Assessing drivers of post-harvest losses: tangible and intangible resources' perspective

FAIBIL, Daniel <http://orcid.org/0000-0002-2853-5782>, AGYEMANG, Martin <http://orcid.org/0000-0002-9313-1207>, AMPONSAH, Owusu <http://orcid.org/0000-0002-8131-1913>, GUPTA, Himanshu and KUSI-SARPONG, Simonov

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Daniel Faibil
School of Management and Economics, Dalian University of Technology, Dalian, Liaoning Province, PR China
Email: dfaibil@gmail.com

Martin Agyemang
New Huadu Business School, Minjiang University, Fuzhou, 350108, Fujian Province, PR China,
Email: martinon463@gmail.com

Owusu Amponsah
Department of Planning, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana
Email: o.amponsah.cap@knust.edu.gh

Himanshu Gupta
Department of Management Studies, Indian Institute of Technology (Indian School of Mines) Dhanbad, India
Email: himanshuguptadoms@gmail.com

Simonov Kusi-Sarpong
Southampton Business School, University of Southampton, Southampton S017 1BJ, UK
Email: simonov2002@yahoo.com

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Abstract

Many stakeholders in agro-food industry are concerned about sustainability, especially in addressing post-harvest loss (PHL). However, resources available to various supply chain stakeholders such as in the raw cashew nuts (RCNs) supply network to address PHL remain a challenge. The extant literature on PHL has limited intricate insight into its drivers from the perspective of resources. This paper, focusing on RCNs supply network, systematically identifies and analyzes critical drivers that influence PHL guided by tangible and intangible resources perspective. Fuzzy-Decision Making Trial and Evaluation Laboratory (Fuzzy-DEMATEL) methodology was employed to analyze and convert an experts' judgment into quantifiable data to establish the causal relationship among the drivers. The findings reveal that urgent and short-term attention to address PHL in the RCNs supply network should be given to the primary tangible driver of lack/insufficient proper packaging materials. Furthermore, in medium-term strategies, RCNs suppliers and government agencies in-charge of agriculture and industry bodies need to surmount three key cause drivers consisting of premature/green harvesting of cashew nuts, financial and economic constraints, and lack of appropriate storage facility. In addition, drivers such as insufficient/lack of management support and commitment and lack of information dissemination on PHL within RCNs suppliers should be addressed in the long term. The study provides a framework for supply chain managers and policymakers to understand the interrelationship among PHL drivers from a resource perspective to enable the implementation of strategies that address PHL.

Keywords: Post-harvest Loss, Supply Chain, Decision Making Trial and Evaluation Laboratory (DEMATEL), Resource.

1. Introduction

The increasing global population has subjected many agro-food supply chains to intense pressure as demand for food continues to increase at a fast rate (FAO 2018; Poduval 2011). In this light, much attention has been directed to PHL, which is defined as the quantitative and qualitative loss of food during and after harvesting of farm produce till it reaches the final consumer (Cardoen et al. 2015). The extant literature indicates that about 1.3 billion tonnes (one-third) of food produced globally is lost during the post-harvest process (Kumar and Kalita 2017; Cardoen et al. 2015; Hodges et al. 2011; Wilewska-Bien et al. 2020). Many studies posit that addressing PHL challenges has increasingly become important for enterprises (Cardoen et al. 2015; Gardas et al. 2018; Macheka et al. 2017; Arias Bustos and Moors 2018; Ayomide et al. 2019; Spadafora et al. 2019). Aawareness of post-harvest loss PHL has grappled the cashew industry, particularly in raw cashew nuts (RCNs) production and processing (hasith Priyashantha et al. 2020). The industry is an important constituent of the agro-sector in Africa and contributes substantially to economic development of the region (Affognon et al. 2015; Agyemang et al. 2018).

In Africa, RCNs are largely produced by small and medium-scale farmers and often traded within a supply network of several actors before it reaches local processing factories or exported for further processing (Agyemang et al. 2020). Many within the RCNs supply network face PHL due to technical inefficiency and their inability to acquire necessary resources to reduce losses that emanate from post-harvest operations (hasith Priyashantha et al. 2020; Gyedu-Akoto et al. 2014). The Africa cashew industry's vision is to be sustainable and competitive in the global industry (ACA 2015).

