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Impacts of human resource management and knowledge management on non-financial organizational performance: Evidence of Thai infrastructure construction firms

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ABSTRACT

This article aims at studying the empirical evidence of the impacts of human resource management (HRM) on knowledge management (KM) and on non-financial OP of infrastructure construction firms in Thailand. We used structural equation modeling (SEM), a hybrid of factor analysis and path analysis, to investigate the relationship among these three construct. Once a conceptual model was developed, we then employed confirmatory factor analysis to verify the factor structure of a set of observed variables. Then, SEM was used to test the three proposed hypotheses. Results supported the theorized model, indicating that a positive and direct relationship exists between HRM and KM; between knowledge and non-financial OP; and between HRM and non-financial OP in Thai infrastructure construction firms. Additionally, KM was found to be a mediator between HRM and non-financial OP. This study provides additional empirical evidence of the importance of improving non-financial OP through people and their valuable knowledge.

1. Introduction

The construction industry is recognized as one of the key engines for economic growth [1,2]. Characterized by its labor intensiveness, the construction industry also provides work for a large proportion of the labor market and accounts for a significant contribution to the world's gross domestic product [3]. For example, the Thai construction industry was valued at about 1.2 trillion baht (about US$40,000 million) and accounted for about 8% of the country's GDP in 2019. The total pool of construction workers in Thailand is about 2.4 million people [4]. On the basis of historical data of public construction projects in Thailand, total labor costs are estimated to be about 30%–37% of total material costs for a typical building project. In addition, with an average markup (i.e., project and general overhead plus profit) of about 25% of total direct costs (i.e., material, labor, and equipment costs), the labor costs can be estimated to be about 20% of the total construction value. Therefore, on the basis of the previously estimated construction cost structure, construction workers in Thailand currently receive, on average, a daily wage of about US$11.57 dollars, which is almost in line with the country's minimum wage of US$11.03 per day (Thailand's Ministry of Labor).

A large proportion of government spending is currently allocated for infrastructure projects. In Thailand, almost half of the country's total construction value is estimated to have been allocated to infrastructure projects over the past five years; thus, infrastructure spending accounts for about 4% of the country's GDP [5]. This amount is still relatively less than those of some countries such as China, whose infrastructure investment was about 13% of the country's GDP in 2015 [6].

Some key infrastructure projects such as high-speed rail and intercity motorways may need even larger investments and require private's expertise and innovation. Therefore, a growing trend is the adoption of public private partnerships (PPP) as an alternative and integrated project delivery method for

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infrastructure projects. These PPP infrastructure projects attract not just large construction companies but also lenders and investors such as financial institutions and sovereign funds. In short, infrastructure has evolved from once being the responsibility of the government into a lucrative business model that attracts both domestic and international construction companies, lenders, and investors. Therefore, Thai construction companies that specialize in infrastructure projects are hard pressed to compete not only with its domestic competitors but also with prominent international ones.

In a PPP setting, the relationship among involved parties, who usually have diverging goals, is especially more complex and highly dynamic. During the construction phase of a PPP infrastructure project, a legal entity known as joint venture may be formed by a domestic construction company and an international one to perform the work specified in the construction contract. Both lenders and sponsors of this project actively engage and monitor the construction progress to ensure that the delivery of the project will be as scheduled and, once the commercial operating date is authorized, that the project will start producing cash flow to repay the initial investments. Therefore, under this PPP setting, the ability to collaborate and work as a team and to share and transfer new knowledge is important to the success of the project and, more importantly, of the construction companies engaged in infrastructure contracts [7,8].

The construction industry has also moved closer to becoming a commodity, which is the primary reason the average profit margins of the construction industry are considerably lower than those of other industries [9]. Lower profit margins could increase the risk exposure of construction companies by allowing less room for errors. Ultimately, profit enhancement over the next decade will have to come primarily from productivity improvements [9]. In addition, large investment in construction equipment of firms may make them highly susceptible to high ownership costs such as depreciation, which is one of the major causes that force many construction companies to compete aggressively to obtain an adequate amount of work on hand to prevent equipment from being vacant or unused. Therefore, a fact that could not be understated is that construction managers, who are key human resources of the construction company, play a critical role in how the company handles challenges such as how to acquire work and how to perform the work more efficiently.

One of the things that Thai construction companies can do to retain their competitive advantage in the future may depend largely on strategically leveraging its employees through human resource and knowledge management (HRM and KM). To work efficiently and effectively as a project team, trust among team members, between the managed and the management, and between employees and owners is necessary, which is worth examining. These characteristics of infrastructure construction make the study of the roles of HR practices and KM in the organizational performance (OP) of infrastructure construction firms an interesting topic.

Although the relationship between HRM practices and organization-level performance is well established, there is still little or no consensus regarding which HRM practices should make up the HRM practices that are related to firm performance [10]. In the construction industry, while there are several studies trying to establish the relationship between HRM and OP, few studies have investigated the impact of HRM on KM and then on non-financial OP. Examples of these studies include Zhai et al. [11], Olomolaiye and Egbu [12], Gunasekera and Chong [13], and Pinkhasik and Herrmann [14].

More details about the theories concerning HRM, KM, OP, and the studies on the relationships among them will be provided in the next section.

As for the Thai construction industry and in particular in an infrastructure construction setting where the PPP market has been predicted to grow over the next decade [15], there are no studies investigating the three relationships of HRM, KM, and OP. Therefore, the results of this study could be used to provide guidance in how Thai construction companies specialized in infrastructure construction leverage more effectively on its HR and KM infrastructure to increase the level of competitiveness in the future. This study also aims at providing additional empirical evidence on the impacts of HRM and KM on the performance of construction organizations.

In this study, the three concepts (i.e., HRM, KM, and OP), which are latent variables or factors, cannot be directly measured. However, they can be observed instead through other variables known as observed or measured variables or simply as indicators. Therefore, to explore and confirm the relationship network of HRM, KM, and non-financial OP of Thai infrastructure construction firms, this study adopted structural equation modeling (SEM) as a method of analysis.

The remainder of this paper is organized as follows: In the next section, a literature review is given (e.g., HRM in the construction industry and the study of the causal link between HRM, KM, and OP). Then, a measurement model and a structural model developed based on previous literature and studies are presented. Research methodology based on confirmatory factor analysis (CFA) and SEM is provided in detail, and sample size and data collection are given. Results are then presented, followed by a discussion of the findings. The paper closes with a conclusion section.

