Green consumer behaviour influences Indonesian palm oil sustainability

H. PURNOMO[a,b], S.D. KUSUMADEWI[a], Q.P. ILHAM[b], H.N. KARTIKASARA[b], B. OKARDA[a], A. DERMAWAN[a], D. PUSPITALOKA[a], H. KARTODIHARDJO[b], R. KHARISMA[b] and M.A. BRADY[a]

[a]*Center for International Forestry Research-World Agroforestry, (CIFOR-ICRAF) Jalan CIFOR, Bogor, 16115, Indonesia*
[b]*IPB University, Jalan Raya Dramaga, Bogor, 16680, Indonesia*

Email: h.purnomo@cifor-icraf.org, s.dyah@cifor-icraf.org, qoripebrialilham@yahoo.com, hatmanova24@gmail.com, b.okarda@cifor-icraf.org, a.dermawan@cifor-icraf.org, d.puspitaloka@cifor-icraf.org, hakabgr@gmail.com, restikharisma@gmail.com, m.brady@cifor-icraf.org

HIGHLIGHTS

- Trade and political economy factors (structures, institutions and actors) significantly influence the sustainability of palm oil in Indonesia.
- The study revealed that the biggest determinants of sustainability in the Indonesian palm oil sector are job creation and no deforestation. The POPETS (Palm Oil Political Economy and Trade Structural equation model) developed in this study suggests the importance of synergizing global trade effects and national government roles to advance palm oil sustainability in Indonesia.
- Green consumer behaviour influences the structures and institutions of Indonesia's palm oil sector and provides opportunities for sustainability.
- Actors are primary drivers of palm oil sustainability, where the national government, civil society organizations/non-governmental organizations and political figures are identified as key actors.

SUMMARY

Palm oil businesses affect livelihoods and the environment, particularly forests, with land-use change and climate change impacts. This research aimed to develop a model for understanding the influences of global trade and political economy factors on palm oil sustainability and livelihoods in Indonesia. It combined systematic review with structural equation modelling through a model called POPETS (Palm Oil Political Economy and Trade Structural equation model). The study revealed that palm oil sustainability is defined by employment opportunities and no deforestation, while livelihoods are defined by household income. Trade and political economy factors (structures, institutions and actors) significantly influence the sustainability of palm oil. Trade has indirect effects on sustainability and livelihoods, while actors have a direct effect on sustainability. There is also a positive correlation between sustainability and livelihoods. These findings suggest the importance of synergizing global trade effects and national government roles to advance palm oil sustainability in the producing countries.

Keywords: palm oil, governance, trade, political-economy, deforestation

Le mode de conduite 'vert' influence la durabilité du secteur de l'huile de palme en Indonésie

H. PURNOMO, S.D. KUSUMADEWI, Q.P. ILHAM, H.N. KARTIKASARA, B. OKARDA, A. DERMAWAN, D. PUSPITALOKA, H. KARTODIHARDJO, R. KHARISMA et M.A. BRADY

Le secteur de l'huile de palme affecte les revenus et l'environnement, en particulier les forêts, du fait du changement d'utilisation des sols et des impacts du changement climatique. Cette recherche s'efforce de développer un modèle permettant d'appréhender les influences du commerce à l'échelle globale et les facteurs économiques affectant la durabilité de la production d'huile de palme et la génération de revenus en Indonésie. Elle a combiné une étude systématique avec une modélisation d'équation structurelle à l'aide d'un modèle appelé POPETS (Modèle d'équation structurelle de l'économie politique et du commerce de l'huile de palme). Cette étude révèle que la durabilité du secteur de l'huile de palme est définie par les opportunités d'emploi et l'absence de déforestation, alors que les moyens de subsistance sont définis, eux, par le revenu des ménages. Le commerce et les facteurs d'économie politique (structures, institutions et acteurs) influencent significativement la durabilité de ce secteur de l'huile de palme. Le commerce a des effets indirects sur la durabilité et les revenus, alors que les acteurs ont un effet direct sur la durabilité. Il existe également une corrélation positive entre cette durabilité et les revenus. Ces résultats suggèrent l'importance de mettre en synergie les effets globaux du commerce et celle du rôle du gouvernement national à faire avancer la durabilité du secteur de l'huile de palme dans les pays producteurs.

El comportamiento ecológico de los consumidores influye en la sostenibilidad del aceite de palma indonesio

H. PURNOMO, S.D. KUSUMADEWI, Q.P. ILHAM, H.N. KARTIKASARA, B. OKARDA, A. DERMAWAN, D. PUSPITALOKA, H. KARTODIHARDJO, R. KHARISMA y M.A. BRADY

Las empresas de aceite de palma afectan a los medios de vida y al medio ambiente, en particular a los bosques, con repercusiones en el cambio del uso del suelo y el cambio climático. El objeto de esta investigación fue desarrollar un modelo para comprender las influencias del comercio mundial y los factores de la economía política en la sostenibilidad del aceite de palma y los medios de subsistencia en Indonesia. El estudio combinó la revisión sistemática con la modelización de ecuaciones estructurales en un modelo denominado POPETS (por sus siglas en inglés), o Modelo de Ecuaciones Estructurales Comerciales y de Economía Política del Aceite de Palma. El estudio reveló que la sostenibilidad del aceite de palma se define por las oportunidades de empleo y la no deforestación, mientras que los medios de vida se rigen por los ingresos familiares. Los factores comerciales y de la economía política (estructuras, instituciones y actores) influyen significativamente en la sostenibilidad del aceite de palma. El comercio tiene efectos indirectos sobre la sostenibilidad y los medios de vida, mientras que los actores tienen un efecto directo sobre la sostenibilidad. También existe una correlación positiva entre la sostenibilidad y los medios de vida. Estos resultados sugieren la importancia de las sinergias entre los efectos del comercio mundial y las funciones de los gobiernos nacionales para avanzar en la sostenibilidad del aceite de palma en los países productores.

INTRODUCTION

Campaigns and discourses on palm oil are high profile both globally and domestically. Palm oil development is a controversial issue, and its expansion is associated with deforestation and peatland degradation (Austin *et al*. 2017, Vijay *et al*. 2016), carbon loss and greenhouse gas emissions (Manning *et al*. 2019, Uning *et al*. 2020).

Major producing countries, e.g., Indonesia and Malaysia, perceive palm oil as a solution to renewable energy and poverty. In Indonesia, oil palm plantation development is concentrated primarily in Sumatra and Kalimantan. Its development on other islands, such as Sulawesi and Papua, is relatively recent, and on a much smaller scale (Figure 1). National figures indicate the extent of oil palm planted area reaching approximately 15 million hectares, with estimated annual production being 49.7 million metric tons (MoA 2022a, 2022b). The Government of Indonesia has mandated palm-oil based biodiesel, which it expects to contribute towards emissions reduction efforts by replacing fossil fuels, and generating foreign exchange reserves (BPDPKS 2018, CMoEA 2021). Indonesia's limited fossil fuel reserves have made it a net importer, forcing it to spend billions of dollars to meet energy needs for its people and development. With palm oil-based biodiesel it can reduce expenditure on fossil fuel imports.

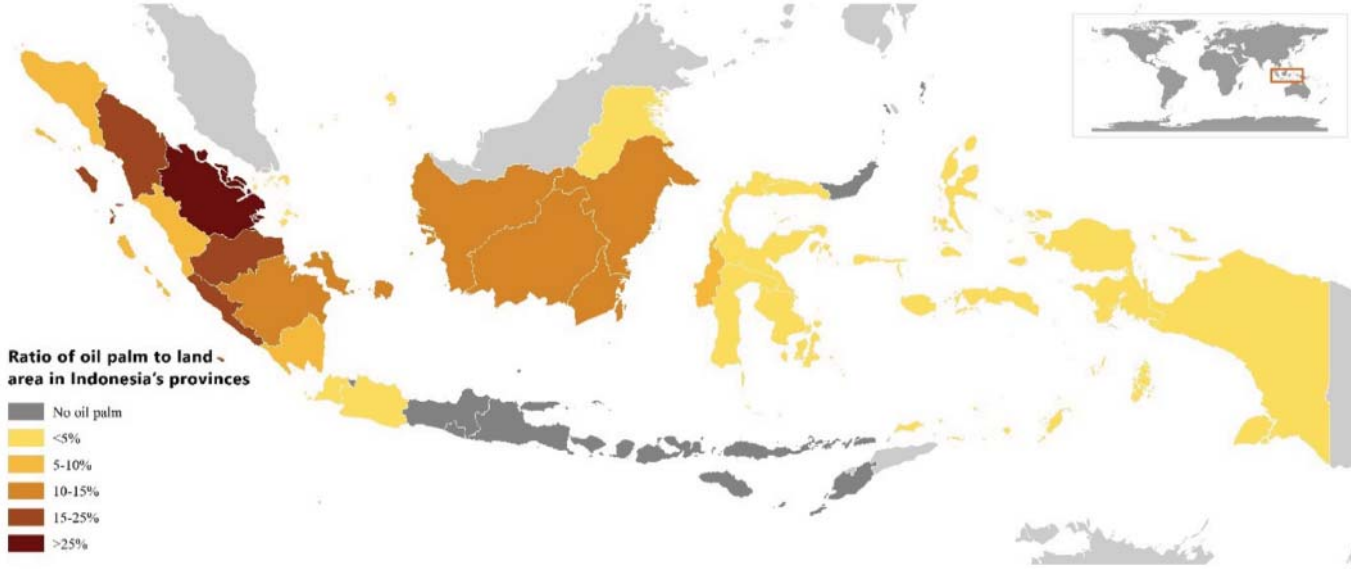
Palm oil contributes significantly to Indonesia's economy and provides livelihoods for smallholders. Even during the pandemic its palm oil export value reached US$ 17 billion (UN Comtrade 2021). As the palm oil economy generates employment for 16 million people (BPDPKS 2018, CMoEA 2021, MoI 2021), its development is perceived as a solution to poverty.

