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A Special Issue Devoted to
Humanities Studies: A Researcher's Paradigm

Guest Editor
Tan Mou Leong

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Pertanika Journal of Social Sciences & Humanities
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PERTANIKA JOURNAL OF SOCIAL SCIENCES & HUMANITIES

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The *Introduction* explains the scope and objective of the study in the light of current knowledge on the subject; the *Materials and Methods* describes how the study was conducted; the *Results* section reports what was found in the study; and the *Discussion* section explains meaning and significance of the results and provides suggestions for future directions of research. The manuscript must be prepared according to the journal's **Instruction to Authors** (http://www.pertanika.upm.edu.my/Resources/regular_issues/Regular_Issues_Instructions_to_Authors.pdf).

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As articles are double-blind reviewed, material that may identify authorship of the paper should be placed only on page 2 as described in the first-4-page format in Pertanika's Instruction to Authors (http://www.pertanika.upm.edu.my/Resources/regular_issues/Regular_Issues_Instructions_to_Authors.pdf).

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2. The Chief Executive Editor sends the article-identifying information having been removed, to 2 to 3 reviewers. They are specialists in the subject matter of the article. The Chief Executive Editor requests that they complete the review within 3 weeks.

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without exception, reviewers' comments (to the authors) are forwarded to the authors. If a revision is indicated, the editor provides guidelines to the authors for attending to the reviewers' suggestions and perhaps additional advice about revising the manuscript.

4. The authors decide whether and how to address the reviewers' comments and criticisms and the editor's concerns. The authors return a revised version of the paper to the Chief Executive Editor along with specific information describing how they have addressed the concerns of the reviewers and the editor, usually in a tabular form. The authors may also submit a rebuttal if there is a need especially when the authors disagree with certain comments provided by reviewers.

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6. When the reviewers have completed their work, the Editor-in-Chief examines their comments and decides whether the manuscript is ready to be published, needs another round of revisions, or should be rejected. If the decision is to accept, the Chief Executive Editor is notified.

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UPM-MTDC Technology Centre

Universiti Putra Malaysia

43400 Serdang, Selangor Malaysia.

General Enquiry

Tel: +603 9769 1622 | 1616

E-mail:

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Preface

Advancing knowledge in both the humanities and sciences is essential for developing and preserving high civilization. This special issue, themed “Research on Humanity, Fostering the Preservation of High Civilization through Impactful Scientific”, compiles five studies that provide valuable insights into advancing knowledge to sustain our culture, socio-economic and environment. It aims to inspire further research and discussions among scholars, policymakers and relevant agencies concerning humanities.

This special issue focuses on “Humanities Studies: A Researcher’s Paradigm”, covering the topics of water use efficiency and sustainability, disaster management based on mosque resources, determinants of sustainable rural community-based value chains, employability skills for graduates, and crop scale and diversification. Humanities research continues to address complex societal and environmental challenges. These studies are vital for fostering critical thinking, cultural appreciation, social change, and disaster resilience as scholars continue to investigate new paradigms and techniques.

The 11th International Conference of Multidisciplinary Research 2023 (iCMR2023), organized by the School of Distance Education at Universiti Sains Malaysia (USM), extends its gratitude to UPM Press for their invaluable support in making this Special Issue possible. The School of Distance Education also extends its sincere appreciation to the School of Humanities, USM, for their continued support.

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Pan-European Water Use Efficiency and Sustainability Evaluation Based on Stochastic Meta-frontier Analysis

Mike Bronner[1,2] and Kok Fong See[1]*

[1]*Economics Programme, School of Distance Education, Universiti Sains Malaysia, 11800 USM, Penang, Malaysia*

[2]*International Experts Office, Shanxi University, 030006 Taiyuan, China*

ABSTRACT

In 2007, the European Union (EU) intended to become a water-efficient community. Yet, despite the EU's commitment to the United Nations (UN) sustainable development goals (SDGs), relevant insights based on scientific research are still sparse. This study presents a pan-European water use performance evaluation, considering differences in production technologies and potential efficiency determinants. The empirical results are obtained by analysing country-level panel data from 2011 to 2020. Our paper provides more instructive and encompassing findings to inform holistic policy formulation and management practices than prior studies that have typically relied on partial-factor indicators with limited explanatory power. We find that European countries are subject to technological and efficiency heterogeneity, and our production function and inefficiency equation estimations attest to the existence of divergent cause-effect relationships, calling for decentralised, customised solutions. Arguably, our comparative benchmarking analysis constitutes the first comprehensive cross-country investigation for Europe of its kind, underscoring the importance of impactful science in fostering the preservation of high civilisation in line with the theme of this special issue.

Keywords: Europe, performance determinants, stochastic meta-frontier analysis, sustainability, water use efficiency

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E-mail addresses:
mbronner@student.usm.my (Mike Bronner)
kfsee@usm.my (Kok Fong See)
*Corresponding author

INTRODUCTION

Water is both an irreplaceable natural and strategic economic resource (Zheng et al., 2018), indispensable for life on Earth and crucial to socio-economic progress (Luo et al., 2018; Yang et al., 2021). Moreover, by ensuring that this vital resource remains available for current and future generations,

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efficient water utilisation is of fundamental importance for the stability and growth of societies. Notably, efficient water use coincides with the overall pursuit of resource sustainability and sustainable development (Bronner et al., 2022; Lombardi et al., 2019; Walker et al., 2019). Thus, we advocate that a thorough understanding of water use efficiency is integral to preserving and advancing human civilisation.

As water quality and availability are considered major concerns in the European Union (EU), the community proposed a set of measures in 2007 to move towards a water-efficient and water-saving economy (European Commission, 2020, 2021). Furthermore, the European Innovation Partnership (EIP) on water was launched in 2012 to "build an economy that is cleaner, greener, and more efficient" (European Commission, 2015). In addition, the EU has embraced the United Nations (UN) sustainable development goals (SDGs) to synchronise corresponding efforts across its member states (Adler, 2011).

In light of the above, we aim to evaluate water use efficiency in a pan-European context to gain insights for corresponding policy formulation and management practices. Our research is motivated by several critical gaps in the relevant literature. Existing research has overlooked regional heterogeneity due to technological differences across Europe. Hence, we apply a meta-frontier framework to account for variations in production technologies. Furthermore, we extend beyond traditional indicators to assess total-factor efficiency, allowing for more encompassing and instructive findings than prior studies that have typically relied on partial-factor measures with limited explanatory power. Additionally, we incorporate neglected aspects such as water quality and the type of resource usage in our analysis.

For our investigation, we employ stochastic frontier analysis (SFA). Originally developed by Aigner et al. (1977), SFA reflects the actual production technology, providing a more accurate depiction of the relevant underlying economic process (Bogetoft & Otto, 2011; Madaleno & Moutinho, 2023) than non-parametric benchmarking methods, particularly data envelopment analysis (DEA). Moreover, whereas DEA is not entirely compatible with statistical analysis because of its deterministic nature, SFA separates inefficiencies from random errors and supports the simultaneous assessment of contextual factors, enabling a more nuanced performance evaluation (Kumbhakar et al., 2021; Madaleno & Moutinho, 2023).

The key significance of our study in this special issue is rooted in the role water plays as a foundational element of humanity. Efficient water utilisation is deeply intertwined with the continuity of advanced civilisation by bolstering natural habitat preservation and human population well-being (Hatfield & Dold, 2019; United Nations, 2021b). In this sense, we seek to make an impactful scientific contribution to help pave the way for a prosperous future. Our paper offers a fresh perspective by focusing on Europe, as opposed to the

commonly studied case of China. To our knowledge, the present work is the first comprehensive transnational study on Europe in this field. The units of analysis are countries and regions based on country clusters.

LITERATURE REVIEW

Although cross-national comparisons play a crucial role in understanding sustainability comprehensively, allowing countries to learn from one another, previous research has paid little attention to the issue of regional heterogeneity (Zheng et al., 2018). In particular, the misconception that different production systems use the same underlying technology has been a common feature in previous SFA applications (Alem, 2021). Countries should be classified according to different production frontiers to facilitate policymaking that caters to their respective circumstances (Ganhadeiro et al., 2018; Sarkhosh-Sara et al., 2020; Yu et al., 2018). To this effect, a meta-frontier approach (Battese et al., 2004; Battese & Rao, 2002; O'Donnell et al., 2008) enables the computation of comparable efficiencies for production subject to distinct technologies (Alem, 2021).

Meanwhile, water efficiency can be defined as the economic value of production per unit of water usage (Wudil et al., 2023), and it is often assessed as such, notwithstanding that corresponding partial-factor metrics consider water as a single input, neglecting other inputs (Zheng et al., 2018). In practice, water is one of several key inputs in the production process (Yang et al., 2021). Hu et al. (2006) constructed an index of total-factor water efficiency, and in the ensuing literature, which mostly concerns China, water utilisation efficiency has typically been measured based on a classical production function approach (Ding et al., 2019; Luo et al., 2018; Wang et al., 2018; Zheng et al., 2018).

According to the European Commission (2020), freshwater abstraction varies among EU member states due to country size, available resources, abstraction practices, climate, and economic structure. Indeed, various exogenous factors can affect water use efficiency (Deng et al., 2016; Luo et al., 2018), including socio-economic ones (Ma et al., 2017). Scholars have considered a range of potential determinants, such as living standards, urbanisation, industrial agglomeration, resource endowment, or environmental regulation.

In particular, water resource efficiency can be influenced by differences in living standards between countries that arise from varying levels of economic development (Yu et al., 2018; Zheng et al., 2018). Previous work showed a positive effect of per capita gross domestic product (GDP) on water utilisation efficiency in Chinese provinces (Bao & Chen, 2017), but other researchers discerned no clear link (Ding et al., 2019).

As symbols of modern civilisation, cities often have advanced water supply and sewage treatment facilities, contributing to improved water use efficiency (Bao & Fang, 2010; Ma et al., 2016). While urbanisation can have a positive impact (Bao & Chen, 2017; Zheng et al., 2018), it may also disturb

the hydrologic balance (Mays, 2013), with population growth and concentration posing concerns about the sustainable use of natural resources (Sarkhosh-Sara et al., 2020). In addition, inappropriate scaling in management and production during urbanisation can impede efficiency enhancements (Ding et al., 2019).

Furthermore, the volume of water abstraction per inhabitant is affected by the prevalence of water-intensive economic activities such as farming and electricity generation (European Commission, 2020). Given that the agricultural and industrial sectors are major water consumers, efficiency improvements could be achieved by refining crop irrigation methods and optimising industrial water usage (Bai et al., 2017). More generally, water use efficiency can be linked to economic structure (Li & Ma, 2015; Su et al., 2012), where it has been shown that industrialisation exerts both a positive (Zheng et al., 2018) and a negative (Wang et al., 2018) effect.

Resource endowment potentially constitutes another influential factor (O'Donnell et al., 2008), with per capita freshwater resources as a sustainability indicator (European Commission, 2020). On the one hand, when water resources are plentiful, outdated production technology and inadequate water resource management may be more prevalent, evidencing the existence of a 'resource curse' (Ding et al., 2018; Zheng et al., 2018). However, other findings suggest no such relationship (Ding et al., 2019).

Moreover, governmental intervention can affect resource usage, for example, by imposing environmental regulations to steer consumption behaviour, stimulate technological innovations targeting recycling and reuse practices, or promote investment in infrastructure upgrades (Ganhadeiro et al., 2018; Zhang et al., 2017). While some research indicates that corresponding policies influence water use efficiency positively (Ding et al., 2019; Zheng et al., 2018), other results suggest little impact (Wang et al., 2018).

Prior results are inconclusive, and in shedding additional light on these issues, we focus on Europe rather than the usual case of China to bring a new perspective to the literature.

METHODS

General Setup

To reflect varying production technologies, we use cluster analysis to create three groups of European countries. Our technology-related segmentation criteria comprise the Competitive Industrial Performance (CIP) index, resource productivity, energy productivity, and the share of renewable energy in total energy.

Constructing separate production frontiers allows us to assess countries against the best practices in a particular cluster (Jiang et al., 2020). Furthermore, the meta-frontier can be seen as an umbrella encompassing all possible frontiers that may emerge due to differences between countries (Molinos-Senante & Sala-Garrido, 2016). The meta-frontier curve envelopes the cluster frontiers in a basic output-oriented framework, as illustrated in Figure 1.

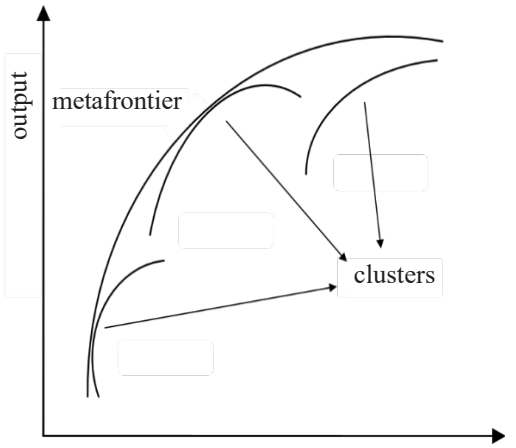

Figure 1. Meta-frontier and cluster frontiers
Source: Authors' work

The discrepancy between each cluster frontier and the meta-frontier can be quantified by employing technology gap ratios (TGRs) that span from 0 to 1 (Jiang et al., 2020). The TGRs provide a measure for the proximity of each cluster frontier, and thus each country, to the meta-frontier (Molinos-Senante & Sala-Garrido, 2016).

Meta-frontier Model

Consider a production process in which each country employs capital stock K, labour force L and water resource W as inputs to produce output Y, which also affects water quality Q as an additional production outcome. Conceptually, the production technology can be defined as:

$$P = \{(K, L, W, Y, Q): (K, L, W) \text{ can produce } (Y, Q)\} \quad [1]$$

Suppose there are G different groups of countries in each region and classified according to their technology level. The group-specific production technologies can be described as:

$$P^g = \{(K, L, W, Y, Q): (L, K, W) \text{ can produce } (Y, Q)\}, \quad g = 1, ..., G. \quad [2]$$

Similar to the definitions suggested by Zhou et al. (2012) and Wu et al. (2012) in their energy-related studies, we stipulate the following Shephard sub-vector input distance function for water use (hereafter named Shephard water distance function):

$$D_w(K, L, W, Y, Q) = \sup\{\theta: (K, L, W/\theta. Y, Q) \in P\} \quad [3]$$

Equation [3] quantifies the maximum potential reduction in W. Consequently, $W/D_w(K, L, W, Y, Q)$ represents the hypothetical water usage.

With respect to group technologies, given capital K, labour L, and outcomes Y and Q, the water input requirement set for group g is defined as:

$$WI^g = \{W: (\overline{K}, \overline{L}, W, \overline{Y}, \overline{Q}) \in P^g\}.$$

Referring to Lin and Du (2013) and Zhou et al. (2012), we define the Shephard water distance function for the group technologies as:

$$D_W^g(K, L, W, Y, Q) = \sup\{\theta: (K, L, W/\theta, Y, Q) \in P^g\}, \quad g = 1, ..., G. \quad [4]$$

This way, countries adjust their water input to move towards the frontier (Lin & Du, 2013).

The term $W/D_W^g(K, L, W, Y, Q)$ is a theoretical measure of water use based on best practices within a particular

group. It represents a country's potential water usage, assuming it utilises the best technology available within its group. The set $\{W/D_W^g(\overline{K},\overline{L},W,\overline{Y},\overline{Q})\}$ represents the lower boundary of the water input set WI^g and is referred to as group g's water input frontier.

Total-factor water efficiency *WE*, which is the ratio of optimal-to-actual water use (Hu et al., 2006), can be computed as follows:

$$WE = \frac{W/D_W(K,L,W,Y,Q)}{W} = \frac{1}{D_W(K,L,W,Y,Q)} \quad [5]$$

WE is the reciprocal of the Shephard water distance function. It ranges from 0 to 1, where a score of 1 indicates full efficiency.

Accordingly, concerning the group-specific frontiers, *WE* is defined as:

$$WE^g = 1/D_W^g(K,L,W,Y,Q), g = 1,\dots,G. \quad [6]$$

Further, we assume that the group-specific production technologies belong to a wider technology set P^*. Hence, the production technology of Europe can be defined as follows:

$$P^* = \{P^1 \cup P^2 \cup \cdots \cup P^G\} \quad [7]$$

$$P^* = \{(K, L, W, Y, Q):(K, L, W) \text{ can produce } (Y, Q)\} \quad [8]$$

In this context, the water input requirement set for the common technology can be expressed as $WI^* = \{W:(\overline{K},\overline{L},W,\overline{Y},\overline{Q}) \in P^*\}$. The lower boundary of this set relates to the meta-frontier.

With respect to the wider technology, the Shephard water distance function is stated as follows:

$$D_W^*(K,L,W,Y,Q) = \sup\{\theta:(K,L,W/\theta,Y,Q) \in P^*\} \quad [9]$$

And, regarding the meta-frontier, total-factor water efficiency is:

$$WE^* = 1/D_W^*(K,L,W,Y,Q) \quad [10]$$

Meanwhile, Equation (7) implies that the meta-frontier envelopes the group frontiers. It can be expressed as follows:

$$D_W^*(K,L,W,Y,Q) \geq D_W^g(K,L,W,Y,Q) \Rightarrow WE^* \leq WE^g \quad [11]$$

Moreover, the technology gap ratio *TGR*, which measures how close group g's frontier is to the meta-frontier, can be defined as:

$$TGR^g(K,L,W,Y,Q) = \frac{W/D_W^*(K,L,W,Y,Q)}{W/D_W^g(K,L,W,Y,Q)} = \frac{WE^*}{WE^g} \quad [12]$$

Based on Equation (12), the following relationship can be established (also see Figure 2):

$$WE^* = WE^g \times TGR^g \quad [13]$$

Next, in accordance with existing literature (Du & Lin, 2017; Zheng et al., 2018), we adopt a translog function to specify the Shephard water distance function for country *i* and period *t*, as follows (Equation 14):

where the random variable v_i^t (which accounts for statistical noise) follows the standard normal distribution, and each β is a parameter to be estimated.

Observing that the Shephard water distance function is linearly homogenous in water input (Färe & Primont, 1995), we can write (Equation 15):

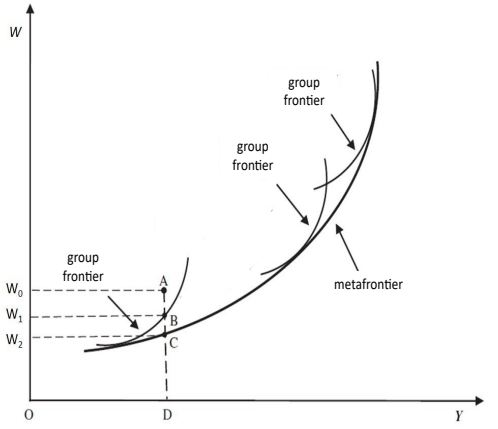

Figure 2. Total-factor water efficiency and technology gap ratio

Note: The curve represents the production isoquant for variables *W* and *Y* when *L* and *K* are fixed. In relation to its group's frontier, country *A*'s water efficiency equals the ratio *BD*/*AD*. With respect to the meta-frontier, it is equal to the ratio *CD*/*AD*. Country *A*'s *TGR* is, therefore, the ratio *CD*/*BD*.

Source: Authors' work

$$\begin{aligned}\ln D_W^t(K_i^t, L_i^t, W_i^t, Y_i^t, Q_i^t) &= \beta_0 + \beta_K \ln K_i^t + \beta_L \ln L_i^t + \beta_W \ln W_i^t \\ &+ \beta_Y \ln Y_i^t + \beta_Q \ln Q_i^t + \beta_{KK}(\ln K_i^t)^2 \\ &+ \beta_{LL}(\ln L_i^t)^2 + \beta_{WW}(\ln W_i^t)^2 + \beta_{YY}(\ln Y_i^t)^2 \\ &+ \beta_{QQ}(\ln Q_i^t)^2 + \beta_{KL} \ln K_i^t \ln L_i^t \\ &+ \beta_{KW} \ln K_i^t \ln W_i^t + \beta_{KY} \ln K_i^t \ln Y_i^t \\ &+ \beta_{KQ} \ln K_i^t \ln Q_i^t + \beta_{LW} \ln L_i^t \ln W_i^t \\ &+ \beta_{LY} \ln L_i^t \ln Y_i^t + \beta_{LQ} \ln L_i^t \ln Q_i^t \\ &+ \beta_{WY} \ln W_i^t \ln Y_i^t + \beta_{WQ} \ln W_i^t \ln Q_i^t \\ &+ \beta_{YQ} \ln Y_i^t \ln Q_i^t + \beta_t t + \beta_{tt} t^2 + \beta_{Kt} t \ln K_i^t \\ &+ \beta_{Lt} t \ln L_i^t + \beta_{Wt} t \ln W_i^t + \beta_{Yt} t \ln Y_i^t \\ &+ \beta_{Qt} t \ln Q_i^t + v_i^t \end{aligned} \quad [14]$$

$$\begin{aligned} &D_W^t(K_i^t, L_i^t, W_i^t, Y_i^t, Q_i^t) \\ &= W_i^t \times D_W^t(K_i^t, L_i^t, 1, Y_i^t, Q_i^t) \end{aligned} \quad [15]$$

Then, Equation (14) can be transformed to read:

$$\begin{aligned} -\ln W_i^t &= \ln(1/W_i^t) \\ &= \beta_0 + \beta_K \ln K_i^t + \beta_L \ln L_i^t + \beta_Y \ln Y_i^t + \beta_Q \ln Q_i^t \\ &+ \beta_{KK}(\ln K_i^t)^2 + \beta_{LL}(\ln L_i^t)^2 + \beta_{YY}(\ln Y_i^t)^2 \\ &+ \beta_{QQ}(\ln Q_i^t)^2 + \beta_{KL} \ln K_i^t \ln L_i^t + \beta_{KY} \ln K_i^t \ln Y_i^t \\ &+ \beta_{KQ} \ln K_i^t \ln Q_i^t + \beta_{LY} \ln L_i^t \ln Y_i^t \\ &+ \beta_{LQ} \ln L_i^t \ln Q_i^t \\ &+ \beta_{YQ} \ln Y_i^t \ln Q_i^t + \beta_t t + \beta_{tt} t^2 + \beta_{Kt} t \ln K_i^t \\ &+ \beta_{Lt} t \ln L_i^t + \beta_{Yt} t \ln Y_i^t + \beta_{Qt} t \ln Q_i^t + v_i^t - u_i^t \end{aligned} \quad [16]$$

where $u_i^t \equiv \ln D_W^t(K_i^t, L_i^t, W_i^t, Y_i^t, Q_i^t)$ is a non-negative variable representing water inefficiency. Following the estimation of the parameters in Equation [16], water efficiency can be computed in the following way: $WE_i = \exp(-\hat{u}_i)$.

Moreover, in line with a model specification proposed by Battese and Coelli (1995) that allows for the estimation of a stochastic frontier with an error term that is associated with external variables, assuming $N(\mu_i^t, \sigma_u^2)$, the water efficiency determinants are incorporated in the following inefficiency equation:

$$\mu_i^t = \delta_0 + \sum_p z_{ip}^t \delta_p \quad [17]$$

where z_{ip}^t refers to the determinants, and each δ is a parameter to be estimated. It should be noted that all parameters in Equations (16) and (17) are computed simultaneously.

The corresponding group-specific and meta-frontier formulations can be derived analogously (Lin & Du, 2013; Zhou et al., 2012). Based on Battese et al. (2004)

and O'Donnell et al. (2008), the following condition (broadly stated in line with the above notation) must be met to ensure that the meta-frontier indeed envelopes the group frontiers: $-\ln W_{it}^{*} \geq -\ln \widehat{W}_{it}^{g}$. The parameters of the meta-frontier can be calculated through optimisation (Battese et al., 2004; O'Donnell et al., 2008), as follows: $Min\left|\ln \widehat{W}_{it}^{g} - \ln W_{it}^{*}\right|$ s.t. $-\ln W_{it}^{*} \geq -\ln \widehat{W}_{it}^{g}$. Subsequently, the *TGR*s can be obtained through $TGR_{it} = \widehat{W}_{it}^{*} / \widehat{W}_{it}^{g}$. In the final step, the total-factor water efficiency scores related to the meta-frontier can be computed using the following formula: $WE_{it}^{*} = WE_{it}^{g} \times TGR_{it}$.

Sample and Data

Our sample consists of 29 European countries, comprising the 27 EU members: Austria (AUT), Belgium (BEL), Bulgaria (BGR), Croatia (HRV), Cyprus (CYP), Czechia (CZE), Denmark (DNK), Estonia (EST), Finland (FIN), France (FRA), Germany (DEU), Greece (GRC), Hungary (HUN), Ireland (IRL), Italy (ITA), Latvia (LVA), Lithuania (LTU), Luxembourg (LUX), Malta (MLT), the Netherlands (NLD), Poland (POL), Portugal (PRT), Romania (ROU), Slovakia (SVK), Slovenia (SVN), Spain (ESP), and Sweden (SWE), as well as the two non-EU members Switzerland (CHE) and the United Kingdom (GBR). The study timeframe covers ten years, from 2011 to 2020. The dataset is based on publicly available data collected and retrieved through database extraction from various sources (see Table 1).

The factors of production considered are labour, capital, and water, while the economic output and environmental outcome variables are total production and water quality, respectively. In addition, the potential determinants of water use efficiency investigated include living standards, urbanisation, economic structure, resource endowment, resource use, and environmental conservation regulation.

A summary of our complete panel dataset is presented in Table 1.

Table 1
Dataset

Categories	Items (description)	Notation	Units	Mean	Max.	Min.	Std. dev.
Clustering (segmentation) criteria							
#1	Competitive Industrial Performance (CIP) index	CIP	Index	16,4	55,0	1,0	10,9
#2	Resource productivity	RP	Purchasing power standards (PPS) per kilogram (kg)	1,97	4,55	0,62	0,92

Table 1 *(Continue)*

Categories	Items (description)	Notation	Units	Mean	Max.	Min.	Std. dev.
#3	Energy productivity	EP	PPS per kg of oil equivalent (KGOE)	8,37	22,22	3,95	2,71
#4	Renewable energy sources	REN	Share of energy from renewable sources, %	20,1	60,0	2,0	11,6
			Inputs				
Labour	Total employment	L	Persons employed (thousand)	8.163	45.133	169	10.701
Capital	Total fixed assets	K	Million PPS	1.579.710	10.557.443	27.235	2.237.115
Water	Total freshwater abstraction	W	Cubic metres (million cbm)	7.026	35.069	41	9.613
			Outcomes				
Output	Gross domestic product (GDP)	Y	Million PPS	512.716	3.147.495	8.986	712.924
Water quality	Water quality standard of natural bathing sites	Q	Index	76,9	100,0	8,0	16,6
			Total-factor water efficiency determinants				
Living standard	Population without sanitation facilities	LST	%	2,8	36,7	0,0	6,2
Urbanisation	Urban population	URB	%	73,3	98,0	53,0	12,6
Economic structure	Gross value added (GVA), agriculture	STR	Share of GDP, %	2,1	6.3	0,2	1,2
Resource endowment	Renewable freshwater resources	END	Thousand cbm per inhabitant	8,3	32,3	0,1	7,7
Resource usage	Freshwater abstraction for public water supply	USE	Share of total freshwater abstraction, %	31,5	96,0	3,0	21,5
Environmental protection	Terrestrial protected area	EPR	%	19,1	37,9	8,3	8,3

Data sources: AQUASTAT, Eurostat, Statistical Review of World Energy of the Energy Institute (EI), Swiss Federal Statistical Office (SFSO), UN Industrial Development Organization (UNIDO), UN Population Division, US Energy Information Administration (EIA), World Database on Protected Areas (WDPA).

Our analysis was conducted using software R.

RESULTS AND ANALYSIS

Factor Analysis

As advocated in the literature (Deng et al., 2016; Ganhadeiro et al., 2018), we perform a factor analysis to avoid potential multicollinearity among certain cluster criteria (Table 2), namely, the Competitive Industrial Performance (CIP) index, resource productivity (RP), and energy productivity (EP), while also reducing dimensionality (Figure 3).

Table 2
Correlation matrix for segmentation criteria

	CIP	RP	EP	REN
CIP	1			
RP	0.49508101	1		
EP	0.37666359	0.4736538	1	
REN	-0.06863821	-0.33122077	0.05008609	1

Source: Authors' work

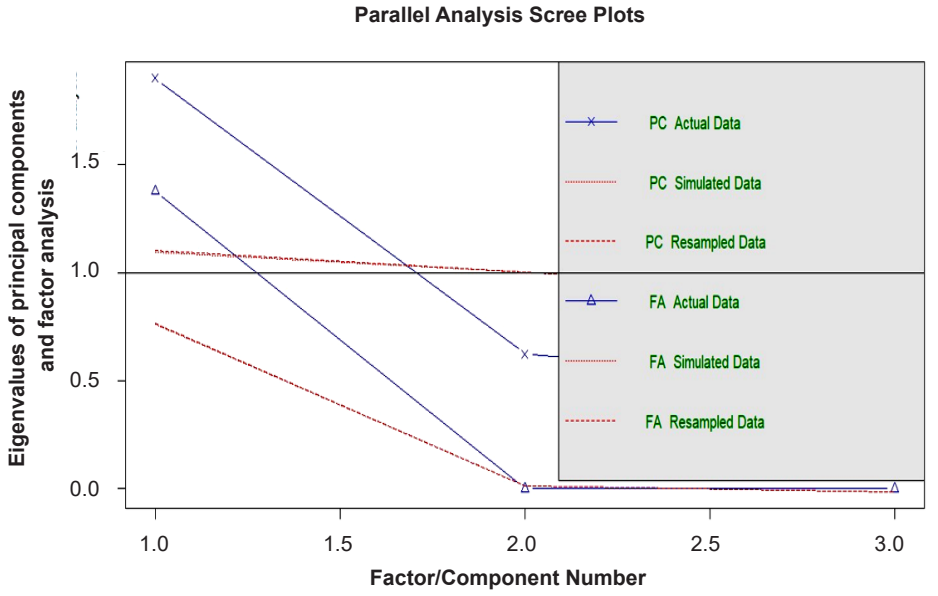

Figure 3. Factor extraction

Note: The factor loadings for CIP, RP, and EP are 0.627, 0.789, and 0.600, respectively.

Source: Authors' work

Cluster Analysis

We apply k-means clustering based on the latent factor (LF) derived from the preceding factor analysis and the REN values (see Table 3).