2. Literature review

This section is to provide the background of the construction industry, theories and previous studies on HRM, KM, OP, and their relationships, with the aim of the developments of a conceptual model and hypotheses.

2.1. HRM in the construction industry

Similar to other business organizations these days, construction firms are operating in a highly competitive environment. In the past, when the rates of changes were not as fast as those of today, the main production factors were land, labor and physical capital, and management [16,17]. Therefore, managers at the time perceived people as just a labor input of a systematic production designed to reduce human errors in an effort to increase productivity. Now, more than ever, people's knowledge, skill, and ability, which are also known as "human capital (HC)," are considered the most valuable assets of an organization, championed by famous economists such as Schultz (1961), Becker (1962, 1964), and Pfeffer (1998) [18–21].

The construction industry has often been characterized as a labor-intensive and low-tech sector [3]. The industry is also one of the riskiest, most complex, and most dynamic businesses. For this reason, the industry has chronically suffered from lower productivity growth compared with other industries [22–24]. Factors that contribute to such low productivity growth include [23]:

- Increased complexity of construction projects.
- Project's uniqueness.
- Adverse weather and climate seasonality.
- Restrictive building codes and regulations.
- Variability of labor productivity.
- Little potential for labor learning.
- Low worker motivation.

Moreover, the fragmentation and dynamism of construction and a wide range of occupational cultures are believed to make construction one of the most complex project-based industries to effectively apply good HRM practices [3]. In addition, the construction industry is now recognized as a knowledge-based industry [25]. Construction firms operate in an increasingly complex and dynamic environment, which is why KM and organizational learning (OL) have become essential to enhance strategic flexibility and adaptation to inevitable changes [26,27]. Therefore, firms may employ HRM as a tool to boost employees' knowledge and skills, to facilitate group interaction and knowledge sharing, and to enable organizations to store knowledge in systems, routines, processes, and cultures, which in turn could drive OP [28].

Both researchers and practitioners acknowledge that employees' knowledge and skills can also be alternatively viewed as human capital in the sense that its value to an organization cannot only be determined but can also be increased through investment in education, training, and health. Similar to other industries, human capital has also been viewed as the most valuable and the most expensive assets deployed within construction firms [3]. One recent study by Khodeir and Nabawy [29] explored HR opportunities and challenges in an attempt to address human resource issues faced by the housing construction in Egypt. They offered primary evidence that Egypt is still in need to improve the HR development in the construction of housing development projects. In addition, they found that certain HR strategies such as HR integration with technology and improving HR skills are key HR factors.

In addition, specific characteristics of construction businesses make HRM practices different from those of other industries. Such characteristics identified by Huemann et al. [30] include project-based management, the temporary nature of projects themselves (e.g., assign to a project and then release once the project is completed), highly dynamic, and project portfolio resource and multi-role demands.

2.2. Strategies and organizational performance

Organizations clearly have varied business strategies, each with implications for HRM [31]. Porter [32], for example, identified cost reduction, quality management, and innovation as generic strategies, each of which will require different HRM response. These strategies are still relevant in the construction business today. For instance, in the public construction market, acquiring a public construction project will require competitive bidding, and the bidder with the lowest responsive bid price will then enter the construction contract with the responsible government agency. This process is similar to a sale in other businesses. Therefore, the ability of the construction firms to manage construction costs effectively could play a major part in their survival. Moreover, their ability to control construction cost and quality will ultimately lead to how financial performance will play out.

Profits driven by cost competitiveness are as old as management itself. However, profit maximization may not be sustainable if the management actions are focused on short term, current profits at the expense of future profits. Therefore, theorists such as Kaplan and Norton [33] proposed a more holistic approach to performance management of an organization, which is called the balanced scorecard (BSC). The BSC comprises four performance perspectives: financial, customer, internal process, and learning and growth.

The financial perspective may be omitted for the study of OP of firms. For instance, Lee et al. [34] and Sucahyo et al. [35] focused their studies on the impacts of KM on non-financial OP. This approach may be, in part, due to the lagging effect of KM on firms' financial outcomes (i.e., longitudinal data required) [36]. Therefore, we adopted this approach by focusing the study of firms' performance on non-financial OP, namely, (1) customer, (2) internal process, and (3) learning and growth.

2.3. Shift from PM to HRM

HRM is arguably one of the oldest management concepts [30]. The concept of HRM evolved from personnel management (PM), which at its bare minimum may be referred to as "people management" [37]. If strategically employed, then HRM may provide an organization with a competitive edge over its competitors. HRM may be broadly defined as a coherent approach to the management of an organization's most valuable assets, which are the people who are employed by the organization and individually and collectively contribute to the achievement of its objectives and goals [38]. The concepts were pioneered by Guest [39], who published his ideas describing the essence of HRM, differentiating it from PM whose focus was on a short-term time scale and at an operational level to a longer-term and strategic level. Pfeffer [21] also suggested that certain HRM activities could essentially help promote a sustainable path to competitiveness. Such activities include (1) employment security, (2) selective recruiting, (3) incentive payment, (4) employee ownership, (5) information sharing, (6) participation and empowerment, (7) teams and job redesign, (8) training as skill development, (9) cross-utilization and cross-training, (10) symbolic egalitarianism, (11) wage compensation, (12) promotion from within, (13) long-term perspective, (14) measurement of practices, and (15) overarching philosophy. A critically important step is for these HR activities to be aligned with the organization's strategies.

2.4. Causal link between HRM, KM, and OP

Traditionally, the long-held belief was that a firm's physical assets paved the way for its success. However, Becker [20] challenged that belief by observing that physical resources explain only a relatively small part of the growth of income in most countries. Pfeffer [21] also believed that high-commitment HR practices could lead to improved performance as committed employees waste less time and resources, and generate ideas for cost cutting. Becker's and Pfeffer's works were supported by Huselid's study [40], which demonstrated how a substantial increase in market value and sales per employee could result from high-performance work practices [41]. The twenty-first century has witnessed a transition from the production economy to the knowledge economy. Drucker [42] foresaw that while the most important contribution of management in the twentieth century was the fifty-fold increase in the productivity of manual workers in manufacturing, the most important contribution management needs to make in the twenty-first century is to increase the productivity of knowledge workers.