In line with the Paris Agreement, through its Enhanced Nationally Determined Contribution (ENDC), Indonesia has pledged to reduce carbon emissions by 31.89% unilaterally and by 43.20% with foreign support against a business-as-usual (BAU) scenario by 2030. Under a BAU scenario, annual emissions would reach 2.87 gigatons of CO_2 equivalent (CO_2-eq) by 2030. Indonesia's contribution to lowering emissions is expected to come from sustainable agriculture and plantations, reducing forest degradation and deforestation, land conservation, and producing renewable energy from degraded land (GoI 2022).

Indonesia is expected to develop its palm oil economy sustainably, as mandated by Article 33 paragraph 4 of its 1945 Constitution. Meanwhile, Law No. 18/2013 on Prevention and Eradication of Forest Destruction clearly states that oil palm may not be planted in the state forest estate, and that fresh fruit bunches (FFBs) sourced from forest estate land are illegal and may not be traded. There are policy scenario options that could reconcile oil palm plantation development with forest conservation (Purnomo *et al.* 2020). How laws and regulations are implemented is affected by political economy factors: structures, institutions, and stakeholder interest and power (Fritz *et al.* 2009). Purnomo *et al.* (2021) found that political economy factors explained 31% (0.31) of the variation in a sustainability and livelihoods model in lowland agriculture in Indonesia. In addition, palm oil sustainability is also conditioned by domestic and international consumers. As the global oil crop revolution is buyer driven (Byerlee *et al*. 2017), palm oil buyers' roles are significant in transforming the palm oil sector in Indonesia. Figure 1 shows oil palm distribution in Indonesia, with most oil palm plantations located in Sumatra, Kalimantan (Indonesian Borneo) and Sulawesi, with recent development taking place in Papua and West Papua provinces.

The role of political economy and trade (PET) in palm oil sustainability has yet to be understood. Furthermore, there is a lack of science-based evidence on how influential structural factors (demography and geopolitics), institutional factors (legislation, law enforcement, corruption), actors (government, the private sector, NGOs, academics and local communities),

FIGURE 1 *Palm oil plantation distribution in Indonesia 2019 (DGP 2020)*



and trade (value chains, domestic and global markets, consumers) are in affecting palm oil sustainability and livelihoods. Consequently, planning and actions are not made based on solid science.

This study was designed to combined a systematic review with structural equation modelling (SEM) in order to understand palm oil sustainability and livelihoods. The use of these methods itself is a novelty. Many studies have used SEM in exploring smallholder behaviour (Adiprasetyo *et al*. 2019), soil (Tao *et al*. 2018, Winanto 2017), contribution to regional gross domestic product (Muda *et al*. 2017), biodiversity (*Giam et al*. 2015), performance (Lukman *et al*. 2019, Winarsih *et al*. 2021) and sustainable behaviour for land remediation (Hou *et al*. 2014). However, there is a lack of studies that systematically build, model and test sets of variables that have the potential to affect sustainability and livelihoods.

Having a clear and quantitative relationship between PET and palm oil sustainability will help policymakers and relevant stakeholders improve the focus of interventions for achieving sustainable palm oil and sustainable livelihoods. The aim of this study was to develop a PET model and scenarios to enhance palm oil sustainability at the national level, based on evidence from the national and global levels. Representative respondents from different sectors were surveyed, and SEM was performed using AMOS software.

The outcome of the study answers the following questions: (a) How and how much influence do political economy and trade variables have on the sustainability of palm oil in Indonesia? (b) What political and trade economy options and scenarios are available to improve palm oil sustainability? (c) How powerful are different palm oil actors in influencing palm oil sustainability? The results will help national policymakers, producers, consumers and the international community to understand key factors influencing palm oil sustainability and livelihoods.

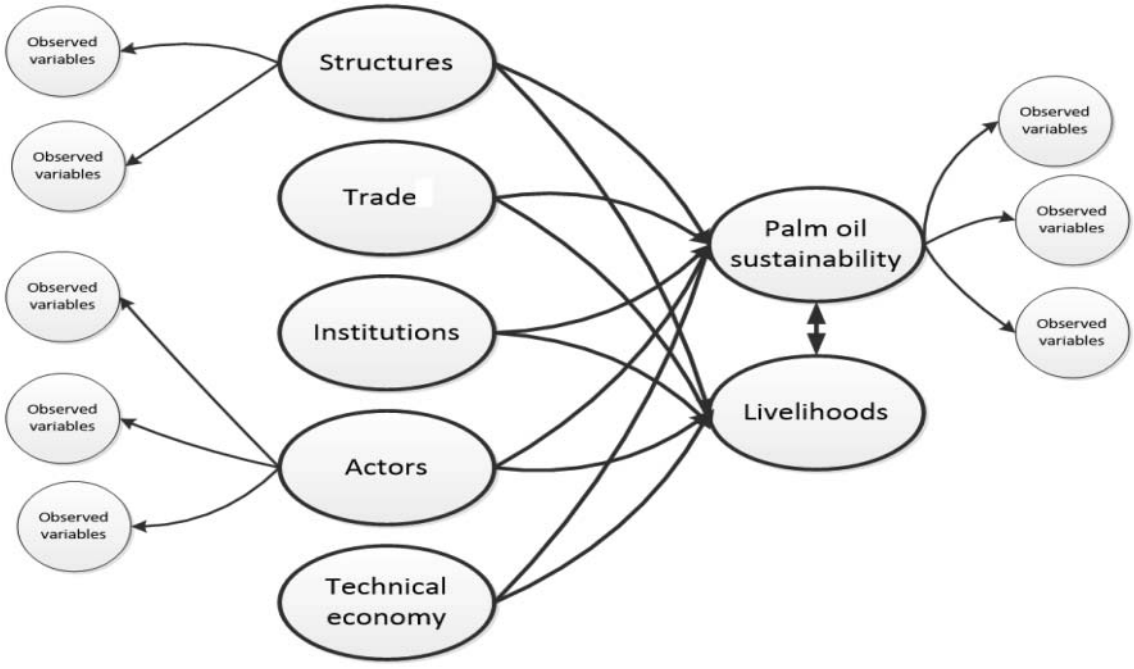
FRAMEWORK AND METHODS

Political economy and trade framework

Fritz *et al.* (2009, 2014) highlight the importance of political economy factors in framing commodity interventions. The success of an intervention is determined by technical, economic and political economic factors (Annex 1). Technical factors consist of land suitability, technical capacity and supporting infrastructure. Economic factors comprise economic value, marketing channels, financial sources, access to information and distribution of profits. Technical and economic feasibility are usually the primary background considerations in developing intervention recommendations. Meanwhile, political economy factors consist of linkages between structures, institutions and actors. Structural factors such as geopolitics and climate change are beyond the control of local actors, such as individuals or organized groups. Institutions refers to 'rules of the game' and regulations, including informal rules underlying political power. From a broader perspective, institutions can also be defined as how the public sector is organized (Fritz *et al.* 2009). In adapting an initial framework, trade factors were separated from other political economy factors.

The aim of this PET analysis was to determine the relevant political economy and trade factors influencing palm oil sustainability at the national level. A hypothetical structural sub-model was constructed on how palm oil sustainability in Indonesia is affected by structures, trade, institutions and actors (STIA) variables in addition to technical economy (TE) variables, as shown in Figure 2. The model, called the POPETS (Palm Oil Political Economy and Trade Structural equation) model, comprises several observed variables and indicates or measures STIA and TE variables to form a measurement sub-model. Palm oil sustainability and community livelihoods were measured and demonstrated using several observed variables.

FIGURE 2 *POPETS hypothetical structural model*



The main hypotheses of the study were as follows: 1) As palm oil sustainability and the livelihoods of people who depend on it are influenced significantly by STIA variables, their influence can be assessed and weighted based on evidence in Indonesia; and 2) The structural equation modelling (SEM) method produces a rigorous model to mimic the quality and potential impacts of the (prioritized) intervention for palm oil sustainability and livelihoods regarding STIA factors.

Methods

POPETS modelling involved identifying, characterizing and parameterizing of STIA variables. A systematic review was conducted to identify STIA variables, then each variable in the hypothetical model underwent a literature review for building the survey questionnaire. The literature review began with a literature search on ISI Web of Science, sorting, first and second screening, then analysis. The scope of the literature search was set only for journal articles from the last 10 years (1 January 2011 – 31 August 2021). Using combinations of keywords as search strings (e.g., structure, trade, institution, actor, technical economy, sustainability, livelihood, factor, palm oil and oil palm), 1 256 journal articles were found, which were then sorted by title to eliminate duplication. This resulted in 675 relevant articles.

As a first step, articles' abstracts were screened to identify their relevance. This resulted in 236 relevant articles discussing and/or showing evidence of STIA and other variables relevant to oil palm sector sustainability in Indonesia (Annex 2). A second screening stage was carried out with an emphasis on methodologies and findings, which resulted in 110 articles. Subsequently, the articles' content was analysed using NVivo through which 55 important factors for observed variables were identified as being related to the seven latent constructs based on the hypothetical model (Table 1). These results formed the basis for a questionnaire comprising variables for assessing current conditions relating to sustainability.