Table 3
The final set of segmentation criteria after data reduction

Items (description)	Notation	Units	Mean	Max.	Min.	Std. dev.
Latent factor (based on original variables CIP, RP, EP)	LF	Index	35,7	100,0	0,0	21,7
Renewable energy sources	REN	% energy from renewable sources	20,1	60,0	2,0	11,6

Source: Authors' work

As shown in Figure 4, the countries are divided into three groups according to technological characteristics. Groups 1 and 3 have nine constituent countries, while Group 2 contains eleven.

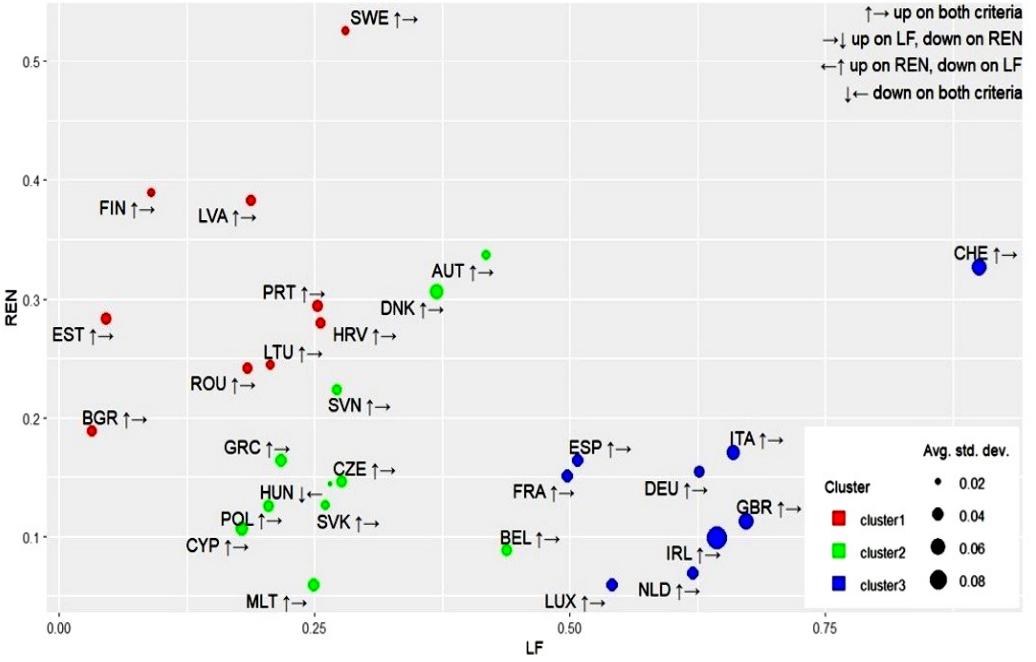

Figure 4. Segmentation (classification of countries)

Note: The impact or weight of each variable on the clustering outcome can be assessed by examining their within-cluster sum of squares. In particular, the standardised within-cluster sum of squares for the factor scores is 0.380 (Cluster 1), 0.176 (Cluster 2), and 0.444 (Cluster 3). For the REN values, the corresponding numbers are 0.715 (Cluster 1), 0.221 (Cluster 2), and 0.064 (Cluster 3).

Source: Authors' work

Figure 5 and the numbers reported in Table 4 reveal that the countries in Cluster 1 are predominantly located in Northern and Eastern Europe. These countries tend to be smaller, less urbanised, less industrialised, and in the process of modernising. Cluster 2 mainly contains medium-sized economies in Central and Southern Europe. Their living standards and extent of urbanisation and industrialisation are generally in the middle range. The countries included in Cluster 3 are primarily situated in Western Europe. On average, they are larger, more advanced, urbanised, and industrialised.

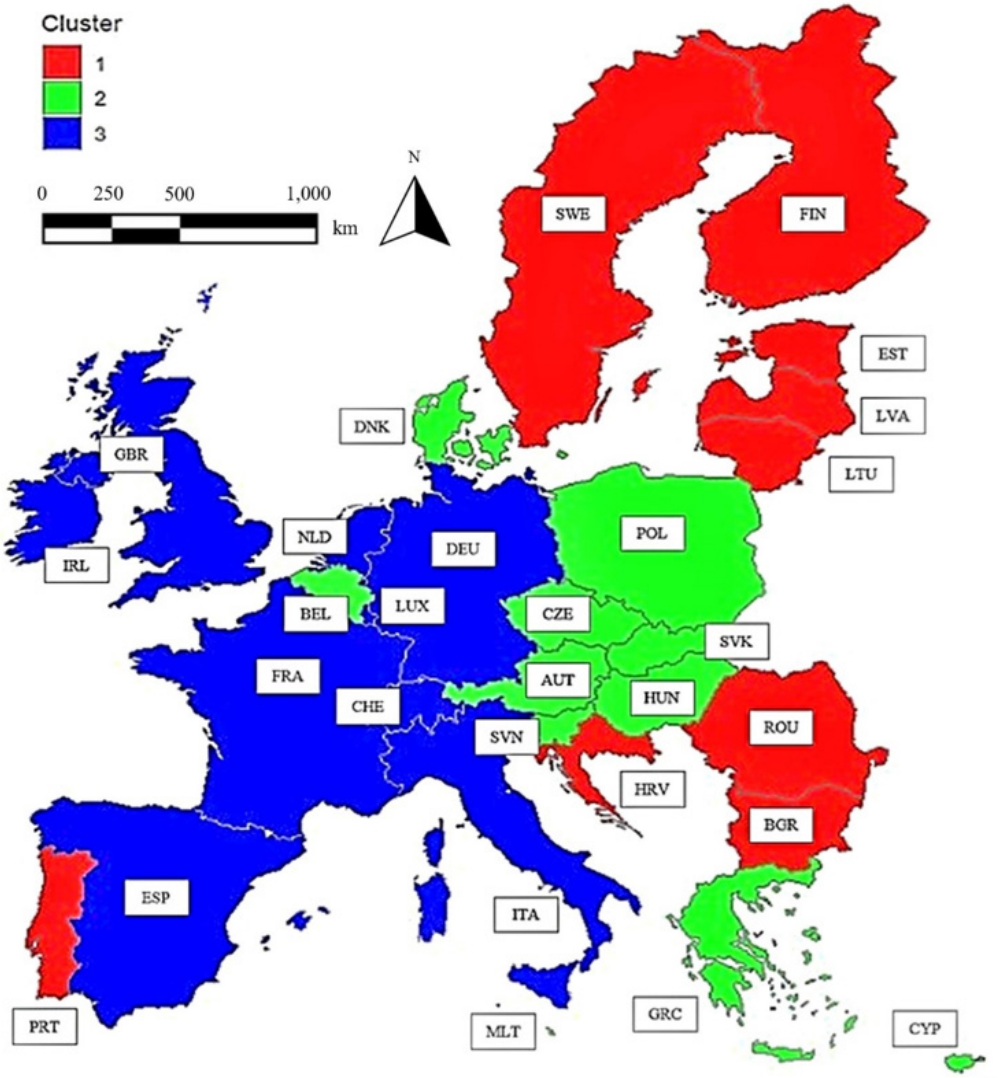

Figure 5. Map

Source: Authors' work

A summary of our panel dataset by cluster is presented in Table 4.

At this stage, it should be noted that we have checked that the relevant data for the production function variables and the performance determinants do not pose concerns regarding multicollinearity.

Table 4
Summary of panel dataset by cluster

Cluster	Mean	Max.	Min.	Std. dev.
Cluster 1 (*90 obs.)*				
Q	73,4	98	8	17,4
Y	153.878	422.627	24.288	119.920
L	3.204	8.829	606	2.466
K	528.872	1.419.057	74.630	389.048
W	3.144	8.880	169	2.730
LST	7,8	36,6	0	9,2
URB	69,3	88	54	10,7
STR	3	6,3	1,4	1
END	15,2	32,3	1,2	8,7
USE	28	78	3	21,3
EPR	20,1	36,7	11,5	9,1
Cluster 2 (*110 obs.)*				
Q	79,4	100	22	17,2
Y	228.418	876.761	8.986	203.119
L	4.177	16.484	169	4.155
K	664.064	1.476.990	27.235	424.049
W	3.438	11.911	41	3.680
LST	0,8	4,2	0	1,1
URB	72,3	98	53	15,1
STR	2	4,2	0,4	1
END	5,7	22,5	0,1	5,5
USE	26,3	52	11	12
EPR	20,6	37,9	8,3	8,7
Cluster 3 (*90 obs.)*				
Q	77,2	100	10	14,6
Y	1.219.030	3.147.495	36.487	922.452
L	17.994	45.133	224	14.227
K	3.749.673	10.557.443	76.506	2.994.167
W	15.294	35.069	43	13.257
LST	0,1	2,6	0	0,3
URB	78,5	92	62	8,6
STR	1,3	3,1	0,2	0,7
END	4,4	15,3	1,2	3,2
USE	41,3	96	11	27,1
EPR	16,2	27,3	8,5	6,1

Source: Authors' work

Stochastic Meta-frontier Analysis

Table 5a reports the computed coefficients for each group, while Table 5b shows the coefficients for the pooled data and the linear optimisation results for the meta-frontier.

Table 5a
Parameter results for group frontiers

	Group 1			Group 2			Group 3		
	Estimates (MLE)	**Std. error**		**Estimates (MLE)**	**Std. error**		**Estimates (MLE)**	**Std. error**	
(Intercept)	-158.8796	1.0587	***	-89.4806	14.5490	***	-10.1228	70.7619	
log(K)	24.7208	0.7629	***	13.5038	3.3105	***	50.3681	14.3098	***
log(L)	5.3601	1.3519	***	-38.3953	4.4095	***	-20.9193	17.8607	
log(Y)	-16.5016	0.8874	***	27.7238	4.7521	***	-37.4762	20.6337	.
log(Q)	34.9694	1.0119	***	-3.5260	3.5275		-7.1407	5.8311	
I(0.5 * log(K)^2)	21.9658	1.1256	***	-2.9469	0.5417	***	3.7362	1.6993	*
I(0.5 * log(L)^2)	-1.8491	1.0091	.	-7.2496	1.1918	***	-4.6047	2.3899	.
I(0.5 * log(Y)^2)	14.9808	0.8552	***	-5.7873	1.8688	**	18.0053	4.2013	***
I(0.5 * log(Q)^2)	0.2382	0.3477		0.1396	0.4951		-0.0267	0.1066	
I(log(K) * log(L))	-7.8560	0.8245	***	2.4347	0.7067	***	7.1164	1.9125	***
I(log(K) * log(Y))	-18.7613	0.9880	***	0.2015	1.0688		-12.5825	2.2594	***
I(log(K) * log(Q))	-7.3808	0.7654	***	0.4950	0.3749		-0.3739	0.3960	
I(log(L) * log(Y))	8.8358	1.1408	***	5.1815	1.2054	***	-2.8627	2.4100	
I(log(L) * log(Q))	2.1663	0.6124	***	0.5520	0.5096		-0.9322	0.7533	
I(log(Y) * log(Q))	3.7224	0.8322	***	-0.6817	0.6068		1.5774	0.8535	.
t	-0.2506	0.2905		-0.7417	0.0961	***	0.3983	0.4752	
I(t^2)	0.0021	0.0033		-0.0002	0.0011		0.0002	0.0012	
I(t * log(K))	0.1258	0.0739	.	0.0365	0.0199	.	0.1275	0.0365	***
I(t * log(L))	-0.2872	0.0537	***	-0.1450	0.0281	***	0.0143	0.0608	
I(t * log(Y))	0.1216	0.0714	.	0.1191	0.0343	***	-0.1801	0.0664	**
I(t * log(Q))	-0.1183	0.0558	*	0.0093	0.0218		0.0108	0.0215	
Z_(Intercept)	-0.0755	0.4443		-7.7907	0.7935	***	2.0583	0.7174	**
Z_LST	0.4341	0.6076		11.6312	4.0518	**	-6.7640	4.9136	
Z_URB	1.0659	0.6085	.	6.5442	0.6333	***	-2.0626	0.6242	***
Z_STR	0.1531	0.9986		24.1149	4.2502	***	49.1883	6.2924	***
Z_END	-0.0112	0.0077		-0.0012	0.0060		0.0121	0.0144	
Z_USE	-1.0995	0.2507	***	-2.5542	0.3507	***	-1.4466	0.4467	**
Z_EPR	1.9777	0.6403	**	16.5403	1.2769	***	-1.3808	0.7861	.
sigmaSq	0.0295	0.0081	***	0.0120	0.0023	***	0.0078	0.0015	***
gamma	1.0000	0.1828	***	0.8387	0.0540	***	0.9593	0.0205	***
log-likelihood value	32.5967			129.5798			124.3207		

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Note: A low gamma value suggests that deviations from the frontier are caused by random error. Specifically, when gamma is close to zero, deviations mainly stem from noise. Conversely, if gamma is close to one, deviations are primarily due to technical inefficiency. When gamma equals one, all deviations from the frontier result from inefficiency (Battese & Coelli, 1995; Coelli et al., 2005; Tran et al., 2008).

Source: Authors' work

Table 5b
Parameter results for common ('pooled') frontier and meta-frontier

	Common frontier			Meta-frontier
	Estimates (MLE)	**Std. error**		**Optimisation results (LP)**
(Intercept)	-44.1545	2.8525	***	0.000307
log(K)	11.2289	1.1116	***	0.002256
log(L)	-12.1156	0.4322	***	0.000292
log(Y)	2.4043	1.0205	*	0.002437
log(Q)	1.9831	0.6229	**	0.001410
I(0.5 * log(K)^2)	-0.9810	0.4178	*	-0.014724
I(0.5 * log(L)^2)	-0.7161	0.0939	***	-0.007614
I(0.5 * log(Y)^2)	-0.3872	0.2899		-0.005939
I(0.5 * log(Q)^2)	-0.2448	0.0728	***	0.003151
I(log(K) * log(L))	0.9979	0.0705	***	-0.025507
I(log(K) * log(Y))	-0.3077	0.3482		0.008407
I(log(K) * log(Q))	-0.6501	0.1133	***	0.000426
I(log(L) * log(Y))	0.3781	0.1357	**	-0.019277
I(log(L) * log(Q))	-0.0312	0.0452		-0.003933
I(log(Y) * log(Q))	0.6251	0.0958	***	0.000835
t	-0.0949	0.0855		0.005529
I(t^2)	-0.0028	0.0004	***	0.006275
I(t * log(K))	0.0046	0.0110		-0.010292
I(t * log(L))	-0.0135	0.0103		0.003544
I(t * log(Y))	0.0082	0.0061		-0.007160
I(t * log(Q))	0.0247	0.0086	**	0.010179
Z_(Intercept)	0.4604	0.2479	.	
Z_LST	-1.7977	0.4906	***	
Z_URB	0.3712	0.2413		
Z_STR	24.8108	2.3208	***	
Z_END	0.0154	0.0035	***	
Z_USE	-4.6519	0.1025	***	
Z_EPR	3.5894	0.4110	***	
sigmaSq	0.0996	0.0070	***	
gamma	1.0000	0.0000	***	
log-likelihood value	63.0515			

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Note: The log-likelihood ratio (LR) test compares the 'pooled' model, where all regions are combined, to an 'unpooled' model, where each group has its frontier. Based on our calculated statistics, there is strong evidence to suggest that the frontiers of the three regional groups are not the same.

Source: Authors' work

Across the three groups, capital exhibits the most consistent and statistically significant association in terms of the first-order partial elasticities of water productivity. This association is strongest for Group 3, where a percentage increase in capital corresponds to a rise in water productivity of approximately 50%. The estimated elasticity for water quality (34.97) is positive and statistically significant in the first group only (and in the pooled sample).

The results also show the elasticities of water productivity in a nonlinear way. For instance, the percentage change in water productivity with respect to capital varies with the level of capital itself. In the case of Group 2, the relevant second-order elasticity is -2.95, i.e., as the scale of capital increases, its enhancing effect on water productivity lessens. The second-order elasticities of total production follow the same pattern, with a negative value for Group 2 but positive values elsewhere.

Meanwhile, the influence of capital on water productivity diminishes as the level of total production climbs, and vice versa, for Groups 1 and 3. Concerning other statistically significant interaction results, for Group 1, the positive association between water productivity and water quality weakens as the level of capital grows (and vice versa). Conversely, the combined effect of water quality and output on water productivity shows the opposite trend.

Moreover, the estimated time trend can generally be interpreted as the average annual rate of technological change (Alem, 2021). In this study, the corresponding parameter for Group 2 is significant and negative, suggesting technological degradation manifested as a decline in water productivity over time. Significant parameter values for interaction terms involving time imply that technological changes affecting water productivity vary depending on capital, labour, production, or water quality levels.

Regarding the estimation results for the inefficiency equation, Table 5a illustrates that all potential determinants, except resource endowment, influence water use efficiency to some extent. However, the type of water usage consistently shows a statistically significant impact across all groups. Resource endowment also emerges as a statistically significant influence when considering the pooled data in Table 5b. Specifically, the impact of LST on water use efficiency remains inconclusive, with a positive effect observed in Cluster 2 and a negative effect for the common or 'pooled' frontier. The influence of URB is also unclear, showing a highly significant positive effect in Cluster 2 and a highly negative effect in Cluster 3. STR generally positively affects water use efficiency, while END shows a positive effect only in the common frontier. Conversely, USE consistently has a negative effect. EPR predominantly exhibits a positive effect. Here, it should be clarified that a statistically significant positive relationship implies that the determinant in question has a negative impact (and vice versa), given the undesirable nature of inefficiency.

The descriptive statistics of the TGRs calculated for the different groups are reported in Table 6.

Cluster 3 leads in terms of TGR, with an average value of 0.46. Hence, the frontier of Cluster 3 is closer to the meta-frontier compared to the frontiers of the other two clusters. In comparison, Cluster 1 has an average TGR of 0.30. On average, countries in Cluster 1 require over 50% more water than those in Cluster 3 to attain the same production outcome with equivalent labour and capital inputs. Across individual observations, TGR values range from a minimum of 0.05 in Cluster 1 to a maximum of 1.00 in Cluster 3.

Figure 6 displays the frequency distributions for the TGRs.

Table 6
Descriptive statistics for TGRs

	Cluster 1	Cluster 2	Cluster 3
Mean	0.3041	0.3933	0.4598
Std. dev.	0.1940	0.1967	0.2208
Min.	0.0455	0.0753	0.1524
Max.	0.8517	0.9227	1.0000
Obs.	90	110	90

Kruskal-Wallis chi-squared = 25.332, df = 2, *p*-value = 3.157e-06

Note: We use the Kuskall-Wallis non-parametric test (Kruskal & Wallis, 1952) to assess whether the TGRs differ among groups. Based on the corresponding result, we strongly reject the null hypothesis that TGRs in different groups come from the same population.

Source: Authors' work

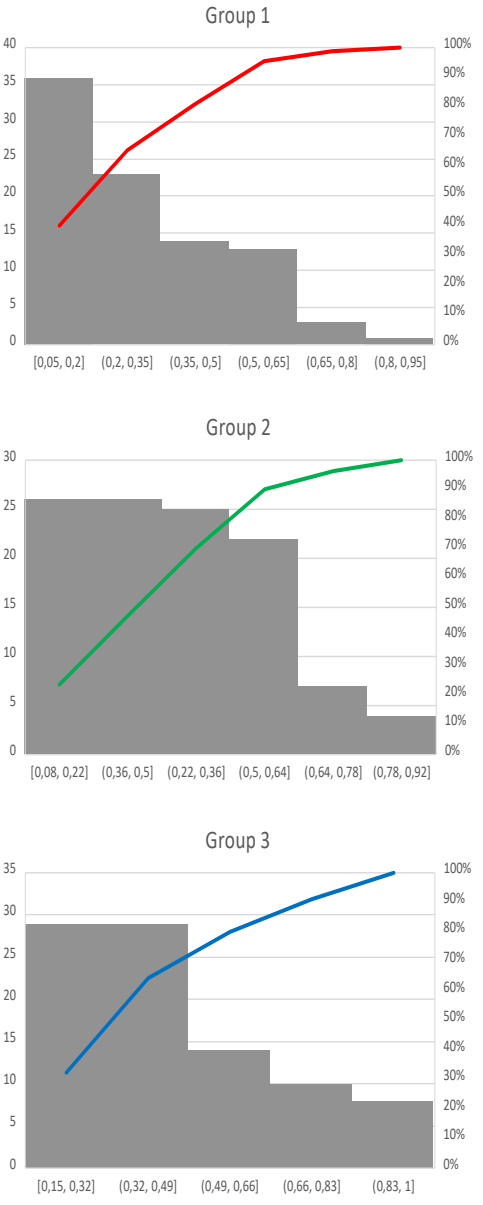

Figure 6. Frequency distributions of TGRs

Source: Authors' work

The three clusters exhibit comparable patterns of variation with respect to their TGRs. Figure 7 depicts the evolution of TGRs for the different groups.

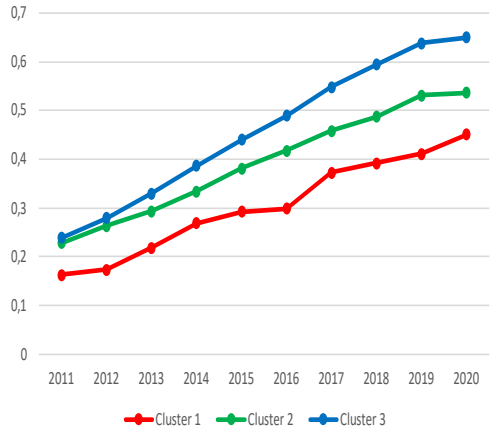

Figure 7. Change in average TGRs over time by cluster

Source: Authors' work

The average TGR of all three clusters trended upward throughout the entire study period, although Cluster 1 almost plateaued midway (Figure 7). Cluster 3 remained steadily ahead of the other two clusters and continuously extended its lead. This divergence, in the form of a widening technology gap, reversed towards the end of the timeframe, with Cluster 1 experiencing sharper growth, whereas Clusters 2 and 3 appeared to flatten out. All clusters peaked in 2020, the final period considered. Cluster 1 reached a TGR of 0.45 (compared to a starting value of 0.16 in 2011), while Clusters 2 and 3 recorded values of 0.54 (2011: 0.23) and 0.65 (2011: 0.24), respectively.

Table 7 provides an overview of the efficiency scores at an aggregated level.

Table 7 illustrates that the countries in Clusters 1, 2, and 3 attained group-specific mean efficiencies of 0.56, 0.66, and 0.67, respectively, compared with the overall European mean efficiency of 0.52, based on the assumption of a common ('pooled') technology, and versus a lower mean meta-frontier efficiency across all clusters of 0.25. The greatest variability (with a standard deviation of 0.37) is observed in Cluster 2.

Taking the meta-frontier technology as a reference, Cluster 1 had an average efficiency score of 0.18, while the average scores for Clusters 2 and 3 were 0.23 and 0.33, respectively. BGR recorded the worst average group-specific performance in Cluster 1, GRC in Cluster 2 and ESP in Cluster 3. In terms of the group frontiers, the best performers on average were LVA (Cluster 1), AUT (Cluster 2) and LUX (Cluster 3). EST posted the lowest average score for the' pooled' frontier and LUX the

Table 7
Descriptive statistics for efficiency scores

	Group-specific frontiers			Common ('pooled') frontier	Meta-frontier
	Cluster 1	***Cluster 2***	***Cluster 3***		
Mean	0.5567	0.6599	0.6675	0.5199	0.2459
Std. dev.	0.1960	0.3674	0.2544	0.3087	0.2000
Min.	0.2388	0.0875	0.2923	0.0734	0.0193
Max.	0.9956	0.9949	0.9966	0.9998	0.9913

Source: Authors' work

highest. In relation to the average meta-frontier scores, the least and most efficient countries were, respectively, EST and LVA (Cluster 1), GRC and MLT (Cluster 2), and ESP and LUX (Cluster 3).

Figure 8 presents the average efficiency scores of the different groups over time.

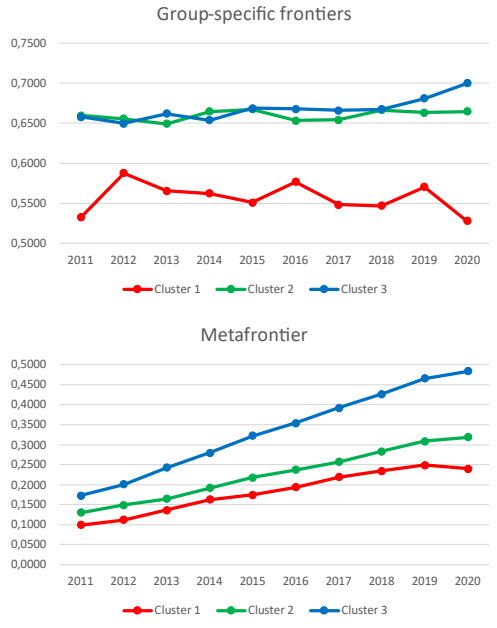

Figure 8. Change in average efficiency scores
Source: Authors' work

Cluster 1's group-specific average efficiency score stayed below those of Clusters 2 and 3 over the entire timeframe. Cluster 1 peaked in 2012 with an average score of 0.59, compared to scores of 0.53 in the first and last years studied. Clusters 2 and 3 had similar scores most of the time, but Cluster 3 reached a maximum score of 0.70 in 2020 (compared to 0.66 in 2011), while Cluster 2 had a score of 0.66 (the same as in 2011). Concerning the meta-frontier, each cluster experienced a continuous upward trend in terms of the average efficiency score, except Cluster 1, which dropped from its highest value of 0.25 in 2019 to 0.24 in the 2020 cut-off period. Cluster 3 had the highest average efficiency every year, while Cluster 1 had the lowest. In addition, Cluster 3's incline was considerably steeper over the entire period than its two counterparts, resulting in a continually diverging score band.

FINDINGS AND DISCUSSION

Although water utilisation is deemed sustainable in the long term in most of Europe, certain regions are at risk of facing water scarcity, necessitating efficiency gains to prevent seasonal water shortages (European Commission, 2020). Moreover, regions with low rainfall, high population density, or intensive agricultural and industrial activity may face sustainability issues in the future, especially considering that water shortages could be exacerbated by climate change impacts on water availability (European Commission, 2020). In addition, recycling and reuse can enhance water system sustainability in Europe (Bronner et al., 2022; European Commission, 2015). While water abstraction exerts the most significant pressure on the quantity of freshwater resources, a large part of the water withdrawn for domestic, agricultural, or industrial use is returned to the environment and its water bodies, albeit often as wastewater with impaired quality (European Commission, 2020). Thus, besides water use efficiency and

corresponding changes in consumption practices, a key water management issue in Europe concerns drinking water quality (European Commission, 2021).

By highlighting the existence of heterogeneity among European countries, our results show that the sampled nations operate under different conditions. Figure 9 illustrates the distinct attributes of each group concerning the size of the economy, the standard of living, and the extent of urbanisation and industrialisation. It should be noted that, in the context of sustainable development, hallmarks of humanity's longevity and high civilisation, such as economic prowess, improvements in living standards through built infrastructure, human settlement in cities, and industrialisation, are closely related to the issue of water use efficiency (United Nations, 2021a).

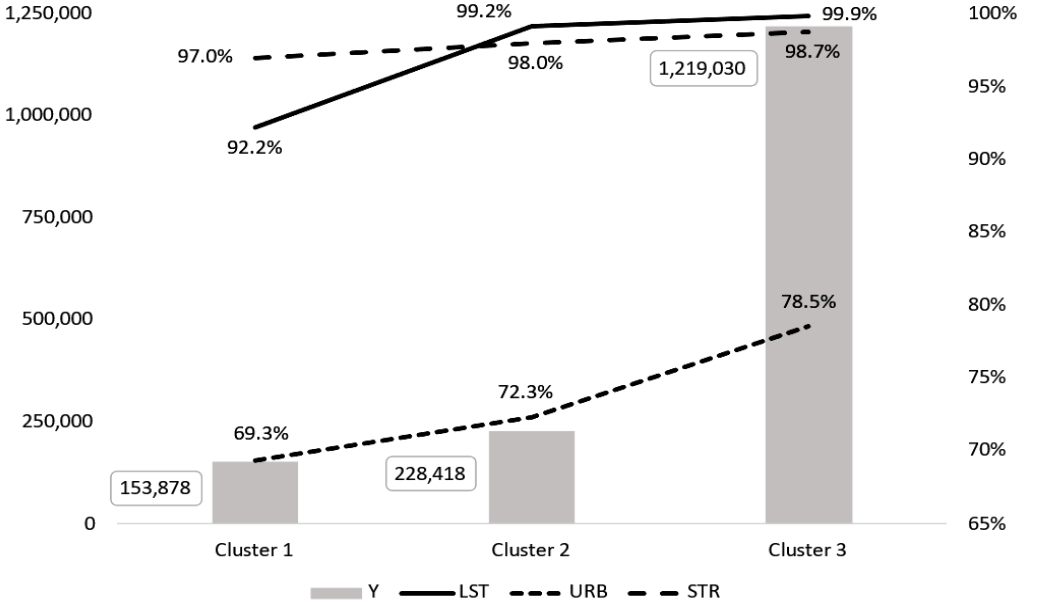

Figure 9. Cluster characteristics

Note: Cluster 1: Smaller, less advanced, less urbanised, less industrialised economies on average. Cluster 2: Middle range for the size of the economy, living standard, urbanisation, and industrialisation. Cluster 3: Larger, more advanced, more urbanised, more industrialised economies on average.

Source: Authors' work

Against the background of the underlying cluster analysis, our results for the TGRs and efficiency scores collectively demonstrate a general positive association between technological progress and water use efficiency. Furthermore, the results for the production function reveal that capital exhibits the most consistent relationship with water productivity. The positive influence of capital tends to diminish with increasing scale and total production. Generally, there is a significant positive

linkage between water productivity and water quality. Group 2 appears to have experienced technological degradation along with a decline in water productivity over time. Additionally, we find that all potential contextual determinants influence water use efficiency to some extent. However, only the actual type of water usage has a consistent, statistically significant impact across all groups (Table 8).