The causal relationship between HRM and a firm's performance has been widely studied over a few decades since the seminal work of Huselid [40] and Arthur [43]. In many years that followed, many research articles provided empirical evidence supporting the links between HRM and OP. In one of the areas of such studies, there was an attempt to determine what HR practices in particular lead to the improvement of firms' performance. One of the papers trying to answer such the question is a study by Paauwe [36] who found that OP was affected not only by single practices like personal planning, performance-based pay, training and development, and internal career path, but also collective HR practices.

Other examples of the studies that had established the HRM and OP relationship include the paper by Akhtar et al. [44], Ahmad & Schroeder [45], Chow et al. [46], Delery & Shaw [47], Dimba [48],

Table 1
Literature and studies on the links between HRM, KM, and OP.

	Authors	HRM								KM				OP				Relationship			Construction industry
		Recruitment and selection	Training and development	Internal work rotation	Compensation	Work security	Performance appraisal	Job design	Participation and engagement	Knowledge acquisition	Knowledge creation	Knowledge storage and retrieval	Knowledge transfer and utilization	Financial perspective	Customer perspective	Internal process perspective	Learning and growth perspective	HRM and performance	HRM and KM	KM and performance	
1	Ahmad & Schroeder [45]	✓	✓		✓	*			✓					✓		✓		✓			
2	Akhtar et al. [44]		✓✓	✓	✓	*	✓	✓	✓					✓		✓		✓			
3	Al-Hakim & Hassan [86]									✓	✓	✓	✓	✓	✓	✓	✓			✓	
4	Al-Hawari [87]										✓	✓	✓	✓		✓				✓	
5	Bakar et al. [84]									✓		✓	✓✓	✓						✓	✓
6	Brewer & Brewer [80]		✓	✓	✓		✓	✓		✓	✓	✓	✓						✓		
7	Chen et al. [88]									✓	✓		✓	✓						✓	
8	Chow et al. [46]		✓		✓	✓	✓		✓					✓		✓		✓			
9	Delery & Shaw [47]	✓	✓		✓		✓	✓						✓		✓	✓	✓			
10	Dimba [48]	*	✓✓		✓		✓	✓						✓	✓	✓		✓			
11	Edvardsson [81]	✓	✓	✓	✓			✓			✓	✓	✓						✓		
12	Ferreira et al. [89]		✓		✓				*					✓				✓			
13	Filius et al. [82]	✓	✓✓							✓	✓	✓	✓						✓		
14	Gurbuz & Mert [79]	✓✓	✓✓	✓	✓	✓	✓	✓	✓					✓	✓	✓	✓	✓			
15	Huselid [40]	✓	✓	✓	✓	✓	✓	✓	✓					✓		✓	✓	✓			
16	Keyser [90]									✓	✓	✓	✓	✓	✓	✓	✓			✓	
17	Lee et al. [34]											✓	✓		✓	✓	✓			✓	
18	Lee et al. [91]	✓	*		*	✓										✓		✓			
19	Liao [50]	✓	✓		✓		✓		✓	✓		✓	✓	✓			✓	✓	✓	✓	
20	Liu & Tsai [92]									✓	✓✓	✓	✓	✓	✓	✓	✓			✓	
21	Mills & Smith [93]									✓		✓	✓✓	✓						✓	
22	Olomolaiye & Egbu [12]	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
23	Prieto et al. [94]		✓		✓		✓		✓		✓	✓	✓						✓		
24	Shih & Chiang [95]	✓	✓				✓	✓	✓	✓	✓	✓	✓						✓		
25	Sucahyo et al. [35]											✓	✓		✓	✓	✓			✓	
26	Sun et al. [49]	✓	✓	✓	✓	✓	✓	✓	✓							✓	✓	✓			
27	Takeuchi et al. [96]	✓	✓	✓	✓		✓	✓	✓					✓				✓			
28	Wibowo et al. [85]									✓	✓	✓	✓✓	✓	✓	✓	✓			✓	✓
29	Wright et al. [97]	✓	✓		✓				✓					✓		✓		✓			
30	Yahya & Goh [83]		✓✓		✓		✓			✓	✓	✓	✓						✓		
31	Zack et al. [98]									✓	✓		✓	*	✓	✓	✓			✓	
32	Zhai et al. [11]	✓	✓		✓				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
33	Dang et al. [105]																			✓	✓
	Total	***15***	***21***	**7**	***19***	**7**	***14***	**11**	**14**	**15**	**15**	**18**	**18**	***20***	**11**	***19***	**14**	***15***	**9**	***15***	**5**

✓ = Positive association found, ✓✓ = Highest level of positive association found, * = No association found.

and Sun et al. [49]. More of the similar studies can be found in Table 1. As shown in Table 1, out of the relevant 33 papers, 15 papers supported the theorized positive relationship between HRM and firm's performance. However, when it comes to the construction industry, there are only a few studies such as a study by Zhai et al. [11] and Olomolaiye & Egbu [12].

As for the studies that tried to find the links between (1) HRM and KM, and (2) KM and OP, there are, for example, the paper by Liao [50], Zhai et al. [11] and Olomolaiye & Egbu [12].

2.5. KM as a mediator between HRM and OP

Knowledge may be defined as the capacity to act, process, and interpret the information to solve a problem or to generate more knowledge [51]. The role of HRM and KM to OP was explored by Farooq et al., Obeidat et al., Iqbal et al. [52–54], and Sahibzada et al. [55–56], among others. As for the role of KM in the construction industry, a study by Boamah et al. [57] found that tacit knowledge sharing had a significant effect on the operational efficiency of Chinese construction companies, while Zhai et al. [11] also confirmed the important role of organizational learning as a mediator that links the HRM and OP of Chinese construction companies.

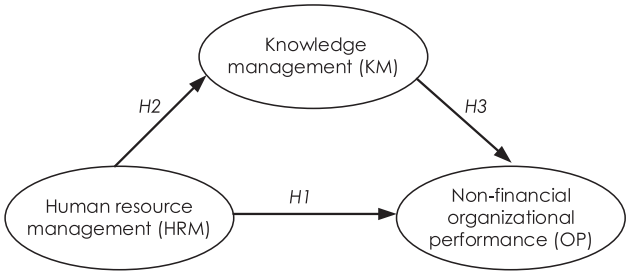

Fig. 1. Conceptual model.