Then, the questionnaire was used for collecting data. It utilized a Likert scale (1-very poor to 5-excellent) to measure evidence and respondents' opinions (Annex 5), and was distributed to 729 pre-identified respondents from November 2021 to January 2022. These respondents, who were identified from an earlier scoping study (Purnomo *et al.* 2020), were key stakeholders in the oil palm sector. A snowball sampling technique (Everitt and Skrondal 2010) was then applied to identify other potential respondents. Due to the pandemic, an online survey was prepared and distributed to target respondents via email and virtual personal communication. In total, 189 questionnaires were received (a 26% return rate) from respondents including academics, research institutions or think tanks (32%); government (21%), CSOs)/NGOs (19%), the private sector (12%) and other organizations.

A structural equation model (SEM) was then developed using AMOS software (ADC 2015) to determine which variables contribute to palm oil sustainability and livelihoods (Hou *et al*. 2014). The SEM's multivariate statistical analysis technique combined factor analysis and multiple regression analysis, which could analyse structural relationships between measured variables and latent constructs. Literature suggests a sample size of 100–200 for an SEM with a maximum likelihood estimation (Hair *et al.* 2006). First, the data from the 189 respondents was checked to see whether it was normally distributed, and to eliminate any outliers. This resulted in 115 respondents' responses being eligible for further analysis for the model. The model was tested with goodness-of-fit (GoF) (ADC 2015, Hair *et al*. 2006), which describes how well the model fits a set of observations or acceptance of null

hypothesis in a test of statistical significance. GoF summarized significant differences between observed values and the values expected under the model, using the chi-square ($\chi 2$) test. Finally, the SEM results showed the direct, indirect and total effects between latent constructs. A direct effect is the effect of one variable on another without going through a mediating variable, and was indicated by a one-headed arrow. An indirect effect is the effect of one variable on another 'transmitted' through a mediating variable. Such indirect effects are the products of at least two paths traceable from one variable to another. In our model, the estimated total effect of one variable on another was equal to the sum of all direct and indirect effects between the two variables.

Stakeholder consultations were conducted for the purpose of triangulation. The preliminary results of the study were presented to key stakeholders in Indonesia, including respondents of the survey, for validation in a dissemination seminar. Feedback was received and used to improve the model.

RESULTS

STIA, sustainability and livelihoods variables review

Structures

The eight most relevant structural factors identified from literature reviews were: land tenure; demography and level of development; human resources capacity of farmers; financial capacity of farmers; geopolitics; smallholder business models; climate change and natural disasters; and national and global political stability. Land tenure systems are a crucial challenge in oil palm development. The Government of Indonesia has indicated that the area of oil palm planted inside the state forest estate exceeds three million hectares (CMoEA 2021). This results in land legality issues being a key impediment to sustainability certification (Brandi *et al.* 2015). Unclear land tenure rights and lack of acknowledgment of indigenous rights in land allocation processes are other critical issues for oil palm development in the forest frontier (Andrianto *et al.* 2019, Gatto *et al.* 2015). Literature findings show that on-site demography and community development level influence the success and profitability of oil palm development, which is more successful in communities with less dependence on forest services (Abram *et al.* 2017), and that oil palm development in indigenous villages progresses at a slower pace than in migrant villages (Gatto *et al.* 2015). The Government of Indonesia has issued several policies to improve palm oil sustainability, including a moratorium on new oil palm licences in primary forest and peatlands, the mapping of oil palm corporations and their licences, and the omnibus law on job creation.

From the smallholder side, type of business model (independent or plasma scheme) determines farmers' sustainability behaviour and capacity to apply sustainable practices (Cahyadi and Waibel 2016, De Vos *et al.* 2021; Jelsma *et al.* 2017, 2019, Lee *et al.* 2014, Schoneveld *et al.* 2017, 2019). Previous studies show that independent farmers face more challenges and sustainability constraints than plasma farmers (Hidayat *et al.* 2021, Hutabarat *et al.* 2019). Human resources and financial capacity, especially for independent farmers, are the main constraints for sustainable practices. Farmers often lack knowledge on applying good agricultural practices, documentation, and administration of farming businesses, and understanding of sustainability standards (Brandi *et al.* 2015, Gatto *et al.* 2017, Glasbergen 2018).

From a broader environmental perspective, the oil palm sector in Indonesia is directed by national, global and regional political situations. This is because oil palm is an export commodity in which the global trade is regulated and influenced by various policy regimes and transnational governance pressures, such as climate change and green deals (Abdullah *et al*. 2020a, Apriyani *et al.* 2020, Astari *et al.* 2019). Political stability is also an influencing factor for palm oil development in which different political eras and their accompanying land tenure approaches reflect today's landscape (Kunz *et al.* 2017). Another important factor is climate change, which threatens palm oil production due to increases in global temperature that may impact land suitability (Paterson 2015, Paterson *et al.* 2017) and yield (Hidayat *et al.* 2021).

Trade

Nine important trade factors for palm oil sustainability were identified: international demand; domestic consumption; competition; market preferences; supply; supply chain governance; voluntary certification; trade incentives and barriers; and consumer behaviour. In addition to domestic consumption, global palm oil expansion is driven by international demand for renewable energy policies, such as by the European Union (EU), and growing demand for food, biodiesel and other commodities (Rulli *et al.* 2019). Domestic consumption in Indonesia began in the late 1970s and early 1980s, primarily for cooking oils (Gaskell *et al.* 2015). Recently, the biodiesel policy in Indonesia has contributed to an increase in domestic palm oil consumption (Harahap *et al.* 2017).

As palm oil is a market-driven commodity, market preferences play an important role in driving trade. Western markets (the EU for instance) now prefer and demand sustainable palm oil (Apriyani *et al.* 2020, Kadarusman and Pramudya 2019). Meanwhile private-driven markets like China and India require fewer sustainability standards (Kadarusman and Pramudya 2019). The sustainability concerns of western markets have led to the emergence of voluntary certification mechanisms (Meijer 2015, Schmidt and De Rosa 2020). These concerns have also been strengthened by the widespread adoption of green consumer behaviour on an individual level (Koh and Lee 2012). Another important driver in the oil palm boom is economic forces, especially incentives or disincentives from global trade, such as price changes (Hidayat *et al.* 2021, Lim *et al.* 2019). Consequently, global market stability strongly influences the Indonesian palm oil industry.

Institutions

Institutional factors comprise public policy; legal and regulatory framework; national politics and policy processes; subnational initiatives; land-use planning and allocation; permits and licensing; mandatory sustainability standards; governance

and rules of the game; local politics and informal institutions; corruption; financing and investment; and zero-deforestation pledges. In Indonesia, public policy and political processes, especially at the national level, play key roles in directing oil palm plantation development (Austin *et al.* 2017, Gaskel *et al.* 2015, Gatto *et al.* 2015, Harahap *et al*. 2017). Indonesia's oil palm development policy is linked to development programmes in other sectors, such as transmigration, food (as a substitute for domestic consumption of coconut oil), climate change and energy (biofuels). Furthermore, policies also indicate land-use planning and allocation, and permits and licensing being critical drivers of oil palm plantation expansion. Lack of participation and clarity in land-use planning and allocation processes has given rise to various tenurial problems, such as unclear land rights, and overlapping and/or mutual land claims between actors (Abram *et al.* 2017, Andrianto *et al.* 2019, Hamilton-Hart 2017a, Juniyanti *et al.* 2021). Cases of misalignment between central and local governments have been identified in permit and licensing processes. Due to ambiguities over authority under decentralization, some local governments have issued concession licenses on forest estate land before the central government has enacted any formal forest estate release (Rusli 2018, Setiawan *et al.* 2016). There have also been cases of corruption in land allocation and licensing processes in land-based sectors (Goh *et al.* 2018), and local politics where local actors identified as political brokers or having patronage networks have been involved in illegal land transactions (Diprose *et al.* 2020, Purnomo *et al.* 2019). Overall, governance and rules of the game in the oil palm sector (i.e., land-use planning, licensing and supply chains) are key to achieving sustainability, as suggested by many studies, including Carlson *et al.* (2012) and Purnomo *et al.* (2018). Mandatory sustainability standards and zero-deforestation pledges are also potential pathways for supporting a transformation to sustainability, although challenges remain in their implementation (Astari *et al.* 2019, Austin *et al*. 2017, Glasbergen 2018, Hidayat *et al.* 2021).

Actors

From the range of collected literature, 13 key actor groups were identified in Indonesia's oil palm sector: traders; small-scale producers; large-scale producers; rent seekers and free riders; local communities; national government; sub-national governments; the financing sector; CSOs, NGOs and other international organizations; exporters; consumers; business associations; and political figures.

These key actors work, interact and form networks embedded with power, authority and influences that can either support or hinder efforts in the transformation to palm oil sustainability. Small-scale producers (Brandi *et al.* 2015), village-level traders (Goh *et al.* 2018), large-scale producers (Gatto *et al.* 2017), exporters (Larsen *et al.* 2018) and consumers (Koh and Lee 2012) are the main supply chain actors. National and sub-national governments (Kadarusman and Pramudya 2019) and the financing sector (Henderson and Shorette 2017). are actors with the power and authority to alter enabling conditions in the oil palm sector. Other influential actors include business associations (Innocenti and Oostever 2020), local communities (Abram *et al.* 2017), political figures (Juniyanti *et al*. 2021), rent seekers and free riders (e.g., national and local elites and political brokers) (Purnomo *et al.* 2017) and CSOs, including environmental and advocacy NGOs as well as other international organizations (Henderson and Shorette 2017).