Implementing sustainable supply management is a major source of competitive advantage (Paulraj 2011). Therefore, the deployment of strategic resources to manage PHL by RCNs producers and processors has gained much interest (I. Das and Arora 2017; hasith Priyashantha et al. 2020). RCNs supply networks in the upstream of the industry that possess requisite strategic resources to address PHL have advantages over those lacking such resources (Ponnuswami et al. 2011).

The Ghanaian cashew sector offers enormous social, ecological and economic benefits for national development (Agyemang et al. 2020). For instance, in 2008, 61,590 tonnes of raw cashew nuts (RCN) valued at US$ 45.37 million were exported from Ghana to India, China, Vietnam for processing, with 26,454 tonnes processed locally, these contributed to 18.2% of agricultural Gross

Domestic Product (GDP) (Ackah et al. 2020). The production of RCN in Ghana has increased significantly from 22, 000 tonnes to an estimated 105, 000 tonnes (Boafo et al. 2019). Again, RCNs production is estimated to about 225,000 tonnes in 2025 (Dubbert 2019; Bannor et al. 2020; ACA,2020). The annual yield of RCNs is projected between 350 and 650 kg/ha, which indicates there is high potential of a higher output when requisite resources are utilized to during the production and processing to overcome PHL challenges in the cashew industry in Ghana (Dadzie et al. 2020).

PHL poses tremendous concerns (Kasso and Bekele 2018; Gardas et al. 2018; Hodges et al. 2011; Arias Bustos and Moors 2018). These include the threat to food safety through pest or fungal infestations, which could cause health repercussion if infected goods are consumed without critical examination and treatment (Affognon et al. 2015; Raut et al. 2018). Also, it tends to impact the income generation of producers and consumer food security, which often leads to higher prices for available substitutes (Bendinelli et al. 2019). These concerns have generated interest in the agro-food industries about the exigency of addressing critical drivers of PHL. Eliminating/minimizing of PHL has the potential to enhance agro-food supply chain to meet global demand and contribute to the realization of sustainable development goals (SDGs), particularly the attainment of SDGs 1 (No poverty) & 2 (Zero Hunger) (Cardoen et al. 2015).

The main goal of this study is to assess the critical drivers contributing for PHL from a resource perspective. Prior studies suggest that PHL are multifaceted concerns that rest on a myriad of factors including economic, environmental, and resources (James and Zikankuba 2017; Cardoen et al. 2015). As such, a growing number of literatures draw in resource concern on PHL (De Moraes and De Souza 2018; Gyedu-Akoto et al. 2014). However, what is rarely considered are studies that clearly shed light on drivers from tangible and intangible resources perspective.

Addressing PHL challenges requires supply chain actors and industry stakeholders to adequately understand the application of the distinctive resources available to design and implement appropriate strategies and policies (hasith Priyashantha et al. 2020; Parimalarangan et al. 2011; Poduval 2011). Therefore, the study argues that it is imperative to consider enterprises in supply network specific strategic resources to address PHL. Understanding the perspective of tangible and intangible resources to PHL in the RCNs supply network can inform managers and policymakers to develop and collaborate effectively to implement innovative initiatives to minimize/eliminate PHL in the cashew sector (Matteo Mario Savino and Shafiq 2018; Silva et al.

2018). To this end, the first objective of the study is to develop a framework to identify PHL drivers guided by tangible and intangible resources viewpoint. The second objective of the study is the application of fuzzy Decision Making and Trial Evaluation Laboratory (fuzzy-DEMATEL) technique to evaluate and determine among the most fundamental and prominent drivers of PHL in the RCNs supply network in a visualized causal relationship diagram. Thus, the proposed method enables prioritization and ranking of the drivers of PHL in the RCNs supply network to facilitate and avoid discrepancies in implementing innovative practices to overcome PHL in the cashew sector. The fuzzy-DEMATEL technique has been widely applied in several studies as a decision making tool to help scholars address complex issues in many fields such as management, engineering, science, business, supplier selection, etc. (Gabus and Fontela 1972; Bacudio et al. 2016). DEMATEL is simple and straightforward to apply, highly effective and accurate in aggregating expert's views (Tseng et al. 2014; Suh et al. 2019; Jeng 2015; Feng and Ma 2020; Hendiani et al. 2019). In this study, fuzzy set theory is integrated with conventional DEMATEL to address vagueness, subjectivity and incomplete information associated with human judgment during the decision making process (Kusi-Sarpong et al. 2016; Sufiyan et al. 2019).

