolini, L., te Brömmelstroet, M., & Rubin, O. (2021). Learning from abroad: An interdisciplinary exploration of knowledge transfer in the transport domain. Research in Transportation Business and Management, 39, 100531. doi:10.1016/j.rtbm.2020.100531.

[61] Guvernator IV, G. C., & Landaeta, R. E. (2020). Knowledge Transfer in Municipal Water and Wastewater Organizations. EMJ - Engineering Management Journal, 32(4), 272–282. doi:10.1080/10429247.2020.1753491.

[62] Hatane, S. E., Setiono, F. J., Setiawan, F. F., Semuel, H., & Mangoting, Y. (2021). Learning environment, students' attitude and intention to enhance current knowledge in the context of choosing accounting career. Journal of Applied Research in Higher Education, 13(1), 79–97. doi:10.1108/JARHE-06-2019-0156.

[63] Mote, N. J. I., & Karadas, G. (2022). The Impact of Automation and Knowledge Workers on Employees' Outcomes: Mediating Role of Knowledge Transfer. Sustainability (Switzerland), 14(3), 1377. doi:10.3390/su14031377.

[64] Li, X., & Li, X. (2021). The impact of different internet application contexts on knowledge transfer between enterprises. Systems, 9(4), 87. doi:10.3390/systems9040087.

[65] Liu, X., Zhang, L., Gupta, A., Zheng, X., & Wu, C. (2022). Upper echelons and intra-organizational learning: How executive narcissism affects knowledge transfer among business units. Strategic Management Journal, 43(11), 2351–2381. doi:10.1002/smj.3406.

[66] Moshood, T. D., Rotimi, F. E., & Rotimi, J. O. B. (2022). An Integrated Paradigm for Managing Efficient Knowledge Transfer: Towards a More Comprehensive Philosophy of Transferring Knowledge in the Construction Industry. Construction Economics and Building, 22(3), 65–98. doi:10.5130/AJCEB.v22i3.8050.

[67] Asatiani, A., Penttinen, E., Ruissalo, J., & Salovaara, A. (2020). Knowledge workers' reactions to a planned introduction of robotic process automation—Empirical evidence from an accounting firm. Information systems outsourcing: The era of digital transformation, 413-452. doi:10.1007/978-3-030-45819-5_17.

[68] Tshuma, B., Steyn, H., & van Waveren, C. (2020). An exploratory case study to validate a method for investigating the role of pmos in knowledge transfer. South African Journal of Industrial Engineering, 31(2), 143–155. doi:10.7166/31-2-2316.

[69] Vaghefi, I., Lapointe, L., & Shahbaznezhad, H. (2018). A multilevel process view of organizational knowledge transfer: enablers versus barriers. Journal of Management Analytics, 5(1), 1–17. doi:10.1080/23270012.2018.1424572.

[70] Ouyang, H., Cui, X., Peng, X., & Udemba, E. N. (2023). Reverse knowledge transfer in digital era and its effect on ambidextrous innovation: A simulation based on system dynamics. Heliyon, 9(12), 22717. doi:10.1016/j.heliyon.2023.e22717.

[71] Singh, N., Pandey, R., Gupta, R., Biswas, B., & Gupta, S. (2022). Reverse knowledge transfer: making sense of two decades of academic research. VINE Journal of Information and Knowledge Management Systems, 155. doi:10.1108/VJIKMS-08-2021-0155.

[72] Wang, H., Chen, K., Zheng, H., Zhang, G., Wu, R., & Yu, X. (2021). Knowledge transfer methods for expressing product design information and organization. Journal of Manufacturing Systems, 58, 1–15. doi:10.1016/j.jmsy.2020.11.009.

[73] Ren, X., Yan, Z., Wang, Z., & He, J. (2020). Inter-project knowledge transfer in project-based organizations: an organizational context perspective. Management Decision, 58(5), 844–863. doi:10.1108/MD-11-2018-1211.