Sustainability and livelihoods

Six observed variables were found for ecological, economic and social aspects of sustainability: no deforestation; biodiversity; exports and government revenue; employment; infrastructure, health and education; and poverty reduction and economic equity. Oil palm plantation expansion is often associated with major direct environmental impacts, such as deforestation and biodiversity loss (Austin *et al.* 2017, Chaudhary and Kastner 2016, Vijay *et al.* 2016). On the other hand, its development and resulting trade provide benefits such as export earnings and government revenues, employment and rural development outcomes (infrastructure, health and education, poverty reduction and enhanced economic equity), although these vary depending on the local socio-economic baseline and situation (Dib *et al.* 2018, Gaskell *et al.* 2015, Gatto *et al.* 2017, Santika *et al.* 2021, Shresta and Coxhead 2018). Several observed variables were identified for socio-economic aspects relating to smallholder farmers: on-farm income; household income; consumption and nutritional diet; and financial assets. Oil palm plantations are known to provide economic benefits for farmers, both directly through cultivation and on-farm income, or indirectly from employment increasing household income (Dib *et al.* 2018, Krishna *et al*. 2017a, Kubitza *et al.* 2018).

Some studies indicated higher incomes leading to more consumption and better nutrition in farmers' households (Krishna *et al.* 2017a, Kubitza *et al.* 2018). Another important outcome from sustainable oil palm plantation practices in Indonesia is improved financial assets in farming households (Hidayat *et al.* 2015, 2021).

Table 1 summarizes observed variables for each exogenous and endogenous latent construct.

POPETS (Palm Oil Political Economy and Trade Structural equation model)

Initial model

An initial model was developed consisting of a measurement sub-model and a structural sub-model (Figure 3). The measurement sub-model describes relationships between latent constructs and observed variables, while the structural sub-model describes the relationships between latent constructs.

This model shows that actors have a significant influence on sustainability with a coefficient value of 0.40. In contrast, technical economy and structures significantly influence livelihoods, with coefficient values of 0.34 and 0.36, respectively.

However, the initial model did not pass a goodness-of-fit (GoF) test. The GoF test indicated values of $\chi 2 = 2\ 940.738$ with df = 1 419 p-value = 0.000, normed $\chi 2$ value = 2.072, GFI = 0.552, CFI = 0.612, and RMSEA = 0.097. These results indicate that the initial iteration failed to meet the criteria for

TABLE 1 *Latent constructs and observed variables*

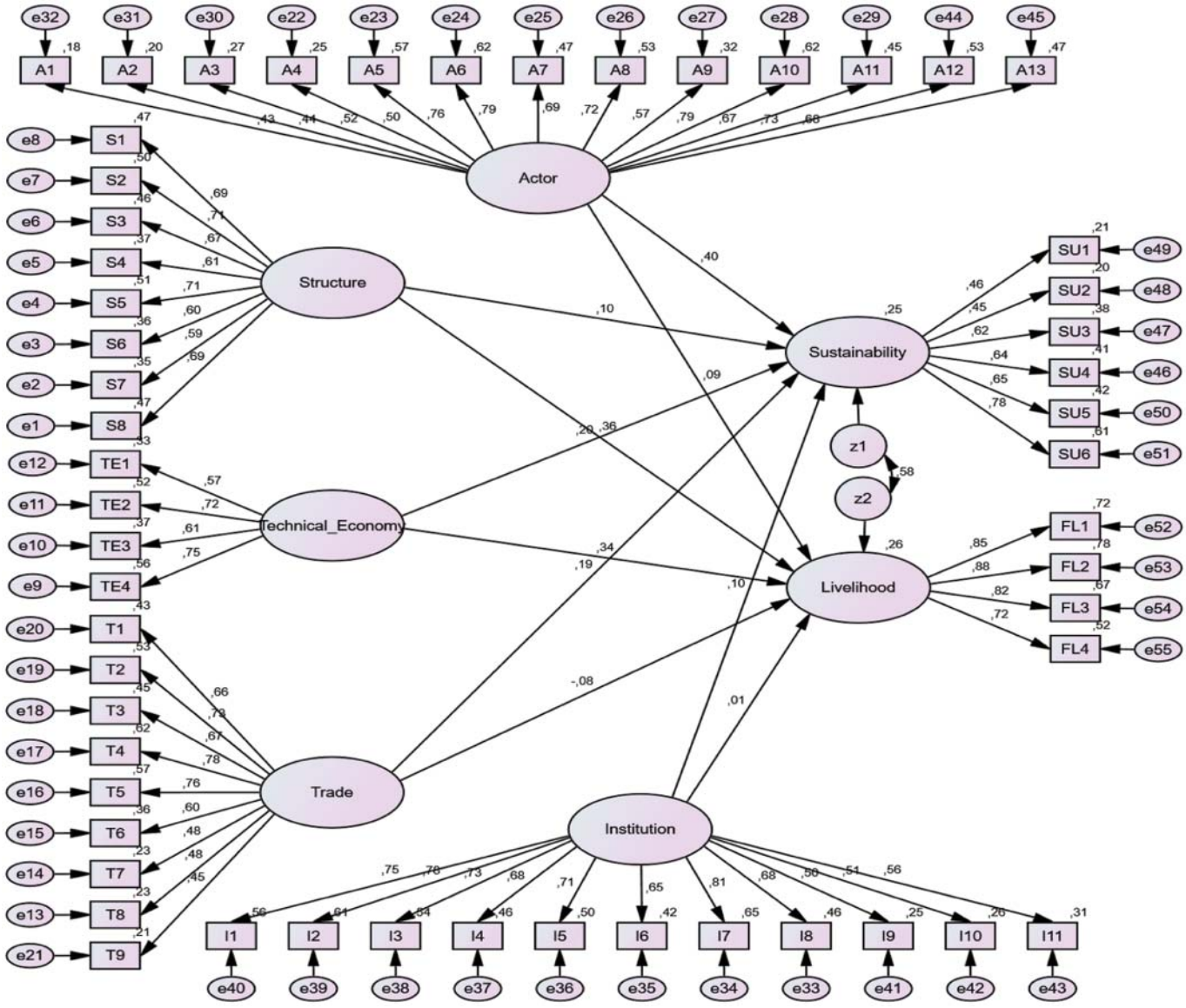
Exogenous					Endogenous	
Technical economy (TE)	**Structures (St)**	**Trade (T)**	**Institutions (I)**	**Actors (A)**	**Sustainability (Su)**	**Livelihoods (L)**
Technology and infrastructure	Land tenure	International demand	Public policy, legal and regulatory framework	Traders, e.g., village-level brokers	No Deforestation	Smallholder on-farm income
Good agricultural practices	Demography and level of development	Domestic consumption	National politics and policy processes	Small-scale producers	Biodiversity	Household income
Economic feasibility for farmers	Human resources capacity of farmers	Competition	Sub-national initiatives	Rent seekers and free riders	Economy – exports and government revenues	Consumption and nutritional diet
Extension services and Technical guidance	Financial capacity of farmers	Market preferences	Land-use planning and allocation	Local communities	Employment	Financial assets
	Geopolitics	Supply	Permits and licensing	Large-scale producers	Infrastructure, health, and education facilities	
	Smallholder business models	Supply chain governance	Mandatory sustainability standards	National government	Poverty reduction and economic equity	
	Climate change and natural disasters	Voluntary certification	Governance and rules of the game	Sub-national government		
	National and global political stability	Trade incentives and barriers	Local politics and informal institutions	Financing sector		
		Green consumer behaviour	Corruption	CSOs/NGOs		
			Financing and investment	Exporters		
			Zero-deforestation pledges	Consumers		
				Business associations		
				Political figures		
4	8	9	11	13	6	4

a fit and proper model because the value of $\chi 2$ was greater than $\chi 2$-table (1507.748), p-value was below 0.05, normed $\chi 2$ value was greater than 2, GFI was smaller than 0.90, CFI was smaller than 0.90, and RMSEA was greater than 0.08 (Hulland *et al*. 1996, Tabachnik *et al.* 2001)

Standardized and compact model

The initial model was modified to become the compact model (Figure 4). The modified model consists of one exogenous construct (trade); four mediating constructs (structures, technical economy, institutions and actors); two endogenous constructs (sustainability and livelihoods); and 20 observed variables. A covariance was added based on the high modification indices in AMOS, i.e., the error term of sustainability (z1), livelihoods(z2), technical economy (z3), actors (z4), institutions (z5) and structures (z6), as seen in Figure 4. The analysis shows that this covariance is significant at the 95% confidence level with coefficient values of 0.2 to 0.7. Thus, the addition of this covariance in the model is considered appropriate.

FIGURE 3 *The initial POPETS model*



Structures, technical economy and institutions act as mediating variables. They are influenced not only by observed variables, but also by other latent constructs. Its measurement model consists of the observed variables, their significance with the latent construct, and their Correlation Coefficient (CC).

The compact model test results show an improvement from the initial model. The value of $\chi 2$ = 180,764 with df = 155, p-value = 0.08, normed $\chi 2$ value = 1.166, CFI = 0.966 and RMSEA = 0.038. These values mean that the model meets GoF criteria because the value of $\chi 2$ is smaller than $\chi 2$-table (185.052), p-value is greater than 0.05, normed $\chi 2$ value is smaller than $\chi 2$, CFI is greater than 0.90, and RMSEA is smaller than 0.08. In addition, the critical ratio (CR) value of the multivariate normality assessment was 2.53, smaller than the critical value of ±2.58 at the 95% confidence level. Therefore, based on the GoF index and the fulfilment of the assumption of multivariate normality, it was concluded that the compact model could reflect actual conditions.