Table 8
Influence of contextual factors on water use efficiency

Factor	Current findings	Interpretation and comparison with previous results (where applicable)
LST	The actual effect of LST (living standard in terms of the percentage of the population without sanitation facilities) on water use efficiency is unclear. For Cluster 2, a higher proportion of the population lacking sanitation facilities corresponds to greater inefficiency, which implies that widening the availability of sanitation facilities enhances efficiency. However, this relationship is reversed in the case of the common frontier.	In Cluster 2, expanding the proportion of the population with sanitation facilities can boost efficiency, but this relationship is inverted in the context of the pooled sample. Overall, this aligns with previous work concerning China, which shows that per capita income can affect efficiency (Bao & Chen, 2017), although the results of Ding et al. (2019) refute this claim.
URB	Concerning URB (percentage of the urban population), there is a highly significant negative effect in Cluster 2, indicating that urbanisation is associated with increased inefficiency, and a highly significant positive effect in Cluster 3, suggesting that urbanisation leads to improved water use efficiency.	These contrasting effects highlight the ambiguous impact of urbanisation on water use efficiency. It is akin to the case of China, where urbanisation has been shown to exert a positive influence (Bao & Chen, 2017; Zheng et al., 2018) or constitute an impediment due to an accompanying rise in water consumption and pollution (Ding et al., 2019).
STR	In terms of economic structure, it is observed that STR, i.e., gross value added (GVA) represented by agriculture as a percentage share of GDP, generally exerts a negative effect on water use efficiency. It means that economies with a more substantial agricultural sector tend to be more inefficient, suggesting that the process of industrialisation augments efficiency.	Economies with larger agricultural sectors tend to be less efficient, implying that countries can improve their performance by becoming more industrialised. In comparison, the process of industrialisation, including industrial transformation and upgrading, has been found to have both a positive (Bai et al., 2017; Zheng et al., 2018) as well as a negative (Wang et al., 2018) impact on China.
END	For the pooled data, the resource endowment variable END (the amount of renewable freshwater resources available per inhabitant) exhibits a negative influence. It suggests that an excessive abundance of water resources imposes a detrimental impact on water use efficiency in the case of the common frontier.	Our results substantiate the notion that an overabundance of water resources may engender complacency in water usage, manifesting the existence of a 'resource curse'. In comparison, resource endowment is regarded as a significant influence in China in some cases (Ding et al., 2018; Zheng et al., 2018) but not in others (Ding et al., 2019).

Table 8 *(Continue)*

Factor	Current findings	Interpretation and comparison with previous results (where applicable)
USE	Considering resource usage as a water use efficiency determinant represents a novel contribution to the existing body of literature. In this context, USE (the percentage share of freshwater abstraction for public water supply in total freshwater abstraction) is consistently associated with reduced inefficiency. Thus, our results suggest that a larger public water sector exerts a positive influence and is linked to increased efficiency.	In Europe, households and manufacturing industries are heavy water users, with the latter often relying on non-public self-supply (European Commission, 2020). It is also noteworthy that, although household water use is generally more uniform due to consistent basic needs, it can far exceed manufacturing water use in service-dominant countries (European Commission, 2020). As such, the proportion of public water supply partly reflects a country's economic structure.
EPR	The environmental protection variable EPR (percentage of terrestrial area under protection) predominantly exhibits a detrimental impact, meaning that an increase in the extent of protected areas is associated with heightened inefficiency.	Expanding land designated for nature conservation (i.e., protecting terrestrial areas) decreases efficiency. With respect to China, while environmental regulation can play an effective role in enhancing water utilisation efficiency in some situations (Ding et al., 2019; Zheng et al., 2018), such intervention may be of little avail in others (Wang et al., 2018).

Source: Authors' work

CONCLUSION

This study presents a first-of-its-kind pan-European assessment of water use efficiency and sustainability, employing cluster analysis and a meta-frontier approach. Moreover, we contribute to existing research by integrating water quality into the evaluation framework and examining the type of resource usage as an efficiency determinant. By aligning with the objectives of this special issue, our research aims to inform responsible, impactful, science-based, and border-transcending resource governance and management. By doing so, we strive to secure the legacy of our shared, thriving civilisation and lay the groundwork for enduring socio-economic progress and a prosperous future.

The results confirm a positive relationship between technological progress and water use efficiency. Our findings also demonstrate a general positive association between water productivity and quality. Our analysis delineates the intricate interplay of essential tenets of high civilisation, including socio-economic factors such as economic scale, living standards, urbanisation, and industrialisation, in shaping water use efficiency. All examined determinants influence efficiency to varying degrees. While some aspects remain inconclusive, we have gained greater clarity on several issues. Specifically, bigger agricultural sectors are less efficient, suggesting that industrialisation can improve performance. Furthermore, an overabundance of

renewable freshwater resources can lead to inefficiency, indicating a 'resource curse'. In addition, a larger public water sector increases efficiency, while expanding land for nature conservation decreases it.

Our investigation reveals substantial technological diversity among European countries and varying cause-effect relationships concerning water utilisation efficiency. It underscores the need for decentralised solutions to address pertinent sustainability challenges based on the formulation of water policies and management approaches tailored to specific local circumstances.

Implications and Recommendation

Investigating water use efficiency and its determinants and providing evidence on corresponding technology gaps form a useful scientific basis for tackling resource sustainability challenges. In particular, our results illustrate that European countries operate under different conditions and exhibit considerable technological and efficiency heterogeneity. Considering these varying circumstances, adopting decentralised solutions and tailoring best resource stewardship practices for individual countries or groups of countries is advisable. We are confident that the insights gained can inform water policy formulation, particularly within the UN's SDG 6 framework on 'clean water and sanitation' (United Nations, 2024), thereby enhancing human well-being and advancing the progress of human civilisation.

In the present European context, smaller economies, often at nascent development stages with limited urbanisation and industrialisation, struggle to attain high water use efficiency, whereas larger economies typically fare better. Moreover, our results pertaining to living standards resonate with the idea that public commitment to human well-being, based on sanitation infrastructure investment, acts as a catalyst for the progress of societies as they transition from a lower to a higher state of development (United Nations, 2024). Meanwhile, urbanisation emerges as a double-edged sword with mixed implications for human civilisation, encapsulating a complex rapport between humanity and natural resources. On the other hand, our analysis shows that industrialisation is associated with more efficient water use, speaking to the improvement of resource management systems in the course of modernisation (United Nations, 2021a).

Limitation and Outlook

Continuing research may focus more dedicatedly on comparing Europe and China. Many relevant findings for China exist, while the present paper could signal the beginning of a similar stream of work on Europe. Additionally, future studies may explore considerations of the Environmental Kuznets Curve (EKC). The EKC concept, which proposes that environmental damage initially increases and then decreases with per capita income (Hamaide, 2022), could be applied to Europe, building on previous results concerning China (Ding et al., 2019;

Wang et al., 2018; Zheng et al., 2018). Moreover, although freshwater endowment may serve as a proxy for location-specific climatic and geographic circumstances (European Commission, 2020), it would be beneficial to explicitly consider the ramifications of such conditions, given that efficient water utilisation can support the endurance of human high civilisation by mitigating climate change threats (United Nations, 2021).

Meanwhile, mirroring humanity's complex relationship with natural resources, urbanisation presents a dual narrative, both hindering and enhancing water use efficiency, thereby posing challenges as well as opportunities in preserving human high civilisation. The multifaceted nature of urbanisation underlines the need for further research to unravel the delicate balance between urban growth and sustainable water management in the interest of humanity. In addition, while our findings illustrate the imperative of industrialisation for improving water use efficiency, affirming the transformative potential of evolving economic structures in sustainable development and safeguarding human civilisation, future research could focus on how innovative resource use practices can propel societies forward (Callejas Moncaleano et al., 2021). Moreover, while guiding economic growth towards sustainability is important for protecting our natural habitat and societal well-being, future studies could explore the potential relationship between efficient water utilisation and social equity, the latter being a key factor in maintaining public harmony and preserving cultural values (United Nations, 2021b).

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Masjid-based Disaster Management: How *Masjids* in Malaysia Support the Needy

Mohd Nazmi Mohd Khalli and Mohd Farid Mohd Sharif*

School of Humanities, Universiti Sains Malaysia, 11800 USM, Penang, Malaysia

ABSTRACT

The COVID-19 pandemic and the great flood of 2021 significantly impacted society. However, *masjids* have proven effective institutions in disaster management efforts, particularly in social welfare. This study examines the role of *masjids* in managing disasters in Malaysia, specifically during the 2021 great flood and the COVID-19 pandemic. The qualitative research involves in-depth interviews based on case studies, with the results analyzed thematically. A total of 14 *masjids* as informants were selected from across Malaysia, including nine of the best *masjids* in 2021 and five with disaster management experience. The findings reveal that *masjids* are crucial in disaster management, encompassing services, health, placement, incentives, and infrastructure. These contributions help effectively manage the community during disasters. The study highlights two key factors contributing to the success of *masjids* in disaster management: the core concern of *maqasid sharʿiah* and the synergy of *da'wah* in strengthening the relationship between *masjids* and the community. The implications of this study contribute to both theory and practice, particularly in designing ideal *masjid* management, preserving community welfare, and maintaining the Sustainable Development Goals (SDGs).

Keywords: Faith-based Institutions (FBO), COVID-19, great flood, *maqasid sharʿiah*, *masjid*-based management disaster, synergy of *da'wah*, social welfare, Sustainable Development Goals (SDGs)

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E-mail addresses:
nazmikhalli.nk@gmail.com (Mohd Nazmi Mohd Khalli)
faridusm@usm.my (Mohd Farid Mohd Sharif)
*Corresponding author

INTRODUCTION

The word *"masjid"* (mosque) is derived from the Arabic root "*sa-ja-da"* (دَجَسَ), which means a place of prostration (*mauḍiʿu al-sujud*). Prostration is an external practice involving placing the forehead, the tip of the nose, palms, knees, and toes on the ground, a pillar of prayer (Syafe'i, 2016). Therefore, the *masjid* is commonly understood as the

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center of Islamic religious worship. In Malaysia, there are 6,808 *masjid*s registered with the religious department, along with 18,364 *suraus* (small *masjids*) (Jabatan Kemajuan Islam Malaysia [JAKIM], 2023). The distribution of *masjids* and *suraus* by state is as follows: Johor (843), Kedah (593), Kelantan (600), Melaka (201), Negeri Sembilan (305), Pahang (652), Penang (215), Perak (705), Perlis (106), Selangor (438), Terengganu (514), Sabah (1,133), Sarawak (408), Kuala Lumpur (74), Putrajaya (3), and Labuan (17). This number reflects the significant presence of the Muslim community, which continues to grow each year.

As the population grows and new cities and housing estates are built, the number of *masjids* also increases. It is important to manage and administer these institutions efficiently to provide a comfortable place of worship and human development and help create a harmonious, advanced, competitive society. While many newly built *masjids* have modern and magnificent structures, many still have weaknesses in their management and maintenance. According to Ashaari and Mokhtar (2018), seven factors lead to low attendance at the *masjid*: limited functionality, individual problems, imperfect basic facilities, suboptimal location, weak administrative and financial management, and issues with the personality of *imams* and *masjid* officials.

Managing a *masjid* can become challenging when unexpected moments of anxiety arise. One such moment was the outbreak of COVID-19, which had caused concern worldwide. Malaysia was also affected by the spread of this disease, with the first case detected on January 25, 2020 (Shah et al., 2020). The pandemic has significantly impacted *masjids*, with several in Putrajaya and the Federal Territory of Kuala Lumpur temporarily closed in the early stages of the outbreak. Masjid Putra and Masjid Tuanku Mizan Zainal Abidin in Putrajaya, as well as Masjid Wilayah Persekutuan in Kuala Lumpur, were closed to non-Muslim tourists due to concerns about the COVID-19 outbreak ("Coronavirus: Masjid Putra", 2020). The situation became even more worrying when positive COVID-19 cases were detected among residents of a *masjid*, leading the government to implement a Movement Control Order (MCO) that temporarily closed all *masjid* institutions. In light of these circumstances, developing effective management strategies and long-term actions is crucial to ensure that the *masjid* and the community are not neglected (Remly et al., 2022).

In addition to COVID-19, Malaysia was hit by flood disasters in almost every state at the end of 2021. While floods are a common natural disaster in Malaysia, the situation has become more challenging due to the COVID-19 pandemic. Floods have damaged various infrastructures, including *masjids*, in some areas, creating additional pressure on *masjid* management and the community. Consequently, *masjids* need to develop an immediate action plan that includes mitigation, preparedness, response, and recovery measures to alleviate the

pressure experienced by the community and the *masjid's* management structure (Sheikhi et al., 2021).

The passage discusses two challenging situations faced by Malaysia - COVID-19 and the great floods of 2020 and 2021. These situations are concerning due to the country's determination to address the implications of natural disasters and diseases and restore severely impacted socio-economic conditions. The government has implemented various initiatives to assist affected communities, including collaborations with NGOs and volunteer activists to provide welfare assistance. Amid these demanding times, *masjids have* also played a significant role by contributing to charitable efforts, utilizing private savings funds, or donations collected from agencies and external communities. Therefore, *masjids* are considered essential components of disaster management and could serve on the front lines to assist communities during emergencies.

The *masjid* plays a crucial role in disaster management by fostering lifelong humanization in this century. It serves as a worship center for Muslims and becomes a hub for developing such values. In Malaysia, *masjids* are easily found in every district and village, allowing for frequent *da'wah* (preaching) programs and community welfare initiatives. The Muslim community trusts the *masjid* and sees it as a suitable place to organize activities that promote human well-being. As a result, the *masjid* has two strengths in developing human civilization based on disaster management.

Firstly, the core concern of a *masjid* is the *maqasid shar'iah* (goals for humankind by Islamic law), which guides the *masjid's* actions for the community. According to Mahmud (1979), the purpose of building a *masjid* is to preserve human well-being, meet basic human needs such as food, clothing, shelter, health, and education, ensure fair distribution of income and wealth, preserve human freedom, and promote cooperation and justice for all. Wartoyo et al. (2022) found that during the COVID-19 pandemic, the Mosque-based Sharia Cooperation (MbSC) greatly contributed to society. MbSC provides a cheap financing system with *qardhul hasan* (sincere loan) contracts, offers a policy of deferring payment of receivables for those affected by the epidemic, implements social services by distributing masks and hand sanitizers for free, provides direct assistance in the form of basic daily needs, and conducts socialization of the importance of maintaining health and cleanliness. This study shows that integrated cooperatives with *masjids* will accelerate their functions in assisting members and communities in need.

Secondly, the synergy of *da'wah* can strengthen the relationship between the *masjid* and the community. When linking the *masjid* with *da'wah*, it is important to have a dynamic and humane approach that considers changing times. In this context, it is important to mention the opinion of Hamka (1984), who suggested that *da'wah* activities in the *masjid* should not only focus on *fardu 'ain* knowledge (obligatory acts)

but should also include programs related to the development of human well-being. Synergy in *da'wah* can occur when there is cooperation between various agencies to address the various problems that occur in society. Al-Tabbaa (2014) describes this approach as innovative in diversifying efforts to tackle societal social problems. Certain philanthropic efforts demonstrate that this collaborative approach is more effective and straightforward in charitable activities (Selsky & Parker, 2005).

In this type of *da'wah* synergy, cooperation is a platform to achieve common social goals. All parties involved demonstrate commitment to enhance each other's capacities (Austin & Seitanidi, 2014). This theory suggests that every activity carried out as a joint effort has greater potential and impact compared to individual efforts (Austin, 2000). This principle holds true during natural disasters such as great floods and pandemics like COVID-19, where *masjids* are crucial in assisting affected communities and supporting government aid missions for the victims involved.

Therefore, this study aims to discuss the role of *masjids* in disaster management in Malaysia by examining their response during the 2021 great flood and the spread of the COVID-19 pandemic. The justification for selecting *masjids* stems from their actions during COVID-19 and the 2021 great flood in Malaysia, demonstrating their credibility in assisting the government and affected communities through various welfare initiatives. Furthermore, their widespread presence in various locations ensures easy accessibility during future disasters. Thus, *masjids* are considered capable of aiding the country in addressing the challenges faced by communities in need, particularly during disaster situations. This assertion will be elucidated based on insights from experienced informants.

LITERATURE REVIEW

The *masjid* serves not only as a place of worship but also as a hub for social activities and the dissemination of knowledge. Despite the COVID-19 pandemic, many *masjids* in Malaysia are still actively involved in facilitating educational activities, according to a study by Wahidin et al. (2020). Similarly, Mohamed and Muhamat (2019) explained that imparting knowledge is a joint activity between the *masjid* and the community. Additionally, other studies have highlighted *masjids*' role in establishing community relationships. Ibrahim et al. (2020) described the *masjid* as a welcoming place for teenagers and youth, while Remly et al. (2020) emphasized the importance of *masjids* in building ties with different segments of society.

Several studies have been conducted on the management of *masjids* using various related theories. Among the theories used are the Kaizen Management System (KMS model) by Jaafar et al. (2013) and the Attention, Interest, Desire and Action (AIDA model) by Yusof (2015). Jaafar et al. (2013) and Yusof (2015) suggest that *masjids* must implement management system models like KMS and AIDA to ensure efficiency and

attract more Muslims. Meanwhile, Abdullah and Aini (2017) discuss the primary management of *masjids*, including planning, implementation, monitoring, control, evaluation, and amendment. Sabri and Tonot (2017) explain that *masjids* should apply management concepts used by corporations to improve their management. Professionals should lead *masjids* to ensure significant improvement in specific management areas such as human resource management and documentation. Additionally, Muhammad et al. (2020) explain internal control involving the separation of duties of committees, maintenance of *masjid* buildings and assets, activities, and financial records. However, these studies do not explain the theoretical aspects practiced in disaster management.

Places of worship worldwide, including *masjids*, often provide emergency aid during disasters. This role is supported by a systematic review conducted by Sheikhi et al. (2021), which collected and analyzed various studies, manuscripts, books and theses discussing the role of religious institutions in disaster management. The review encompassed countries such as the United States of America (USA), New Zealand, Indonesia, and Japan. The study identified 11 themes related to the involvement of religious institutions in disaster management, such as their potential for disaster management, level of preparedness for disasters, response, recovery, social capital, partnership with stakeholders, collaboration and communication between mental health professionals and faith-based organization leaders, unity of information and message, religious institution shelters, dealing with disasters using old and new approaches, and barriers and challenges. However, the studies reviewed fail to explain the situation within the context of Malaysia.

Meanwhile, in Malaysia, studies have discussed the role of *masjids* as places of refuge during natural disasters, such as floods. Zainol et al. (2022) debated the importance of *masjids* in protecting flood victims. The *masjid* serves not only as a place of worship for the Muslim community but also as a center for welfare and safety, regardless of religious background. Additionally, some studies have explored the role of *masjids* during the COVID-19 outbreak through initiatives aimed at assisting the community. Mahat et al. (2022) and Ikhmal et al. (2020) explained the role of *masjids* in Malaysia during the period of the Restriction Movement Control Order (RMCO) due to the ongoing COVID-19 pandemic. Meanwhile, Remly et al. (2021) discussed the important roles and responsibilities that must be taken by the *masjid* management and congregation members to address the COVID-19 outbreak, ensuring the safety of the *masjid* for congregational visits. The study highlighted the critical relationship between *masjid* administrators and congregations in controlling the risk of infection. However, these studies are limited to certain areas and do not elaborate on specific aspects of disaster management. The data discussed in these studies primarily derives from observational field studies.

Some studies suggest combining the concept of cooperation, known as *ta'āwun*, with the management practices of *masjids*. According to Matandra et al. (2020), implementing *ta'āwun* in *masjids* can assist in reducing the economic crisis faced by poor communities, as the *masjid* can function as a center for civilization. Meanwhile, Dahlan et al. (2021) conducted a welfare aid project through Masjid al-Syakirin Gombak, Selangor, which served as the main platform for executing aid based on the practice of *ta'āwun* between donors and recipients. The project involved the community around the *masjid* and included various welfare aids such as food donations during the RMCO period of COVID-19.

It is widely recognized that *masjids* play an important role in their communities, particularly in providing relief aid and managing disasters. Specifically, this study focuses on the role of *masjids* in Malaysia during the COVID-19 pandemic and the great flood. While there have been some studies on similar topics, they are limited and require more in-depth research (such as Ikhmal et al., 2020; Mahat et al., 2022; Sheikhi et al., 2021; Zainol et al., 2022). One area that needs further exploration is the role of *masjids* in providing community welfare assistance during disease outbreaks and natural disasters. A study by Dahlan et al. (2021) has similar goals to this study, but it focuses only on one *masjid* and its experience in providing basic food items. Therefore, it is possible that the roles of other *masjids* in different locations could differ.

Based on newspaper reports from 2020 to 2021, it has been observed that *masjids* in Malaysia are striving to become centers for extending welfare, especially to the needy community and managing disasters. It is evident from the cooperation that was shown throughout the COVID-19 MCO period and during the floods in 2021, where various parties, particularly houses of worship of different religions, played a significant role in providing welfare assistance to the community ("Banjir: Masjid, kuil jadi pusat transit", 2021). It has led to the idea of conducting a study to understand the role of masjids in disaster management and how they can help the community prepare for future disasters. The study will focus on disaster management based on the experience of selected masjids across Malaysia, particularly during the COVID-19 MCO and the major floods that hit the country.

METHODS

This study utilized a qualitative method, focusing mainly on in-depth interviews. It was a case study, with the informants' experiences being the primary focus. The case studies were obtained by conducting in-depth interviews with 14 informants representing *masjids* from each state in Malaysia, as shown in Table 1. Most selected *masjids* were those that had won the Best Masjid award in Malaysia in 2021 (JAKIM, 2021). However, a few that were not among the best *masjids*, such as those in Malacca, Kuala Lumpur, Terengganu, and Sarawak, were also included. Each

transcription document was assigned a reference number to facilitate a more structured and systematic data analysis process. The reference number also helped the researcher code the discussion process without revealing the original name of the *masjid*.

The study used three methods to obtain interview data from *masjid* informants. The first method was face-to-face, where the researcher met the informant in person. The second method was virtual, conducted through Webex software, for informants from Sabah. The third method was through a questionnaire, which an informant from Sarawak completed. The reason for selecting these *masjids* was to gather informants' experiences in matters related to disaster management and to gain insights from *masjids* across every state in Malaysia.

After collecting field data, researchers used a thematic analysis approach to identify themes in the content of the interviews. This approach, as suggested by Braun and Clarke (2022), helps to find themes through the collected interview data. The original transcriptions are not included in the study to ensure that the writer can clarify the real meaning conveyed by the informant. Instead, the researchers arranged all ideas according to themes, making them easier to understand than the original transcription, which can be too long or general. It is important to note that this study does not aim to make generalizations about a particular state or group.

Table 1
The demography of masjid informants

No.	Institution	State	Reference number	Date and time of interview
1.	Masjid Abdullah Fahim, Kepala Batas	Pulau Pinang	Inf01-M	22 February 2023 10.00 a.m. (Physical)
2.	Masjid Jamek Pengkalan Hulu	Perak	Inf02-M	7 March 2023 12.00 p.m. (Physical)
3.	Masjid Ar-Rahmah	Melaka	Inf03-M	15 March 2023 9.00 p.m. (Physical)
4.	Masjid Zaid Haritsah	Kuala Lumpur	Inf04-M	27 March 2023 10.00 a.m. (Physical)
5.	Masjid Kota Damansara	Selangor	Inf05-M	29 March 2023 3.00 p.m. (Physical)
6.	Masjid Putra Nilai	Negeri Sembilan	Inf06-M	31 May 2023 10.00 a.m. (Physical)
7.	Masjid Ismail Petra	Kelantan	Inf07-M	3 June 2023 11.00 a.m. (Physical)
8.	Masjid Pangkalan Pandan, Chukai	Terengganu	Inf08-M	7 June 2023 9.00 p.m. (Physical)
9.	Masjid Taman Temerloh Jaya	Pahang	Inf09-M	9 June 2023 10.00 a.m. (Physical)

Table 1 *(Continue)*

No.	Institution	State	Reference number	Date and time of interview
10.	Masjid Al-Jawahir	Johor	Inf10-M	21 June 2023 10.00 a.m. (Physical)
11.	Masjid Imam Haji Hashim	Sabah	Inf11-M	21 July 2023 9.30 a.m. (Online)
12.	Masjid As Sobirin	Perlis	Inf12-M	27 July 2023 5.00 p.m. (Physical)
13.	Masjid Sharifah Fatimah	Kedah	Inf13-M	28 July 2023 9.00 p.m. (Physical)
14.	Masjid Jamek Negeri Sarawak	Sarawak	Inf14-M	31 January 2024 (Report)

Source: Authors' work

RESULTS

The interview results in the field are summarized in a schedule.

Table 2 explains the list of *masjid* roles arranged according to themes of services, health, placement, incentives, and infrastructure related to *masjid* management. These themes are based on informant interview data. The themes presented are adaptations from several studies collected by Sheikhi et al. (2021), which gather studies on aspects of disaster management. Based on the findings, it can be said that the themes identified are common practices in most *masjids* in Malaysia. Observations in related *masjids* support this explanation and have been widely discussed in academic literature (e.g., Sheikhi et al., 2021; Ikhmal et al., 2020; Mahat et al., 2022; Zainol et al., 2022). However, the unique aspect of

Table 2
The role of masjid in disaster management

Role (Adapted from Sheikhi et al., 2021)	**COVID-19** (Informant experience)	**Great flood** (Informant experience)
Services	Masjid volunteers to the field. Sending aid to homes. Managing the deceased. Helping hospitals.	Pick up and deliver to the Temporary Placement Center (TPC). Providing lifeboats. Masjid volunteers to the field. Collaboration with safety agencies (e.g., police, firefighters).
Health	Health equipment (e.g., wheelchairs, walking sticks). Critical illness assistance. Basic medical assistance. Counseling sessions. Hospital collaboration.	Basic medical assistance. Health equipment (e.g., wheelchairs, walking sticks). Counseling sessions.

Table 2 *(Continue)*

Role (Adapted from Sheikhi et al., 2021)	**COVID-19** (Informant experience)	**Great flood** (Informant experience)
Placement	Food aid transit center.	Transit center for flood victims.
Incentives	Financial assistance. Clothes. Cooked food. Help with essential goods (e.g., sugar, rice, oil, clothes) Food bank.	
Infrastructure	Restroom. Toilet and bathroom. Women's and men's rooms. Multipurpose hall Kitchen. Expansive yard.	

Source: Authors' work

this study, as referenced in Table 2, is the combination of the COVID-19 disaster and the great flood. This combination is summarized based on the experience of the study informants to produce a discussion that is different from previous studies.

DISCUSSION

The role of *masjids* in disaster management is crucial in managing the community's situation during emergencies. Therefore, the discussion of these findings will be detailed according to the themes identified.

Services

The service a *masjid* provides involves implementing programs and initiatives by the *masjid's* administrators or committee. In simpler terms, it refers to the management provided by the *masjid* committee in handling community activities, including disaster management matters (Yusof et al., 2023). In this study, services are viewed as initiatives involving human resource management. The *masjid* committee plays a crucial role in handling welfare aid, encompassing material assistance and physical efforts (Radwan, 2020).

Informant *masjids* provide services as part of their welfare initiatives for the community. These services are implemented during emergencies such as floods and the COVID-19 MCO. *Masjids* assist those in need and deploy volunteers to the field. For instance, during the COVID-19 MCO period, volunteers delivered food directly to recipients' homes and supported hospitals by providing free meals. They also collect special welfare funds and disseminate information to the community (Inf03-M; Inf04-M; Inf05-M; Inf06-M; Inf08-M; Inf09-M; Inf11-M; Inf12-M; Inf13-M; Inf14-M). In addition, some *masjid* informants volunteer to assist hospitals in

handling the corpses of COVID-19 patients. (Inf01-M; Inf02-M; Inf03-M; Inf05-M; Inf07-M; Inf11-M; Inf12-M; Inf13-M).

During the flood, the informant *masjid* actively participated in the rescue missions. They collaborated with rescue agencies such as the police and firefighters and also operated independently using boats provided for emergency needs (Inf05-M; Inf08-M). Volunteers were sent to help flood victims stranded and facing difficulties moving due to the floodwaters (Inf01-M; Inf04-M; Inf05-M; Inf06-M; Inf09-M; Inf10-M; Inf11-M; Inf12-M). This situation illustrates that the informant *masjid* does not focus on a single aid initiative but diversifies the types of aid services it offers to ensure the community's welfare is consistently supported.

Health

Health is a necessity that *masjids* need to address. It coincides with the role of the *masjid* as a center of community gatherings, aiming to minimize the risk of infection among attendees. In addition, prioritizing health ensures the community's overall well-being, encompassing physical, mental, and social aspects, thus transforming the *masjid* into a healthy environment where community members can interact safely. Although traditional *masjids* were not venues for specialized medical care, especially for high-risk diseases, nowadays, many *masjids* have taken the initiative to offer health assistance to their communities (Mustafa et al., 2017).

Regarding the case of the informant *masjids*, some assistance was provided in the form of medical aid, health equipment, and counseling sessions. During the COVID-19 MCO and floods, several informant *masjids* provided equipment to assist with medical needs. The *masjid* acted as a 'middleman' to help health institutions provide necessary medical assistance. Some informant *masjids* provided medical equipment for minor illnesses or specific medicines to particular patients, as requested by the hospital (Inf02-M; Inf06-M). The hospitals permitted the *masjid* to distribute special medicines for certain patients with high blood pressure, diabetes, and other ailments. Patients could visit the *masjid* to obtain their medicine directly. The *masjid* also provided emergency preparedness medicines for minor illnesses required by the community.

The second example involves health equipment such as wheelchairs, beds, and canes for patients (Inf01-M; Inf12-M). Sometimes, certain communities require such equipment, but obtaining it can be challenging during disasters. In such cases, the *masjid* takes the initiative to store the equipment for those in need, allowing them to use it at home until they recover or no longer require it.

Thirdly, the *masjid* offers counseling sessions by an informant with expertise in conducting such sessions (Inf05-M). Some individuals may have experienced trauma due to floods or feel stressed during the COVID-19 MCO. Therefore, the *masjid* conducts sessions to listen to expressions

and provide useful advice to those in need. These counseling sessions are open to anyone requiring support, whether it pertains to disaster-related or personal matters such as family issues.

Placement

The *masjid* provides a place for the community to rest temporarily and acts as a transit center for those traveling or in an emergency (Asif et al., 2019). Travelers can stop at the *masjid* to rest during their long journeys, while those in an emergency, such as those affected by floods or fires, can use the *masjid* as a temporary shelter (Bangsawan et al., 2019; Utaberta & Nasif, 2017). Thus, this study focuses on the second situation, where the *masjid* is a transit center during disasters. The *masjid* serves as a place for the community and as a center for emergency assistance. The informant's experience at the *masjid* provides insight into this situation.

The informant *masjid* initiative exemplifies a community coming together to assist those who lost their homes during a flood disaster. They provided temporary sites, rooms, and spaces to accommodate those affected by the flood (Inf05-M; Inf07-M; Inf08-M; Inf12-M). The informant *masjid* transformed into a Temporary Placement Center (TPS) as it was not severely affected by the flood and still could help the community. Some *masjid* informants volunteered outside their immediate area to assist other flood-affected regions. Moreover, informant *masjids* provide special rooms or spaces for individuals who lost their homes due to other disasters such as fires (Inf01-M).