[74] Spraggon, M., & Bodolica, V. (2020). On the heterogeneity and equifinality of knowledge transfer in small innovative organizations. Management Decision, 59(6), 1421–1441. doi:10.1108/MD-03-2019-0318.

[75] Temple, J., & Landaeta, R. E. (2020). Countervailing Risk Management Through Knowledge Transfer. EMJ - Engineering Management Journal, 32(4), 242–252. doi:10.1080/10429247.2020.1753489.

[76] Vick, T. E., & Robertson, M. (2018). A systematic literature review of UK university- industry collaboration for knowledge transfer: A future research agenda. Science and Public Policy, 45(4), 579–590. doi:10.1093/SCIPOL/SCX086.

[77] Chung, S., Zhan, Y., Noe, R. A., & Jiang, K. (2022). Is It Time to Update and Expand Training Motivation Theory? A Meta-Analytic Review of Training Motivation Research in the 21st Century. Journal of Applied Psychology, 107(7), 1150–1179. doi:10.1037/apl0000901.

[78] Prihadyanti, D., Sari, K., Hidayat, D., Laili, N., Triyono, B., & Laksani, C. S. (2022). The Changing Nature of Expatriation: The Emerging Role of Knowledge Transfer Readiness. Journal of the Knowledge Economy, 13(2), 1496–1541. doi:10.1007/s13132-021-00777-y.

[79] Zhang, X., & Xu, R. (2022). A Multi-Level Fuzzy Comprehensive Evaluation Method for Knowledge Transfer Efficiency in Innovation Cluster. Mobile Information Systems, 2022, 3949597. doi:10.1155/2022/3949597.

[80] Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). Multivariate Data Analysis (7th ed.). Pearson, New York, United States.

[81] George, D., & Mallery, P. (2019). IBM SPSS statistics 26 step by step: A simple guide and reference. Routledge, London, United Kingdom.

[82] Liyanage, C., Elhag, T., Ballal, T., & Li, Q. (2009). Knowledge communication and translation - a knowledge transfer model. Journal of Knowledge Management, 13(3), 118–131. doi:10.1108/13673270910962914.

[83] Yaghi, A., & Bates, R. (2020). The role of supervisor and peer support in training transfer in institutions of higher education. International Journal of Training and Development, 24(2), 89–104. doi:10.1111/ijtd.12173.

[84] Alzubi, Y. (2018). Knowledge transfer for sustainability. World Journal of Science, Technology and Sustainable Development, 15(4), 325–337. doi:10.1108/wjstsd-04-2018-0023.

[85] Owusu-Manu, D. G., John Edwards, D., Pärn, E. A., Antwi-Afari, M. F., & Aigbavboa, C. (2018). The knowledge enablers of knowledge transfer: a study in the construction industries in Ghana. Journal of Engineering, Design and Technology, 16(2), 194–210. doi:10.1108/JEDT-02-2017-0015.

[86] Mainga, W. (2017). Examining project learning, project management competencies, and project efficiency in project-based firms (PBFs). International Journal of Managing Projects in Business, 10(3), 454–504. doi:10.1108/IJMPB-04-2016-0035.

[87] Zhou, Q., Deng, X., Hwang, B.-G., & Ji, W. (2020). Integrated Framework of Horizontal and Vertical Cross-Project Knowledge Transfer Mechanism within Project-Based Organizations. Journal of Management in Engineering, 36(5), 4020062. doi:10.1061/(asce)me.1943-5479.0000828.

[88] Phung, V. D., Hawryszkiewycz, I., & Chandran, D. (2019). How knowledge sharing leads to innovative work behaviour: A moderating role of transformational leadership. Journal of Systems and Information Technology, 21(3), 277–303. doi:10.1108/JSIT-11-2018-0148.

[89] Ni, G., Cui, Q., Sang, L., Wang, W., & Xia, D. (2018). Knowledge-Sharing Culture, Project-Team Interaction, and Knowledge-Sharing Performance among Project Members. Journal of Management in Engineering, 34(2), 4017065. doi:10.1061/(asce)me.1943-5479.0000590.