Table 1 summarizes previous studies that tried to establish a relationship among HRM, KM, and OP, with some studies focusing on construction firms.

3. Conceptual model

On the basis of theories and previous literature and studies, we then formulated a conceptual model, as shown in Fig. 1.

As shown in Fig. 1, our main hypotheses include:

H1: HR practices have positive impacts on non-financial OP.
H2: HR practices have positive impacts on KM.
H3: KM has positive impacts on non-financial OP.

4. Structural equation modeling

Structural equation modeling is a family of statistical techniques that allow for testing multivariate models. It is a hybrid of factor analysis and path analysis. SEM's goal is similar to that of factor analysis, which is to provide a parsimonious summary of the interrelationships among variables [58]. Similar to path analysis, SEM is used to test the hypothesized relationships between constructs [59].

Before SEM is performed, three model constructs of the study are proposed, as shown in Fig. 2. Table 2 presents detailed descriptions of item codes and theoretical support for each construct.

A list of questions to be asked and measured in the five-point Likert-scale questionaire survey are given in Table 3.

5. Research methodology

This study uses a partial disaggregation approach for SEM proposed in Bagozzi and Heatherington [60] to investigate the roles and impacts of HRM on KM, and on non-financial OP in leading Thai construction companies that specialize in infrastructure projects.

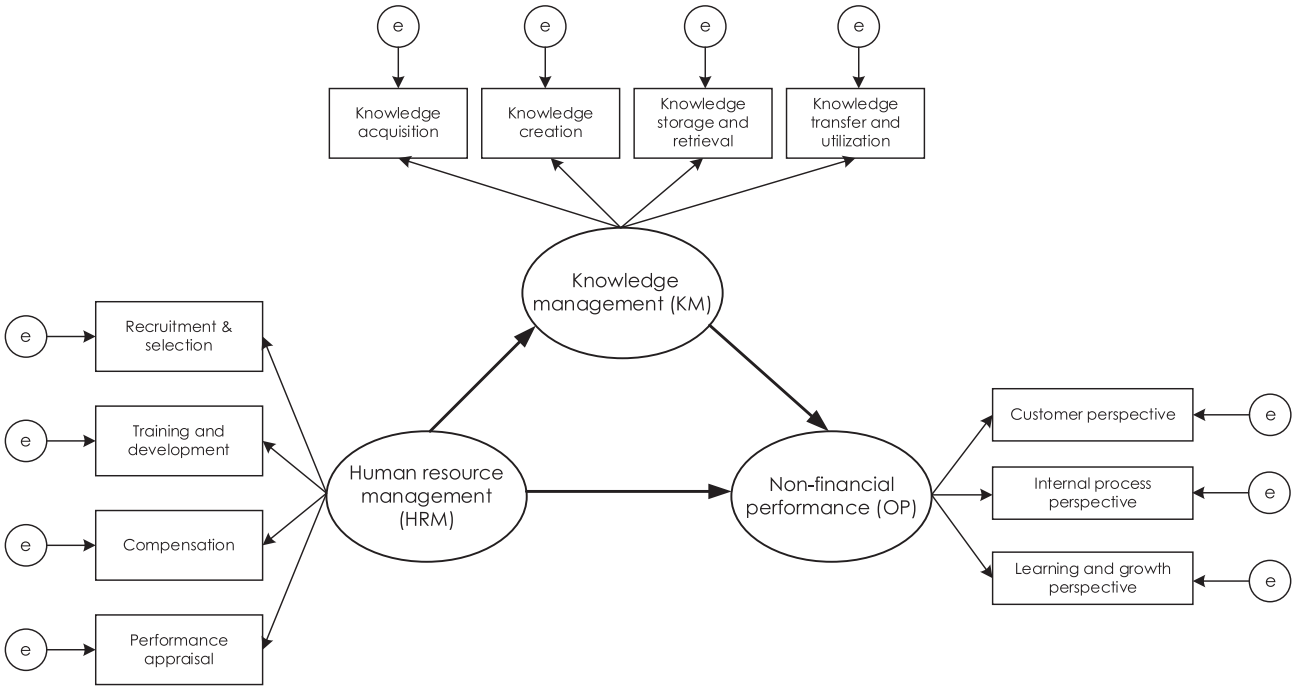

Fig. 2. Proposed structural model of the study.

Table 2
Constructs of the research and theoretical support.

Item code	Description	Theoretical support
Construct: HRM		
HRM1: Recruitment and selection	Is the process of hiring the people who are willing to join the organization and selecting potential and qualified candidates based on objective criteria for a particular job?	Bernardin & Russel, Mondy, NOE & Premeau), and Dessler [99–101].
HRM2: Training and development	Does the process to improve the current or future performance of an employee involve increasing their ability through education and increasing their skills or knowledge in a particular subject?	
HRM3: Compensation	Are attractive yet efficient benefits and compensation packages offered to attract more employees to the workplace without disturbing the finances of the company to boost employee productivity and establish a good public image of the business?	
HRM4: Performance appraisal	Is employee performance assessed by comparing present performance with already established standards, subsequently providing feedback to employees about their performance level for the purpose of improving their performance as needed by the organization?	
Construct: KM		
KM1: Knowledge acquisition	The organization has a process of gathering knowledge that is important and beneficial to the operation of the organization.	Nonaka & Takeuchi and Marquardt [102,103].
KM2: Knowledge creation	The organization has a process to create new knowledge by the mobilization and conversion of tacit knowledge.	
KM3: Knowledge storage and retrieval	The organization has a process that facilitates the storing and retrieving the acquired or created knowledge.	
KM4: Knowledge transfer and utilization	The organization has a process that facilitates the application and disseminating knowledge within the organization and uses that knowledge to benefit the organization.	
Construct: Non-financial OP		
OP1: Customer perspective	This perspective measures the company's performance related to customers and the market, e.g., customer satisfaction, market share, and brand awareness.	Kaplan & Norton, Lee et al., and Sucahyo et al. [33–35].
OP2: Internal process perspective	This perspective measures organizational processes that must be optimized to deliver products to a customer, e.g., process improvements, quality control and assurance, and capacity utilization.	
OP3: Learning and growth perspective	This perspective measures organizational change and growth, e.g., employee training.	