During the COVID-19 Movement Control Order (MCO), an informant *masjid* was established as a food transit center to distribute food aid to the community. This initiative was undertaken by various informants based on experiences gained during the MCO nationwide. Unlike the flood situation, where only a few informants were involved, the informant *masjid* took the lead in becoming a food transit center. It was accomplished through sponsors' donations or the *masjid's* initiatives to assist the community.

Incentives

Incentives can take the form of material gifts or rewards given to someone in exchange for specific work or services. In this study, incentives refer to the contributions made by *masjids* to support the community's needs, such as providing financial aid, food, or necessities (Rijawanti & Fadloli, 2019). The nature of these incentives can vary depending on the *masjid's* ability and capacity to provide support based on the community's needs.

Throughout the disaster, the informant *masjids* extended several types of incentives to the community, including financial assistance, goods, and food. The method of providing incentives varied, whether through direct gifts, coupons, or similar means. The type of incentive provided also depended on the community's circumstances and current needs. Financial incentives were the most common and easiest form

of assistance provided by most informant *masjids*, as money allows for easy allocation based on specific needs (all informants). The informant *masjids* offered financial incentives in two significant situations: first, during disasters such as floods or the COVID-19 MCO, and second, as monthly incentives given in the form of money to the main beneficiary groups such as the *asnaf* group, orphans, and others. Along with helping the community in need, the executors and volunteers of the *masjid* were also given coupons or tokens in place of cash for their contributions and devotional services (Inf01-M; Inf06-M; Inf13-M). Some informant *masjids* opted to provide coupons as monthly assistance instead of money to the *asnaf* group (Inf06-M).

Informants have reported providing incentives in the form of goods such as clothing, bedding, basic food items, and others, in addition to financial incentives, depending on the current situation (all informants). For instance, financial assistance may be less effective during disasters like floods, prompting *masjids* to offer goods that better meet the local community's needs. Similarly, during the COVID-19 lockdown and floods, *masjids* served as locations where the community could access cooked food. Community members visited the *masjid* to collect pre-prepared food packages, given the restricted movement outside homes during lockdowns. *Masjids* also distributed cooked meals to flood victims, whether temporarily staying in the *masjid* or their safe homes. Additionally, a food bank was established at the *masjid* with essential items such as oil, rice, and fast food to meet the needs of those in distress.

Infrastructure

Infrastructure is a crucial aspect of any *masjid*. It is meant to provide the necessary facilities and comforts to those who visit the *masjid*. These facilities are not only for those who come to perform their prayers but also for people who use the *masjid* for social gatherings and other ceremonies. Moreover, the infrastructure is designed to cater to the needs of the elderly, disabled, and children (Aji et al., 2022). Some facilities typically found in *masjids* include prayer rooms, toilets, ablution rooms, women's rooms, and multi-purpose halls. Providing such facilities is essential for creating a comfortable and convenient environment for the community. It makes the *masjid* a focal point for the community to gather, pray, and strengthen relationships (Hoelzchen, 2022). It is noteworthy that *masjid* infrastructure can also be used during emergencies, especially in *masjids* that have never previously experienced calamities. This observation stems from the experiences reported by the informants at their *masjids*.

Based on the informants' experiences at their *masjids*, the existing infrastructure and equipment serve not only for comfort but also prove highly useful during emergencies (all informants). For instance, during the COVID-19 MCO and floods, the community utilized all facilities, including multi-purpose halls, rooms, boarding houses, kitchens, and large areas of the *masjid* grounds. During the

COVID-19 MCO, for example, volunteers used the kitchen to prepare food distributed to the community. Similarly, basic food items such as rice, oil, sugar, and others were stocked in a food bank for distribution to those in need. During the flood season, the utilization of infrastructure becomes even more significant. *Masjids* serving as temporary shelters utilize numerous rooms, halls, open spaces, and kitchens to temporarily accommodate affected individuals. Therefore, the availability of this infrastructure is essential not only during normal times but also during emergencies such as disasters.

The management of informant *masjids* is not a new finding; however, it has become more common in Malaysia. This study examined the experiences of *masjids* who acted as informants and compiled the information to create a disaster management system. These systems are managed by experienced *masjids* who are aware of emergencies, especially during COVID-19 MCO and floods. Both disasters require different methods of societal management. For example, during the COVID-19 MCO, people were restricted from leaving their homes, whereas during floods, affected communities had to relocate to safer areas. Thus, the *masjid* becomes the frontline and intermediary for agencies assisting the community in both scenarios. Therefore, this study combines these two situations and proposes "*masjid*-based disaster management" as a beneficial action plan. This approach aims to ensure the long-term prosperity of communities in the face of any disaster.

CONCLUSION

Disaster is an unfortunate occurrence that cannot be foreseen or anticipated. Everyone must be prepared to reduce the risks involved, especially when it comes to human life. It underscores the significant role of *masjids* as part of institutions leading disaster management efforts within society. Malaysia's current experiences highlight various agencies and institutions' determination to curb the spread of COVID-19 and help flood victims by providing aid to those affected.

The role of a *masjid* in Malaysia is significant as a religious institution that helps the country alleviate community situations, either as a mediator to health and safety agencies or as a direct initiative from the *masjid* to the community because *masjids* are present everywhere, both in urban and rural areas, making it easier for people to access them. Although some *masjids* have been affected by disasters, many continue highlighting their functionality in supporting communities in times of need. This situation exemplifies the constructive relationship between the community and *masjids*.

Therefore, it is essential for *masjids* to be active in disaster management and use this opportunity to map out a more holistic strategy to prove that *masjids* can meet people's spiritual needs and also defend the fate of all parties through human empowerment actions to achieve economic, social, and environmental sustainability.

Research Implications

The study discusses the implications derived from the informants' experiences.

The findings indicate that aspects of *masjid* management can provide practical assistance at the grassroots level. *Masjid* management involves a systematic approach to coordinate, strategize, and monitor resource allocation, task execution, and operational functions within the context of a religious institution. It is important because the *masjid* links religious believers' spiritual mission and the institution's administrative system, which implements a strategy to achieve objectives. *Masjid* management encompasses organizational and administrative tasks that are performed to ensure the smooth operation of the institution. It extends beyond financial aspects to include action plans in which the community can actively participate. Therefore, *masjid* management involves various tasks similar to the experiences shared by the informants regarding the management of their *masjids* during emergency periods.

Secondly, the importance of preserving community welfare is highlighted. Welfare refers to efforts to provide a basic level of well-being through social services like healthcare, education, infrastructure, vocational training, and public housing. In a welfare state, the government assumes responsibility for ensuring these services' provision, thereby ensuring its citizens' well-being. Social work is crucial in achieving this objective, especially in assisting those in need during times of crisis, such as the COVID-19 pandemic and floods. This study focuses on the efforts made by *masjids* to extend welfare assistance to the needy, taking into account the needs and problems the target group faces. The implications of this study will depend on the effectiveness of the methods used to reach out to the community and address their needs.

Thirdly, realizing the Sustainable Development Goals (SDGs) through the role of *masjids* aligns with the core values of religion, which plays a vital role in advancing the mission of the SDGs. Religion has significantly shaped human thought and action since the beginning of human civilization and continues to strongly influence society today. The belief systems promoted by religions contribute significantly to addressing contemporary global challenges, exemplified by the 17 Sustainable Development Goals (SDGs) that form the spirit of the 2030 agenda. These goals, which include justice, peace, and unity, resonate across nearly all religious traditions. In Islamic tradition, *masjids* promote healthcare, reduce poverty, emphasize education, and preserve society's welfare for a long time. Based on the experiences of the study's informants, all informant *masjids* implement the 17 SDGs, reflecting the integral role of Islam in shaping society and tackling global challenges.

Limitations and Recommendations

This study has several limitations as it only focuses on disaster management related to the COVID-19 pandemic and floods. The findings obtained from the research only revolve around five themes that are related to the results of interviews conducted

with informants. These themes align with the experiences of selected *masjids* in handling disaster situations, adapted from Sheikhi et al.'s (2021) study as previously discussed. However, the research does not cover the entirety of Malaysia. Although the study takes information from all states, the experiences gained from one area may differ.

After analyzing the abovementioned limitations, the study proposes recommendations for future studies. Firstly, future studies should adopt a holistic, practical, and comprehensive approach. "Holistic" refers to emphasizing religious perspectives, "practical" suggests findings that can be put into practice at the field level, and "comprehensive" indicates long-term and multi-faceted effects. Secondly, future studies could expand the number of experienced informants to obtain more comprehensive and diverse data. For instance, each state could include five to ten experienced informants. Thirdly, *masjid* management could be expanded to include community welfare aspects. While this study focused on disasters, future research could explore *masjid* management in community welfare by examining implementation factors, initiatives, and aid recipient groups, potentially yielding more diverse and interesting findings.

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Determinants of Sustainable Rural Community-based Value Chains

Norziani Dahalan*, Nurul Najwa Syafiah Ramlee, Mohd Faiz Hilmi and Fatimah Hassan

School of Distance Education, Universiti Sains Malaysia, 11800 USM, Penang, Malaysia

ABSTRACT

Failure to understand business from a value chain perspective was identified in the National Entrepreneurship Policy 2030 as one of the challenges that need to be addressed for an entrepreneur's sustainability. Value chains refer to the activities that add value at each stage in developing, producing, and delivering quality products to customers. This paper aims to identify the determinants of effective and sustainable factors that underpin rural community-based value chains in their business conduct. In achieving these objectives, the methodology includes a case study on the Warisan Dapur Lenggong Business Project in Lenggong, Malaysia, library searches, and an analysis of previous literature reviews on value chains and community-based small businesses. The finding shows that factors contributing to the success of rural entrepreneurs in value chains can be categorised into internal and external patterns. Internal individual factors include entrepreneurial culture, skills and knowledge, adaptability, continuous improvement and Innovation, networking and collaboration. In contrast, internal community factors include community, leadership, local association and staff support, value proposition and differentiation, financial management, community resilience and perseverance. In comparison, external factors include access to market information, technology and infrastructural limitations, political influence and government policy. This paper also hopes to strengthen the body of knowledge on how effective value chains help entrepreneurs achieve sustainable competitive advantage as one of the agenda for 2030 Sustainable Development and for making Malaysia a higher-income and civilised nation.

Keywords: Community-based small business, Lenggong Malaysia, rural entrepreneurs, sustainable development, value chains

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E-mail addresses:
norziani@usm.my (Norziani Dahlan)
najwasyafiqah@student.usm.my (Nurul Najwa Syafiah Ramlee)
faiz@usm.my (Mohd Faiz Hilmi)
hfatimah@usm.my (Fatimah Hassan)
*Corresponding author

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INTRODUCTION

Every company has its business chains because each business involves activities that transform inputs into highly valuable customer outputs. A chain system is a management concept that explains the interconnectedness or relationship of multiple segments to strengthen the organisation involved, transform and increase value and service offerings to meet consumer demand, and have a continuous competitive advantage. According to Murphy et al. (2020), value chains refer to the various activities that add value at each stage of developing, producing, manufacturing, and delivering quality products to customers. In simple terms, a value chain refers to the series of activities a company undertakes to develop and deliver a product or service to its customers. It includes various stages, such as sourcing raw materials, manufacturing, distribution, marketing, and customer service (Liu et al., 2023; Paul & Shrivastava, 2015). In this regard, improving the value chain in a company is crucial and cannot be taken for granted by companies. It must also be regularly explored to transform and enhance the value and services offered to achieve high performance, satisfy user demand, and have a continuous competitive advantage (Murphy et al., 2020).

The importance of the value chain to the economy is undeniable. In Malaysia, the inability to understand businesses from a value chain perspective was cited in the National Entrepreneurship Policy 2030 as one of the challenges that need to be addressed in terms of business sustainability (Malaysia, 2020). From a global perspective, Global Value Chains (GVCs) were disrupted when the global pandemic of COVID-19 affected one or more company's clusters of entities in the value chain (Organisation for Economic Cooperation and Development [OECD], 2021). During the pandemic, many countries' domestic value chains are also affected when countries implement export bans and reduce demand for products produced in other countries. According to Liu et al. (2023), a few studies have shown the importance of exploring the relationships between value chains and related community outcomes from all over the world, such as in China, Nicaragua and South India, highlighting the need to combine the development of the value chain while addressing livelihood and community development concepts such as asset building, vulnerability and well-being, and where necessary to build crucial institutions such as co-operatives because value chain restructuring is affected by local historical, social and environmental factors.

Therefore, value chain issues should become increasingly relevant and important for all businesses, especially small businesses in rural areas. Unfortunately, value chain issues for small businesses in rural areas are often under-researched and often taken for granted by stakeholders. It has become the practice of policymakers and implementers in Malaysia to generalise the policies and programmes they develop in all areas and regions in Malaysia (Gould, 2018). The fact is that a programme designed, developed

and successfully implemented based on the conditions of one place may not necessarily be suitable and successful for another community due to the differences between urban and rural characteristics, citizens, leaders and locations. Local customs and culture, as well as administrative structures and political sensitivities in the immediate neighbourhood, must be taken into account. The same applies to the chain system for community-based entrepreneurs in the rural business sector, which needs further exploration.

Community-based entrepreneurship is a growing concept in entrepreneurship research that capitalises on the demand for community involvement in business development. Community-based entrepreneurs are individuals or businesses that operate within a specific community and focus on the needs and desires of that community. In other words, personal networking that impacts the local start-up process and regional development has fostered community-based entrepreneurship. Gurau and Dana (2018) and Jaafar et al. (2020) describe community-based entrepreneurship as a form of local entrepreneurship based on environmental stewardship, social responsibility, collective action and traditional values of mutual support. They are driven by a desire to positively impact their local environment rather than focusing solely on profit. These entrepreneurs may start businesses that offer goods or services specifically tailored to the community's needs, such as local farmers' markets, small neighbourhood shops, or social enterprises that address local social or environmental issues. They often work with community members and organisations to create sustainable and mutually beneficial relationships.

Three main characteristics of community-based entrepreneurship are (1) available skills in the community, (2) diverse goals and intentions, and (3) community involvement (Galappathti et al., 2017). Therefore, community-based entrepreneurs play an important role in promoting economic growth, social cohesion and the overall well-being of their communities. Supply, demand and value chains are becoming increasingly important for all entrepreneurs, regardless of where they are based, including community-based entrepreneurs, as they form the cornerstone of entrepreneurs' business sustainability. The literature review revealed that several studies address aspects of this chain in the tourism sector (Damodar et al., 2019; Diah Ayu & Siti Rahayu, 2018; Rajashekariah & Chandan, 2013). However, most of these studies were only conducted by organisations and product operators in urban areas. The reading revealed that the contribution of the local community in the form of groups rather than individual entrepreneurs and intermediation received less attention and was studied even less in rural areas (Szpilko, 2017).

Therefore, this article aims to explore the factors that contribute to the success of community-based enterprises in rural areas and to try to understand the determinants of effective and sustainable factors that support the performance of community-

based value chains in rural areas in terms of their business behaviour and resilience. This work can contribute to the literature on value chains among rural community-based entrepreneurs in a case study in Malaysia. It is hoped that this development will expand and strengthen knowledge. This study will help rural communities develop their human sciences to cope with future problems. The value chain research mainly focused on the structural elements of production and neglected the elements of humanity and adaptability.

These elements could promote local identity, create employment opportunities and contribute to poverty alleviation by improving income opportunities within the community. They can also help preserve traditional knowledge and practises, promote sustainable resource management, and strengthen social cohesion by encouraging economic activity in urban or rural areas. When integrated into a well-managed value chain, human research can contribute to academic knowledge and improve human life, community progress, social change, and solutions to pressing global problems, particularly poverty alleviation and sustainability.

In today's global landscape, the preservation of high civilisation and the advancement of humanity depends crucially on the ability to address not only environmental challenges but also pressing socio-economic, legal and ethical issues of human values and business practices. Our study focuses on an area where there are numerous opportunities to promote positive change at both the local and global levels. By examining the complex dynamics of value chains in rural communities, we aim to contribute to academic discourse and practical efforts to improve human well-being, preserve cultural heritage and maintain the integrity of human civilisation. This endeavour aligns seamlessly with the theme of this special issue: "Research on Humanity, Fostering the Preservation of High Civilization through Impactful Scientific." Linking our study to this theme is not merely a matter of academic convenience; it reflects our deep-rooted belief in the transformative power of science when used with empathy and foresight. By examining the dynamic of value chains in rural communities, our research emphasises the as we explore the dynamics of rural community-based value chains; our research emphasises the interconnectedness of humanity's collective efforts to build a better future. Through our analysis, we hope to provide insights that can expand academic knowledge, inform policymakers, inspire grassroots initiatives, and drive positive change in communities worldwide. In this way, we reaffirm our commitment to the enduring values of humanity and the preservation of a civilisation based on compassion, innovation, and scientific research.

LITERATURE REVIEW

Concepts of the Value Chain

Entrepreneurs recognise opportunities in the market and take risks to create new businesses or improve existing ones. They

play a crucial role in value chains by introducing innovative ideas, technologies and business models. A value chain encompasses the entire coordinated chain of activities in a company, including the stages from the development of ideas and concepts for a product or service through distribution to consumption at the end and after use by the consumer (Murphy et al., 2020; Collier et al., 2017). This range of activities includes different stages in which input-output transformation and distribution are carried out at different stages to complete the desired life cycle of the product or service (Collier et al., 2017). According to Nabi et al. (2023), the value chain has multiple spatial embeddings due to the geographical dispersion of activities in the value chain.

The geographical dispersion of activities within the value chain has made it possible to correlate regions' different levels of participation in the value chain with their economic and social development (Nabi et al., 2023). Whether urban or rural, entrepreneurs often recognise gaps or inefficiencies in existing value chains and seek to address them through their ventures. They bring together capital, talent and technological resources to create value-added products or services. In this way, they contribute to the overall growth and development of the economy. It is important to realise that entrepreneurs face various challenges along the value chain. These challenges include managing business operations, raising capital, understanding market dynamics and securing human resources.

However, their ability to adapt, innovate and create value characterises them and drives economic progress. To summarise, value chains encompass producing and delivering products or services. In other words, the value chain can be used as an analytical tool to understand the links between the actors in a chain (Lowitt et al., 2015; Liu et al., 2023). At the same time, entrepreneurs are the people who drive innovation and create value within these chains. Their contributions are critical to economic growth and the potential impact on development.

The Significance of the Value Chain

A value chain is generally understood to be the relationship between actors, activities, processes, markets and their contributions to completing the life cycle of a product or service. Therefore, knowledge of value chains is important for rural entrepreneurs for several reasons (Collier et al., 2017; Liu et al., 2023; Murphy et al., 2020). Firstly, understanding value chains helps entrepreneurs to recognise opportunities for value creation in their local environment. By understanding the different stages and actors in the value chain, rural entrepreneurs can identify potential areas for innovation, cost reduction, or quality improvement.

Secondly, knowledge of the value chain enables rural entrepreneurs to build strategic partnerships and collaborations. By understanding the interdependencies and relationships between the different actors in the value chain, entrepreneurs can identify potential suppliers, buyers, or distributors.

This knowledge helps them to build strong networks and establish mutually beneficial relationships to improve their market access and competitiveness.

Thirdly, knowledge of the value chain enables rural entrepreneurs to make informed decisions about allocating resources and investments. By understanding the value chain dynamics, they can identify critical points where investments yield the highest returns. This knowledge helps them optimise their use of resources, whether introducing technologies, production processes or marketing strategies.

In addition, knowledge of the value chain helps rural entrepreneurs recognise potential bottlenecks or constraints within the value chain. By understanding these challenges, they can proactively develop strategies to overcome them, such as improving infrastructure, enhancing their skills, or obtaining financial support. This knowledge enables entrepreneurs to navigate the complex value chain and effectively mitigate risks. In rural areas, value chains often revolve around agriculture, forestry, crafts or other locally available resources. They can be driven by smallholder farmers, artisans or entrepreneurs who use their skills and knowledge to create value-added products or services. These value chains are deeply rooted in the local context, culture, and traditions and play an important role in the rural economy and communities.

Rural community-based value chains refer to activities and relationships within a particular rural community that contribute to creating, producing, and distributing goods or services. These value chains typically involve local producers, suppliers, processors, traders and consumers working together to create economic opportunities and improve livelihoods in the community. Community-based value chains offer several benefits (Murphy et al., 2020; Liu et al., 2023). They promote local entrepreneurship, create employment opportunities and contribute to poverty alleviation by improving income opportunities within the community. They can also help preserve traditional knowledge and practises, promote sustainable resource management, and strengthen social cohesion. However, rural value chains at the community level also face challenges. Limited access to finance, infrastructure, technology, and markets can hinder their development. Lack of skills and capacity, as well as inadequate support services, can also be an obstacle. Overcoming these challenges requires the cooperation of various stakeholders, including government agencies, NGOs, and private sector actors.

To summarise, rural value chains are essential for economic development and poverty reduction in rural areas. They empower local communities, promote entrepreneurship and harness local resources to create sustainable economic opportunities. By addressing challenges and fostering collaboration, these value chains can contribute to rural communities' overall well-being and resilience. By utilising this knowledge, rural entrepreneurs can improve their competitiveness, create sustainable businesses and contribute to the economic development of their communities.

Value Chain and Entrepreneur Sustainability

According to Murphy et al. (2020), Barua et al. (2021), and Liu et al. (2023), value chains are important for the sustainability of community-based entrepreneurs for several reasons, including economic development, market access, knowledge and expertise, collaboration and networking, and sustainability and resilience.

In terms of economic development, value chains provide opportunities for community entrepreneurs to start and grow their businesses, leading to local economic development. Participating in value chains allows these entrepreneurs to tap into larger markets, gain access to new customers, and increase their revenue and profitability. It creates employment opportunities, increases income levels and contributes to the overall economic well-being of the community.

In terms of market access, value chains could provide community entrepreneurs with access to established distribution networks, allowing them to reach a larger customer base. It helps overcome some challenges small businesses face, such as limited marketing budgets or lack of visibility. Involvement in value chains allows entrepreneurs in the community to familiarise themselves with the best practices, knowledge, and experience in the industry. They can learn from other actors involved in the value chain, such as larger companies or more experienced entrepreneurs, and adopt proven strategies for success. It is, therefore, necessary to promote cooperation, trust, and learning between actors in the value chain.

Value chains facilitate cooperation and networking between community-based entrepreneurs. By working with other companies and actors within the value chain, entrepreneurs can form partnerships, share resources, and collaborate on projects. The value chain promotes innovation, creates synergies and opens new avenues for growth and expansion. In addition, networking within the value chain can lead to new business opportunities, referrals and valuable connections within the sector.

According to Barua et al. (2021), value chain sustainability can be described in three dimensions: the economic or profit, social or people and environmental or planet. In terms of the economic dimension, issues related to the value chain are considered sustainable if the required activity plans are commercially viable at the level of each actor or support provider. In the social dimension, sustainability refers to socially acceptable outcomes in terms of the distribution of benefits and costs linked with increased value formation. For the environmental dimension, the ability of value chain actors to have a positive impact and little or no negative impact on the natural environment through their value-creating activities will determine its sustainability. Thus, for sustainability and resilience, entrepreneurs involved in community value chains can benefit from shared resources, collective problem-solving, and risk management strategies.

As the OECD (2021) mentioned, business practices can minimise or worsen value chain disruptions and their

impacts. Even though value chains provide opportunities for business growth, market access, knowledge sharing, collaboration and resilience for entrepreneurs in the community, there is still room for improvement. Therefore, the three stages of value chains, which consist of the upstream stages of the value chain (development and research, high-value production, business practises), the middle stages of the value chain (processes, high-value end-use) and the downstream stages of the value chain (traceability, commercialisation, targeted consumers), need to be widely researched and promoted for better understanding (OECD, 2021). By participating in value chains, entrepreneurs can contribute to local economic development, improve their competitiveness and increase their chances of long-term success. Thus, community-based entrepreneurs are crucial in promoting economic development and humanitarian values by fostering civilisation for a better future.

MATERIALS AND METHODS

Case Study

Our case study was a seven-year multidisciplinary research and development partnership project focussing on community-based entrepreneurs known as Warisan Dapur Komuniti Kampung Luat (WDKKL). This community-based enterprise project adopted a value chain approach in Lenggong Valley, Northeast Perak, Malaysia (see Figure 1). Located in Hulu Perak, Lenggong Valley is a centre of attraction for tourists because there are many historical caves in areas where prehistoric people once lived. The Lenggong Valley was chosen as a study site because it was recognised as a World Heritage Site by the United Nations Educational, Scientific and Cultural Organisation (UNESCO) on 30 June 2012.

Apart from tourism activities based on archaeological sources or archaeological tourism (archaeotourism), the Lenggong Valley could become a potential destination for rural tourism and heritage tourism. Lenggong Valley is also rich in various historical sites (the unique design of Masjid Yahya Ubudiyah and Masjid Jamek Lenggong), agricultural activities (paddy fields, fruits orchards) and cultural events (traditional foods festivals, Orang Asli communities) that can attract tourists to an area and market past events or assets that existed in that area. Thus, the choice of Lenggong Valley as the study area is also aimed at increasing its competitiveness and highlighting its advantages.

In Lenggong Valley, the Community-Based Tourism Entrepreneur (CBTE) programme is an initiative to develop local businesses by transforming their socio-economic way of life. This case study is among the popular CBTE projects in Lenggong Valley. The project is in Kampung Luat and is owned by the Kampung Luat Community Cooperation. The aim of establishing WDKKL is to produce and market traditional foods from the Lenggong Valley and strengthen tourism in the area. The cooperative founded WDKKL in January 2017 to ensure that its traditional local dishes, such as Kebebe, Ikan Pindang

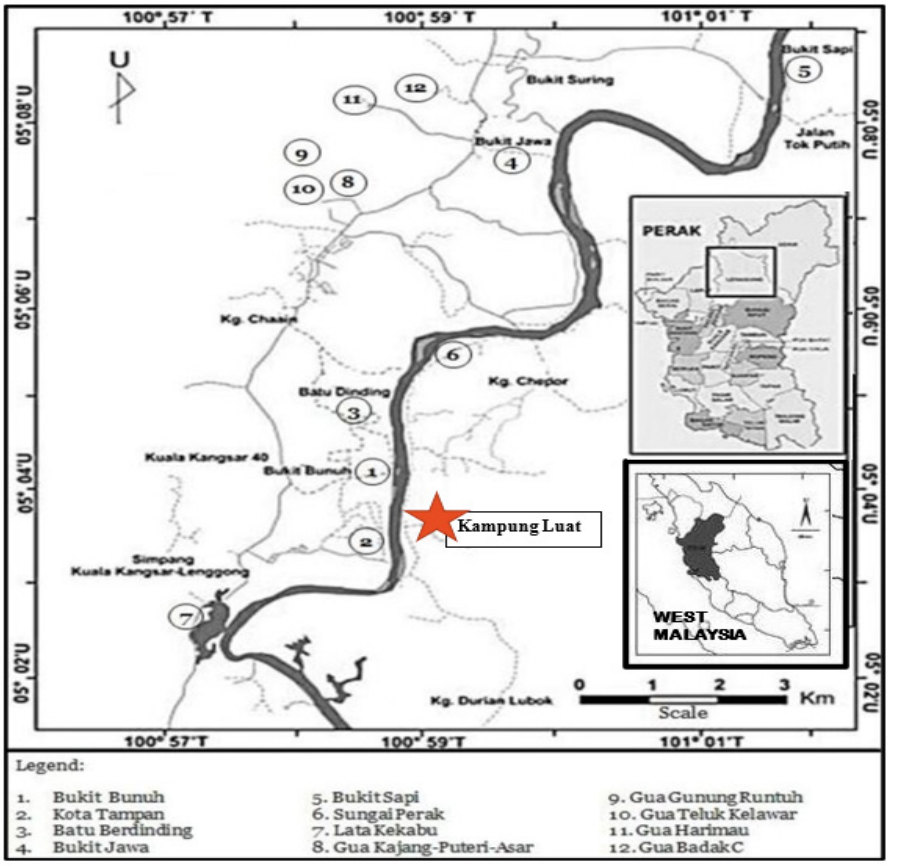

Figure 1. Location of Lenggong Valley, Perak, and the study site Kampung Luat
Source: Rapidah et al. (2018) with amendments

Lenggong, and Sambal Serai, remain on the market and provide an additional attraction for this UNESCO cultural heritage site. Since the establishment of WDKKL, these foods have been produced under the 'Lenggong Delicious' brand and marketed locally and nationally. In 2017, the village was named Bestari Vision Village (Kampung Wawasan Bestari) by the Ministry of Rural Development Malaysia. Thus, CBTE is a practical approach to encourage the community to participate and succeed in entrepreneurial activities.

According to Jaafar et al. (2014), Lenggong residents are engaged in small family businesses, such as handicrafts and food production, with some having been in business for generations. Nevertheless, the contribution of these activities in Lenggong Valley is not particularly large (Jaafar et al., 2021). Therefore, the development of the WDKKL project is justified for the following five reasons. Firstly, a business entity should be created to promote cottage industries and provide new employment opportunities for the community. Secondly,

the traditional heritage of traditional foods can be protected by fully utilising the raw materials available in the Lenggong area. Thirdly, to provide new and relevant activities and products to support tourism development in the Lenggong Valley. Fourthly, to create a new source of income that can prevent the migration of youth to the cities, as youth involvement in nature conservation is an important concern for the Lenggong Valley, and finally, to promote the national development and competitiveness of the Lenggong Valley. This cooperative was selected because of its active collaboration with other institutions and energetic management practices.

Data Collection Techniques

In this study, we rely on two methods of data collection. First, we focused on a library search and document analysis of previous literature on value chains and community-based entrepreneurs when the global COVID-19 pandemic hit the study area. Secondly, in-depth interviews were conducted with 10 out of 15 community members leading the project to obtain their views on the success and challenges associated with the project's value chain, including their experiences, future suggestions and the potential value of their involvement. Only 15 project members were invited to be the research respondents, but only ten were willing to be interviewed. Interviewees were selected to cover all activities involved in the project, from the raw material collectors to the marketers of the products. The profiling of respondents is summarised in Table 1.