[90] Armstrong, M. B., & Landers, R. N. (2018). Gamification of employee training and development. International Journal of Training and Development, 22(2), 162–169. doi:10.1111/ijtd.12124.

[91] Bashir, N., & Long, C. S. (2015). The relationship between training and organizational commitment among academicians in Malaysia. Journal of Management Development, 34(10), 1227–1245. doi:10.1108/JMD-01-2015-0008.

[92] Xie, X., Wang, L., & Zeng, S. (2018). Inter-organizational knowledge acquisition and firms' radical innovation: A moderated mediation analysis. Journal of Business Research, 90, 295–306. doi:10.1016/j.jbusres.2018.04.038.

[93] Xie, X., Zou, H., & Qi, G. (2018). Knowledge absorptive capacity and innovation performance in high-tech companies: A multi-mediating analysis. Journal of Business Research, 88(C), 289–297. doi:10.1016/j.jbusres.2018.01.019.

[94] Ngo, V. M., Nguyen, H. H., Pham, H. C., Nguyen, H. M., & Truong, P. V. D. (2023). Digital supply chain transformation: effect of firm's knowledge creation capabilities under COVID-19 supply chain disruption risk. Operations Management Research, 16(2), 1003–1018. doi:10.1007/s12063-022-00326-z.

[95] Cao, X., Qin, P., & Zhang, P. (2022). Knowledge Transfer Characteristics of Construction Workers Based on Social Network Analysis. Buildings, 12(11), 1876. doi:10.3390/buildings12111876.

[96] Ibrahim, S., & Heng, L. H. (2017). The effect of individual motivational factors towards knowledge sharing at small and medium enterprises. International Journal of Knowledge Management Studies, 8(3–4), 210–231. doi:10.1504/IJKMS.2017.087068.

[97] Nguyen, T. M., Siri, N. S., & Malik, A. (2022). Multilevel influences on individual knowledge sharing behaviours: the moderating effects of knowledge sharing opportunity and collectivism. Journal of Knowledge Management, 26(1), 70–87. doi:10.1108/JKM-01-2021-0009.

[98] Fasbender, U., & Gerpott, F. H. (2022). Knowledge Transfer Between Younger and Older Employees: A Temporal Social Comparison Model. Work, Aging and Retirement, 8(2), 146–162. doi:10.1093/workar/waab017.

[99] Hsu, M. H., & Chang, C. M. (2014). Examining interpersonal trust as a facilitator and uncertainty as an inhibitor of intra-organisational knowledge sharing. Information Systems Journal, 24(2), 119–142. doi:10.1111/isj.12000.

[100] Probodha, J., & Vasanthapriyan, S. (2019). Analysis of knowledge sharing barriers in Sri Lankan software companies. International Journal of Knowledge Management, 15(4), 78–93. doi:10.4018/IJKM.2019100105.

[101] Hughes, A. M., Zajac, S., Woods, A. L., & Salas, E. (2020). The Role of Work Environment in Training Sustainment: A Meta-Analysis. Human Factors, 62(1), 166–183. doi:10.1177/0018720819845988.

[102] Goswami, S., Anitescu, C., Chakraborty, S., & Rabczuk, T. (2020). Transfer learning enhanced physics informed neural network for phase-field modeling of fracture. Theoretical and Applied Fracture Mechanics, 106, 102447. doi:10.1016/j.tafmec.2019.102447.

[103] Gunasekera, V. S., & Chong, S. C. (2018). Knowledge management critical success factors and project management performance outcomes in major construction organisations in Sri Lanka: A case study. VINE Journal of Information and Knowledge Management Systems, 48(4), 537–558. doi:10.1108/VJIKMS-06-2018-0051.

[104] Wijaya, L. I., Ardiansyahmiraja, B., Wicaksono, A. P., Rianawati, A., Hadi, F. S., Silalahi, M. A. R., Izharuddin, M., & Zunairoh. (2023). The impact of IT capability and organizational learning on halal food SMEs' performance. Cogent Business and Management, 10(3), 2264562. doi:10.1080/23311975.2023.2264562.