Drawing on the exigency of addressing PHL drivers, this study contributes to existing studies by focusing on critical gaps in the literature. The first contribution of the study is the systematic development of a framework to identify and understand PHL drivers guided by tangible and intangible resources perspective. Secondly, the prioritization of identified drivers with MCDM tools to facilitate the strategic implementation of initiatives to minimize PHL in the cashew production sector. Again, this study provides insights to supply decision-makers, governments, and relevant stakeholders to find strategic and innovative approaches to address drivers of PHL in the RCNs supply network.

The remaining section of the paper is organized as follows; Section 2 presents a literature review on PHL, resources, and identifies drivers of PHL. In Section 3, we introduce the fuzzy-DEMATEL technique and data collection. The results of the study are presented in Section 4. In Section 5, we present the discussion, implication, and sensitivity analysis. Finally, we provide conclusions with the limitations and future studies scope of the paper in Section 6.

2.0 Research background

2.1 Post-harvest losses and resources

Although there are several studies on PHL (Tröger et al. 2020; Restrepo et al. 2020; Bradford et al. 2018; Ellis et al. 2020; Hodges et al. 2011; Ponnuswami et al. 2011), in-depth focus from the perspective of tangible and intangible resources is rare. Inadequate and poor resources impedes systematic and effective operationalization of initiatives to minimize/eliminate PHL, particularly in developing and emerging countries (Reutter et al. 2017; Alexander et al. 2017; Hodges et al. 2011). The resource-based view (RBV) underscores how enterprises can strategically leverage their available resources, which are distinctive, rare, and unduplicatable, to attain sustainable competitive advantage over its competitors (J. Barney et al. 2001). De Marchi et al. (2013), strongly suggest that as enterprises develop strategies to address their sustainability constraints, they are transformed into new drivers of competitive advantage. Thus, through an enterprise resources, it can gain competitive advantage among its competitors at the local and international markets (Coates and McDermott 2002; Restrepo et al. 2020; Parimalarangan et al. 2011), as well as achieve sustainability goals (Seddon 2014). The theory focuses on elements such as capabilities, materials, information sharing, knowledge, and practices, possessed and controlled by enterprises (He et al. 2020; Jardón et al. 2018). It emphasizes on enterprise strategic inputs in planning and developing its distinctive features, and regards resources as the basis of profits (Grant 1991). RBV posit that enterprise factors of production, as resources, can be classified into tangible assets and intangible assets (Jay Barney 1991). Enterprises who possess the resources in the supply chain have the competitive advantage to address challenges (Molloy et al. 2011). Therefore, drawing from the RBV, we suggest that PHL drivers in the RCNs supply network can be segmented into tangible and intangible resources (Gu et al. 2016; Lonial and Carter 2015).

A study by Cardoen et al. (2015), suggests that in developed economies, PHL usually occurs in the final stage of the supply chain due to the adoption of advanced innovative practices to reduce the phenomenon in the upstream. According to Bradford et al. (2018), qualifying fractions of the PHL are mostly unknown since the losses occur at the various stages in the supply chain at different levels. Thus, minimizing/eliminating of PHL across various sectors in the agro-food industry requires the deployment of several resources to equip enterprises in the supply chain (Spadafora et al. 2019). Tangible and intangible resources such as infrastructure, roads, and information dissemination are vital to managing PHL concerns (Gardas et al. 2018). The availability of road network facilitates faster transportation, lower cost, and generate advance access to markets which fast-track trade and reduce delay in selling farm produce (Ellis et al. 2020; D. Das 2018).

The construction of storage and drying facilities, proper harvesting techniques, and transfer of information among suppliers/enterprises lead to the reduction of PHL (Underhill and Kumar 2014). Other studies have highlighted how the lack of tangible and intangible resources impedes the minimization of PHL at the upstream in agro-food processing (Prusky 2011). For example, Affognon et al. (2015), argued that poor or inefficient resources affect and slow down the implementation of contemporary techniques to scale-up the reduction of PHL. It was further expounded that the unavailability and misunderstanding of tangible related resources are major sources of PHL in cereals, pulses and fruits in sub-Saharan Africa. Bendinelli et al. (2019), employed econometric model and global level panel data to evaluate macroeconomic conditions influencing PHL in grains (namely: rice, maize, soybeans and wheat). The study's goal was to understand macroeconomic factors that contribute to PHL in grains and the role of key resources to address PHL challenges. The study indicated that the lack of post-harvest infrastructure, especially in food storage and food marketing, contribute sharply to the level of increase in PHL. Kaminski and Christiaensen (2014), investigated key factors causing PHL in Sub-Saharan Africa. They revealed that lack of access to markets and training was the key driving force of PHL in the agriculture industry in Africa. Notwithstanding the plethora of studies on PHL (Gardas et al. 2017; Kaminski and Christiaensen 2014; Hodges et al. 2011; Ellis et al. 2020), there is a rare in-depth focus on the drivers of PHL from resources perspective Table 1 below enlists a sample of existing studies on PHL related to resources perspective.