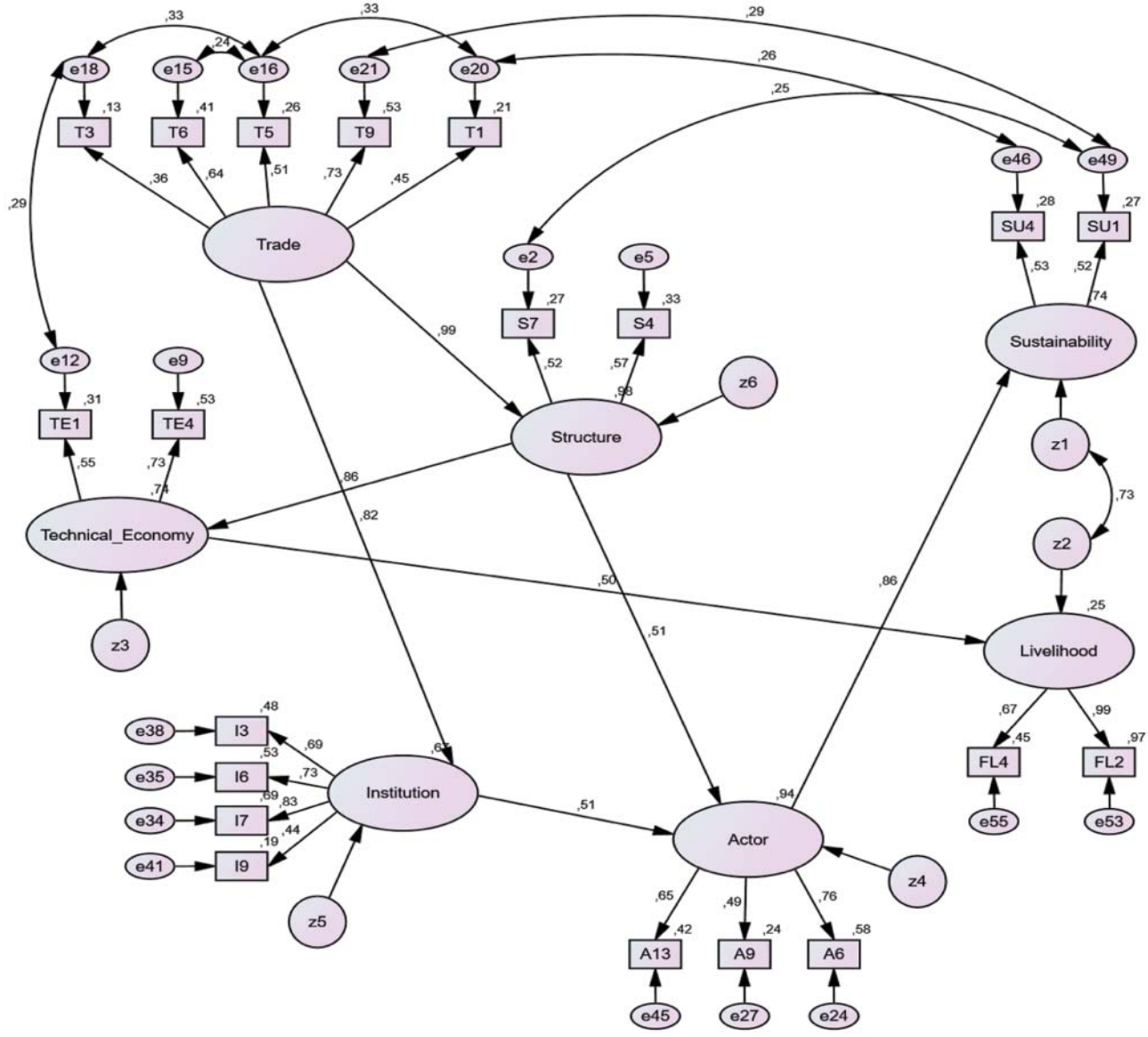
Relationships between variables

Each observed variable has a significant relationship with the latent constructs, which is indicated by a p-value smaller than 0.05, hence the observed variable can describe the latent construct. The relationships between variables are shown in Table 2.

Seven significant relationships were also observed between latent constructs at the 95% confidence level (Table 3).

The pathways of trade to palm oil sustainability are shown through trade to structures, then technical economy to livelihoods. Other pathways are trade to institutions, then actors to sustainability. These indicate trade going through the elements of political economy, i.e., structures, institutions and actors, and technical economy in affecting sustainability and farmers'

FIGURE 4 *POPETS compact model with 20 observed variables*



livelihoods. The results of the SEM analysis show the POPETS model inferred the presence of significant direct and indirect effects of political economy, i.e., structures, institutions and actors on sustainability and livelihoods of farmers in the oil palm sector in Indonesia (Table 4). Actors is the only construct with a direct effect on sustainability (0.86), and technical economy is the only construct with a direct effect on livelihoods (0.5).

Our findings also indicate three pathways having indirect effects on sustainability and two pathways having indirect effects on livelihoods. Trade has an indirect effect on sustainability through structures and actors (0.79). It also has an indirect effect on livelihoods via structures and technical economy (0.43). Institutions affect sustainability through actors (0.44). Actors also play an intermediary role in the pathway from structures to sustainability (0.44). Structures has an indirect effect on livelihoods via technical economy (0.43). In addition, there is also a positive correlation of 0.73 between sustainability and livelihoods, which implies that the more sustainable palm oil is, the greater the increase in farmers' livelihoods.

Stakeholder perceptions of the model

A public consultation was conducted where survey participants were asked to comment on the model using the 5-point Likert scale – with score 1 meaning making no sense at all, and score 5 meaning making complete sense – to accommodate their expert judgements on the model. Stakeholders and practitioners from diverse backgrounds participated in the survey, which received a total of 46 responses. Most respondents were academics or researchers (63%), with government officials (15%), NGO and advocacy group staff (13%) and private sector practitioners (10%). Around 20% of respondents perceived the model to make complete sense (score of five); 48% perceived it to partly make sense, (score of three); 30% perceived it to make little sense (score of two); and 2% said it made no sense at all (score of one).

TABLE 2 *Significant relationships between latent constructs and observed variables and coefficient correlation (CC)*

Latent constructs	Observed Variables	p-value	Coefficient correlation
Trade (Exogenous variables)	International demand (T1)	***	0.45
	Competition (T3)	***	0.36
	Supply (T5)	***	0.51
	Supply chain governance (T6)	***	0.64
	Green consumer behaviour (T9	***	0.73
Structures (Mediating variables)	Financial capacity of farmers (S4)	***	0.52
	Fewer climate change impacts and natural disasters (S7)	***	0.57
Technical economy (Mediating variables)	Technology and infrastructure (TE1)	***	0.55
	Extension services and technical guidance (TE4)	***	0.73
Institutions (Mediating variables)	Sub-national initiatives (I3)	***	0.69
	Mandatory sustainability standards (I6)	***	0.73
	Governance and rules of the game (I7)	***	0.83
	No Corruption (I9)	***	0.44
Actors (Mediating variables)	National government (A6)	***	0.76
	CSOs/NGOs (A9)	***	0.49
	Political figures (A13)	***	0.65
Sustainability (Endogenous variables)	No-Deforestation (SU1)	***	0.52
	Employment (SU2)	***	0.53
Farmer livelihoods (Endogenous variables)	Household incomes	***	0.99
	Financial assets	***	0.67

Note: *** indicates a very small number, far below 0.05

TABLE 3 *POPETS compact model with 20 observed variables*

Latent constructs			p-value	Coefficient correlation
Trade	→	Structures	*** < 0.05	0.99
Trade	→	Institutions	*** < 0.05	0.82
Structures	→	Technical economy	*** < 0.05	0.86
Institutions	→	Actors	0.023 < 0.05	0.51
Structures	→	Actors	0.025 < 0.05	0.51
Actors	→	Sustainability	*** < 0.05	0.86
Technical economy	→	Livelihoods	*** < 0.05	0.50

Note: ***: very small numbers far below 0.05

TABLE 4 *Pathway analysis results*

Constructs			Path Coefficient (Standardized Estimate)
Direct effects			
Trade	→	Institutions	0.82
Trade	→	Structures	0.99
Institutions	→	Actors	0.51
Structures	→	Actors	0.51
Structures	→	Technical economy	0.86
Actors	→	Sustainability	0.86
Technical economy	→	Livelihoods	0.50
Indirect effects			
Trade	→	Actors	0.92
Trade	→	Technical economy	0.85
Trade	→	Livelihoods	0.43
Trade	→	Sustainability	0.79
Institutions	→	Sustainability	0.44
Structures	→	Livelihoods	0.43
Structures	→	Sustainability	0.44

DISCUSSION

Key findings

Finding key variables in understanding palm oil sustainability
The political economy and trade (PET) and sustainability aspects of palm oil are intricate and defined by complex variables. Our study is important for its contribution, through

its systematic review and structural equation modelling (SEM), to the identification of key variables appropriate for answering and quantifying PET and palm oil sustainability. This will allow policymakers, practitioners, experts and advocates to easily comprehend how PET factors influence palm oil sustainability and livelihoods in the context of Indonesia. From the systematic review, 55 initial variables were obtained (Table 1), which served as the basis for constructing our initial POPETS model (Figure 3). As this initial model was unable to satisfy goodness-of-fit (GoF) test criteria, it was necessary to explore an alternative model that would not only fulfil GoF criteria, but also have significance in explaining relationships between PET and palm oil sustainability. Although the variables identified in the systematic review did seem to play critical roles in supporting sustainable palm oil, the initial model failed to show their significance. Reducing the number of variables by recognizing which ones were key formed the basis for the POPETS compact model (Figure 4). The modified model contains 20 key, dominant variables, some of which have the greatest effects, meaning they are significant in achieving sustainable palm oil and improved livelihoods. For example, improving extension services together with building farmers' financial capacity and improving national government capacity can help achieve palm oil sustainability and improve livelihoods. Each latent construct has one highest affecting observed variable, except for sustainability (Table 5). The key variables in POPETS help simplify ways to improve palm oil sustainability and livelihoods.