Partially disaggregated models use the sum or average of subsets of items from a measure to form indicators for a latent variable (e.g., Bandalos & Finney [61]), with these indicators referred to as parcels. A partial disaggregation approach was used for the measurement model because this approach reduced random error, took fewer iterations to converge, and produced stable solutions, while maintaining the multiple indicator approach [62]. Item parcels were created by averaging the questionnaire items into their respective factors and then treating them as reflective indicators of their respective construct [63].

SEM uses various types of models to depict causal relationships among observed variables, with the same basic goal of providing a quantitative test of a theoretical model hypothesized by the researcher [64]. More specifically, various theoretical models can be tested in SEM that hypothesizes how sets of variables define constructs and how these constructs are related to each other.

Observed variables or indicators of interest in this study are four observed variables related to HRM (i.e., recruitment and selection, training and development, compensation, performance appraisal), four observed variables related to KM (i.e., knowledge acquisition, knowledge creation, knowledge storage and retrieval, knowledge transfer and utilization), and three observed variables related to non-financial OP (i.e., customer perspective, internal process perspective, and learning and growth perspective).

We first employed CFA to verify the factor structure of a set of observed variables. Then, we use SEM to test the three hypotheses (i.e., *H1, H2,* and *H3*).

6. Sample size and data collection

6.1. Sample size

To perform SEM, Hair et al. and Schumacker and Lomax [65,66] suggested that the sample size of respondents should be greater than 160 or at least 10–20 cases per observable variables. Hair et al. [67] also proposed rules for determining the minimum sample size for SEM: If latent variables are seven or fewer and each latent variable is measured from more than three observable variables, the minimum sample size must be at least 150 cases.

Accordingly, in this study, which uses a set of 11 observable variables, the estimated sample size should be between 110 and 220 cases. Our sample size is 203, which is greater than the minimum sample size of 150 as required by Hair et al. [67].

6.2. Data collection instruments and methods

A close-ended five-point Likert-scale questionnaire was used for data collection in. The questionnaire was first tested by five experts for its validity using IOC measure with the acceptance value being higher than 0.5. Then, the pilot test with 30 samples was conducted and analyzed to exclude questions that failed to pass the reliability test (i.e., those having a Cronbach's alpha of less than 0.7).

Quota sampling questionnaire survey was conducted from March to June of 2021, with 250 questionnaires distributed to engineers working for 13 leading construction firms in Thailand representing more than 70% of the total market value. We received 203 responses with no missing data, indicating an outstanding response rate of 81%.

7. Results

7.1. Descriptive analysis

The characteristics of the questionnaire survey respondents are shown in Table 4.

As shown in Table 4, most of the respondents are male, i.e., 94.58%. As for the position involved in infrastructure construction, about 70.44% are project engineers, followed by senior engineers representing about 14.78%, project managers representing about 13.79%, and project directors representing about 0.99%.

Table 3
Questions for measuring variables relating to each construct and references.

Item code	Description	References of questions used
HRM Construct		
HR1	Great efforts are taken to select the right person.	Zhai et al. [11].
HR2	Long-term employee potential is emphasized.	
HR3	The members of the department or project team of which the new worker will be part participate in the selection of candidates.	
HR4	In the selective process, not only are knowledge and experience taken into account, but also the capacity to work in synergy and continuous learning.	
HR5	Formal training programs are provided for employees.	
HR6	Comprehensive training policies and programs are in place.	
HR7	Formal training programs are provided to teach new staffs the skills they need to perform their job.	
HR8	Training for problem-solving ability is given.	
HR9	The organization has a mixed system of rewarding: fixed + variable.	
HR10	Individuals in this job receive bonuses based on the profit of the organization or the project.	
HR11	The company offers incentives to its employees related to their performance.	
HR12	Performance appraisals are based on objective quantifiable results.	
HR13	Performance appraisals are based on employee's behaviors.	
HR14	Employee appraisals emphasize long-term and group-based achievement.	
KM Construct		
K1	Our firm has processes for absorbing knowledge from individuals into the organization.	Gold et al. [104].
K2	Our firm has processes for acquiring knowledge from outside the organization such as our customers or business partners.	
K3	Our firm has a structure that facilitates the discovery of new knowledge.	
K4	Our firm has a structure that facilitates the creation of new knowledge.	
K5	Our firm has processes for makes knowledge accessible to those who need it.	
K6	Our firm has processes for organizing knowledge and replacing outdated knowledge.	
K7	Our firm has processes for distributing knowledge throughout the organization.	
K8	Our firm has processes for using knowledge to solve new problems and improve efficiency.	
Non-financial OP Construct		
P1	Market share.	Zhai et al. [11].
P2	Client satisfaction.	
P3	The organization uses the fewest possible resources to meet its objectives.	
P4	The organization is developing its capacity to meet future opportunities and challenges.	
P5	Employee satisfaction.	
P6	Innovation for construction method, material, and project management method.	

Table 4
Characteristics of questionnaire respondents.

Characteristics	Frequency	Percentage
Male	192	94.58%
Female	11	5.42%
Project Director	2	0.99%
Project Manager	28	13.79%
Project Engineer	143	70.44%
Senior Engineer	30	14.78%
Total	203	100%

7.2. The measurement model

The measurement model in this study is presented as shown in Fig. 3. The proposed measurement model is verified as follows.

We performed SEM analysis based on data from 203 engineers working for leading infrastructure construction firms in Thailand by using the *AMOS 22* statistical package on 22 questions measuring HRM, KM, and non-financial OP of firms.

Table 5 shows a correlation table with means and standard deviations for CFA and SEM analyses. The dataset passed the test for multivariate normality and linearity issues. The data were normally distributed; thus, we chose maximum likelihood parameter estimation over other estimation methods. The results of the reliability and validity test are presented in Table 6.

In this study, Cronbach's alpha and composite reliability (CR) are adopted as the measures of *internal consistency reliability* [68]. On the basis of the results shown in Table 6, the Cronbach's alpha of all constructs was between 0.81 and 0.89, which is higher than 0.70 as suggested by Nunnally and Bernstein [69]. In addition, the CR value of each construct is within the range of 0.82 to 0.89, which is higher than the recommended threshold value of 0.70 suggested by Nunnally [70]. Therefore, the internal structure of the latent factor with multiple indicators presented in this study is deemed reliable.