Table 1 A summary of sample previous studies on PHL related to resources viewpoint

No	Year	Problem	Country/Origin	References
1	2020	Economic and nutritional implications of losses and contributing factors along the bean value chain.	Canada	(Ellis et al. 2020)
2	2020	Assessing the quality of collaboration in transdisciplinary sustainability research: Farmers' enthusiasm to work	Kenya	(Underhill and Kumar 2014)

		together for the reduction of post-harvest dairy losses in Kenya		
3	2019	What are the main factors that determine PHL of grains.	Africa	(Bendinelli et al. 2019)
4	2018	Improving environmental performance of post-harvest supply chains of fruits and vegetables in Europe: Potential contribution from ultrasonic humidification	Europe	(Fabbri et al. 2018)
5	2015	The effects of reducing food losses and food waste on global food insecurity, natural resources, and greenhouse gas emissions	Japan	(Munesue et al. 2015)
6	2017	Exploration of logistics and quality control activities in view of context characteristics and PHL in fresh produce chains	Africa	(Macheka et al. 2017)
7	2019	Assessing the quality of collaboration in transdisciplinary sustainability research: Farmers' enthusiasm to work together for the reduction of PHL.	China	(Lu et al. 2019)
8	2018	Modeling the drivers of PHL– MCDM approach	India	(Raut et al. 2018)
9	2018	Reducing post-harvest food losses through innovative collaboration: Insights from the Colombian and Mexican avocado supply chains.	Brazil	(Arias Bustos and Moors 2018)
10	2019	Addressing the losses and waste of Chinese rice supply chain: Sources, drivers and mitigation strategies.	China	(Lu et al. 2019)
11	2018	Improving environmental performance of post-harvest supply chains of fruits and vegetables in Europe: Potential contribution from ultrasonic humidification.	Europe	(Fabbri et al. 2018)
12	2020	PHL in rural-urban value chains: Evidence from Ethiopia	Ethiopia	(B. Minten et al. 2020)
13	2020		Salvador and Brazil	(Santos et al. 2020)

		PHL of fruits and vegetables in supply centers in Salvador, Brazil: Analysis of determinants, volumes and reduction strategies.		
14	2019	Techno-economic analysis of a cogeneration system for PHL reduction: A case study in sub-Saharan rural community.	Africa	(Lamidi et al. 2019)
15	2020	A scoping review of interventions for crop postharvest loss reduction in sub-Saharan Africa and South Asia.	Sub-Saharan Africa and South Asia	(Stathers et al. 2020)
16	2020	Returns to investment in postharvest loss reduction technologies among mango farmers in Embu County, Kenya.	Kenya	(Mujuka et al. 2020)
17	2018	Postharvest losses and their determinants: A challenge to creating a sustainable cooking banana value chain in Uganda.	Uganda	(Kikulwe et al. 2018)
18	2020	Post-harvest losses in rural-urban value chains: Evidence from Ethiopia	Ethiopia	(Bart Minten et al. 2020)

2.2 Drivers related to tangible resources of Post-harvest loss

The tangible resources involve physical and financial resources available to enterprises and critical in achieving sustainability (Tran et al. 2020; Jensen et al. 2016; Pfister and Baccini 2005). The availability of financial resources leads to significant investment in storage facilities, drying materials, road networks, new technology, etc., all these are essential in the transportation and processing of RCNs (Seddon 2014; Song et al. 2020). Therefore, tangible resources have a major influence on PHL in the RCNs supply network and play an important role in the implementations of related innovative practices (Chhipi-Shrestha et al. 2019). The following factors are common drivers of PHL in the RCNs supply network related to tangible resources (assets) in the RCNs supply network.