Defining palm oil sustainability

The sustainability of palm oil is indicated by two key variables, i.e., employment and no deforestation, while livelihoods is indicated by household income of farmers. Employment is a key factor in palm oil economic development from the Government of Indonesia (GoI)'s perspective at national and sub-national levels, while no deforestation is the key indicator of palm oil sustainability from the global community. Therefore, any discussion of increasing palm oil sustainability should involve efforts to secure employment in the oil palm sector and ensure zero-deforestation.

The palm oil sector in Indonesia currently employs around seven million people and is projected to employ more than 23 million people within the next 22 years (Purnomo *et al.* 2020). Through its National Economic Recovery or *Pemulihan Ekonomi Nasional* (PEN) programme, GoI aims to recreate jobs lost due to the Covid-19 pandemic (MoF 2022). GoI is trying to increase employment opportunities in all sectors, including palm oil, and is supported by evidence that palm oil sustainability means securing jobs for millions of people along palm oil supply chains in the longer term.

Securing and boosting post-Covid-19 employment opportunities is critical to ensuring palm oil sustainability. This will favour national and local government agendas as well as people on the ground. Palm oil sustainability is closely tied to the livelihoods of people involved in its value chain, which is indicated by household income. Previous findings reveal that at the community level, the oil palm industry not only contributes to on-farm income, but also to total household income from off-farm employment (Dib *et al.* 2018) The other key indicator for palm oil sustainability is no deforestation, which falls in line with the European Union Deforestation-Free Regulation (EUDR) scheme, the United Kingdom's law on Forest Risk Commodities (UK-FRC), and with G20 commitments.

TABLE 5 *Key variables in palm oil sustainability as described by the POPETS model*

Latent construct		Exogenous					Endogenous	
		Technical Economy (TE)	**Structures (St)**	**Trade (T)**	**Institutions (I)**	**Actors (A)**	**Sustainability (Su)**	**Livelihoods (L)**
Observed variable	**1**	Technology and infrastructure	**Financial capacity of farmers**	International demand	Sub-national initiatives	**National government**	**No Deforestation**	**Household incomes**
	2	**Extension services and technical guidance**	Climate change and natural disaster	Competition	Mandatory sustainability standards	CSOs/NGOs	**Employment**	Financial assets
	3			Supply	**Governance and rules of the game**	Political figures		
	4			Supply chain governance	Corruption			
	5			**Green consumer behaviour**				
Reduced variables (from➔to)		4➔2	8➔2	9➔5	11➔4	13➔3	6➔2	4➔2

The European Commission passed a set of policies in December 2019 called the EU Green Deal to support the EU's commitment to climate neutrality by 2050, which was strengthened in its second Renewable Energy Directive (RED II) (European Union 2022a). At the heart of the EU Green Deal is the "Farm to Fork Strategy" on sustainable food systems, which also places emphasis on green supply chains and will support the region's demand for sustainable palm oil (European Union 2022b). In November 2021, the EU issued a proposal for a regulation on deforestation-free products prohibiting commodities and products produced on land subject to deforestation after 31 December 2020 from entering EU markets. At the end of 2020, the UK government also proposed a highly debated due diligence law on Forest Risk Commodities, with the main aim of avoiding deforestation. Both proposals include palm oil as a high-risk commodity. Another no deforestation commitment on land-based activities was voiced during COP 26 in Glasgow, where at least 110 world leaders pledged to end deforestation by 2030 (United Nations 2021). In addition, G20 leaders have committed to environmental conservation, protection and sustainable use of natural resources (G20 Rome 2021). President Joko Widodo of Indonesia, who holds the G20 Presidency in 2022, wants to set an example in addressing climate change by Indonesia becoming a 'net carbon sink' by 2030 and achieving net-zero emissions by 2060 or sooner (Cabinet Secretariat of the Republic of Indonesia 2021).

The role of PET in influencing palm oil sustainability

Palm oil sustainability is influenced by political economy and trade factors (Figure 5). Livelihoods of people in the palm oil sector are connected to palm oil sustainability (CC. 0.72). Livelihoods are influenced mostly by technical economy factors (CC. 0.50) such as extension services, while sustainability is influenced by actors (CC. 0.86), with the national government being the dominant actor. Structures, which are dominated by financial capacity of farmers, influence technical economy (CC. 0.86) and actors (CC. 0.51). Structures are influenced by climate change and natural disasters. Actors' behaviour and actions are affected by institutions (CC. 0.51), mainly by governance and rules of the game. Trade, in which green consumer behaviour is the strongest variable, influence structures (CC. 0.99) and institutions (CC. 0.82). POPETS can provide justification, for example, that green consumer behaviour in the UK and Europe influence efforts to reduce deforestation due to oil palm. Actors is the primary driver of palm oil sustainability, in which the national government, CSOs/NGOs and political figures are all key. Increasing the technical economy of palm oil will have a greater impact on livelihoods than sustainability, though both factors are correlated. Therefore, we cannot rely solely on technical economy factors to improve sustainability. This accords with a study by Pacheco *et al.* (2018), which indicates the importance of STIA factors, particularly institutions and interaction of actors in governing sustainable palm oil supply chains.

Scenarios to improve palm oil sustainability and livelihoods

POPETS is useful in developing scenarios and narratives to improve palm oil sector sustainability and livelihoods (Table 6).

First, the Trade Scenario describes how trade interventions will improve palm oil structures and institutions. Improving structures will enhance technical economy, which will enable livelihoods and actors to improve palm oil sustainability.

FIGURE 5 *POPETS and its factors and key variables*

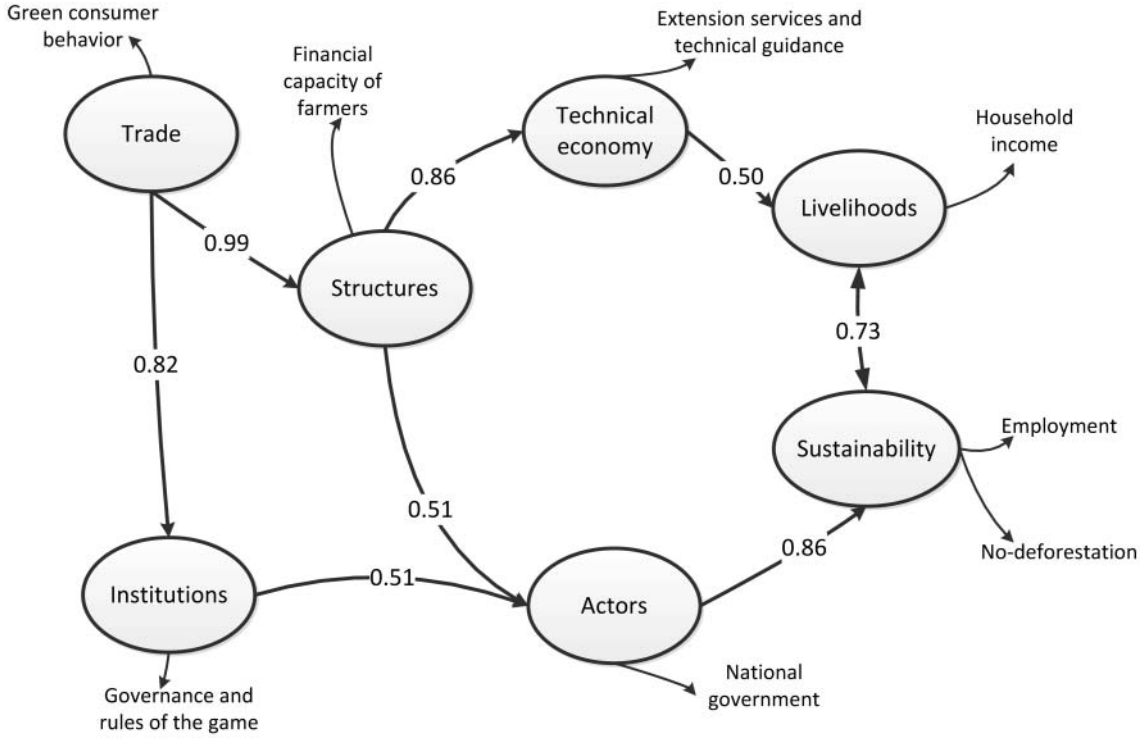


TABLE 6 *Scenarios, interventions and their effects on palm oil sustainability and livelihoods*

Intervention	Direct effect	Indirect effect	Effect on goal	Total effect on goal
Trade Scenario				
Trade: a. International demand b. Competition c. Supply d. Supply chain governance e. Green consumer behaviour	Structures (0.99)	Technical economy (0.86)	Livelihoods (0.50)	0.43
		Actors (0.51)	Sustainability (0.86)	
	Institutions (0.82)	Actors (0.51)	Sustainability (0.86)	0.79
Technical Economy Scenario				
Technical economy: a. Technology and infrastructure b. Extension services and technical guidance			Livelihoods (0.50)	0.50
Political Economy Scenario				
Structures: a. Financial capacity of farmers	Technical economy (0.86)		Livelihoods (0.50)	0.43
b. Mitigating and adapting to climate change and natural disasters	Actors (0.51)		Sustainability (0.86)	0.44
Institutions: a. Sub-national initiatives b. Mandatory sustainability standards c. Governance and rules of the game d. (Anti)-corruption	Actors (0.51)		Sustainability (0.86)	0.44
Actors: a. National government b. CSOs/NGOs c. Political figures			Sustainability (0.86)	0.86

However, Jafari *et al.* (2017) indicate that trade interventions, e.g., sustainable consumption, will be more profound when imposed in all importing countries. POPETS also modelled the impact of increasing trade interventions via institutions. Such interventions would increase the capacity of actors to achieve palm oil sustainability. Improving livelihoods means improved household income, while improving sustainability means increasing employment and reducing deforestation. Therefore, improvements to sustainability will generate effects to enhance livelihoods, and likewise, livelihood improvements will boost sustainability.