The next step is to assess the validity of indicators in the measurement model by examining a construct's *convergent validity* and *discriminant validity*. Support is provided for convergent validity if each item has a *loading factor of* 0.5 or higher and when each construct's average variance extracted (AVE) is 0.50 or higher [71]. The AVE is the grand mean value of squared loadings of a set of indicators [72]. As can be seen in Table 6, each construct's AVE is above the threshold of 0.5, indicating that the construct explains more than half of the variance of its indicators.

A *correlation coefficient* for each pair of constructs of 0.850 or lower is a cut-off for discriminant validity [73]. Discriminant validity evaluates the degree of correlation or divergence between two variables that *should* not be theoretically similar when operationalised, i.e. the extent to which a construct is distinct from others and not measuring the same thing [74]. On the basis of the analysis results (see Table 7), two pair of constructs (HMR → KM and KM → OP) had a correlation coefficient of 0.85 and 0.81, respectively, while one pair of the constructs (HRM → OP) had a correlation coefficient of 0.90, which is higher than the threshold of 0.85 suggested by Kline [73]. Kline [73] pointed out that a result greater than 0.85 suggests that the two constructs may overlap and, therefore, discriminant validity between the two constructs cannot be claimed.

We acknowledge that discriminant validity is critical to model development, ensuring that a construct is truly distinct from other constructs. However, despite the HRM and OP constructs displaying a high correlation, suggesting that they could represent the same concept, combining them or treating them as the same concept was not justifiable for the following reasons. First, the indicators of the two constructs did not have definitional overlaps, thereby measuring different concepts (i.e., questions used for HRM and OP are distinct as shown in Table 3). Second, these two constructs had different groups within the models, namely, causes (i.e., HRM as independent construct) and results (i.e., OP as dependent construct) [63,75]. In addition, HRM and OP, in theory, are different constructs. Therefore, based on this theoretical perspective, we treat the two constructs as distinct so that the next stage of SEM can be proceeded.

The results of the fit measures shown in Table 8 and Fig. 3 indicate that they all met the minimum values recommended by researchers such as Byrne [76], Hair et al. [67], and Hoyle [77].

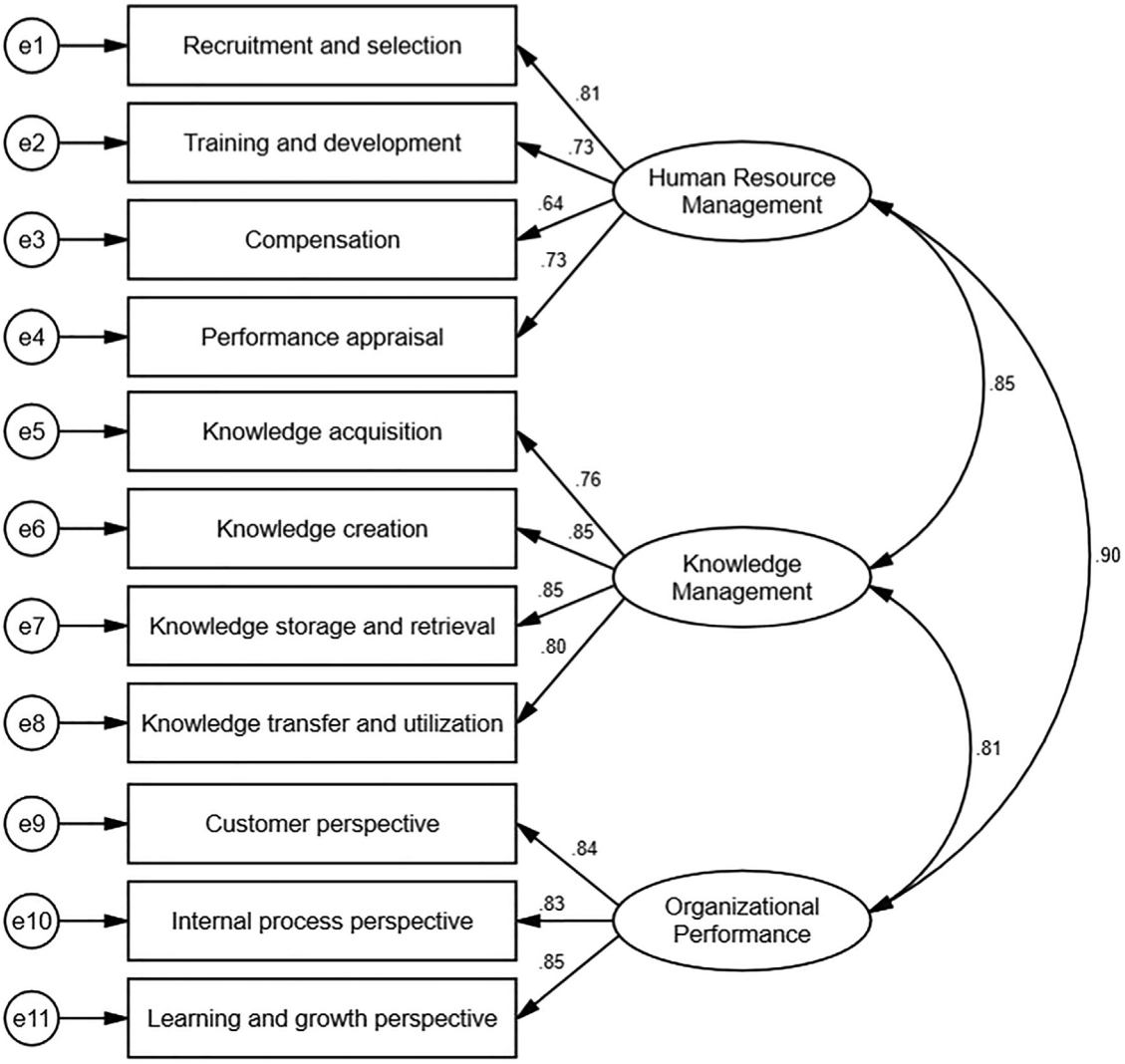

Fig. 3. Results of the measurement model.

Table 5
Correlations for CFA and SEM analyses (N = 203).