Following the interviews, detailed notes and interview recordings were made and transcribed. These were then analysed thematically using descriptive case study categories (Yin, 2017). It is recognised that thematic analysis was undertaken as it can help to identify patterns or themes

Table 1
Profiling of respondents

Profile	Age	Marital Status	Education Level	Year as member	Position in Community	Role or Experience
Respondent 1	66	Married	Primary	6	Active Member	Cooking, Packaging and Sales
Respondent 2	60	Widow	SRP/PMR	6	Active Member ex-treasurer	Cooking and Sales
Respondent 3	64	Widow	Primary	6	Stockist	Cooking, Inventory and Sales
Respondent 4	46	Married	Degree	2	Ex Member	Marketing
Respondent 5	68	Widow	STPM	6	Leader	Involve in all process

Table 1 *(Continue)*

Profile	Age	Marital Status	Education Level	Year as member	Position in Community	Role or Experience
Respondent 6	71	Married	Primary	6	Active Member	Preparation and Cooking
Respondent 7	66	Widow	SRP/PMR	6	Active Member	Preparation and Cooking
Respondent 8	77	Widow	Primary	6	Active Member	Preparation and Cooking
Respondent 9	54	Married	SRP/PMR	6	Active Member	Preparation and Cooking
Respondent 10	63	Widow	SRP/PMR	6	Treasurer	Cooking, Packaging and Sales

Source: Authos' work

within the qualitative data collected. The summary of the research questions includes factors that influence the running of the projects, such as political, economic, social, technological, legal and environmental elements, entrepreneurial characteristics, behavioural collaboration, views of the current state and environment for the product and project direction.

A detailed profile shows that most respondents are 50 or older, as older women from this project. All respondents are female, Malay and Muslim. The education level of most respondents is primary or upper secondary. Since they stay in the village, they do not need to pursue higher education to make a living.

Most respondents have been active members since the project community was built in 2018. Only one interviewee (Interviewee 4) is withdrawing from the project community to focus on her child. There is a leader, a treasurer, a storekeeper and other active members in the project organisation or management. The leader ensures that the process runs as planned smoothly. The leader is also involved in the process from preparation until the final stage as a marketing officer. Usually, the respondents cook the food together in the community workstation in the Kampung Luat Community Retail Hall. Tasks such as preparing raw materials, packaging, sales, and inventory are usually separated.

This qualitative research is using Thematic Analysis. Thematic analysis is a flexible approach that allows researchers to adapt their methods to the unique characteristics of the data. It is widely used in various disciplines to explore and understand patterns in qualitative data. A six-step guide was used to conduct this analysis (Maguire & Delahunt, 2017). These steps include understanding the data, creating initial coding, finding, reviewing, defining, and writing down themes. After examining the codes for patterns, similarities and differences, themes were identified and

analysed. The research themes emerged after organising the codes into potential themes based on common content, such as "the internal" or "external factors" in determining the success factor in the value chain. The final steps involved writing the report to ensure the analysis's credibility, reliability, confirmability and transferability. The report was concluded by presenting the themes found with evidence from the data.

RESULTS AND DISCUSSIONS

Library research and analysis of previous literature on value chains and community-based small businesses shows that the factors contributing to the success of community-based entrepreneurship are categorised into internal and external factors (Table 2). Internal factors that contribute to their success and sustainability include self-determination, attitudes, entrepreneurial skills, communication skills, leadership skills and entrepreneurial cultures (Gurău & Dana, 2018; Jaafar et al., 2020; Murphy et al., 2020; Pinheiro et al., 2020). On the other hand, external factors such as access to finance, social networks and social capital, political commitment and leadership skills are important external factors for community-based entrepreneurship (Hassan et al., 2021; Galappaththi et al., 2017; Sankaran & Demangeot, 2017).

On the other hand, lack of government support, outdated technology, limited infrastructure and oversight, limited market information and lack of financial incentives are the main problems of community-based entrepreneurship (Argyrou & Hummels, 2019; Jaafar et al., 2020; Paul & Shrivastava, 2015). Thus, internal and external factors play an important role in the success and sustainability of community-based entrepreneurship. The result of the library research is summarised and presented in Table 2.

In response to the research question, the result shows that all ten respondents believe that many external influences, such as the

Table 2
Important factors for the success and sustainability of community-based entrepreneurship through library search

Library Search	Factors in Community-based Entrepreneurship	
AAA	Internal factors	External factors
Sankaran and Demangeot (2017)	Resilience and entrepreneurship understanding Promotion of self-reliance, self-governance	Virtual community engagement Forms of social capital Political involvement
Parwez (2017)	Requisite entrepreneurial skills Mutual cooperation Trust in others	Lack of existing capacities at individual levels and groups Multiplicity of local needs Lack of community affiliation
Galappaththi et al. (2017)	Lack of individual opportunity Less entrepreneurial skills Leadership	Lack of capacities at multiple levels Network of Community Cooperatives

Table 2 *(Continue)*

Library Search	Factors in Community-based Entrepreneurship	
AAA	Internal factors	External factors
Gurau and Dana (2018)	Self-determination Real-time action Adaptive initiatives and activities	Resources unavailable Environmental issues Lack of government support

Source: Authors' work

political, economic, social, technological, legal and environmental factors, affect their project development and sustainable business conduct. Respondents believe that this traditional food project can grow with the help of technologies that accelerate food production and packaging. Policy factors such as participation in exhibitions organised by the government can help to promote these traditional foods to the public and increase the demand for traditional foods. However, four respondents do not agree at all with the current situation and environment for the product, which is related to the current situation of raw material supply and environmental degradation in Tasik Raban, as well as political and economic instability. Five respondents agreed that a unique collaborative work culture can influence their business's excellent development and flourishing.

The unique culture of collaboration means that members of WDKKL undertake this project together rather than individually, enabling them to produce products quickly. For example, Respondent 2 said, "I like coming here and working," "I like working in a group so we can get the work done faster" (Respondent 3) and "I like coming every day" (Respondent 5), which shows their close collaboration in completing their tasks. Flexible working hours make it easier for them to fulfil their daily tasks and the activities of the WDKKL project. Almost all respondents agreed with the statement that an effective and efficient organisational/ collaborative working culture has an impact on excellent development and thriving. The work culture of the organisation/cooperative enables the members to perform their duties with commitment and enables the traditional food project to achieve its goals smoothly. This work culture fosters team spirit and strengthens the relationship with each other.

The pattern that emerges from the thematic analysis shows that internal and external factors determine the success and sustainability of entrepreneurs at the community level. Table 3 below summarises the research findings.

Several factors merged as the most mentioned factors accordingly and chosen as themes contributing to the success and sustainability of community entrepreneurs based on the research findings are discussed in detail below:

1. Community, leadership, local association and staff support. The study results show that this factor is the most frequently cited

Table 3
Determining factors contributing to the success and sustainability of community-based entrepreneurs based on research findings

Pattern		Themes
Internal factors	Individual	Entrepreneurial culture, skills, and knowledge
		Adaptability, continuous improvement, and innovation
		Communication and collaboration
	Community	Community, leadership, local organisation, and staff support
		Value proposition and differentiation
		Financial management
		Long-term vision and planning
		Community resilience and perseverance
External factors		Market information (demand and opportunity)
		Networking and collaboration
		Technology and infrastructural limitation
		Political influence and government policy

Source: Authors' work

and important factor contributing to the success and sustainability of entrepreneurs in the community. A supportive and caring community, many credible and committed leaders and organised local groups such as the Kampung Luat Cooperation provide raw material sourcing, local resources, networking opportunities and a customer base. By building strong relationships with community members, committed employees and the cooperative, trust, loyalty and credibility can be built and fostered within the community, leading to sustainable business growth.

2. Entrepreneurial culture, skills and knowledge. The thematic analysis results show that community-based entrepreneurs need a solid foundation of entrepreneurial culture, skills and knowledge to overcome the challenges of starting and running a business. The continuous improvement and development of these skills are essential for long-term success. This finding is consistent with a previous study (Jaafar et al., 2021), which found that the skills needed by entrepreneurs can be categorised into three main areas: personal entrepreneurial skills, technical skills and business management skills. Personal entrepreneurial skills reflect the ability to take risks, creativity, perseverance, innovation and a vibrant vision for growth. In contrast, technical skills include writing, listening, oral presentation, organising, coaching, the ability to be a player, and technical know-how. Business management skills or knowledge include starting, developing, and managing businesses.

3. Understanding market information, such as market demand and opportunities. The study's results showed that recognising and responding to market demand is critical to the success and sustainability of the business. They conducted market research and analyses to understand customer needs, preferences and trends. For example, they have identified market opportunities and adapted their products or services to meet these needs by using e-marketing and repackaging them. Adapting to changing market conditions and customer preferences is essential for sustainable growth.

4. Value proposition and differentiation: Entrepreneurs based in one community need to create a unique value proposition that sets them apart from their competitors, as this traditional cuisine was also made and sold in their neighbouring village. They can attract customers and build a loyal customer base by offering something unique and valuable, like Homestay Rumah Tiang 16. It was mentioned that this homestay regularly serves WDKKL Ikan Pindang Lenggong to its guests as an authentic delicacy that should not be missed. Value proposition and differentiation could also support local businesses by promoting a culture of sustainability and entrepreneurship that can bring about positive change in their community.

5. Financial management: The study results show that sound financial management is crucial for the success of community-based entrepreneurs. Many have attended a short course for entrepreneurs and know their finances well. Access to finance and knowledge of different funding sources can also contribute to success, sustainability and planning for future growth. They should limit their dependence on cooperative capital and political influence. It was mentioned that their financial management skills enable WDKKL members to borrow some funds instead of self-financing to prepare their seed capital. These experiences and findings align with a previous study (Asah, 2015), which highlighted the need for entrepreneurs to develop their management skills, such as financial management, marketing, strategic planning, human resource management, networking and organisational skills (administrative skills).

6. Adaptability, continuous improvement and innovation: Community entrepreneurs are open and adaptable to change to be successful and sustainable. In today's dynamic business world, they need to be able to change, evolve and stay ahead of industry trends and customer expectations. Using new technologies, such as social media platforms as marketing tools and sustainable business models, can also open new opportunities for growth while minimising the negative impact on the environment and society. The admission of inadequate digital marketing skills implies that training in related areas is necessary to improve their marketing strategies. They seem to rely heavily on conventional marketing strategies to sell their products.

7. Networking and collaboration: Building solid networks and collaborating with other businesses and stakeholders can provide valuable opportunities for growth and support. By getting involved in industry associations, attending trade events and local festivals, and joining relevant communities, entrepreneurs can learn from others, form partnerships, access resources and gain visibility. Relationships with other local and state agencies, such as Jabatan Perikanan, FAMA, Kolej Kemahiran Tinggi MARA and Pertubuhan Peladang Kawasan, which have been established as key stakeholders, need to be considered for product improvement and marketing strategies. Utilise participatory approaches that aim to engage local stakeholders and provide opportunities for strategic learning and innovation

8. Resilience and perseverance: Challenges and setbacks often accompany entrepreneurship. Successful community entrepreneurs demonstrate resilience and perseverance in the face of obstacles. They learn from failure, adapt their strategies and maintain a positive attitude. Overcoming difficult times and focusing on long-term goals contribute to their ultimate success. Regular supply chain assessments and monitoring, for example, help identify improvement areas and proactively address potential issues. As part of environmental management, they can also look for opportunities to grow their raw materials and recycle or reuse materials to minimise their environmental footprint. It was mentioned that they sometimes have to look outside their district for their limited raw materials due to ripening times, weather conditions and unstable material prices. These challenges have made them more resilient and persistent.

9. Technological and infrastructural constraints. In the digital age, this technology should be maximised for businesses and not taken for granted. Business owners at the community level should be informed and educated by attending workshops or short courses. Since all respondents are older, they should invite younger employees to help them overcome this problem. Lack of space and other infrastructural constraints were overcome in several steps, most recently by moving to a new shop built by the local authorities. Technological innovations can increase value creation and delivery as well as the company's overall progress.

10. Political influence and government policy. Successful and sustainable entrepreneurs at the community level should be independent of politics and learn from failures. Different governments' policies should be according to their local resources, capacities and capabilities. Previously, WDKKL depended on its politicians, who also chaired the Kampung Luat Community Cooperation. However, due to the unstable political situation in recent years, they were forced to be independent in this matter.

To summarise, successful and sustainable community-based entrepreneurs should continuously evaluate and adapt their strategies to remain competitive and

sustainable in the years to come. Effective management of the entire supply and value chain is crucial for sustainability. Community entrepreneurs should ensure transparency, traceability and fair practises throughout the value chain, from sourcing to distribution. They should work with suppliers and distributors who share the same values and apply sustainable practices. Regular assessment and monitoring of the supply chain can help identify areas for improvement and proactively address potential issues. In this way, community-based entrepreneurs can contribute to the community's social development.

For example, they are creating employment opportunities, even part-time jobs, paying fair wages, providing safe working conditions and offering training and skills development programmes, such as learning new retorting techniques at Kolej Tinggi Mara in Lenggong. They also need a long-term vision and plan to achieve this through regular monitoring, evaluation, and reporting on sustainability performance. By incorporating these sustainability factors into their value chains, entrepreneurs can create community-based businesses that positively impact the environment, society and the overall well-being of their community.

Our study shows that the progress of value chains sets in motion a change process caused by either external or internal factors. It shows how rules, policies, organisations, communities and individuals influence the dimensions of community and livelihood for the benefit of all. Their work culture, participation, and commitment have proven that value chains are built not only on the economic dimension but also on the social and human dimensions. There is a need to combine value chain development with livelihood and community development approaches to build key institutions such as cooperatives, as local historical, social and environmental factors influence value chain restructuring. Similarly, there are many internal influences, such as cooperative behaviour, where the nature of mutual aid, cooperation, non-envy and other factors are important for excellent development and growth. The respondents believe that the members of Kampung Luat always display a spirit of cooperation, helpfulness and tolerance when they do their work together from start to finish.

CONCLUSION

This paper has highlighted two main patterns: internal and external factors contributing to a successful and sustainable community-based enterprise in Malaysia. Various aspects such as support systems, skills and knowledge, financial management, continuous improvement, and innovation were identified as internal determinants that contribute to a successful and sustainable community-based enterprise in Malaysia based on library research and case studies. External determinants include market information (demand and opportunities), networking and collaboration, technology and infrastructure, political influences and government policies.

In conclusion, we hope this study will provide insight into successful and sustainable community-based entrepreneurs and encourage relevant agencies to consider the findings for future practice. Furthermore, the findings of this study suggest that further studies should be conducted in this area to understand and effectively address the issues throughout the supply and value chain, which is critical to the sustainability of the National Entrepreneurship Policy 2030. Awareness of the elements involved in creating a profitable and sustainable value chain will help equip entrepreneurs with knowledge that will help them manage the situation skillfully.

Implications for Theory and Practise

These research findings have several implications for theory and practitioners involved in rural development initiatives. The implications for theory include contributing to the existing literature, integrating multidisciplinary perspectives, and extending existing theories. Implications for practice include community empowerment, business strategies and market opportunities, policy relevance, and capacity and knowledge building for stakeholders.

This work can contribute to the literature on the determinants of value chain success and sustainability among rural community-based entrepreneurs in rural areas, particularly in the context of a Malaysian case study. Our study also contributes to the theoretical framework in rural community-based value chains. By examining the interplay of various internal and external factors within these value chains, we contribute to a deeper understanding of best practices and the lessons learned from different practices and contexts that can be integrated into rural enterprise development strategies. Our research demonstrates the importance of a multidisciplinary approach to studying rural value chains. Integrating different theoretical perspectives provides a more comprehensive understanding of the complex interactions that determine rural economies and livelihoods. Please refer to Table 2, which shows the determinants from library research, and Table 3, which shows the perspectives of these determinants based on the results of our empirical research.

Research on value chains in Malaysia covers various industries and sectors, such as the palm oil industry, halal industry, electronics industry and tourism value chain, reflecting the diverse economic landscape of the country. Most value chain research focused mainly on the structural elements of production and neglected the elements of humanity, adaptability and community engagement initiatives. These neglected elements could promote local identity, create employment opportunities and contribute to poverty alleviation by improving income opportunities within the community. They can also help preserve traditional knowledge and practises, promote sustainable resource management, and strengthen social cohesion by encouraging economic activity in urban or rural areas. By further empirically testing, our findings can expand the existing theoretical framework and contribute to

advancing theoretical paradigms in this area of value chains, such as value chain theory, value chain analysis, and rural livelihoods.

These research findings have significant implications for practice, such as policy relevance. Our research findings directly affect policymakers and practitioners involved in collaboration and integration for rural development initiatives, whether as agencies, departments, leaders, managers, or political figures. By identifying key drivers of sustainability and resilience within rural value chains, we provide actionable insights that can inform the design and implementation of policies and programmes to promote sustainable rural development, e.g., TEKUN, MARA, AIM, and other non-governmental organisations supporting rural small entrepreneurs, such as the Yayasan Basmi Kemiskinan, MyCARE, Women of Will (WOW), Association of Bumiputera Women (PENIAGAWATI) and others.

For businesses operating in rural value chains, our research provides valuable insights into new market opportunities and sustainable business practices. By identifying market gaps, promoting value creation and fostering linkages between producers and consumers, businesses can contribute to economic growth and environmental protection in rural areas. We believe strong synergies exist between 'understanding and developing rural community enterprises' and 'understanding and developing value chain governance approaches' that better address social relationships. Traditional boundaries do not bind rural communities, so value chains bring together actors across sectors and spatial scales.

The practice provides insights into how different rural community-based entrepreneurs come together in a value chain, suggesting that community-based entrepreneurs facilitate social learning through various forms of affiliation, such as engagement (about what people do together and how they do it), imagination (shared visions and goals), and alignment about how individuals coordinate their perspectives and actions with the broader community to achieve larger goals.

It consistently maintains a high culture through responsible and ethical business practices. Our study emphasises the importance of capacity-building and knowledge-sharing initiatives to enhance rural entrepreneurs' and stakeholders' skills and capabilities. We can promote a culture of continuous improvement and adaptive management within rural value chains by facilitating learning networks, encouraging innovation and sharing best practices. The content of this paper can also stimulate future research to improve the literature review on entrepreneurship and open new perspectives for the study of value chains. The number of small entrepreneurs is growing, but they lack knowledge about value chains. There are many gaps in entrepreneurs' education on managing their finances and value chains, especially supply and demand.

By elucidating these implications for theory and practice, our research seeks to bridge the gap between academic enquiry and practical application and ultimately contribute to the promotion of sustainable rural development and the well-being of

rural communities through the field of rural entrepreneurs and value chains.

Limitations and Recommendations

The lessons from this case study are that those seeking a community-based entrepreneurial position/role should focus on greater outreach and generalisability. One of the main limitations of our study is that it focuses on a specific geographical region and community, thus limiting the generalisability of our findings to other rural contexts. Future research should examine comparative studies examining rural value chains in different regions or contexts. Such an assessment would reveal relevant barriers to creating new businesses and make initiatives more targeted and effective. This approach would allow for a deeper understanding of the factors that influence the sustainability and resilience of value chains while highlighting best practices and lessons learnt from different contexts. While the methods used in our study are appropriate for our research questions, they may also have limitations.

For example, qualitative approaches such as interviews can lead to bias or subjectivity in data analysis. Combining multiple methodological approaches, such as quantitative surveys and participant observation, could increase the robustness of future studies. Our study was conducted during the global pandemic of COVID-19, which limited our time and data availability. These constraints limited our ability to capture long-term trends, operational changes in project activities, and dynamic changes within rural community value chains. Future research could benefit from longitudinal studies that track the evolution of value chains over time and provide deeper insights into the resilience and sustainability of communities.

Future studies could also look at analysing the value chain using interdisciplinary and multidisciplinary approaches. Involving local communities, policymakers, and other stakeholders in the research process is crucial to ensure the relevance and transferability of results. Future research should adopt participatory approaches that involve stakeholders in problem definition, data collection, and decision-making to promote the co-creation of knowledge and empower communities to change. In addition, including diverse perspectives would enrich our understanding of the complex interactions that drive rural economies and livelihoods. By understanding the effective value and drivers for a successful and sustainable chain, community-based entrepreneurs will be better prepared for future challenges, especially for achieving a sustainable competitive advantage in the 2030 Agenda for Sustainable Development context.

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Unravelling the Key Ingredients of Employability Skills for Surveyor Graduates: A Systematic Literature Review

Musfirah Mustaffa and Siti Hamidah Husain*

School of Housing, Building and Planning, Universiti Sains Malaysia, 11800 USM, Penang, Malaysia

ABSTRACT

The surveying profession has proven its value in the current era of development, as it offers services that generate, enhance, preserve, and protect valuable property and assets. Despite increasing attention, surveying education seems to be falling behind in meeting the demands of the construction industry by producing graduates with essential employability skills. Only a few studies have attempted to review the employability skills expected by employers from surveyor graduates. Therefore, this systematic review aims to identify essential elements of employability skills for surveyor graduates. The preparation of this review follows the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) review method. A total of 25 related studies were obtained from three databases: Scopus, ScienceDirect, and Google Scholar. The findings revealed that the most crucial employability skills expected from surveyor graduates are communication skills (functional work skills), leadership skills (functional work skills), teamwork skills (functional work skills), critical thinking skills (cognitive skills), and emotional intelligence (personal and entrepreneurial skills). Surveying education should consider incorporating these identified skill sets into their curriculum and training modules to ensure the employability and readiness of graduates for the workforce.

Keywords: Employability skills, graduates, industry demand, surveying profession, systematic review

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E-mail addresses:
ahfamuslim12@gmail.com (Musfirah Mustaffa)
sitihamidahhusain@usm.my (Siti Hamidah Husain)
*Corresponding author

INTRODUCTION

Surveyors' involvement in the lifecycle of buildings and construction projects has demonstrated its significance in the construction industry sector, where it offers services such as generating, enhancing, preserving, and protecting valuable property and assets (Wong et al., 2007). Surveyors are

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professionals who can give expert advice in all aspects of the construction industry. They are categorised into four main divisions: building surveying, quantity surveying, property surveying, property surveying, and geomatics and land surveying. In preparing competent and highly qualified surveyors, several professional associations and bodies have been established worldwide, such as the Royal Institution of Chartered Surveyors (RICS) in the United Kingdom, the Royal Institution of Surveyors Malaysia (RISM) in Malaysia, the Hong Kong Institute of Surveyors (HKIS) in Hong Kong, and the Society of Chartered Surveyors Ireland (SCSI) in Ireland, among others.

The rapid economic growth of the construction industry has increased the employment rate across various departments, including surveyor departments. Consequently, there is a heightened demand for new employees (graduates). Despite this, the increasing number of graduates produced by higher education institutions (HEIs) has gradually forced employers to screen for the best candidates who excel in both hard and soft skills, ensuring their adaptability in changing business circumstances (Abidoye et al., 2022; Bhuruk et al., 2018). Aliu et al. (2022a) also claimed that an academic degree will not guarantee personal or industry success.

Although surveying education was drafted in coordination with the core competency requirements for surveyors to perform their work professionally, tertiary education remains concerned with the demand for additional knowledge, skills, and competencies that should be adopted by surveyor graduates (Masum et al., 2019) to suit the changing era of globalisation in the construction industry. In helping fulfil this demand, governments have taken the initiative to develop Technical and Vocational Education and Training (TVET) programmes as a platform for acquiring knowledge and job-relevant skills (Osidipe, 2017). These are relatively known as employability skills, which refer to the generic skills needed in the 21st century to secure and remain in a job (Ahmadu et al., 2023).

The increasing concern about graduates' employability has attracted many researchers from various fields of work to conduct studies on the crucial skills and competencies needed to remain employable and workable, such as Deep et al. (2022), Vaz-Serra and Mitcheltree (2021), Moyo and Chigara (2023), Balakrishnan and Ishak (2021), and Ayodele et al. (2021). While many studies focus on the skills and competencies needed to survive in the world of work, only a few attempts have been made to systematically review the employability skills expected from surveyor graduates by employers. Conducting a systematic literature review (SLR) provides an overview of the results from different individual studies (Kraus et al., 2020). The authors are able to report the essential employability skills that surveyor graduates should possess from the perspective of employers with different backgrounds and regions.

According to the United Nations, 17 Sustainable Development Goals (SDGs)

were adopted in 2015. They serve as a universal call to all countries to take action to end poverty, protect the planet, and ensure that all people enjoy peace and prosperity by the year 2030. This study helps contribute to two of the SDGs, which are “ensuring inclusive and equitable quality education and promoting lifelong learning opportunities for all” (Goal 4) and “promoting sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all” (Goal 8). In alignment with SDGs 4 and 8, which emphasise the importance of embracing digital transformation in education, including the development of ICT skills, as well as promoting productive employment and decent work opportunities for all societies, this study seeks to contribute to the preservation and advancement of high civilisation by exploring the competencies needed to maintain employability and productivity in the construction industry with impactful scientific knowledge and skills aimed at the betterment of society.

Parallel to the goals of the SDGs and amid today's rapid change, professionals in the surveying field play a leading role in advancing sustainable construction and preserving civilisation at a high level. Cultivating a highly trained workforce capable of handling complex social, climate, and environmental challenges is critical for achieving sustainable development that aligns with the SDGs’ aims. The demand for qualified surveyors is growing as resource constraints intensify in urban settings, alongside global concerns such as climate change and rapid technological advancements in the industry. Surveyors impact the physical landscape, urban growth, and building safety and contribute to communities' social, economic, and environmental well-being. For instance, lifelong learning, emotional intelligence, flexibility, adaptability, effective communication, interpersonal skills, teamwork, and problem-solving are all critical for surveyor graduates to remain relevant in their field and contribute meritoriously to preserving a high standard of civilisation. Defining the key employability skills for surveyor graduates allows them to make a valuable contribution to the preservation of advanced civilisation, which enables graduates to approach complicated situations with creativity, compassion, and foresight, thereby making real contributions to society. Providing graduates with key employability skills will help promote a highly trained workforce capable of tackling complex social issues and guaranteeing long-term growth.

Guiding Theory Towards the Phenomenon of Employability Skills

Emerging issues in graduates’ performance and employability skills underscore the need for more productive collaboration between industry and educators to foster significant reform. These issues in graduates’ job performance and employability skills concepts are integral to developing the grounded theory for this research. Harvey (2001) introduced the "magic bullet" model of employability, suggesting that students

gain employability simply by being students, ultimately leading to employment. He emphasises that an individual's employability is "a propensity of students to obtain a job" (Romgens et al., 2020; Sumanasiri et al., 2015). Hence, it is important to differentiate between the employability of individuals and institutional performance (Romgens et al., 2020), with the latter referring to how well institutions perform. A graduate's employment should be viewed solely as a measure of the individual's employability, not as a means for institutional enhancement (Sumanasiri et al., 2015). This model outlines the three main parties involved in the process of employability development: graduates (students), higher education institutes (HEIs), and employers.

Graduates are responsible for selecting and participating in the employment opportunities offered by HEIs (Weligamage, 2009). Meanwhile, HEIs offer various opportunities to enhance students' employability, such as developing self-presentation skills and promoting lifelong learning (Sumanasiri et al., 2015). In addition, as summarised by Weligamage (2009), the model outlines three fundamental mechanisms that influence employability, which are: a) the pedagogic process that encourages development, b) self-reflection by the student, and c) the articulation of experiences and abilities. Harvey's concept of employability is not solely about students' potential to be employed but rather about their ability to develop skills that make them suitable for the working world (Aliu & Aigbavboa, 2020). Therefore, as depicted in Figure 1, researchers employed this model to direct and establish the phenomena of this study. A force without proper direction may not ensure success and complete satisfaction. Therefore, this paper aims to demonstrate all employability skills necessary for surveyor graduates to secure employment.

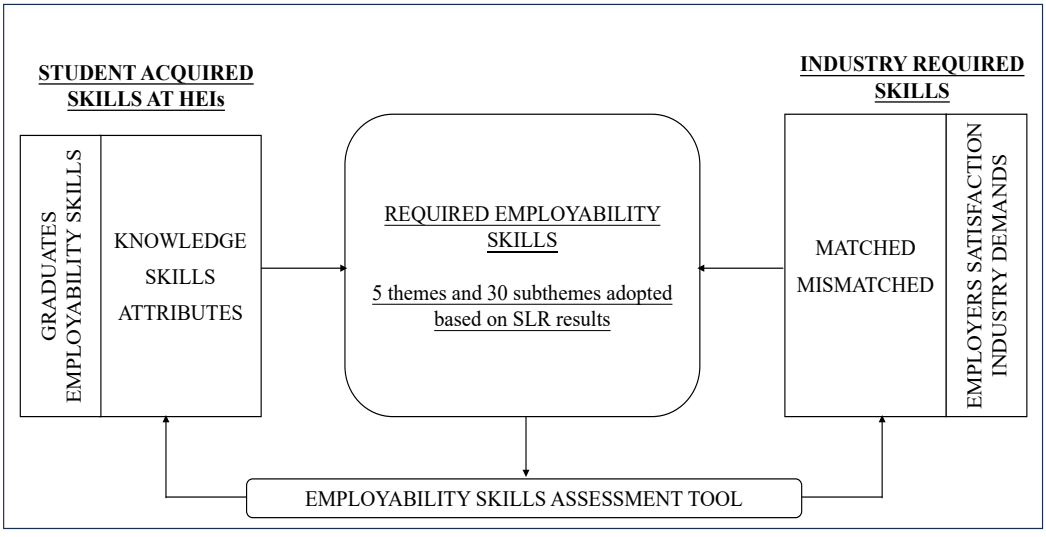

Figure 1. The guiding theory for employability skills development for surveyor graduates
Source: Adapted from Harvey (2001)

LITERATURE REVIEW METHODS

The Review Protocol (PRISMA)

The PRISMA statement served as a guide for this SLR study. The PRISMA statement was developed to help authors report their systematic reviews and meta-analyses. Sierra-Correa and Cantera Kintz (2015) mentioned that the PRISMA statement provides three main benefits: (1) clearly defining research questions prior to conducting the SLR, (2) distinctly outlining inclusion and exclusion criteria, and (3) enabling evaluation of a substantial body of scientific literature within a specified timeframe.

Formulation of the Research Question

The research question for this study is formulated based on the Population, Interest, and Context (PICo) approach. PICo is a tool that guides researchers in developing a clear and precise research question (Lockwood et al., 2015). Following these concepts, the authors have included three main aspects for review: Surveyor (population), employability skills (interest), and graduates (context). These aspects guide the authors in formulating their main research question: What employability skills are required by surveyor graduates in performing professional roles? This study aims to fill the gap by reviewing related studies to better understand employers' demands regarding the employability skills that surveyor graduates need to possess and excel in.

Systematic Review Process

The PRISMA method consists of three main processes for the systematic review: identification, screening, and eligibility.