2.2.1 Lack of appropriate storage facility D_1: The use of proper storage facilities for the storage of cashew nuts is crucial to reduce PHL. Again, the location/setting of storage facilities must be accessible for smooth commutation to buyers to enhance sustaining product quality, prevent pests and insect infestation (Prusky 2011; Kasso and Bekele 2018).

2.2.2 Lack/Insufficient use of proper packaging materials D_2: The use of proper packaging materials for RCNs helps in minimizing PHL and prolong the storage period without infestation or damage (Lamboni et al. 2016; de Figueirêdo et al. 2016). Generally, the use of plastics, buckets, boxes, or fertilizer sacks are inappropriate for packaging RCNs, and it is a key factor contributing significantly to PHL in the sector (hasith Priyashantha et al. 2020). A well-dried RCNs need to be packed and stored in jute sacks for safe transportation to the market. The packed RCNs must be placed on wooden pallets in a dry, well-ventilated leak proof room (Gardas et al. 2017).

***2.2.3 Lack/Insufficient drying technologies and materials D_3*:** RCNs are best dried on concrete floors, drying mat under shade for 3 or 4 days with regular turning to ensure uniformity (Ogunsina and Bamgboye 2014). Well-dried RCNs must produce a rattling sound when turned (Moreira et al. 2019; Gardas et al. 2019). PHL often occurs when suppliers dry collected nuts on metallic surfaces directly under the scorching sun, which results in nuts deterioration or shrinkage (Cardoen et al. 2015).

2.2.4 Lack of availability/proximity to the marketplace D_4: Access roads to marketplaces and warehouses in RCNs growing areas or regions is a crucial driver for reducing PHL (Mithun Ali et al. 2019). RCNs are predominately cultivated in rural areas, where many communities lack good road networks to transport their products to marketplaces (M. M. Savino et al. 2015). RCNs suppliers in rural communities often endure long distances and sparse road networks to reach markets or buyers warehouse (Kaminski and Christiaensen 2014). As such RCNs, are often kept for longer periods before processing, which may affect the quality and value (Gyedu-Akoto et al. 2014).

2.2.5 Drivers related to financial and economic constraints D_5: The issue of PHL concerns is attributed to financial constraints to implement innovative practices (Cardoen et al. 2015; Agyemang et al. 2018). PHL mitigation in the cashew industry requires initial financial investment such as, for clearing cashew trees ahead of harvesting to facilitate picking of fruits and prevent pathogen infestation, acquiring the appropriate drying materials, storing facilities, etc. (Berry and Sargent 2011). Although the implementation of a PHL mitigation strategy can produce a long-run cost reduction, many of the essential practices for preliminary implementation can increase the investment cost (Mapfeka et al. 2019; Palei et al. 2019). Such financial investment to adopt innovative practices by RCNs suppliers are often beyond their financial strength (Brito De Figueirêdo et al. 2016).

2.3 Drivers related to intangible resources influencing Post-harvest loss

In this study, intangible resources comprise sustainable knowledge and organizational culture to help suppliers/enterprises gain competitive advantage over their competitors (hasith Priyashantha et al. 2020; Dendena and Corsi 2014). Hence, the following are drivers of PHL, which are related to intangible resources in the RCNs supply network.

2.3.1 Premature harvesting of RCNs D_6: The time of harvesting RCNs is assessed by the degree of its maturity. This is the situation in which RCNs are harvested in its partial ripened state by farmers (Ogunsina and Bamgboye 2014). The quality of RCNs is ascertained by allowing the ripened fruit to drop to the ground before picking (Bradford et al. 2018). Suppliers who harvest RCNs prematurely cause effects on the nutritional quality, make it easily susceptible to pest and insect infestations as well as make it shrinks during the drying process (I. Das and Arora 2017)

2.3.2 Inadequate knowledge about post-harvest technologies D_7: This is the situation where RCNs suppliers do not know post-harvest techniques, technology, and innovative practices to reduce PHL in the RCNs sector (Rais and Sheoran 2015). The method which they apply to dry RCNs, sorting, and packing contributes significantly to PHL of the cashew industry (Arias Bustos and Moors 2018).

2.3.3 Improper handling of RCNs and detaching fruit D_8: Poor handling of RCNs is a relevant factor contributing to PHL in the cashew industry. The quality of the RCNs is affected when the cashew apple is not neatly detached using thread or a sharp edge. Skills, training, and practical education about the proper ways of handling RCN sand detaching of cashew apple can lead to the adoption of innovative practices to handling RCNs (Gokarn and Kuthambalayan 2017). Various stakeholders such as governmental departments, NGOs, research institutes, and other development agencies can substantially lend technical advice to cashew farmers to adopt innovative RCNs handling practices (Hsiao et al. 2017).