Observed variable	1	2	3	4	5	6	7	8	9	10	11
1. HRM1: Recruitment and selection	1	–	–	–	–	–	–	–	–	–	–
2. HRM2: Training and development	0.593	1	–	–	–	–	–	–	–	–	–
3. HRM3: Compensation	0.539	0.407	1	–	–	–	–	–	–	–	–
4. HRM4: Performance appraisal	0.621	0.539	0.489	1	–	–	–	–	–	–	–
5. KM1: Knowledge acquisition	0.573	0.630	0.426	0.600	1	–	–	–	–	–	–
6. KM2: Knowledge creation	0.544	0.591	0.453	0.453	0.680	1	–	–	–	–	–
7. KM3: Knowledge storage and retrieval	0.563	0.550	0.506	0.459	0.597	0.710	1	–	–	–	–
8. KM4: Knowledge transfer and utilization	0.500	0.631	0.387	0.466	0.575	0.665	0.716	1	–	–	–
9. OP1: Customer perspective	0.627	0.491	0.476	0.566	0.473	0.557	0.566	0.471	1	–	–
10. OP2: Internal process perspective	0.589	0.493	0.488	0.564	0.509	0.546	0.565	0.534	0.732	1	–
11. OP3: Learning and growth perspective	0.599	0.562	0.498	0.568	0.534	0.641	0.661	0.580	0.698	0.680	1
Mean	3.874	3.427	3.182	3.780	3.458	3.256	3.315	3.539	3.628	3.855	3.593
Standard deviation	0.644	0.866	0.798	0.801	0.826	0.849	0.832	0.810	0.800	0.780	0.759

7.3. Structural model

Once the reliability and validity of the measurement models is established, hypothesized causal relationships within the inner model can be evaluated using covariance-based SEM. The results of the study are presented in Table 9 and Fig. 4.

7.4. Direct and indirect effects

The direct effects between the exogenous variable and the endogenous variable are depicted in Fig. 4 and Table 9. For Hypothesis 1 (*H1*), which anticipated that a positive relationship exists between HRM and non-financial OP in Thai infrastructure

Table 6
Reliability and validity (N = 203).

Construct	Mean	SD	Item	Loading	Cronbach's alpha	CR	AVE
HRM	3.58	0.98	HRM1	0.808 ***	0.81	0.82	0.53
			HRM2	0.730 ***			
			HRM3	0.642 ***			
			HRM4	0.730 ***			
KM	3.39	0.92	KM1	0.763 ***	0.89	0.89	0.67
			KM2	0.849 ***			
			KM3	0.848 ***			
			KM4	0.798 ***			
OP	3.69	0.88	OP1	0.840 ***	0.88	0.88	0.70
			OP2	0.829 ***			
			OP3	0.845 ***			

Note: *** $p < 0.001$.

Table 7
Correlation coefficients of constructs (N = 203).

Construct	HRM	KM	OP
HRM	0.73	–	–
KM	0.85	0.82	–
OP	0.90	0.81	0.84

Table 8
Fit index of CFA (N = 203).

Fit Index	Score	Recommended Value
Absolute fit measures		
λ^2/df	2.29	< 2–3
Incremental fit measures		
NFI	0.939	⩾ 0.90
TLI	0.951	⩾ 0.90
CFI	0.964	⩾ 0.90
Other measures		
GFI	0.925	⩾ 0.90
RMSEA	0.080	⩽ 0.08

construction firms, and on the basis of the results shown in Fig. 3, HRM has a positive influence on non-financial OP (standardized coefficient = 0.66, $p < 0.001$). As for Hypothesis 2 (*H2*), which states that a positive relationship exists between HRM and KM in the Thai infrastructure construction firms, HRM was found to have a strong positive influence on KM (standardized coefficient = 0.85, $p < 0.001$). We also hypothesized that the relationship between HRM and non-financial OP was mediated by KM in Thai infrastructure construction firms. The result supported that KM acts as a mediator between HRM and non-financial OP (standardized indirect coefficient = 0.23 ([i.e., 0.85 × 0.27]).

8. Discussion

8.1. Findings and contributions

The analysis results in the previous section showed that the causal relationship among HRM, KM, and non-financial OP of leading Thai infrastructure construction firms is as follows:

Table 9
SEM analysis results.

Hypotheses	Relationship	Anticipated Impact		*p*-value	Results
H1	HR → OP	Positive	0.66***	$p < 0.001$	Supported
H2	HR → KM	Positive	0.85***	$p < 0.001$	Supported
H3	KM → OP	Positive	0.27*	$p < 0.05$	Supported

Note: N = 203, *** for significance at $p < 0.001$ level, and * for significance at $p < 0.05$ level.

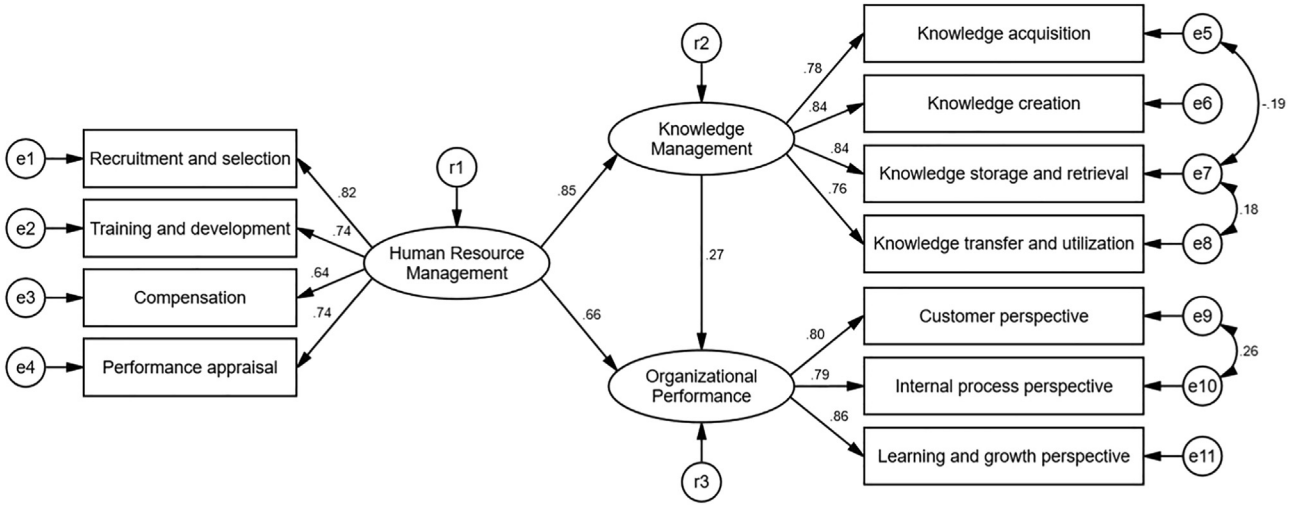

Fig. 4. Results for the structural model.