Second, the Technical Economy Scenario describes interventions through improvements to technology and infrastructure, as well as provision of more intensive extension services and technical guidance. Under this scenario, technical economy interventions would directly improve the livelihoods of people along palm oil value chains. Due to the correlation between livelihoods and sustainability, there are opportunities for such interventions to have an indirect effect on sustainability. This is confirmed in a study by Herdiansyah *et al.* (2020), who indicate that good agricultural practices are important contributions to farmers' prosperity and well-being, and such knowledge and improvements in practices can only be obtained through assistance from all relevant stakeholders.

Third, the Political Economy Scenario describes various interventions on structures, institutions and actors. Structural interventions, such as improving farmers or smallholders' financial capacity, as well as mitigating and adapting to climate change and natural disasters would improve technical economy, lead to improved livelihoods, and strengthen actors. This would also lead to palm oil sustainability. Sub-national initiatives with landscape and jurisdictional approaches, mandatory certification schemes like Indonesian Sustainable Palm Oil (ISPO), strengthening governance and rules of the game, and anti-corruption movements can all be used to strengthen palm oil institutions. These strengthened institutions would lead to improving the capacity of actors, which in turn would lead to improved sustainability. Actors have the greatest direct influence on palm oil sustainability. Strengthening key actors, such as the national government and CSOs/NGOs, and ensuring powerful political figures support environmental and community causes would also lead to sustainability. The national government role is clear in developing and endorsing national policies that will be followed by sub-national governments, communities, and private sector practitioners. CSO and NGO movements that represent the interests and voices of civil society and communities should also be increased. The Political Economy Scenario goes beyond technical solutions, and may provide an ideal approach for

addressing the complex issues surrounding palm oil in Indonesia, such as addressing legality issues with more than three million hectares of oil palm plantations being unable to comply with mandatory and voluntary standards as they are located inside the state forest estate (CMoEA 2021).

Limitations

The findings of this paper are based on a systematic review and evidence captured and modelled using structural equation modelling (SEM). However, it may include subjective opinions from respondents. Around 32% of respondents were affiliated with academic, research and/or think tank organizations, while NGOs/advocacy groups also had significant representation. These respondents may not be fully impartial regarding marginalized communities. Another limitation of the study is that its findings mostly relate to the situation in Indonesia, and may not reflect situations in other producer countries such as Malaysia, Thailand, Colombia or Nigeria. This is mainly because despite the systematic review representing current global knowledge, survey respondents were all Indonesian stakeholders. Nevertheless, similar studies could be undertaken in other producer countries by replicating this paper's research frameworks and methods. As Indonesia is the leading palm oil producing country, it could be a benchmark for other countries in improving palm oil sustainability and livelihoods.

Science advancement

This research integrates deductive and inductive approaches through systematic review and SEM methods. A systematic review of key publications was conducted and through a process of deduction generated 55 key political economy and trade variables that influence palm oil sustainability. These deduction-based variables were then tested to develop the POPETS model based on evidence or perceptions of evidence on the ground. This model was developed inductively through data collection and analysis, with deductive variables collected through the systematic review to meet the national context through SEM. These methods are replicable for other palm oil producing countries such as Malaysia, Thailand, Colombia and Nigeria.

POPETS can connect global initiatives quantitatively to make palm oil more sustainable by providing insights and evidence from the national context. We now know how important the issue of global trade is in driving palm oil sustainability in Indonesia. Global and national campaigns from consumers relating to 'green behaviour' have impacts in reducing deforestation from oil palm plantation development. These cannot be achieved without the national government taking an active role as the primary actor in governing palm oil sustainability. How scenarios and key factors interact and impact on sustainability and livelihoods are well modelled in POPETS.

From the modelling perspective, POPETS offers a more comprehensive political economy types of analysis as compared to other models. Some palm oil modelling tools, for example Apsim (Holzworth *et al*. 2014) and Palmsim (Hoffmann *et al*. 2014), focus on biophysical activities, and specifically on yield gap. Some partial equilibrium models are used to estimate potential future productivity, an example being the Impact Model from Wiebe *et al*. (2019). Other studies, such as Rifin *et al*. (2020) and Sahara *et al*. (2022) apply general equilibrium models to estimate macroeconomic impacts of palm oil policies or shocks. POPETS is positioned to focus on what happens across palm oil value chains by looking at the palm oil sector through a combination of institutional and technical economy analyses. As such, it can indicate the roles key actors can play in contributing to the achievement of sustainability in palm oil political economy.

Contributions beyond addressing the gap

These findings can contribute to the National Action Plan for Sustainable Palm Oil endorsed by different ministries in Indonesia. In 2014, the Ministry of Agriculture, supported by UNDP, launched the Indonesian Sustainable Palm Oil Forum or *Forum Kelapa Sawit Berkelanjutan Indonesia* (FoKSBI) to coordinate all sectors and initiatives focusing on sustainable palm oil. This multi-stakeholder dialogue forum is led by the Government of Indonesia. Research findings from POPETS could be beneficial for FoKSBI dialogues and supplementing the national action plan and its implementation, including in advancing efforts to address underlying complexities surrounding oil palm in Indonesia, such as legality issues, which go beyond technical solutions. In addition, they can also be used for understanding how to achieve Sustainable Development Goals (SDGs) in the palm oil sector. POPETS can contribute to formulating interventions for improving sustainability and lead to the advancement of SDG 13 (Climate Action) and SDG 15 (Life on Land). It can also contribute to the advancement of farmer livelihoods, and benefit efforts to achieve SDG 1 (No Poverty) and SDG 8 (Decent Work and Economic Growth). Through POPETS, trade and political economy factors and their observed variables can be further explored to achieve and harmonize these SDGs.

At the international level, POPETS can contribute towards green deals and G20 discussions. Trade is a critical sector for any green deals to address climate change issues and achieve social and economic aims such as employment creation. Through its modelling scenarios, POPETS can describe clearly how to connect global trade with no deforestation and job creation. Key elements of trade have been modelled to study the impacts of interventions. For example, one of the key elements of trade is green consumer behaviour, which drives demand and consumerism that take climate change issues into account. Many scenarios and actions can be modelled in POPETS, the findings of which can promote better understanding of key factors and interventions to benefit G20 discussions.

CONCLUSION

Palm oil sustainability is defined mostly by no deforestation and employment opportunities, while livelihoods are defined

by household income. Trade and political economy factors, i.e., structures, institutions and actors, significantly influence palm oil sustainability. Trade has indirect effects on sustainability and livelihoods with Correlation Coefficients of 0.79 and 0.43, respectively. Actors have a direct effect of 0.86 on sustainability, and structures have an indirect effect of 0.43 on livelihoods. There is a positive correlation of 0.73 between sustainability and livelihoods. These findings demonstrate the importance of green global trade mechanisms like the European Union Deforestation Regulation (EUDR) in shaping the sustainability of oil palm production. Global trade mechanisms take shape in both green consumer behaviour and green trade policies from buyer countries. On the one hand, these findings are relevant for efforts to strengthen palm oil sustainability through global trade and green deals, which can work if palm oil actors, particularly the national government, support the idea. On the other hand, since POPETS is a single-commodity model focusing on oil palm, it is still necessary to consider the effects of global trade on other vegetable oils. While other vegetable oils may not be perfect substitutes for palm oil, consumer countries may still make the shift if sustainability pressures are only applied to palm oil. This model and its findings can inform national- and international-level discussions, but further research is recommended to enable generalization to contexts in other producing countries, and determine what effects other vegetable oils may have.

ACKNOWLEDGEMENTS

This study is a part of the TRADE (Trade, Development and the Environment) Hub funded by the UK Research and Innovation Global Challenges Research Fund (project number ES/S008160/1) and led by the UN Environment Programme World Conservation Monitoring Centre (UNEP-WCMC).