Identification

The identification phase determines the keywords and databases for the search. Based on the formulated research question, two main keywords were identified: "employability skills" and "surveyors". Following this, Mohamed Shaffril et al. (2020) searched the online thesaurus for synonyms and related terms using keywords from earlier studies and expert suggestions to enrich the keyword list. According to Xiao and Watson (2019), a systematic literature review (SLR) must be derived from multiple databases, as no database comprises a complete set of published materials. Three familiar databases were identified for this SLR: Scopus, ScienceDirect, and Google Scholar. Scopus and ScienceDirect were chosen for their status as leading indexing systems with strong recognition for publishing scientific articles (Noraishah Ismail et al., 2021). Meanwhile, Google Scholar was selected for its extensive coverage across various fields and its easy and open access (Yusop et al., 2022).

Although other databases are available, the authors limited their research to three search engines due to time constraints and chose not to research other rich search engines such as Web of Science (Social Science Citation Indexed). According to Wilder and Walters (2021), the most significant disadvantage of the Web of

Science to most scholars is its resource availability. The authors discovered that most recommended journals were unavailable or duplicated on Scopus and ScienceDirect during the database selection process. The formatted search string, which includes Boolean operators, phrase searching, and field code functions, was used for both Scopus and ScienceDirect databases. Excluding the field code function, the same techniques were used for Google Scholar (Figure 2). Due to Scopus's limitation of using Boolean operators up to eight times, the keywords were restricted to nine only.

Databases	Keywords
• Scopus	TITLE-ABS-KEY(("employability skills" OR"employability skill" OR "generic skills" OR "generic skill") AND ("building surveyors" OR "quantity surveyors" OR "land surveyors" OR "property surveyor") AND "construction industry")

Databases	Keywords
• ScienceDirect	TITLE-ABS-KEY(("employability skills" OR "employability skill" OR "generic skills" OR "generic skill") AND ("building surveyors" OR "quantity surveyors" OR "land surveyors" OR "property surveyor") AND "construction industry")

Databases	Keywords
• Google Scholar	(("employability skills" OR "employability skill" OR "generic skills" OR "generic skill") AND ("building surveyors" OR "quantity surveyors" OR "land surveyors" OR "property surveyor") AND "construction industry")

Figure 2. The search string used for search purposes
Source: Authors' work (2023)

Screening

The 505 documents identified from the identification process underwent the screening phase. Screening is the second step in the SLR process, based on the inclusion and exclusion criteria established by the researchers (Mohamed Shaffril et al., 2021). Patino and Ferreira (2018) added that this process helps determine the key characteristics of a target population in answering the research questions while eliminating several traits of the population that might be hindrances to the study. Prior to this, three duplicate documents were removed from the list based on the inclusion and exclusion criteria (Figure 3).

Firstly, a publication timeline between 2013 and 2022 was selected, which is within a 10-year duration. Following the concepts of "research field maturity" highlighted by Kraus et al. (2020), the longer duration of research was selected to ensure sufficient study maturity, as researchers identified only a small number of articles that had been

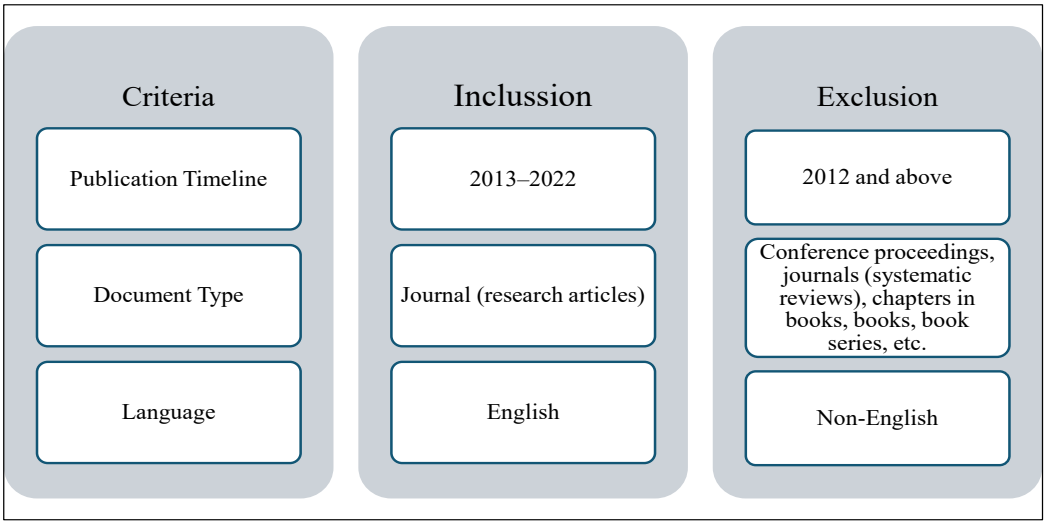

Figure 3. The criteria for inclusion and exclusion
Source: Authors' work (2023)

published within a short period. Regarding the document or literature type criteria, the researchers only concentrated on the journal (research articles) type because it is the primary source that offers empirical data. Only papers published in English were considered to reduce errors or confusion in extracting and analysing the data. The screening process was conducted manually because Google Scholar is not equipped with such functions to filter the criteria except for publication timelines. During the process, 338 articles were excluded as they seemed unsuited to the inclusion criteria, and 38 articles were removed as they had not been retrieved and were from inaccessible resources (Figure 4).

Eligibility

The third phase (second screening) is known as the eligibility process, where the authors manually monitor the retrieved articles to verify that all surviving articles meet the authors' detailed criteria (Mohamed Shaffril et al., 2020). The process involved scrutinising the articles' titles and abstracts and, if necessary, the findings of the studies. This process excluded 100 articles from the SLR due to not focusing on employability skills, focusing on employers' perception rather than employers' demand on the graduates' employability skills, and the study being conducted for other professions that were not within surveyors' professions or even the construction industry sector.

Quality Appraisal

Referring to the guidelines proposed by Kitchenham and Charters (2007), assessing the quality of primary studies is crucial because it influences the degree of inference. Therefore, the remaining 26 articles were assessed using the Quality Assessments

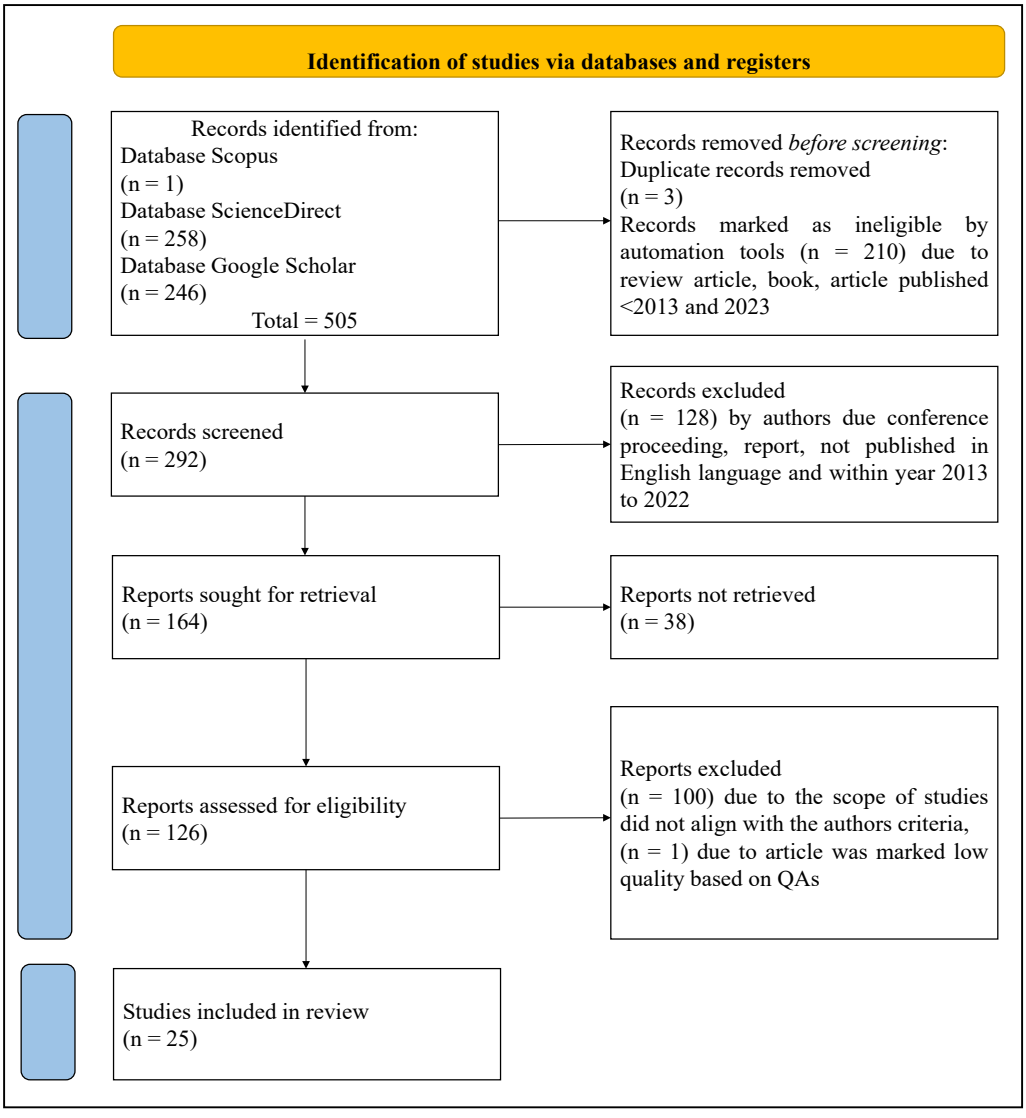

Figure 4. PRISMA flow diagram application for this SLR study
Source: Adapted from Page et al. (2021)

(QAs) list in Figure 5. The quality appraisal or criteria assessment focused on presenting the scanning process and data to ensure its reliability for the study data. The criteria for quality appraisal were selected based on established guidelines, as Abouzahra et al. (2020) suggested, focusing on employability skills for the surveying profession. There are six criteria used to judge the remaining articles: the purpose of the study must be made clear (Q1), the work must be presented in an interesting and useful way (Q2), the study methodology must be made clear (Q3), the approach's ideas must be made

clear (Q4), the work must be compared and measured with other similar work (Q5), and the work must have its limitations made clear (Q6). The scoring procedure used to evaluate each QA was: Yes (Y) = 1, Partly (P) = 0.5, or No (N) = 0. Of the 26 articles, 16 were marked as high quality, 10 as moderate quality, and one as low quality. Therefore, one article was deducted, and the remaining 25 continued for data abstraction and analysis.

Data Abstraction and Analysis

The surviving articles were evaluated, screened, and analysed. The tasks focused on the studies that answered the formulated research questions. The data were extracted to identify the appropriate themes and sub-themes by reading the abstract and then the full articles (in-depth). Qualitative analysis was performed using thematic analysis, which required searching for relationships among the domains and how these relationships are linked to the overall topic (Onwuegbuzie et al., 2012).

The first step of thematic analysis is to generate themes, which was determined by referring to the Malaysian Qualification Framework (MQF) 2nd edition. A total of five themes were formed. Later, the authors examined the extracted data from the reviewed articles to identify patterns between the data and found 40 sub-groups (items on elements of employability skills) to be generated and organised around the five themes by typology (Table 1).

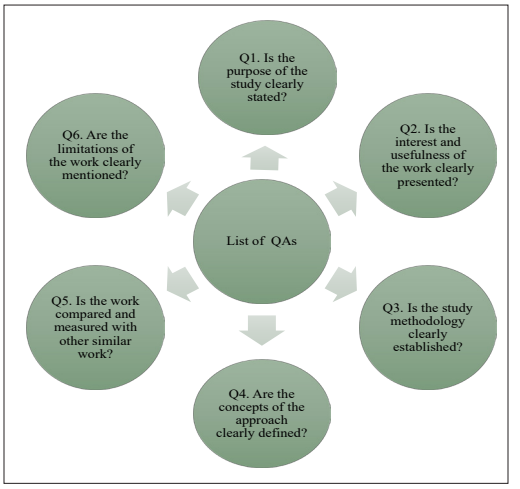

Figure 5. The list of QAs
Source: Adapted from Abouzahra et al. (2020)

RESULTS

Background of the Selected Studies

Through the reviewing process, 25 articles were identified that met the criteria and focus of the study. Upon reviewing the research design employed by the primary studies, it was found that 17 studies utilised the quantitative technique, while an additional four studies employed the qualitative method (Table 1). The mixed method was used in the remaining studies, except for one study where the study design was unclear. Additionally, most studies identified were conducted in Nigeria (seven studies) and Malaysia (six studies), followed by three studies in South Africa, two in India and the United Kingdom, and one in Australia, China, Egypt, Slovenia, and Sri Lanka.

Regarding the focus on the essential employability skills for surveyor graduates, most articles were found for quantity surveyor roles (seven studies), followed by building surveyor roles (two studies),

Table 1
The findings of primary studies from the years 2013 to 2022

Studies	Country	Focus profession	Study design	Employability skills				
				Knowledge and understanding	Cognitive skills	Functional work skills	Personal and entrepreneurial skills	Ethics and professionalism
1. Khodeir and Nessim (2020)	Egypt	Others	QN		CTS-DMS, PSS	TWS-CS	TMS	
2. Golob and Lisec (2022)	Slovenia	Land surveyor	MM		CRS-DMS	MS-CS	EI	
3. Aliu et al. (2022a)	South Africa	Others	QN			MS	EI	
4. Perera et al. (2017)	UK	Quantity Surveyor	MM		CRS	CC-NS-TWS-CS		CL-EPP
5. Zaheer et al. (2021)	UK	Building surveyor	MM	KL		CC-TWS-CS-ICT-OPT	PMS-EI-TMS	
6. Aliu and Aigbavboa (2020)	Nigeria	Others	QN	KL	CIA	MOS-TWS-LDS		EPP
7. Ebekozien et al. (2021)	Nigeria	Others	QL		DMS-CIA-PSS	TWS-CS-WS-ICT-LDS	EI	EPP
8. Ebekozien et al. (2022)	South Africa	Others	QL		ANS-CTS-PSS	LDS	ES	
9. Oladokun and Gbadegesin (2017)	Nigeria	Property surveyor	QN		CTS-PSS	CC-NS-CS-LTS-WS-ICT	ES-TMS	EPP
10. Shafie et al. (2014)	Malaysia	Quantity Surveyor	QN		CTS-DMS-PSS	CS-LGS	CWI-EI	EPP
11. Wang and Cheng (2022)	China	Others	QN		CRS	RM-CC-CS-PS-ICT-LDS		EPP
12. Hashim et al. (2021)	Malaysia	Quantity Surveyor	QL			NS-CS		CL-EPP
13. Kalgo et al. (2019)	Nigeria	Others	QN		CIA	RM-TWS-CS-LDS-RB		
14. Omoraka et al. (2022)	Nigeria	Others	QN		ANS-CRS-CTS	COS-MOS-MNS-MTS-IS-NS-CS-LDS	ES-TMS	

Table 1*(Continue)*

Studies	Country	Focus profession	Study design	Employability skills				
				Knowledge and understanding	Cognitive skills	Functional work skills	Personal and entrepreneurial skills	Ethics and professionalism
15. Bhuruk et al. (2018)	India	Others	NA	KL	ANS-CRS-CTS-DMS-PSS-RC	COS-MOS- MNS-CC-IS-MS-NS-TWS-CS-LTS-WS-LDS	FS-IP-PMS-EI-TMS-WL	EPP
16. Rajput et al. (2022)	India	Others	QN	KL	ANS-DMS	MOS-RM-TWS-CS-WS-ICT-LDS	AWU	EPP
17. Arowoiya and Akinradewo (2022)	Nigeria	Quantity Surveyor	QN	KL	ANS-CTS	MOS-IS-NS-TWS-CS-WS-ICT-NMS-LDS		
18. Tan and Chan (2016)	Malaysia	Quantity Surveyor	QN		CTS	TWS-CS		
19. Aliu et al. (2022b)	South Africa	Others	QN	KL	CTS-CIA-PSS	COS-CS-ICT-LDS	ADS-IP-EI	
20. Karunasena et al. (2015)	Sri Lanka	Quantity Surveyor	QN			CC-NS-CS-LGS-LTS-WS	PMS	
21. Haryanti et al. (2017)	Malaysia	Others	QN		ANS-PSS	NS-TWS-LDS-RB	ES-FS-PMS	
22. Oluwole and Yetunde (2020)	Nigeria	Quantity Surveyor	QN		CRS-CTS-DMS	TWS-CS-LDS	AWU-ADS-FS-EI	
23. Husain et al. (2020)	Malaysia	Building surveyor	QL		PSS	CS-LGS	CWI-EI	
24. Salleh et al. (2013)	Malaysia	Others	QN	KL	CIA	IS-CS-PS-ICT-LDS-OPT	AWU-FS-CWWI-IP-PMS-EI-TMS-WL	
25. Abidoye et al. (2022)	Australia	Property surveyor	QN		CTS-PSS	CC-MS-NS-CS-WS-ICT-NMS	ADS-CWI-EI	EPP

Table 1*(Continue)*

Note.
Study design
QN=Quantitative; QL=Qualitative; MM=Mixed method

Knowledge and understanding
KL=Knowledge

Cognitive skills
ANS=Analytical skills; CRS=Conflict resolution skills; CTS=Critical thinking skills; DMS=Decision making skills; CIA=Creative and innovative ability; PSS=Problem solving skills; RC=Reading comprehension

Functional work skills
COS=Coordination skills; MOS=Management and organising skills; MNS=Monitoring skills; MTS=Multitasking skills; RM=Risk management skills; CC=Client care; IS=Interpersonal skills; MS=Mediation skills; NS=Negotiation skills; TWS=Team working skills; CS=Communication skills; LGS=Language skills; LTS=Listening skills; PS=Presentation skills; WS=Writing skills; ICT=ICT skills; NMS=Numeracy skills; LDS=Leadership skills; OPT=Optimistic personality traits; RB=Relationship building

Personal and entrepreneurial skills
AWU=Ability to work under pressure; ADS=Adaptability skills; ES=Entrepreneurship skills; FS=Flexibility skills; CWI=Capability to work independently; IP=Initiative and proactive; PMS=Personal management skills; EI=Emotional intelligence; TMS=Time management skills; WL=Willingness to learn

Ethics and professionalism
CL=Conduct rules; EPP=Ethics and professional practice

Source: Authors' work (2023)

property surveyor roles (two studies), and land surveyor roles (one study). A total of 13 studies were not specified in the surveyor profession but within the construction industry sector and were included in the data analysis.

The Themes and Sub-Themes

Knowledge and Understanding

Knowledge is the capacity to use information to survey work practices and comprehend information methodically. For instance, most research highlights that surveying graduates should possess and thoroughly understand the overarching concept and foundation of their chosen discipline (Aliu et al., 2022b; Aliu & Aigbavboa, 2020; Zaheer et al., 2021). Rajput et al. (2022), Bhuruk et al. (2018), and Salleh et al. (2013) emphasised the importance of graduates possessing a broad range of technical knowledge. For example, building surveying graduates should possess knowledge of building pathology and maintenance, construction and deconstruction methods, and building survey and inspection (Zaheer et al., 2021), while quantity surveying graduates should be knowledgeable in the estimation of materials, time, and labour costs to conduct feasibility studies (Aliu et al., 2022b).

Besides, surveying graduates should know the rules and legislation at work (Bhuruk et al., 2018; Zaheer et al., 2021) and understand their and others' professional practices and ethics. In addition to understanding knowledge, graduates should be able to apply the principles in their work practice to fully support the knowledge competencies (Aliu et al., 2022b). Furthermore, the studies by Aliu and Aigbavboa (2022b) and Bhuruk et al. (2018) highlighted the need for graduates to know about market philosophy and keep abreast of societal trends.

Cognitive Skills

The critical employability skills attributed to cognitive skills include critical thinking, problem-solving, decision-making, analytical thinking, conflict resolution, creativity and innovation, and reading comprehension skills. Based on Table 1, the most important cognitive skills valued by employers are critical thinking skills (44%), problem-solving skills (40%), and decision-making skills (28%). Eleven studies emphasise the need for graduates to have the ability to examine objectively, understand the different components, and break down problems into smaller parts, making critical thinking skills the most expected cognitive skill of graduates. Meanwhile, Khodeir and Nessim (2020), Ebekozien et al. (2021, 2022), Oladokun and Gbadegesin (2017), Shafie et al. (2014), Bhuruk et al. (2018), Aliu et al. (2022b), Haryanti et al. (2017), Husain et al. (2020), and Abidoye et al. (2022) emphasise the importance of graduates' ability to recognise and solve problems. Only Bhuruk et al. (2018) indicated that graduates should have reading comprehension skills when interpreting drawings.

Functional Work Skills

Under functional work skills, 20 subtopics are found and divided into six groups: (1) practical work skills, (2) interpersonal skills, (3) communication skills, (4) digital skills, (5) numeracy skills, and (6) leadership, autonomy, and responsibility. Interpersonal skills and communication skills are the most important skills. Practical work skills include managing and organising, coordination, risk management, monitoring, and multitasking. Based on the findings in Table 1, graduates in the construction industry are expected to effectively manage and utilise resources, energy, and time and demonstrate perseverance to achieve their goals. In addition, graduates working in supply chain management should possess coordination skills to efficiently coordinate all activities within the supply chain (Omoraka, 2022).

Teamwork, negotiation, client care, interpersonal, and mediation skills are categorised under interpersonal skills. Given the collaborative nature of the construction and surveying fields, graduates are expected to be willing and able to work effectively in teams, often comprising diverse members (Aliu & Aigbavboa, 2020; Bhuruk et al., 2018; Zaheer et al., 2021). As negotiation skills complement communication skills, employers expect graduates, especially quantity surveying and property surveying graduates, to have good negotiation skills to reduce conflict, reach consensus, and improve client satisfaction (Abidoye et al., 2022; Hashim et al., 2021; Karunasena et al., 2015; Perera et al., 2017).

To achieve excellent communication skills, graduates must possess various communication abilities, including writing skills, language proficiency, listening skills, and presentation skills. The ability to interact, communicate effectively, and connect with colleagues and clients are critical factors that prompt employers to actively seek graduates with strong listening and communication skills. In addition to verbal communication skills, written communication is a significant way of conveying information. Employers place a high value on writing proficiency because it is necessary for tasks such as report writing and schedule preparation (Bhuruk et al., 2018; Rajput et al., 2022).

With the ongoing revolution of technology in the construction industry, graduates are not only expected to know these technologies but also to understand and be able to apply them (Aliu et al., 2022b; Rajput et al., 2022). In addition, ICT skills are important so that graduates can utilise digital tools and services to complete their tasks (Bhuruk et al., 2018; Zaheer et al., 2021). Furthermore, since conducting market analysis on real estate or material supplies forms the basis of the work of quantity and property surveyors, graduates are expected to have excellent numerical skills (Abidoye et al., 2022; Arowoiya & Akinradewo, 2022).

The last category is leadership, autonomy, and responsibility, which includes leadership skills, optimistic personality traits, and relationship building. Graduates with leadership qualities are usually willing

to take responsibility and be accountable when leading a team (Aliu & Aigbavboa, 2020; Rajput et al., 2022). When leading diverse teams, employers expect graduates to possess optimistic personality traits to maintain mental resilience and positivity in their work (Zaheer et al., 2021). Additionally, graduates are expected to build relationships and maintain networks, which are crucial for professional development (Haryanti et al., 2017).

Personal and Entrepreneurial Skills

The first sub-theme and the dominant skill among personal and entrepreneurial skills is emotional intelligence (n = 11). Emotional intelligence is a person's ability to express, regulate, and use their emotions and those of others (Aliu et al., 2022b). Based on the results from Table 1, employers value graduates who demonstrate initiative and aspire to lead themselves and others to success. The need to interact with and approach people from diverse backgrounds leads employers to seek graduates with high levels of self-confidence. Additionally, Golob and Lisec (2022), Aliu et al. (2022a), and Abidoye et al. (2022) add that employers are highly interested in hiring graduates who can control, understand, and communicate their most intense emotions.

The second sub-theme and the second most important skill is time management skills (n = 6). Graduates who can manage and complete the task assigned to them within the desired time frame are highly valued and appreciated by employers. Other sub-themes under this cluster include personal management skills, entrepreneurship skills, flexibility skills, capability to work independently, ability to work under pressure, adaptability skills, initiative and proactive skills, and willingness to learn. The least mentioned skill for graduates to possess among those under the personal and entrepreneurial skills category is willingness to learn (n = 2).

Ethics and Professionalism

Two sub-themes formed under this theme include ethics, professional practice, and conduct rules. Employers expect graduates to be familiar with ethics and professional practice because they must be firm, honest, and unbiased in their dealings with clients (Abidoye et al., 2022; Hashim et al., 2021; Rajput et al., 2022). Strong work ethics and business skills indicate the graduates' capacity to adapt to a changing marketplace (Aliu & Aigbavboa, 2020). Meanwhile, Perera et al. (2017) and Hashim et al. (2021) have shown that employers require quantity surveyor graduates to have codes of conduct, ethics, and professional practice to maintain the company's reputation.

The Essential Elements of Employability Skills for Surveyor Graduates

After the first analysis, the authors continued to exclusively analyse the essential employability skills required by surveyor graduates. Out of 40 items of employability skills, ten were removed as the skills were not mentioned in any studies focusing on the surveyor profession. According to the

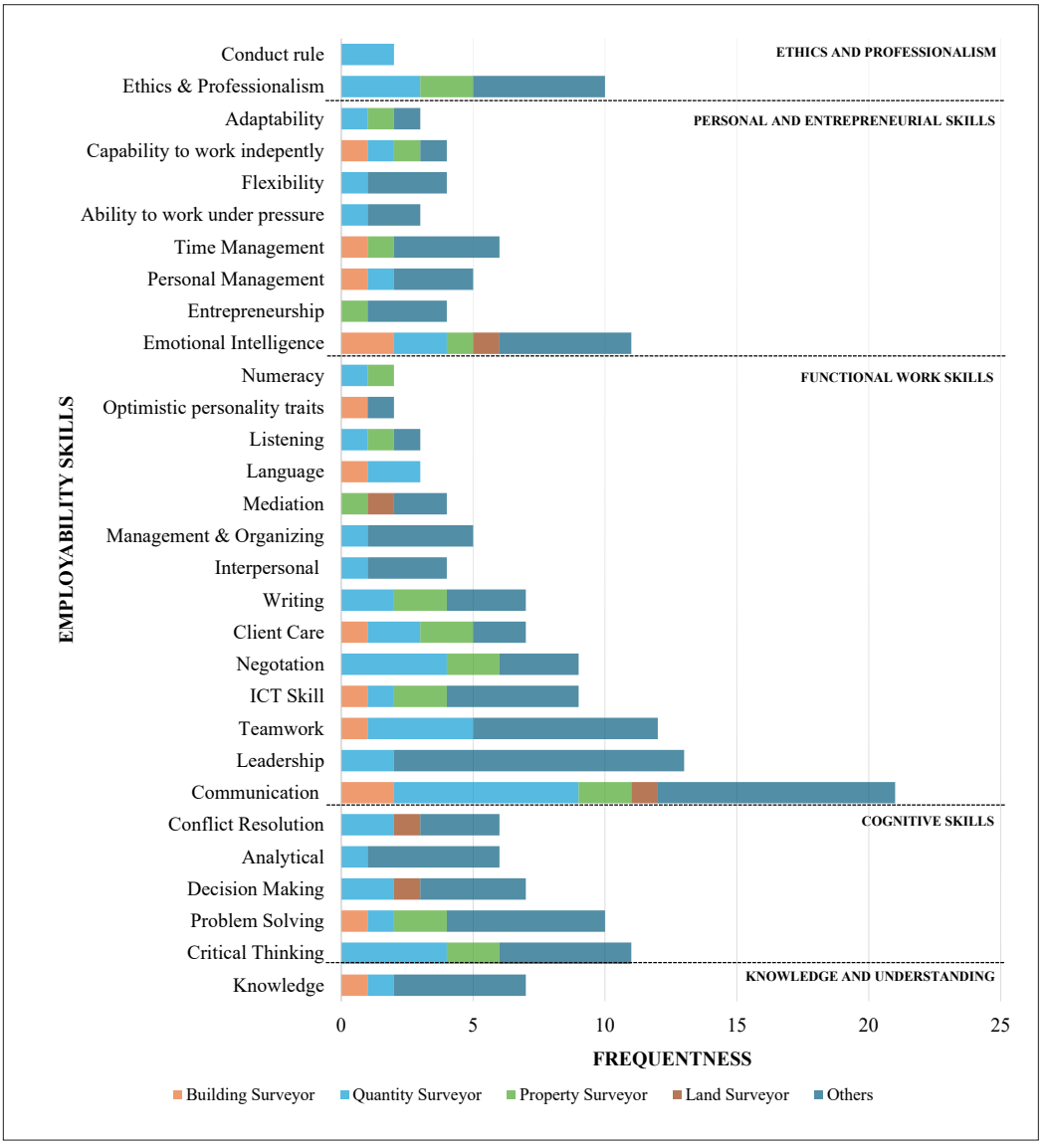

Figure 6. Frequentness of essential elements of employability skills expected from surveyor graduates
Source: Compiled by the authors (2023)

findings, communication skills emerged as the most important component of employability skills that surveyor graduates should possess, followed by leadership skills, teamwork skills, critical thinking skills, emotional intelligence, problem-solving skills, ethics and professionalism, ICT skills, negotiation skills, and decision-making skills (Figure 6). It suggests that employers expect surveyor graduates to possess more functional work skills and cognitive skills compared to other graduates,

with five functional work skills and three cognitive skills being among the most crucial components of employability skills.

FINDINGS AND DISCUSSION

The thematic analyses identified five themes and 30 sub-themes, with ten themes deemed unfit and removed. Functional work skills are the most crucial employability skills that surveyor graduates should possess to increase their employability and effectiveness in current and future roles. It mainly includes strong communication, leadership, teamwork, negotiation, and ICT skills. Effective communication skills are vital for interactions between clients and consultants, consultants and design teams, and consultants and contractors (Moyo & Chigara, 2023). Coupled with negotiation skills, graduates can effectively solve problems, enhance client satisfaction, and serve as effective representatives of their firms (Abidoye et al., 2022; Golob & Lisec, 2022; Oladokun & Gbadegesin, 2017; Zaheer et al., 2021).