First, our study shows that *HRM has a high and significantly positive impact on non-financial OP*. This finding of this study is consistent with previous studies in the context of construction by, for example, Olomolaiye and Egbu [12] and Zhai et al. [11]. HRM indicators in this study adopted from Zhai et al. [11] include (1) recruitment and selection, (2) training and development, (3) compensation, and (4) performance appraisal. As shown in Table 1, several studies found a positive causal link between HRM and OP. The positive impacts of HRM on financial and non-financial OP have been widely accepted by academia in the US and Europe since the publication of the seminal research articles by Huselid [40], Arthur [43], and Guest et al. [78]. This relationship was also supported by recent studies such as Lee et al. [34], Zhai et al. [11], and Chow et al. [46]. As for the study in the context of construction, this relationship was established by Olomolaiye and Egbu [12] and Zhai et al. [11].

Similar to a study by Gurbuz and Mert [79], which indicated a highly positive impact of (1) recruitment and selection and (2) training and development on OP, our results showed high factor loadings of these two HRM indictors (see Fig. 4). These findings suggested that Thai construction firms focus their HR activities on the first process, which is recruitment and selection, followed by training and development of those human resources. However, unlike the work by Akhtar et al. [44] who found that *training and development* helped better financial and *internal process performance* of firms, this study suggested that strategic employment of HRM of Thai construction firms through aggressive selection and development can lead to *learning and growth* of people working for the firms.

Second, *HRM in this study has a high and significantly positive impact on KM*. This finding of the study is in line with previous studies by Brewer and Brewer [80], Edvardsson [81], Filius et al. [82], Yahya and Goh [83], and Iqbal et al. [54]. As for the study in the context of construction, this relationship was also established by Olomolaiye and Egbu [12], who confirmed that there were the causal links between HRM and KM of construction firms in the UK. In Asia, Zhai et al. [11], whose work in the context of Chinese construction firms, found that recruitment and selection and training represented about 47% of the total loadings of the HRM construct. In this study, *recruitment and selection* and *training* represented about 53% of total loadings of the HRM construct. As for KM, *knowledge creation* and *knowledge transfer and retrieval* were the indicators with the highest loading, representing about 52% of total loadings.

Finally, *KM has a significantly positive impact on non-financial OP*. This result of the study is consistent with, for example, Lee et al.'s [34] and Sucahyo et al.'s [35]. In Southeast Asia, Bakar et al. [84] and Wibowo et al. [85] also suggested that the employment of HRM led construction firms in Malaysia [84] and Indonesia [85] to high organizational performance, which was in line with the findings in this study. This study also found that Thai construction firms gave higher weight for *knowledge creation* and *knowledge storage and retrieval* while Indonesian and Malaysian construction firms tended to focus on *knowledge utilization*.

This study provides additional empirical evidence of the importance of improving the non-financial OP of firms that specialize in infrastructure construction through people and their valuable knowledge. The findings of this study can be used by Thai construction firms for performance improvement in the following ways.

8.2. Practical implications

Thai construction firms practically embrace human resource management as a way to improve non-financial organizational performance. The HR department of Thai construction firms uses a highly selective approach to the recruitment of key personnel (e.g., civil engineers, construction managers, and directors). For example, several firms in this study chiefly recruit entry-level engineers from top engineering schools in Thailand. This practice, as a result, provides these firms with a competitive edge in terms of human capital. However, being selective in a recruitment and hiring process could inadvertently led the firms to focus too much on *individual performance* evaluation, which in turn led their employees to compete for increasing individual performance and growth. This practice can, in some ways, impede certain KM processes such as knowledge sharing, transfer, and utilization.

Therefore, if Thai construction firms want to increase their OP though KM, which is a mediator between HRM and non-financial OP, they may need to implement policies that help facilitate *knowledge sharing* among team members and increase the *applications of knowledge* to better meet objectives of construction projects, namely, time, cost, and quality.

9. Conclusion

The construction industry is recognized as a key engine for economic growth. The industry represents about 8%–9% of Thailand's GDP. The Thai construction industry currently benefits from large government spending on strategic infrastructure projects such as high-speed rail, intercity motorways, and airports.

Past theories and empirical evidence indicated that there existed a positive relationship between HRM and OP; between HRM and KM; and, between KM and OP. However, these theories have never been tested in the context of construction firms specialized in infrastructure projects. This article, therefore, aimed at studying the impacts of HRM on KM and, ultimately, on non-financial OP of leading infrastructure construction firms in Thailand, using SEM to investigate the causal relationship among the three constructs (i.e., HRM, KM, and non-financial OP).

The results of this study supported the theorized model, indicating that a positive and direct impact of HRM on KM and non-financial OP in Thai infrastructure construction firms, with KM as a mediator between HRM and non-financial OP. The findings of this study are consistent with Olomolaiye and Egbu's [12] and Zhai et al.'s [11] results that HR practices (recruitment & selection, training and development, compensation, and performance appraisal) positively affect knowledge management (knowledge acquisition, knowledge creation, knowledge storage and retrieval, and knowledge transfer and utilization) and firm-level performance (customer, internal process, and learning and growth). The study also supported the theorized model that KM acted as a mediator between HRM and non-financial OP. Additionally, this study found that Thai construction firms tended to focus their HRM on *recruitment and selection and training*. As for KM, *knowledge creation* and *knowledge transfer and retrieval* were the KM activities commonly used by Thai construction firms. Finally, the use of HRM and KM of Thai construction firms somehow led the people working for the firms to concentrate particularly on *learning and growth perspective*, one of the three non-financial performance indicators.

The findings of the study provide additional empirical evidence of the importance of improving non-financial OP through people and their valuable knowledge. However, because the sample of this study is large Thai construction firms that specialize in infrastructure construction, the results and findings may not be extended to small and medium-sized construction firms. This research direction is worth further investigation.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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