2.3.4 Lack of information dissemination on PHL within RCNs suppliers D_9: Many experts' in the agro-food industry have highlighted the significance of information sharing among suppliers to reduce PHL. However, due to competition among suppliers in the industry, there is a significant gap in information sharing (Gardas et al. 2018). Prior studies have proven that willingness to share information between enterprises in the supply networks enhances the potential for better implementation of innovative practices (K. P. Lin et al. 2018). Nonetheless, suppliers are unwilling to exchange information for fear of revealing vital information, which will make other suppliers take advantage (Agyemang et al. 2018).

2.3.5 Insufficient/Lack of management support and commitment D_{10}: Leadership roles are central factors for the formulation and implementation of strategic measures in imitating PHL (Arumugam and Ponnusami 2015; I. Das and Arora 2017). Leadership/top management failure to show a keen interest and commitment to initiate strategic measures appropriate to address PHL in the sector may incapacitate organizations surmount PHL challenges and implementation of innovative practices (Gardas et al. 2017). Ghana is a developing economy with higher potential cashew production; however, not all cashew suppliers, managers, and stakeholders are very much committed to solving critical factors contributing to PHL at the early stages in the cashew industry in Ghana (Gyedu-Akoto et al. 2014).

2.3.6 Lack/Inadequate partnership among industry players, intermediaries, and NGOs D_{11}: Lack/inadequate support and guidance from industry players, individuals, supply chain experts, academicians, and development agencies affects their quest to implement innovative practices in the cashew industry (Agyemang et al. 2018). Capacity building concerning skills, training, awareness creation, and expert guidance on the implementation of appropriate techniques to address PHL challenges and implementation of practices in the RCNs supply network is significant (I. Das and Arora 2017; Hodges et al. 2011). Again, government and other non-governmental organizations (NGOs) keen on PHL issues of the RCNs supply network could profess technical and professional assistance and guidance to cashew suppliers on available alternatives to surmount PHL, especially the provision of complementary measures and skills (Affognon et al. 2015).

2.3.7 Lack/Insufficient commitment and trust among cashew suppliers/enterprise and industry actors' D_{12}: Low degree of trust and commitment in RCNs supply relation is a pivotal impediment to the implementation of measures to overcome PHL (Honfoga et al. 2016). Previous studies suggested that the level of commitment RCNs suppliers demonstrates is critical for implementing innovative practices to address PHL (Agyemang et al. 2016; Richter and Bokelmann 2016). Cashew supplier's commitment in supplier relation is usually obstructed by a lack of trust, which often ensues between suppliers and RCNs buyers (Honfoga et al. 2016). Table 2 shows the categorization of identified tangible and intangible resources drivers of PHL in the RCNs supply network.

Table 2 Segmentation of drivers of PHL based on resources based view

Resources	Code	Drivers of PHL in the RCNs supply network	References
Tangible resources drivers of PHL	**D_1**	Lack of appropriate storage facility.	(Gardas et al. 2018; Kasso and Bekele 2018; Gyedu-Akoto et al. 2014).
	D_2	Lack/Insufficient of proper packaging materials.	(Murthy et al. 2009; Raut et al. 2018; Hodges et al. 2011).
	D_3	Lack/Insufficient drying technologies and materials.	(Hodges et al. 2011; Dendena and Corsi 2014; hasith Priyashantha et al. 2020).
	D_4	Lack of availability/proximity to selling centers/marketplace.	(Bendinelli et al. 2019; Gyedu-Akoto et al. 2014).
	D_5	Driver/factors related to financial and economic constraints.	(Hodges et al. 2011; Agyemang et al. 2018; Raut et al. 2018)
Intangible resources drivers of PHL	**D_6**	Premature/green harvesting of RCNs.	(hasith Priyashantha et al. 2020)
	D_7	Inadequate knowledge about post-harvest technologies.	(Raut et al. 2018; Gyedu-Akoto et al. 2014; Hodges et al. 2011)
	D_8	Improper handling of RCNs and detaching fruit.	(Murthy et al. 2009; Dendena and Corsi 2014)