[105] Hair, J. F., Sarstedt, M., Hopkins, L., & Kuppelwieser, V. G. (2014). Partial least squares structural equation modeling (PLS-SEM): An emerging tool in business research. European Business Review, 26(2), 106–121. doi:10.1108/EBR-10-2013-0128.

[106] Sarstedt, M., Ringle, C. M., & Hair, J. F. (2021). Partial Least Squares Structural Equation Modeling. Handbook of Market Research, 587–632. doi:10.1007/978-3-319-57413-4_15.

[107] Kock, N. (2017). Common method bias: A full collinearity assessmentmethod for PLS-SEM. Partial Least Squares Path Modeling: Basic Concepts, Methodological Issues and Applications: Springer International Publishing, 245–257. doi:10.1007/978-3-319-64069-3_11.

[108] Fornell, C., & Larcker, D. F. (1981). Evaluating Structural Equation Models with Unobservable Variables and Measurement Error. Journal of Marketing Research, 18(1), 39. doi:10.2307/3151312.

[109] Ringle, C.M., Wende, S., & Becker, J.-M. (2022). SmartPLS 4. Oststeinbek: SmartPLS. Available online: https://www.smartpls.com (accessed on August 2024).

[110] Park, S., Kang, H.S. (Theresa), & Kim, E. J. (2018). The role of supervisor support on employees' training and job performance: an empirical study. European Journal of Training and Development, 42(1–2), 57–74. doi:10.1108/EJTD-06-2017-0054.

[111] Salamon, J., Blume, B. D., Orosz, G., & Nagy, T. (2021). The interplay between the level of voluntary participation and supervisor support on trainee motivation and transfer. Human Resource Development Quarterly, 32(4), 459–481. doi:10.1002/hrdq.21428.

[112] Tran, H. Q., & Pham, N. T. B. (2019). Organizational learning as a moderator of the effect of employee participation on academic results: An empirical study in Vietnam. Learning Organization, 26(2), 146–159. doi:10.1108/TLO-03-2018-0040.

[113] Mordorintelligence. (2024). IT Industry in Thailand Size & Share Analysis - Growth Trends & Forecasts (2024 - 2029). Mordor Intelligence. Hyderabad, India. Available online: https://www.mordorintelligence.com/industry-reports/thailand-it-and-security-market (accessed on August 2024).

[114] Zhou, Q., & Deng, X. (2024). A configuration analysis on knowledge transfer between projects: from horizontal and vertical perspectives. Engineering, Construction and Architectural Management. doi:10.1108/ECAM-07-2023-0743.

[115] Duva, M., Zhao, D., Frank, K. A., & Mollaoglu, S. (2024). Interaction between Project- and Group-Level Knowledge Transfer in Project Team Networks: A Social Influence Analysis. Journal of Management in Engineering, 40(2), 5024001. doi:10.1061/jmenea.meeng-5718.

[116] Wu, S., & Ding, X. H. (2024). The Effect of Coordination Capability on Knowledge Transfer: The Moderating Role of Learning Orientation. IEEE Transactions on Engineering Management, 71, 5953–5964. doi:10.1109/TEM.2024.3374238.

Appendix I

Open-ended questions in the semi-structured interview:

Topic 1: What are the factors affecting knowledge transfer for software project managers?

Example of questions: How do you develop or train junior project managers? What do you think influences the development of project managers and why?

Topic 2: What are the current challenges and obstacles in knowledge transfer for software project managers?

Example of questions: What problems do you face in developing other project managers? What obstacles do you think there are in transferring knowledge to other project managers and why?

Topic 3: What should a good knowledge transfer application prototype look like for a software project manager?

Example of questions: What should a knowledge transfer application for software project managers look like? What features are there and why?

Topic 4: Suggestions

Example of questions: Do you have any additional comments or suggestions and how?