Furthermore, Hashim et al. (2021) reported that employers are not looking for standalone employees. However, at construction sites, individuals with a team-player spirit comprise a diverse group of people with different backgrounds and statuses who work together (Haryanti et al., 2020). Besides that, in developing countries, graduates should be able to manipulate digital tools and services to keep pace with advancements in industry technology (Aliu et al., 2022b; Balog & Demidova, 2021). Although leadership skills were listed as the most employability skill expected by employers, in the context of surveyor graduates, it is less expected due to graduates typically being in entry-level positions (Oladokun & Gbadegesin, 2017). Leadership skills are generally acquired through work-life experience (Liu et al., 2020).

Likewise, graduates should also possess cognitive skills, including critical thinking, problem-solving, and decision-making skills. Employers from property and quantity surveying firms mostly expect surveying graduates to be capable of making logical judgements by identifying underlying issues and determining the best approach to problem-solving. This critical thinking ability is essential for effectively managing supply chains and properties, involving careful planning and task organisation (Omoraka, 2022), thus preventing project and company losses (Ralston & Blackhurst, 2020).

In addition to such skills, the study emphasises the need for surveying graduates to have the ability to fully grasp the overall idea of the chosen discipline (Aliu et al., 2022b), which helps in preparing graduates for their jobs and future careers (Fitriani & Ajayi, 2022; Stanton & Stanton, 2020). Above and beyond that, surveying graduates should know related rules and legislation. Employers value graduates who acknowledge and are prepared to abide by any related legislation and rules at work, safeguard client data, and maintain compliance with current regulatory and industry standards (Bhuruk et al., 2018;

Zaheer et al., 2021). In environments with diverse individuals, graduates need a basic understanding of others' professional practices and ethics.

Unforeseen circumstances in the working environment have pushed employers to seek graduates with personal skills, mainly emotional competencies (emotional intelligence). Graduates who possess this skill can motivate themselves when feeling down, regulating their emotions to make better choices, taking initiative, and driving themselves to success (Aliu et al., 2022a). Besides, it provides reassurance that graduates can learn, overcome hurdles, and resolve conflict situations responsibly (Golob & Lisec, 2022; Zaheer et al., 2021). Furthermore, employers also value graduates with good time management skills because it guarantees employers that they can complete their assigned tasks and projects on time without overexerting themselves to one task (Omoraka, 2022; Salleh et al., 2013). Moreover, proficient time management skills not only improve graduates' job performance but also provide opportunities for career advancement (Zaheer et al., 2021).

It is important for surveying graduates to possess ethics and professional practice skills to ensure their professional performance. Graduates who adhere to the code of ethics assure employers of their impartiality, honesty, and steadfastness in their dealings (Hashim et al., 2021; Rajput et al., 2022). Surveying graduates who cultivate ethical work practices also adapt to an ever-changing and dynamic work environment (Aliu & Aigbavboa, 2020).

STUDY IMPLICATIONS AND CONCLUSION

Employability skills encompass work-readiness skills, including knowledge, skills, and competencies enhancing individual performance in their respective fields. Therefore, this SLR was conducted to identify and analyse the crucial employability skills expected by employers for surveyor graduates. According to the findings, the crucial employability skills that employers seek are communication skills, leadership skills, teamwork skills, critical thinking skills, emotional intelligence, problem-solving skills, ethics and professionalism, ICT skills, negotiation skills, and decision-making skills. It indicates that surveying graduates needs to develop functional work skills and cognitive abilities to effectively perform their professional duties and exercise sound judgement when required.

After completing the literature on the required employability skills for surveyor graduates, this study aligns with Harvey's theory that the main parties—graduates, HEIs, and employers—play crucial roles in enhancing employability. HEIs need the employers' perspective on the required employability skills to enhance the opportunity for graduates to generate employment. The results of this systematic review reveal opportunities to enhance the employability skills set required for surveyor graduates. For HEIs to design chances for surveyor graduates to obtain employment, they should focus on the following clusters of employability skills: five themes (knowledge and understanding,

cognitive skills, functional work skills, personal and entrepreneurial skills, ethics and professionalism) along with 30 subthemes.

In addition to filling the knowledge gap, this outcome guides educators, policymakers, and organisers who intend to enhance the traditional learning workshops through problem-based or project-based learning (PBL). It suggests integrating role-playing activities that promote social and critical thinking skills, as well as implementing continuing professional development (CPD) programmes that focus on mastering the crucial employability skills required by surveyor graduates. It may require integrating evolving trends, technology, and optimal approaches into CPD sessions to guarantee that surveyor graduates stay current with market improvements. Furthermore, it is possible to implement specialist technical training programmes that concentrate on advanced technical competencies pertinent to the surveying profession. These programmes would include digital technology tools and equipment, advanced data analysis approaches, and competence in surveying-specific software. Regarding developing soft skills, it is important to organise seminars focusing on crucial skills such as communication, leadership, teamwork, critical thinking, emotional intelligence, problem-solving, ethics, professionalism, ICT, negotiation, and decision-making. These abilities are crucial for surveyors to efficiently collaborate with stakeholders and manage complex projects.

In conclusion, this study not only addresses the specific objectives outlined in this paper but also resonates with overarching societal values and fosters the preservation of high civilisation with impactful scientific knowledge and skills aimed at the betterment of society, especially for surveyor graduates. By unravelling the key ingredients of employability skills for surveyor graduates, this research substantially contributes to preserving and advancing high civilisation through impactful scientific knowledge and skill endeavours, as perceived by employers and industry.

STUDY LIMITATION AND RECOMMENDATIONS

The limited use of direct and restricted keywords has indirectly reduced the number of relevant papers available for evaluation. Currently, other professions, such as property surveyors, building surveyors, and land surveyors, have limited results compared to quantity surveyors. This situation is due to the use of different terms of employability in the research paper for those professions. Therefore, researchers recommend expanding the search terms by increasing the keywords and adopting more commonly used terms. Additionally, the searches conducted were restricted to three databases and did not include other rich search engines such as Web of Science (Social Science Citation Indexed). Prior to finalisation, the researchers performed a preliminary search on the chosen databases. They discovered that most recommended journals from the Web of Science were inaccessible due to

institutional subscriptions (limited access or discontinued). It is recommended that future research adopt a more comprehensive approach to database selection, ensuring the inclusion of outnumbered published articles or literature sources in the research field. Furthermore, due to the ever-changing nature and trends of research, it is recommended that systematic reviews be conducted after several years to update current changes and developments in the surveying industry. This iterative approach enables the examination of research findings over time, aiding in gaining a more profound comprehension of trends, changes, and transformations in the study discipline, enhancing the significance and applicability of the combined data.

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Impact of Farmer Associations on Sales and Crop Diversification

Vatana Chea[1]*, Socheat Keo[2] and Sereyvath Yoeun[1]

[1]School of Graduate Studies, Cambodia University of Technology and Science (CamTech), Phnom Penh 121003, Cambodia

[2]National Institute of Science, Technology, and Innovation, Phnom Penh 120601, Cambodia

ABSTRACT

Contributing to the growing interest in understanding the impact of farmer cooperatives on rural household welfare, we add new empirical evidence to the current literature and debate. In particular, this study investigates the impact of farmer cooperatives on sales per hectare of land and crop diversification, which have been largely overlooked. We apply the Propensity Score Matching method to the Cambodia Inter-Censal Agricultural Survey 2019, with its large sample size of 16,000 small-scale producers. Additionally, we perform a robustness check to ensure our findings are unbiased. Results indicate that Cambodian farmers perceive the cooperatives as a risk-sharing mechanism or knowledge-sharing platform that provides technical know-how to cope with natural calamities. Propensity Score Matching (PSM) outputs show a significantly positive impact of participating in the cooperatives on sales and the crop diversification index. This study thus advocates increasing technical support and implementing policies by the government to help cooperatives thrive and expand.

Keywords: Agriculture, Cambodia, crop, farmer association, impact

INTRODUCTION

The growth of farmers' organisations has been remarkable in many parts of the world, especially in imperfect markets (Candemir et al., 2021). In 2015, the European continent had over 51,000 farmer associations with a turnover of approximately USD 415 billion (Grashuis & Su, 2019). Additionally, the United States had 1,871 organisations with more than two million members. Due to its considerable importance, the concept of farmers' associations has drawn much attention from scholars and the governments of developing countries

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E-mail addresses:
vatana.chea@camtech.edu.kh (Vatana Chea)
socheat.msu@gmail.com (Socheat Keo)
sereyvath@gmail.com (Sereyvath Yoeun)
*Corresponding author

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(Abebaw & Haile, 2013). However, despite increasing empirical evidence, their impact is unclear (Bizikova et al., 2020). Theoretically, farmer organisations improve agricultural smallholders' profit, income, and productivity by increasing their collective bargaining power, improving product quality and access to farming knowledge and technologies, minimising logistic and marketing costs due to economies of scale, and reducing information asymmetry (Ito et al., 2012). Therefore, such an institutional arrangement is deemed a consequential route out of poverty for small-scale producers.

Many studies have proven such a claim. For instance, Bernard et al. (2008) and Wollni and Zeller (2007) show that joining a farmer cooperative leads to a significant increase in price received and agricultural profit. Likewise, a study in Nigeria suggests higher technical efficiency among cooperative members than those who do not join any organisation (Olagunju et al., 2021). In Kenya, members of agricultural cooperatives sell bananas for a price of 23% higher than non-members (Fischer & Qaim, 2012). Other empirical studies also document the strong and positive influence of participation in farmer associations on other indicators of member performance, such as fertiliser and pesticide adoption (Abebaw & Haile, 2013), rising yields, and household income (Ma & Abdulai, 2016), and the reduction of cropland abandonment (Ma & Zhu, 2020). Furthermore, agricultural cooperatives improve technology choices, information sharing, and access to banking and credit systems for smallholder farmers in Cambodia (Ofori et al., 2019).

Nevertheless, there are also cases where cooperatives do not necessarily improve farmers' conditions or, at worst, have an adverse effect. In particular, Malvido Perez Carletti et al.(2018) found no benefits in joining a farmer's organisation. On the contrary, they observe farmer cooperatives' negative impact on the wine price in Argentina. Similarly, an empirical study from the Austrian wine market indicates that members of cooperatives have a high tendency to free-ride on quality. Consequently, wines produced by the cooperatives generally have considerably lower quality on average (Pennerstorfer & Weiss, 2013). In Ethiopia, Chagwiza et al. (2016) found no significant impact of cooperative membership on the price of milk and butter, although they assert that such membership facilitates technological transformation. Barrett (2008) also claims that while farmer associations significantly impact high-value crops, there is little evidence to prove this statement is true for staple food grains.

With that said, the research studies mentioned above also have limitations. Therefore, their findings should be interpreted with caution. For example, Chagwiza et al. (2016) use quantitative data from only 400 samples. Many other studies also rely only on small sample sizes, even though most of them use a popular econometric method called Propensity Score Matching (PSM), which requires a dataset with a large sample size to improve its matching mechanism and accuracy (Ito et al., 2012; Ma & Abdulai, 2016).

Furthermore, Ainembabazi et al. (2017) assume the decision to participate in the farmer association is random. However, such an assumption is unlikely because participation can be driven by education, knowledge, ability, or motivation to improve household income (Candemir et al., 2021). Such limitations may be another reason for the mixed evidence in the current body of literature.

This study provides empirical evidence to the growing literature on the role of farmer association by estimating its impact on farming households. We use one developing country, Cambodia, as our case study, and the decision is based on several reasons. Firstly, much previous research has been conducted in the context of Africa and India. Very little evidence can be found in the least developed countries in Asia in general, and in Cambodia in particular, where they grow one of the highest quality rice in the world (Bizikova et al., 2020; Theng et al., 2014). Secondly, unlike in many other countries, especially in the Global North, where cooperatives are highly autonomous, farmer associations in Cambodia depend largely on funding from NGOs, and they tend to collapse once the funding is exhausted. Thus, the context differs from those previously studied, making it fascinating to understand different cooperatives.

Results indicate that poorer households and those who have experienced or frequently faced natural disasters are significantly more likely to join a farmer cooperative than those who are less likely to face such challenges. These findings suggest that poor rural farmers in Cambodia use cooperatives as a risk-sharing mechanism or an agricultural knowledge-sharing platform that teaches them how to deal with environmental calamities. PSM outputs also show a significant effect of joining an agricultural organisation on crop sales per hectare of plant area and crop diversification. For sales, the positive effects range from 11.7% to 15.7%. At the same time, for crop diversification, member households are found to be 3.3% more likely to adopt commercial crops, including aromatic rice, mango, banana, cassava, or cashew nuts, for plantation. This effect is also significant at the 1% level.

The contribution of this study is threefold. First, while previous literature concentrates on understanding whether participating in cooperatives influences farmers' income or profit—factors influenced by production costs and current market prices of commodities—we shift the focus to sales per hectare of land and crop diversification. These indicators are often overlooked (Bizikova et al., 2020) despite diversification being reported as crucial for farm sustainability (Booth & Golooba-Mutebi, 2014). Secondly, most research in Asia or developing countries uses only a few hundred samples, whereas we employ a nationally representative dataset of approximately 16,000 household samples. It enables us to improve the accuracy of our estimations and meet the essential requirements of PSM. Thirdly, previous literature has focused on specific commodities such as bananas (Fischer

& Qaim, 2012), apples (Ma & Abdulai, 2016), and coffee (Wollni & Zeller, 2007). In contrast, we study multiple valuable agro-industry crops, including aromatic rice, mango, banana, cashew nut, and cassava. It is noteworthy that rice is a staple in the everyday diet of much of the Southeast Asian population, making this research study relevant to food security. To the best of our knowledge, no studies have used nationally representative data on the impact of farmer associations on agricultural sales and crop diversification in Southeast Asia.

This study also aligns well with the special issue theme in several ways. Firstly, it focuses on farmer associations, foundational to ensuring global food production's sustainability, food security, and resilience. In addition, farmer associations have the potential to enhance climate change adaptation. By examining their impacts, this study provides valuable insights into how to strengthen and support these vital components of human civilisation. Secondly, emphasising empirical evidence is highly aligned with conducting impactful scientific research. Grounding the analysis in rigorous data and quantitative methods allows the study to provide robust, evidence-based conclusions that inform policy and practice. This type of rigorous, scientifically driven research is essential for fostering the preservation of high civilisations, as it allows for developing effective, data-driven interventions and solutions. Finally, the study's focus on the role of farmer associations directly addresses the research theme. These institutions are inherently human-centric, as they exist to support and empower agricultural communities, many of which are a crucial part of Southeast Asian countries. By understanding their impacts, the study provides insights into how humans organise and collaborate to tackle shared challenges. It aligns with the broader goal of understanding humanity and using that knowledge to drive positive social change.

LITERATURE REVIEW

Many academics argue that farmer cooperatives are an effective solution to address agricultural challenges in developing nations. This idea is grounded in the induced innovation theory (Rogers, 2003), which suggests that farmer associations or cooperatives, due to their close relationships with individual farmers, are the most effective mechanisms for enhancing agricultural technology and meeting the needs of farmers. These associations commonly provide services such as technological training and encourage members to transition from traditional farming methods to modern practices and technologies. In some instances, associations also offer assistance in the form of crop and livestock production inputs. While contracting companies or supporting agencies may be involved in training programs, the members of these associations generally have greater access to resources such as fertiliser, new seeds, markets, knowledge, and machinery compared to non-organised farmers. Consequently, this increased access motivates organised and non-organised farmers to form or join associations.

By coming together as a group and pooling their resources, individual farmers can benefit by sharing production costs and expanding their investments. It allows them to use economies of scale, resulting in significant advantages. Using Ostrom's (2009) socio-ecological system framework, Zhu and Wang (2024) assert that Chinese farmers in the Tarim River Basin who participate in cooperatives are more likely to adopt water-saving irrigation technology, which in turn tends to reduce the water shortage problem in the area. Additionally, farmers' associations have been recognised as important catalysts for the commercialisation of farming, connecting smallholders with agri-businesses (Reardon et al., 2019). For example, smallholder farmers who join a cooperative can collectively sell their products to agro-processors, offering greater convenience for buyers and exporters compared to non-organised farmers. Farmer associations play a crucial role in facilitating business transactions between farmers and potential buyers or companies, exemplified by Kenya, Ethiopia, and Zambia exporting their green beans to Europe (Fischer & Qaim, 2012). Furthermore, farming cooperatives serve as a risk-sharing mechanism, providing insurance against crop failure and a knowledge-sharing platform for disseminating best practices and minimising or preventing disaster impacts. Moreover, a cooperative, acting as a small-scale producer's cartel, can exert more control over the market and prices, thereby improving its position and bargaining power.

However, it should be highlighted that cartels typically do not last long because every member has an incentive to oversupply. Cheating members can reap the benefits of additional sales without bearing the full costs of driving prices down, which all members share. In other words, each member has an incentive to raise their profits at the expense of others. Moreover, large organisations face additional institutional management and governance challenges, including (1) heterogeneity among farmers with varying interests, leading to resistance to necessary changes, and (2) inefficient voting systems that hinder consensus on immediate decisions or cooperative strategic investments promptly (Candemir et al., 2021). These issues can thus prevent any attempt for reform, making the cooperatives themselves inefficient.

MATERIALS AND METHODS

Data and Outcome Variable

This study utilises data from the Cambodia Inter-Censual Agricultural Survey (CIAS) 2019, jointly conducted by the National Institute of Statistics (NIS) and the Ministry of Agriculture, Forestry and Fisheries (National Institute of Statistics, 2019). CIAS 2019 observes a sample of roughly 16,000 farm households across all 25 provinces throughout Cambodia, except for a few districts that are deemed highly urbanised.

The sampling method involved a two-step approach known as two-stage stratified sampling. Enumeration Areas (EAs) were designated as the primary units, and households involved in agricultural

activities were the secondary units. A total of 1,350 EAs were to be selected, with 12 agricultural households chosen for each EA, resulting in a targeted sample size of 16,000 households. In cases where the chosen EA did not have 12 agricultural households, NIS distributed the remaining households to other EAs within the same province. This adjustment ensured that the overall sample size of the province remained consistent with the anticipated number of households for that province. It should be highlighted that the distribution of the 1,350 EAs among provinces was based on the proportion of rural households in each province. Notably, 50 EAs were automatically assigned to Phnom Penh, while the remaining 1,300 EAs were allocated to other provinces accordingly.

The survey took place between June and November 2019. It also provides comprehensive household information, including crop cultivation, livestock, aquaculture, and other agricultural activities. However, CIAS did not collect village-specific data, such as distance from the village to the nearest national road, seasonal labour movements, or soil types. Additionally, not all households provided complete information about themselves. Furthermore, some households have not been able to cultivate crops in the past 12 months. Therefore, due to incomplete information necessary for the study, these households had to be excluded from the data analysis. Our sample comprises 13,327 households, of which 1,358 (10.2%) participated in various farmer organisations and are considered treated households. The remaining 11,969 farm holdings did not participate in any association during the last 12-month period and served as the control or comparison group.

Table 1 highlights summary statistics of selected characteristics of the household sample disaggregated by their participation in farmer associations. It is worth noting that the average farm size of Cambodian households is 2.5 hectares. Treated households generally hold 2.8 hectares of cultivated land, while the non-treated or comparison groups possess slightly less at 2.6 hectares. However, statistically, there is no significant difference in farm size between households that participate in farmer cooperatives and those that do not. This result suggests that the amount of cultivated land among Cambodian farmers is rather small, consistent with findings from other studies. Government figures indicate that in 2017, 59% of Cambodian households owned agricultural land of less than 1 hectare, while 35% held between 1 and 3 hectares (NIS, 2017). The average household size is around four persons, which has fallen remarkably compared to the same indicator in 2013, in which the average household size was 4.6 (NIS, 2013). Moreover, most households are headed by males, with only about 20% of Cambodian families being female-headed, indicating a societal structure in some contexts.

Other characteristics of treated and non-treated households, including the age of the household head, their educational level, and the number of working adults

Table 1
Summary statistics of selected socioeconomic characteristics of treated and non-treated sample

Variables	**Mean (treated)** (1)	**Mean (non-treated)** (2)	***S.E*** (3)	***Diff*** **(t-test)** (1)-(2)
Land areas cultivated by households (ha)[a]	2.837	2.556	0.192	0.281
Household size	3.937	3.998	0.048	-0.06
Female-headed households (0/1)	0.224	0.223	0.012	0.002
Age of household head (years)[b]	48.682	48.540	0.330	0.142
Household head that completed high school (0/1)	0.098	0.097	0.009	0.001
Dependency ratio	0.506	0.530	0.018	-0.025
Number of working-age members (15–64)	2.765	2.775	0.039	-0.009
House with concrete wall (0/1)	0.129	0.152	0.010	-0.022**
Outstanding loans for agriculture production	0.305	0.243	0.013	0.061***
Outstanding loans from banks (0/1)	0.136	0.116	0.009	0.020**
Engagement in agro-processing activities (0/1)	0.045	0.034	0.005	0.011**
Experience with insects and crop diseases	0.148	0.116	0.009	0.033***
Engagement in aromatic rice farming (0/1)	0.195	0.139	0.010	0.056***
Engagement in mango plantation (0/1)	0.284	0.212	0.012	0.072***
Engagement in banana plantation (0/1)	0.222	0.189	0.012	0.033***
Engagement in cassava plantation (0/1)	0.096	0.107	0.009	-0.012
Engagement in cashew plantation (0/1)	0.115	0.094	0.009	0.021**
Share of agricultural income to total income (>40%)	0.619	0.526	0.015	0.092***
Obs.	1,358	11,969		

Notes: [a] observations for the treated group are 1,287 and 10,850 for the non-treated. One thousand one hundred ninety observations were excluded from the calculation because they did not report their land areas.
[b] observations for the control are 11,968.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
Source: Authors' calculations using CIAS 2019

living in the household, are expected and of limited scientific interest. Moreover, the mean difference test does not suggest any remarkable variation between them. However, some notable distinctions are noteworthy: outstanding loans, engagement in agro-processing activities, experience in insects and crop diseases, engagement in cultivating commercial crops, and share of agricultural income to total income. The latter indicates that households participating in farmer associations tend to rely more on agriculture to generate income. Their engagement in planting multiple commercial crops is also higher compared to the control group. However, they are also likely to experience natural disasters relative to non-organised farmers. It suggests that the association might also be formed as a risk-sharing approach in terms of financial support or dissemination of knowledge. In other words, farmers who face frequent natural calamities consider the association as a method to cope with agricultural challenges. Descriptive statistics additionally show that only about 3.5% of households in Cambodia are engaged in agro-processing activities, a figure that needs to increase, implying that farm holdings are not fully integrated into the value chain. Despite these small numbers, cooperative farmers are significantly more likely to engage in agro-processing activities than non-members, which aligns with the abovementioned literature.

It should be noted that we further divided the treated households into two categories: those who officially participated in formal cooperatives registered at the provincial department of agriculture and those who joined informal associations unofficially acknowledged by local village headmen or commune chiefs (Theng et al., 2014) and regarding the number of households, 737 households, or 6% of the total sample, participated in a formal farmer association, whereas 873 households, or 7%, participated in an informal, unregistered farmer association such as farmer groups. Additionally, 252 households participated in formal and informal cooperatives and were counted in both groups. However, we do not present their summary statistics here; readers are referred to appendices A-1 and A-2 for such tables.

There are two indicators: sales and engagement in commercial crop plantation. The former is the total sales per hectare of all agricultural products during the previous 12 months, measured in KHR10,000 (Cambodian Riel). The latter is an index scale representing the diversification of commercialised crops, including aromatic rice, mango, banana, cashew nut, and cassava, which are considered cash crops and used by the agro-industry in Cambodia (World Bank, 2015). The index is computed using the following formula:

$$(Ch - Cmin)/(Cmax - Cmin)$$

where Ch represents the number of commercialised crops grown by the farm-holding; $Cmax$ and $Cmin$ are the maximum and minimum numbers of commercialised crops in the sample, respectively. The scale

variable ranges from 0 to 1, with 1 indicating the highest level of crop diversification. Crop diversification is recognised as a strategy to minimise the negative effects of climate change on farmers in developing countries, improving efficiency and income stability (Mzyece & Ng'ombe, 2021), and increasing return to scale due to complementarity between rice and other crop production.

Table 2 presents the disparities in outcome variables between households participating in farmer cooperatives and those that did not. The differences are further analysed based on participation in formal or informal associations to gain a better understanding. The t-test results show no significant difference in sales of agricultural products between treated and non-treated households (Panel A). Regardless of the cooperative's status, this finding remains consistent across all panels. When comparing the total amount of household sales regardless of land area, there is no notable discrepancy among them. However, this does not hold for sales of agriculture products per hectare of planted area. In other words, member households can sell more of their cultivated products in proportion to the land they own. For instance, if member and non-member households each have a hectare of land, the former can significantly sell more of their cultivated products compared to the latter. Additionally, those who join associations are more likely to engage in commercial crop cultivation, with a probability of approximately 3.4%. Nevertheless, it is important to note that these descriptive statistics and t-test results should not be solely relied upon, as the differences observed may be due to chance and influenced by other factors. However, these findings serve as an initial indication for further detailed and empirical analysis. Similar results regarding outcome differences have also been discovered between households that are members of formal farmer organisations (Panel B) or informal farmer organisations (Panel C) and those that are not.

Table 2
Summary statistics of outcome variables by household participation in farmer associations

Variables	**Obs. (treated)**	**Obs. (non-treated)**	**Mean (treated)** **(1)**	**Mean (non-treated)** **(2)**	***S.E*** **(3)**	***Diff*** **(t-test)** **(1)-(2)**
Panel A	All sample					
Sales (in KHR10, 000) [a]	820	6,211	1,100.67	1,000.22	115.74	100.45
Sales per hectare of planted areas (in KHR10, 000) [b]	798	5,741	264.58	215.47	12.73	49.11***

Table 2 *(Continue)*

Variables	Obs. (treated)	Obs. (non-treated)	Mean (treated) (1)	Mean (non-treated) (2)	*S.E* (3)	*Diff* (t-test) (1)-(2)
Engagement in commercial crop plantation (0–1 index)	1,358	11,969	0.18	0.15	0.005	0.03***
Panel B			Formal			
Sales (in KHR10, 000)	462	6,211	1,211.27	1,000.22	151	211.05
Sales per hectare of planted areas (in KHR10, 000)	449	5,741	290.87	215.47	16.74	75.41***
Engagement in commercial crop plantation (0–1 index)	737	11,969	0.18	0.15	0.007	0.03***
Panel C			Informal			
Sales (in KHR10, 000)	498	6,211	1,074.78	1,000.22	144.16	74.56
Sales per hectare of planted areas (in KHR10, 000)	484	5,741	294.47	215.47	16.08	79.01***
Engagement in commercial crop plantation (0–1 index)	873	11,969	0.17	0.15	0.01	0.03***

Notes: [a]6,296 households (47.2% of the total observations) were excluded from the analysis because they did not report sales value in the past 12 months prior to the survey date.
[b]6,788 households (50.9% of the total observations) were excluded for similar reason s.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
Source: Authors' calculations using CIAS 2019

Estimation Strategy

As this study utilises cross-sectional data, addressing potential selection bias is crucial. One approach to achieve this is using either the Instrumental Variable (IV) or the Propensity Score Matching (PSM) method. In principle, the IV approach is preferred over PSM. However, finding a valid IV correlated with association membership but has no direct effect on outcome variables such as sales is arguably very difficult, if not impossible, making it empirically impractical. Therefore, this study employs PSM to investigate the causal effect of participation in farmer associations.

The PSM method has also been used elsewhere to evaluate the impacts of program interventions when limited to using cross-sectional data, as in our case, because it can minimise selection bias by reducing the differences in observable characteristics of households that are members of farmer associations and those that are not (Abebaw et al., 2010; Rosenbaum & Rubin, 1985).

Moreover, this method is highly effective and increasingly popular when the dataset comprises a sufficiently large sample size, such as the one we use. In general, a large sample size presents a considerable advantage for matching purposes, as it increases statistical power and reduces bias in impact estimation (Khandker et al., 2010). PSM involves a two-step procedure, beginning with estimating the probability that a farm household will participate in the cooperative, commonly known as the propensity score. The estimation is typically conducted using logit regression and can be best understood through the following econometric specification:

$$P(X_i) = G(\alpha + X_i'\beta) \quad (1)$$

Where subscript i indexes individual households, T is the binary treatment variable, which takes the value of 1 if a farm household participates in a formal or informal association, and 0 otherwise. The control group comprises households that do not participate in any agricultural organisation. G is a function strictly taking on values between 0 and 1 and following the logistic distribution; $G(z) = \frac{e^z}{1+e^z}$; α is the intercept; $X'\beta$ equal to $\beta_1 X_1 + \beta_2 X_2 + \cdots + B_k X_k$ where X is a vector of household attributes that help explain the probability of participating in a formal or informal farmer association. These include *household size* which is defined as the total number of people in a household (representing the available farm labour supply); *female,* a dummy variable recorded as 1 if the household head is female and 0 otherwise; *age,* the age of household head in years; *education,* a binary variable taking the value of 1 if household head completed high school and 0 otherwise; *dependency,* defined as the ratio of dependents aged 0 to 14 and over 65 to adult household members aged between 15 and 64; *concrete house wall,* an indicator variable taking the value of 1 if a household's wall is made of concrete and 0 otherwise (used as a proxy for household wealth in the absence of other useful asset variables); and finally, *insects and crop problems,* a dummy variable indicating farm households that experienced insects and crop diseases in the previous 12 months.

The selection of these control variables is based on the general research literature and Cambodia-specific studies on the impact of farmer association on various household indicators (Abebaw & Haile, 2013; Ofori et al., 2019; Theng et al., 2014). After the model is estimated in the first step, the propensity score is predicted for every treatment and control group sample. In the second step, we will match observations in the treatment group with those in the control group based on the comparability of their propensity score using several matching algorithms—Nearest Neighbour (NN), Kernel, and Stratification.

We also address the region of common support to avoid comparing incomparable samples, which could result in a certain degree of evaluation bias. The samples with comparable propensity scores are dropped from the data analysis. Additionally, we compare the covariates X_i before and after

matching to validate the quality of our matching. It can be achieved by examining the mean absolute bias, which is expected to decrease significantly after matching. Furthermore, the standardised bias of each independent variable in the logistic regression before and after matching is also used to assess whether there are systematic differences in the means of the covariates across both groups (Rosenbaum & Rubin, 1985). In other words, no significant differences in the covariates between both groups should be found after such matching, suggesting that the observed characteristics of samples between the treatment and the control groups are comparable. To this end, Caliendo and Kopenig (2008) propose a rule of thumb that a standardised bias below 3% or 5% after the matching should be seen as sufficient. In addition, we follow Sianesi's (2004) suggestion to compare the Pseudo-R^2 before and after matching, expecting the Pseudo-R^2 before matching to be higher than that after matching. In addition, the P-values of likelihood ratio tests for joint significance in the logit model should be rejected after matching, indicating no systematic differences in the distribution of observable independent variables between both groups.