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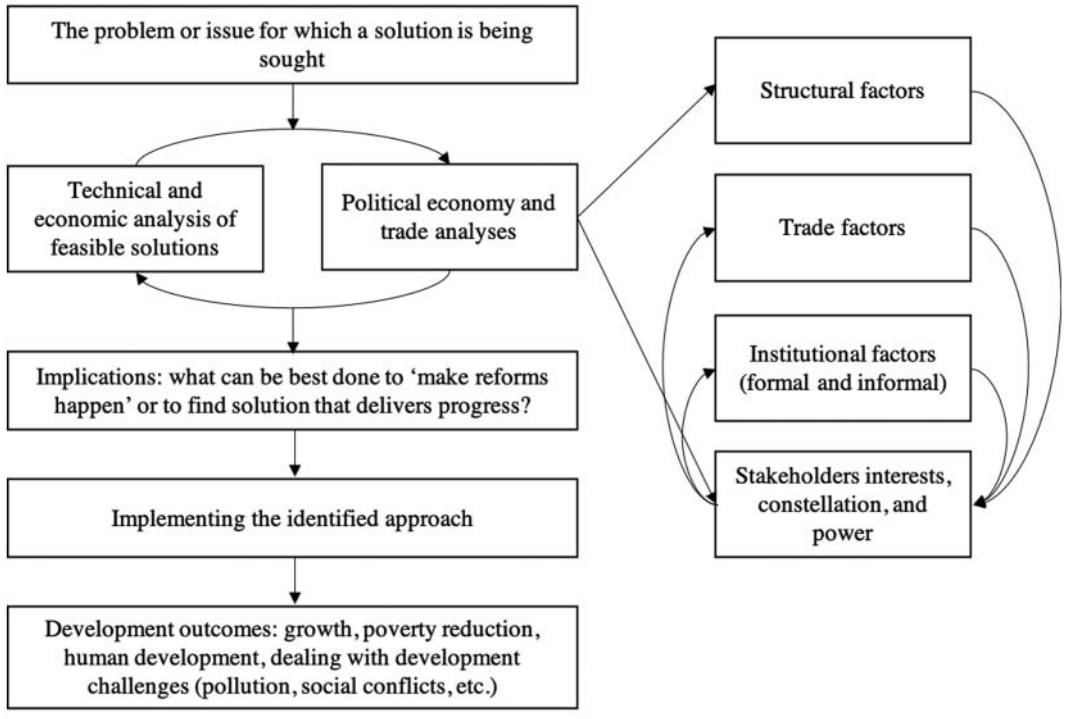
ANNEX 1 *Political economy and trade framework (adopted from Fritz* et al. *2009)*



ANNEX 2 *Numbers of articles found based on the first screening*

Factors and variables		Number of articles found in the 1st screening
Technical economy		51
Trade		55
Political economy	Structures	46
	Institutions	83
	Actors	57
	Total	236*

*Several articles mentioned more than one STIA variable

ANNEX 3 *Selected latent and observed variables and numbers of articles found*

Latent variables	Observed variables	Number of articles
Technical economy	1. Technology and infrastructure	5
	2. Good agricultural practices	10
	3. Economic feasibility for farmers	4
	4. Extension services and technical guidance	1
Structures	1. Land tenure	8
	2. Demography and level of development	17
	3. Human resources capacity of farmers	10
	4. Financial capacity of farmers	6
	5. Geopolitics	5
	6. Smallholder business models	4
	7. Climate change and natural disasters	3
	8. National and global political stability	1

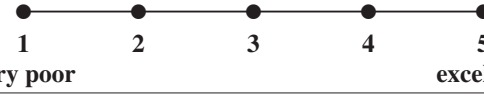
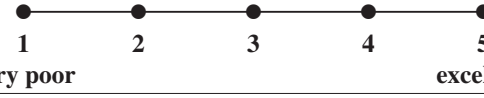
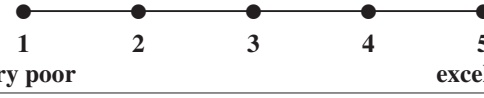
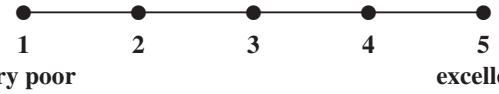
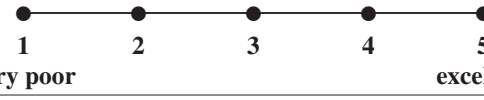
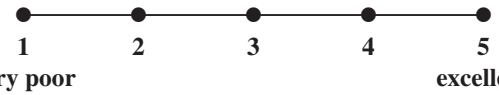
Latent variables	Observed variables	Number of articles
Trade	1. International demand	6
	2. Domestic consumption	2
	3. Competition	1
	4. Market preference	4
	5. Supply	1
	6. Supply chain governance	4
	7. Voluntary certification	14
	8. Trade incentives and barriers	7
	9. Green consumer behaviour	1
Institutions	1. Public policy, legal and regulatory framework	14
	2. National politics and policy processes	13
	3. Sub-national initiatives	1
	4. Land-use planning and allocation	13
	5. Permits and licensing	2
	6. Mandatory sustainability standards	5
	7. Governance and rules of the game	20
	8. Local politics and informal institutions	19
	9. Corruption	1
	10. Financing and investment	12
	11. Zero-deforestation pledges	1
Actors	1. Traders	1
	2. Small-scale producers	12
	3. Rent seekers and free riders	7
	4. Local communities	3
	5. Large-scale producers	7
	6. National government	6
	7. Sub-national government	4
	8. Financing sector	2
	9. CSOs/NGOs	8
	10. Exporters	1
	11. Consumers	5
	12. Business associations	1
	13. Political figures	1
Sustainability	1. No deforestation	4
	2. Biodiversity	3
	3. Export and government revenue	2
	4. Employment	1
	5. Infrastructure, health and education	1
	6. Poverty reduction and economic equity	6
Farmer livelihoods	1. Smallholder on-farm income	5
	2. Household income	3
	3. Consumption and nutritional diet	2
	4. Financial assets	1

ANNEX 4 *Questionnaire to assess the current condition or situation using the Likert scale*

Variable name	Code	Scale
Latent variable: Technical and Economic		
Technology and infrastructure	TE1	1 2 3 4 5 very poor excellent
Good agricultural practices (GAP)	TE2	1 2 3 4 5 very poor excellent
Economic feasibility for farmers	TE3	1 2 3 4 5 very poor excellent
Extension services and technical guidance	TE4	1 2 3 4 5 very poor excellent
Latent variable: Structures		
Land tenure	S1	1 2 3 4 5 very poor excellent
Demography and level of development	S2	1 2 3 4 5 very poor excellent
Human resources capacity of farmers	S3	1 2 3 4 5 very poor excellent
Financial capacity of farmers	S4	1 2 3 4 5 very poor excellent
Geopolitics (e.g., international and regional regimes such as on climate change, free trade agreements, trade bans, trade wars)	S5	1 2 3 4 5 very poor excellent
Smallholder business models (e.g., scheme or independent farmer)	S6	1 2 3 4 5 very poor excellent
Fewer climate change impacts and natural disasters	S7	1 2 3 4 5 very poor excellent
National and global political stability	S8	1 2 3 4 5 very poor excellent
Latent variable: Trade		
International demand	T1	1 2 3 4 5 very poor excellent
Domestic consumption (e.g., substitute products such as other vegetable oils, market share among producers)	T2	1 2 3 4 5 very poor excellent
Competition	T3	1 2 3 4 5 very poor excellent
Market preferences	T4	1 2 3 4 5 very poor excellent

Variable name	Code	Scale
Supply	T5	1 2 3 4 5 very poor excellent
Supply chain governance	T6	1 2 3 4 5 very poor excellent
Voluntary certification (e.g., RSPO, ISCC)	T7	1 2 3 4 5 very poor excellent
Trade incentives and barriers	T8	1 2 3 4 5 very poor excellent
Green consumer behaviour	T9	1 2 3 4 5 very poor excellent
Latent variable: Institutions		
Public policy, legal and regulatory framework	I1	1 2 3 4 5 very poor excellent
National politics and policy processes	I2	1 2 3 4 5 very poor excellent
Sub-national initiatives	I3	1 2 3 4 5 very poor excellent
Land-use planning and allocation	I4	1 2 3 4 5 very poor excellent
Permits and licensing	I5	1 2 3 4 5 very poor excellent
Mandatory sustainability standards (e.g., ISPO)	I6	1 2 3 4 5 very poor excellent
Governance and rules of the game	I7	1 2 3 4 5 very poor excellent
Local politics and informal institutions	I8	1 2 3 4 5 very poor excellent
No corruption	I9	1 2 3 4 5 very poor excellent
Financing and investments	I10	1 2 3 4 5 very poor excellent
Zero-deforestation pledges	I11	1 2 3 4 5 very poor excellent

Variable name	Code	Scale
Latent variable: Actors		
Traders (e.g., village-level brokers)	A1	1 2 3 4 5 very poor excellent
Small-scale producers (e.g., farmers and growers)	A2	1 2 3 4 5 very poor excellent
Rent seekers (e.g., village elites and political brokers)	A3	1 2 3 4 5 very poor excellent
Local communities	A4	1 2 3 4 5 very poor excellent
Large-scale producers (e.g., industrial plantation companies and corporations)	A5	1 2 3 4 5 very poor excellent
National government	A6	1 2 3 4 5 very poor excellent
Sub-national government (district and provincial)	A7	1 2 3 4 5 very poor excellent
Financing sector (e.g., banks and investors)	A8	1 2 3 4 5 very poor excellent
CSOs/NGOs (e.g., local, national and international CSOs/NGOs, advocacy groups)	A9	1 2 3 4 5 very poor excellent
Exporters	A10	1 2 3 4 5 very poor excellent
Consumers	A11	1 2 3 4 5 very poor excellent
Business associations (e.g., GAPKI)	A12	1 2 3 4 5 very poor excellent
Political figures	A13	1 2 3 4 5 very poor excellent
Latent variable: Livelihoods		
On-farm income for smallholder farmers	FL1	1 2 3 4 5 very poor excellent
Household income for smallholder farmers	FL2	1 2 3 4 5 very poor excellent
Consumption and nutritional diet in the farmers' households	FL3	1 2 3 4 5 very poor excellent
Financial assets of smallholder farmers	FL4	1 2 3 4 5 very poor excellent

Variable name	Code	Scale
Latent variable: Sustainability		
No-deforestation.	SU1	 **1 2 3 4 5** **very poor excellent**
Biodiversity conservation	SU2	 **1 2 3 4 5** **very poor excellent**
Contribution to exports and government revenues	SU3	 **1 2 3 4 5** **very poor excellent**
Employment generation	SU4	 **1 2 3 4 5** **very poor excellent**
Improved infrastructure, health and education facilities	SU5	 **1 2 3 4 5** **very poor excellent**
Poverty reduction and improved economic equity	SU6	 **1 2 3 4 5** **very poor excellent**