Furthermore, the PSM method requires two necessary assumptions: conditional independence and common support or overlapping conditions. The former is sometimes known as the exogeneity assumption, which simply states that participation in the farmer association is based entirely on observed household characteristics. We can attempt to hold the conditional independence assumption valid by controlling for many observable household characteristics that can affect farmer association participation, as Khandker et al. (2010) recommended. It leads us to our second assumption: the overlap condition in PSM, which requires that observations in the treatment group have comparable counterparts in the control group within the propensity score distribution. It is why data drawn from a representative sample is preferred, as this assumption is likely to hold if the sample size is quite large, ensuring a sizeable overlap in the propensity distribution and, in turn, increasing the precision of the estimation.

RESULTS AND DISCUSSION

We now proceed to address the initial questions posed. First, we will estimate the propensity of participation in a farmer cooperative and examine the observable factors that may explain such participation. To achieve this, we will utilise a Stata command called '*pscore'* to estimate Equation (1) above and to test the balancing property.

Table 3 presents the results from the logistic regression of participation in farmer associations, including the marginal effects. A balancing test across all specifications confirms that balancing properties are satisfied. However, the overall goodness of fit (*pseudo* R^2) is not strong, ranging from 0.001 to 0.008, although all specifications are statistically significant. Interestingly, some household-level characteristics do

Table 3
Probability of participating in farmer cooperative (Marginal effect)

	All samples	**Formal**	**Informal**
	(1)	(2)	(3)
Household size	-0.018	-0.008	-0.036
	(0.019)	(0.025)	(0.023)
Female-headed households (0/1)	-0.006	-0.141	0.077
	(0.071)	(0.098)	(0.085)
Age of household head of holding	0.006	0.009	0.013
	(0.028)	(0.038)	(0.034)
Age squared of the household head holding	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)
Household head completed high school (0/1)	0.049	0.141	0.063
	(0.098)	(0.125)	(0.119)
Dependency ratio	-0.044	-0.004	-0.062
	(0.051)	(0.067)	(0.064)
Concrete house wall (0/1)	-0.187**	-0.068	-0.072
	(0.086)	(0.110)	(0.101)
Experience with insects and crop diseases (last 12 months)	0.277*	0.671*	0.102
	(0.082)	(0.096)	(0.106)
All controls	11,969	11,969	11,969
Treatment	1,358	737	873
Observations	13,326	12,705	12,841
Prob > x^2	0.0136	0.0000	0.4139
Pseudo R^2	0.002	0.008	0.001
Log-likelihood	-4377.976	-2789.642	-3185.554
Balancing test	Satisfied	Satisfied	Satisfied
# Of blocks	2	4	1

Notes: The dependent variable takes the value of 1 if the sample households are members of agricultural cooperatives and 0 otherwise. Standard errors are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
Source: Authors' calculations using CIAS 2019

not appear to influence the decision to join the cooperatives, a finding consistent with Ofori et al. (2019) in Cambodia and Fischer and Qaim (2012) in Kenya, who observed similar results. The similarity in socioeconomic characteristics between Kenyan households, cooperative members and non-members, as evidenced by Kernel density distribution of propensity scores of treated and untreated groups before and after matching, is provided in Appendix B. This close similarity in propensity scores is crucial as it enables a robust comparison of outcome variables.

We will now discuss the factors potentially influencing the decision to join

a cooperative or association. These factors include having experienced problems with insects and crop diseases in the previous 12 months and having a concrete house wall (more or less a proxy for household assets). Those who are poorer and have faced natural disasters are 27.7% more likely to participate in farmer organisations than those who have not faced such challenges. It suggests that, for poor Cambodian farmers, joining a cooperative tends to be a risk-sharing strategy. They might also see it as a knowledge-sharing opportunity that provides technical know-how to cope with environmental calamities. Regardless, the first stage estimation results enable us to construct the propensity score on which control groups are established, and the outcomes of the two groups are compared.

Table 4 presents the main estimation results of the effect of participation in farmer cooperatives on agriculture sales per hectare of planted area and engagement in commercial crop plantation. The matching estimators are propensity score (Column 4) and nearest neighbour (Column 5), and we use both. Propensity score matching does not allow for bias adjustment, so we complement that by using the nearest neighbour matching approach and comparing the outputs. Additionally, we perform several postestimation after-matching analyses to check the robustness of the estimates by the main matching approaches. The results of such estimates are presented in Columns 7, 8, and 9. Given the inclusive results of the effect of specification on outcome variables, we use propensity score from the same first-step selection equation for all outcome variables examined (Marchetta & Sim, 2021).

Overall, the matching outcomes show a positive and significant impact of farmer association participation on crop sales per hectare of planted area and crop diversification. The effects range from 11.7% to 15.7% for PS matching (Panel A, Column 4) or 13.7% to 15.4% for Nearest Neighbour matching adjusted for potential explanatory variable bias (Panel A, Column 5). Furthermore, the results are robust, whether based on the number of nearest neighbour matches or other estimators on the matched sample. To put it another way, the results on agriculture sales per hectare of planted area are similar even when we separate the sample between those who participate in formal and informal organisations, as shown in Appendix C-1 and C-2, respectively. Other matching methods, including Kernel and Stratification, also give similar results, so we omit them due to space limitations. In addition, we also carried out OLS and fixed-effects regressions to compare the results. However, we did not rely on these models because the coefficients are distorted by selection bias, as discussed earlier, despite controlling for other independent variables in the regression. Nevertheless, complete results are available upon request.

In sum, our positive findings are consistent with those of Ofori et al. (2019), who found that participation in Cambodia's agricultural cooperatives substantially impacts farm revenue. Member households

Table 4
The effect of participation in farmer community or organisation on agriculture sales per hectare of planted area and engagement in commercial crop plantation

	Obs.					Matched sample		
n	Treated	Matched Controls	ATET	ATET Adj.	OLS (Unmatched sample)	*Diff* t-test	OLS	FE
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A	**Outcome: Sales per hectare planted area (log)**							
1	820	252	0.141***	0.129***		0.119	0.130*	0.030
			(0.005)	(0.049)		(0.095)	(0.072)	(0.138)
2	820	512	0.146***	0.131***		0.034	0.054	0.149
			(0.050)	(0.049)		(0.077)	(0.060)	(0.111)
3	820	757	0.136***	0.126***		0.087	0.071	0.175*
			(0.049)	(0.049)		(0.070)	(0.055)	(0.100)
4	820	987	0.130***	0.126***		0.134**	0.116**	0.253**
			(0.049)	(0.049)		(0.066)	(0.052)	(0.090)
5	820	1,212	0.136***	0.125***	0.121**	0.140**	0.118**	0.227***
			(0.049)	(0.049)	(0.06)	(0.063)	(0.050)	(0.084)
6	820	1,430	0.129***	0.124***		0.144**	0.108**	0.202**
			(0.049)	(0.049)		(0.060)	(0.049)	(0.081)
7	820	1,636	0.132***	0.121***		0.138**	0.072	0.168**
			(0.049)	(0.049)		(0.060)	(0.05)	(0.080)
8	820	1,828	0.134***	0.122***		0.144	0.074**	0.174**
			(0.063)	(0.063)		(0.059)	(0.049)	(0.078)
9	820	2,001	0.130***	0.128***		0.158***	0.079	0.176**
			(0.049)	(0.049)		(0.058)	(0.049)	(0.076)
10	820	2,161	0.128***	0.128***		0.176**	0.099***	0.201***
			(0.049)	(0.049)		(0.057)	(0.048)	(0.075)
Panel B	**Outcome: Crop Diversification (0-1 index)**							
1	1,358	329	0.033***	0.032***		0.043***	0.044***	0.047***
			(0.006)	(0.006)		(0.012)	(0.012)	(0.013)
2	1,358	654	0.034***	0.033***		0.039***	0.042***	0.043***
			(0.006)	(0.006)		(0.009)	(0.009)	(0.013)
3	1,358	971	0.034***	0.033***		0.040***	0.042***	0.043***
			(0.006)	(0.006)		(0.007)	(0.009)	(0.013)
4	1,358	1,275	0.033***	0.033***		0.040***	0.044***	0.040***
			(0.006)	(0.006)		(0.007)	(0.007)	(0.013)
5	1,358	1,567	0.033***	0.033***	0.033***	0.041***	0.045***	0.052***
			(0.006)	(0.006)	(0.005)	(0.007)	(0.007)	(0.009)
6	1,358	1,840	0.033***	0.033***		0.041***	0.044***	0.041***
			(0.006)	(0.006)		(0.006)	(0.007)	(0.013)
7	1,358	2,106	0.033***	0.033***		0.040***	0.044***	0.034***
			(0.006)	(0.006)		(0.006)	(0.006)	(0.013)
8	1,358	2,362	0.033***	0.033***		0.041***	0.045***	0.050***
			(0.006)	(0.006)		(0.006)	(0.006)	(0.013)
9	1,358	2,609	0.033***	0.033***		0.040***	0.044***	0.027***
			(0.006)	(0.006)		(0.005)	(0.006)	(0.013)
10	1,358	2,853	0.033***	0.033***		0.040***	0.043***	0.036***
			(0.006)	(0.006)		(0.005)	(0.006)	(0.013)

Notes: ATET is the average treatment effect on the treated, whereas ATET Adj. is the ATET adjusted for biases of the covariates. Given that the sales value is in logarithmic form, resulting in a semilogarithmic estimation, we employ the approach by Halvorsen and Palmquist (1980) for coefficient interpretation. That is, $\%\Delta\beta = (e^{\beta} - 1) \times 100$. Standard errors are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
Source: Authors' calculations using CIAS 2019

can sell more of their cultivated products than non-members. The same discovery is also documented in Rwanda's coffee sector, where cooperative membership positively influences farmer's productivity (Ortega et al., 2019). A possible explanation for such findings would include disseminating information on agricultural technology, which increases productivity (Zhang et al., 2020), and improving market information and bargaining power (Wossen et al., 2017). In addition, a cooperative's name might act like a collective business brand signalling the quality of products to consumers, who, in turn, can develop a positive view of certain producers or groups of producers (Grashuis & Magnier, 2018). Furthermore, as producer theory predicts, product differentiation leads to higher sales and incomes.

We also discover a significant influence of farmer associations on the household crop diversification index (Panel B). That is, farming households who participate in such associations are observed to be 3.3% more likely to adopt commercial crops. The effect is statistically significant even at 1%. Similar gains are also observed for farming households participating in formal or informal farmer organisations (Appendix C-1 and C-2, Panel B). Again, the results can be attributable to the members' improvement in technical efficiency, as found by Mzyece and Ng'ombe (2021) and Wollni and Brümmer (2012). In particular, Theng et al. (2014) assert that the significant effects of Cambodian farmer associations largely stem from better technological understanding and usage. We can thus understand that besides providing a risk-sharing mechanism, the country's cooperatives also function as a knowledge-sharing platform for farmers. It explains why those who had experienced natural disasters in the previous 12 months were likelier to join an association to learn methods to minimise the damage of such catastrophes.

From a social sciences point of view, the participation of Cambodian farmers in agricultural cooperatives highlights the potential for these organisations to promote social cohesion and community-building (Lang & Novy, 2014). Farmers have developed stronger social networks and a sense of collective identity by working together, fostering mutual trust and cooperation. Thus, it facilitated the sharing of knowledge, the adoption of new farming practices, and the collective bargaining power of the farmers, leading to better market access and higher incomes. Furthermore, the humanities perspective offers insights into the cultural and societal implications of agricultural cooperatives in Cambodia. Research studies in anthropology and sociology have explored how these organisations intersect with local traditions, values, and power dynamics (Schneiberg et al., 2008). For instance, the role of cooperatives in preserving and transmitting traditional agricultural knowledge and practices can contribute to the preservation of cultural heritage (Moscatelli et al., 2017). Additionally, the cooperative model can provide a platform for marginalised groups, such as women and ethnic minorities, to participate more actively

in the agricultural sector and assert their rights and interests (Mhembwe & Dube, 2017). Integrating these social sciences and humanities perspectives illustrates how the cooperative model in Cambodia's agriculture sector goes beyond just economic impacts. It fosters more equitable, culturally grounded, and psychosocially empowered rural communities—a vital foundation for preserving Cambodia's rich civilisation and advancing human development sustainably.

CONCLUSION

Using the PSM approach, this study investigates the impact of farmer associations on agricultural sales per hectare of planted area and crop diversification, two indicators largely overlooked in the literature. Unlike most previous studies, which rely on small sample sizes and/or focus on a specific crop, we employ the Cambodia Inter-Censal Agricultural Survey 2019 and used multiple commercial crops to measure rural households' agricultural success. To the best of our knowledge, ours is the first research study conducted in Cambodia and one among several in the region that can utilise such data and outcome variables. As a result, our study contributes not only new and strong empirical evidence on the influence of farmer cooperatives on various household performance indicators but also offers significant potential in offering Cambodian policymakers to gain applicable knowledge and evidence-based policy implications to enhance agricultural insights for farmers and their communities.

Findings show that many rural households see cooperatives as a risk-sharing strategy and that member households benefit from participating in such organisations in terms of increasing sales as well as knowledge on crop diversification. A possible explanation for this is that through formal or informal training, farmers can learn about the advantages of crop diversification and receive support in terms of inputs such as seeds and technology. However, we cannot clearly understand how cooperatives influence crop diversification. In contrast, the effect on sales is more likely to result from increased market and bargaining power, as well as access to information about potential markets.

Implications for Theory and Practice

Given the central role of agriculture in rural income, expanding and strengthening farmer cooperative management is critical for achieving sustainable development. However, at their current development stage, the Cambodian agricultural cooperatives still largely depend financially on donors, which means their operations will not be sustainable, and the cooperatives themselves will go bankrupt once the funding is exhausted. Therefore, establishing a sustainable financing model is crucial for their survival. Additionally, these associations' governance and financial management should be autonomous and streamlined to minimise bureaucratic obstacles. The government can also play a big role in helping establish, improve, and support cooperatives by providing technical

assistance, including how to set up a local cooperative and other crucial training on management, farming technologies, and know-how. Research evidence encouraged the role of government intervention in promoting collective action, particularly for the farmer association (Li et al., 2023).

Limitation of the Study

It should be highlighted again that PSM requires two assumptions, and with these assumptions come inherent limitations that must be acknowledged. Despite being a method for causal impact evaluation (Imbens & Wooldridge, 2009), PSM has a few definite drawbacks. One major limitation is that the approach assumes selection bias stems mainly from observed characteristics, thereby not addressing unobservable factors that could influence the probability of receiving treatment (Cerulli, 2015; Cunningham, 2021; Khandker et al., 2010). One potential solution is to include household or community covariates that are likely fixed before and after treatment or to construct pre-treatment variables that are unlikely to be affected by treatment. With the current dataset, particularly with regard to the limitation on covariates surveyed, we can only adopt the former solution. Therefore, in general terms, the Propensity Score Matching method significantly reduces selection bias but does not eliminate it. Nevertheless, bias in PSM estimates in our case can be low and thus negligible because our study and data meet all three broad requirements postulated by Heckman et al. (1997, 1998). First, data on treatment and control groups were collected using the same survey instrument, by the same interviewers, and during the same survey period. Second, our data are derived from a nationally representative survey with a large sample size, as described earlier. Third, the large sample size in the comparison group facilitates a smoother matching process.

Recommendations for Future Research

Future research on farmer associations could explore two key areas. First, measuring the impact of these associations through rigorous impact evaluation research can help establish causal relationships. However, such quantitative studies may not fully explain the underlying mechanisms driving the observed impacts. In this regard, qualitative research would provide a more comprehensive understanding. Second, while existing studies have found positive effects of farmer association membership, the net economic benefits to farming households remain unclear because the analysis has not factored in the costs incurred by members, such as membership fees or in-kind contributions to cooperative operations. Essentially, the monetary gains from membership may be smaller than the direct and opportunity costs borne by the households. Conducting a thorough cost-benefit analysis could be a fruitful area for future research to ascertain the true economic implications of farmer association membership.

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APPENDICES

Appendix A.1: Summary statistics of selected socioeconomic characteristics (formal)

Variables	Mean (treated) (1)	Mean (non-treated) (2)	*S.E* (3)	*Diff* (t-test) (1)-(2)
Land areas cultivated by households (ha)[a]	3.132	2.556	0.256	0.576**
Household size	3.986	3.998	0.063	-0.011
Female-headed households (0/1)	0.200	0.223	0.016	-0.023
Age of household head (years)[b]	48.711	48.540	0.438	0.171
Household head completed high school (0/1)	0.109	0.097	0.012	0.012
Dependency ratio	0.519	0.530	0.025	-0.012
Number of working-age members (15-64)	2.799	2.775	0.052	0.025
House with concrete wall (0/1)	0.143	0.152	0.014	-0.009
Outstanding loans for agriculture production	0.350	0.243	0.017	0.107***
Outstanding loans from banks (0/1)	0.154	0.116	0.012	0.037***
Engagement in agro-processing activities (0/1)	0.059	0.034	0.007	0.025***
Experience of insects and crop diseases	0.204	0.116	0.013	0.088***
Engagement in aromatic rice farming (0/1)	0.177	0.139	0.013	0.039***
Engagement in mango plantation (0/1)	0.285	0.212	0.016	0.072***
Engagement in banana plantation (0/1)	0.227	0.189	0.015	0.038**
Engagement in cassava plantation (0/1)	0.102	0.107	0.012	-0.005
Engagement in cashew plantation (0/1)	0.102	0.094	0.011	0.008
Share of agricultural income to total income (>40%) (0/1)	0.599	0.526	0.019	0.072***
Obs.	737	11,969		

Source: Authors' calculations using Cambodia Inter-Censual Agricultural Survey 2019.

Notes: [a] observations for the treated group are 695 and 10,850 for the non-treated. 1,161 observations were excluded from the calculation because they did not report their land areas.

[b] observations for the control are 11,968.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Appendix A.2: Summary statistics of selected socioeconomic characteristics (informal)

Variables	**Mean (treated) (1)**	**Mean (non-treated) (2)**	***S.E* (3)**	***Diff* (t-test) (1)-(2)**
Land areas cultivated by households (ha)[a]	2.579	2.556	0.232	0.023
Household size	3.877	3.998	0.058	-0.120**
Female-headed households (0/1)	0.239	0.223	0.015	0.016
Age of household head (years)[b]	48.488	48.540	0.405	-0.052
Household head completed high school (0/1)	0.101	0.097	0.011	0.004
Dependency ratio	0.494	0.530	0.022	-0.036
Number of working-age members (15-64)	2.722	2.775	0.048	-0.053
House with concrete wall (0/1)	0.143	0.152	0.013	-0.008
Outstanding loans for agriculture production	0.287	0.243	0.015	0.043***
Outstanding loans from banks (0/1)	0.123	0.116	0.011	0.007*
Engagement in agro-processing activities (0/1)	0.046	0.034	0.007	0.012
Experience of insects and crop diseases	0.127	0.116	0.011	0.012
Engagement in aromatic rice farming (0/1)	0.184	0.139	0.012	0.044***
Engagement in mango plantation (0/1)	0.272	0.212	0.015	0.059***
Engagement in banana plantation (0/1)	0.197	0.189	0.014	0.009
Engagement in cassava plantation (0/1)	0.100	0.107	0.011	-0.007
Engagement in cashew plantation (0/1)	0.118	0.094	0.011	0.024**
Share of agricultural income to total income (>40%) (0/1)	0.637	0.526	0.018	0.111***
Obs.	873	11,969		

Source: Authors' calculations using Cambodia Inter-Censual Agricultural Survey 2019.

Notes: [a] observations for the treated group are 829 and 10,850 for the non-treated. 11,163 observations were excluded from the calculation because they did not report their land areas.

[b] observations for the control are 11,968.

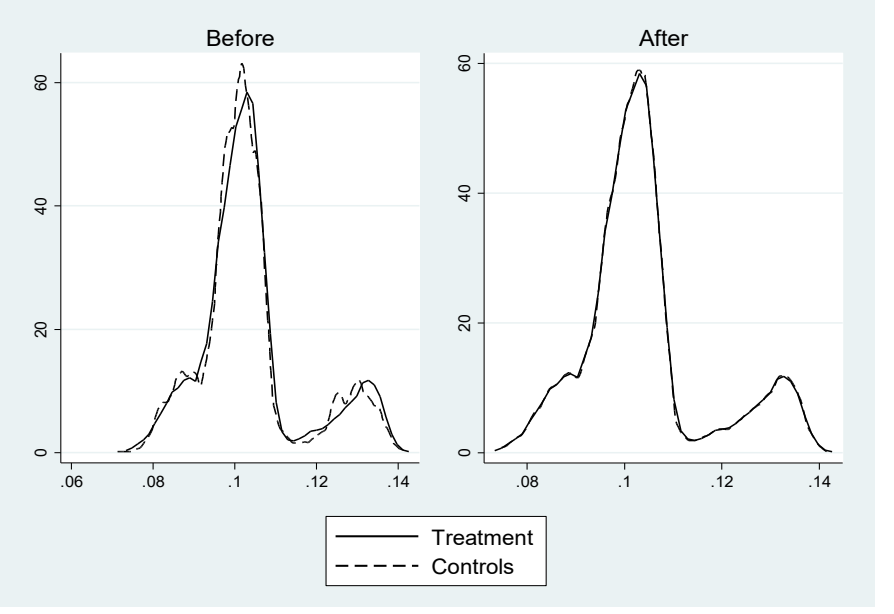
$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Appendix A.3: One-way analysis of variance

		Sum of square	df	Mean square	F	Sig.
(1)	Between group	2.0252e+7	2	1.0126e+7		
	Within group	6.8192e+10	7,028	9.7028e+6	1.04	0.352
	Total	6.8212e+10	7,030	9.7029e+6		
(2)	Between group	2.3996e+6	2	1,199,821.53		
	Within group	7.4192e+10	6,536	11,3513.887	10.570	0.001
	Total	7.4432e+10	6,538	113846.193		
(3)	Between group	1.4279	2	0.713		
	Within group	396.492	13,324	0.029	23.990	0.001
	Total	397.920	13,326	0.029		

Source: Authors' calculations using Cambodia Inter-Censual Agricultural Survey 2019.
Notes: (1) sales; (2) sales per hectare; (3) engagement in commercial crop plantation. The grouping is 1 for non-treated, 2 for participation in formal or in informal association.

Appendix B: Kernel density distribution of propensity score of the treated and non-treated groups before and after matching (all sample)



Appendix C.1: The effect of participation in farmer cooperatives on sales and engagement in commercial crop plantation (formal)

n	*Obs.*		ATET	ATET Adj.	OLS (Unmatched sample)	Matched sample		
	Treated	Matched Controls				*Diff* t-test	OLS	FE
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A: Outcome: Sales per hectare of land (log)								
1	462	201	0.138**	0.117*		-0.112	0.177*	-0.050
			(0.067)	(0.067)		(0.117)	(0.097)	(0.151)
2	462	399	0.147**	0.127*		0.035	0.062	0.147
			(0.067)	(0.067)		(0.095)	(0.081)	(0.120)
3	462	591	0.142**	0.111*		0.104	0.098	0.186*
			(0.066)	(0.066)		(0.087)	(0.075)	(0.106)
4	462	776	0.138**	0.104		0.136*	0.124*	0.200**
			(0.066)	(0.066)		(0.082)	(0.070)	(0.096)
5	462	953	0.131**	0.104		0.131*	0.102	0.177*
			(0.066)	(0.066)	0.112*	(0.079)	(0.067)	(0.091)
6	462	1,126	0.123*	0.106	(0.060)	0.136*	0.088	0.163*
			(0.065)	(0.066)		(0.076)	(0.066)	(0.087)
7	462	1,294	0.122*	0.105		0.134*	0.044	0.160*
			(0.066)	(0.066)		(0.075)	(0.067)	(0.087)
8	462	1,454	0.122*	0.106		0.142*	0.041	0.179**
			(0.066)	(0.066)		(0.074)	(0.066)	(0.084)
9	462	1,610	0.122*	0.110*		0.159**	0.044	0.196**
			(0.066)	(0.066)		(0.073)	(0.065)	(0.082)
10	462	1,753	0.123*	0.108		0.175**	0.067	0.203**
			(0.066)	(0.066)		(0.072)	(0.065)	(0.081)
Panel B: Outcome: Crop Diversification (0-1 index)								
1	737	266	0.026***	0.025***		0.030**	0.031**	0.038***
			(0.007)	(0.007)		(0.013)	(0.013)	(0.014)
2	737	526	0.027***	0.025***		0.028***	0.031***	0.033***
			(0.007)	(0.007)		(0.009)	(0.010)	(0.014)
3	737	784	0.027***	0.026***		0.035***	0.037***	0.054***
			(0.007)	(0.007)		(0.009)	(0.009)	(0.014)
4	737	1,032	0.027***	0.026***		0.034***	0.037***	0.034**
			(0.007)	(0.007)		(0.014)	(0.008)	(0.014)
5	737	1,275	0.028***	0.026***		0.036***	0.038***	0.045***
			(0.007)	(0.007)	0.027***	(0.007)	(0.008)	(0.014)
6	737	1,512	0.028***	0.027***	(0.006)	0.036***	0.037***	0.042***
			(0.007)	(0.007)		(0.007)	(0.008)	(0.014)
7	737	1,738	0.028***	0.027***		0.037***	0.039***	0.047***
			(0.007)	(0.007)		(0.007)	(0.007)	(0.014)
8	737	1,961	0.028***	0.027***		0.037***	0.040***	0.049***
			(0.007)	(0.007)		(0.007)	(0.007)	(0.014)
9	737	2,171	0.028***	0.027***		0.037***	0.039***	0.028***
			(0.007)	(0.007)		(0.007)	(0.007)	(0.014)
10	737	2,376	0.028***	0.026***		0.036***	0.039***	0.039***
			(0.007)	(0.007)		(0.007)	(0.007)	(0.014)

Source: Authors' calculations using Cambodia Inter-Censual Agricultural Survey 2019.

Notes: ATET is the average treatment effect on the treated, whereas ATET Adj. is the ATET adjusted for biases of the covariates. We also controlled for other variables for the ordinary least square and fixed effect regressions. Given limited space, coefficients are not presented but available upon request. Standard errors are in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Appendix C.2: The effect of participation in farmer cooperatives on sales and engagement in commercial crop plantation (informal)

	Obs.					Matched sample		
n	**Treated**	**Matched Controls**	**ATET**	**ATET Adj.**	**OLS (Unmatched sample)**	***Diff* t-test**	**OLS**	**FE**
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A: Outcome: Sales per hectare of land (log)								
1	484	192	0.201***	0.185***		0.072	0.140	0.047
			(0.063)	(0.063)		(0.117)	(0.092)	(0.136)
2	484	383	0.181***	0.180***		0.066	0.071	0.159
			(0.063)	(0.063)		(0.094)	(0.077)	(0.117)
3	484	572	0.180***	0.177***		0.122	0.081	0.219**
			(0.064)	(0.063)		(0.085)	(0.070)	(0.106)
4	484	758	0.174***	0.181***		0.175**	0.135**	0.303***
			(0.063)	(0.063)		(0.079)	(0.066)	(0.097)
5	484	938	0.178***	0.180***		0.193**	0.151**	0.279***
			(0.063)	(0.063)	0.182***	(0.076)	(0.064)	(0.091)
6	484	1,109	0.176***	0.180***	(0.058)	0.208**	0.146**	0.286***
			(0.063)	(0.063)		(0.074)	(0.063)	(0.088)
7	484	1,277	0.171***	0.173***		0.200***	0.112*	0.246***
			(0.063)	(0.063)		(0.073)	(0.063)	(00.087)
8	484	1,435	0.172***	0.172***		0.195***	0.113*	0.229***
			(0.063)	(0.063)		(0.072)	(0.062)	(0.084)
9	484	1,584	0.173***	0.182***		0.206***	0.120**	0.237***
			(0.063)	(0.063)		(0.071)	(0.061)	(0.082)
10	484	1,730	0.169***	0.184***		0.220**	0.138**	0.268***
			(0.063)	(0.063)		(0.07)	(0.061)	(0.081)
Panel B: Outcome: Crop Diversification (0-1 index)								
1	873	268	0.026***	0.026***		0.037***	0.040***	0.033***
			(0.007)	(0.007)		(0.013)	(0.013)	(0.014)
2	873	534	0.028***	0.026***		0.037***	0.040***	0.033***
			(0.007)	(0.007)		(0.010)	(0.010)	(0.014)
3	873	797	0.027***	0.026***		0.035***	0.039***	0.032***
			(0.007)	(0.007)		(0.009)	(0.009)	(0.014)
4	873	1,054	0.028***	0.026***		0.034***	0.038***	0.023***
			(0.007)	(0.007)		(0.008)	(0.008)	(0.014)
5	873	1,308	0.027***	0.026***		0.035***	0.039***	0.030***
			(0.007)	(0.007)	0.026***	(0.007)	(0.008)	(0.014)
6	873	1,557	0.027***	0.026***	(0.006)	0.036***	0.038***	0.030***
			(0.007)	(0.007)		(0.007)	(0.007)	(0.015)
7	873	1,802	0.027***	0.026***		0.035***	0.039***	0.033***
			(0.007)	(0.007)		(0.007)	(0.007)	(0.015)
8	873	2,045	0.027***	0.026***		0.036***	0.040***	0.046***
			(0.007)	(0.007)		(0.007)	(0.007)	(0.015)
9	873	2,286	0.027***	0.026***		0.035***	0.038***	0.024***
			(0.007)	(0.007)		(0.007)	(0.007)	(0.014)
10	873	2,523	0.027***	0.027***		0.034***	0.037***	0.025***
			(0.007)	(0.007)		(0.007)	(0.007)	(0.015)

Source: Authors' calculations using Cambodia Inter-Censual Agricultural Survey 2019.

Notes: ATET is the average treatment effect on the treated, whereas ATET Adj. is the ATET adjusted for biases of the covariates. We also controlled for other variables for the ordinary least square and fixed effect regressions. Given limited space, coefficients are not presented but available upon request. Standard errors are in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

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Pertanika Editorial Office, Journal Division
Putra Science Park
1st Floor, IDEA Tower II
UPM-MTDC Technology Centre
Universiti Putra Malaysia
43400 UPM Serdang
Selangor Darul Ehsan
Malaysia

http://www.pertanika.upm.edu.my/
E-mail: executive_editor.pertanika@upm.edu.my
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