D_9	Lack of information dissemination on PHL within RCNs suppliers.	(Agyemang et al. 2018; Hodges et al. 2011; Kasso and Bekele 2018)
D_{10}	Insufficient/Lack of management support and commitment.	(Cardoen et al. 2015; De Steur et al. 2016; Dubey et al. 2015)
D_{11}	Lack/Inadequate partnership among industry players, agriculture intermediaries, and NGOs.	(Joshi and Visvanathan 2019; Agyemang et al. 2018; Sarkis et al. 2010)
D_{12}	Lack/Insufficient of commitment and trust among cashew suppliers/enterprise and industry actors.	(Honfoga et al. 2016; hasith Priyashantha et al. 2020)

3.0 Research methodology and data collection

This section presents the research method and details of data collection for an analysis of drivers of PHL in the RCNs supply network.

3.1 DEMATEL Method

The Decision Making and Trial Evaluation Laboratory (DEMATEL) methodology was developed by the Science and Human Affairs of the Battelle Memorial Institute in Geneva to address a complex large number of criteria (Gabus and Fontela 1972). The DEMATEL technique is useful for research purposes, due to its ability to distinguish the contextual relationship among the criteria into cause and effect groups to explicitly construct causal-effect diagram for a clear understanding of the study (Liu et al. 2019; Asan et al. 2018; Bhalaji et al. 2019). For instance, Kukar et al. (2019) employed DEMATEL to evaluate green supply chain management barriers in Canadian manufacturing firms. Gardas et al. (2018), utilized DEMATEL to investigate the factors related to PHL for Indian vegetables and fruits supply chain. Also, Karuppiah et al. (2020) applied DEMATEL to model barriers in implementing green manufacturing practices in SMEs. The application of classic DEMATEL for a study is characterized by shortcomings related to incomplete information, imprecision and subjective evaluation (Xia et al. 2015). Hence, in this study, fuzzy theory is integrated with conventional DEMATEL to address the problem of subjective evaluation, incomplete information and imprecision during the decision making process (R. J. Lin 2013). This has resulted in many scholars applying fuzzy DEMATEL for research purposes over other multi-criteria decision-making methods such as Best Worst Method, Analytical Network Process, Analytical Hierarchy Process, Technique for Order Preference by Similarity to Ideal Situation (Jeng 2015; Chang et al. 2011; Munny et al. 2019; Torkabadi et al. 2018). Fuzzy DEMATEL method is currently applied in many studies due to the following reasons: Fuzzy DEMATEL technique explicitly distinguishes drivers/criteria/factors into cause and effect dataset groups, fuzzy DEMATEL is straightforward and easy to understand, fuzzy DEMATEL computation is easy and simple, fuzzy DEMATEL express study findings in pictorial diagram for easy understanding by decisions makers (Agyemang et al. 2018; Kusi-Sarpong et al. 2016; Ocampo 2019). Hence, the steps involved DEMATEL application (Sharma et al. 2020; Govindan et al. 2015) are as follows:

Step 1. Calculate the direct-influence matrix of scores (based on the opinions of the experts) and evaluate the relationships among drivers, variables, attributes, and or criteria of mutual influence. Next, experts are to form a comparison matrix to obtain the direct matrix of D using the scale ranging from 0 to 4. (0 indicates “no influence”, 1 indicates very “low influence”, 2 indicates “low influence”, 3 “high influence” and 4 designates very high influence”). Then the initial data can be obtained as the direct-relation matrix, which is a $i * j$ is denoted element of d_{ij} in which the criterion i affects the criterion j. Assuming, if there are n variables that impact the system, the direct-influence matrix D is indicated in Eq. (1).

$$D = \begin{bmatrix} 0 & d_{12} & \cdots & d_{1n} \\ d_{21} & 0 & \cdots & d_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ d_{n1} & d_{n2} & \cdots & 0 \end{bmatrix} \quad (1)$$

Step 2: Normalized the direct influence matrix. Normalization is done based on the direct-influence matrix using Eqs. (2) and (3).

$$N = D / u \quad (2)$$

$$u = \max_{ij}\left\{\max_{i}\sum_{j=1}^{n} d_{ij}, \max_{j}\sum_{i=1}^{n} d_{ij}\right\}, i, j Î \{1,2,...,n\} \quad (3)$$

Step 3: Attaining the total-relation matrix. After normalizing direct influence matrix N where i or j is calculated by summation, the total relation matrix T can be acquired by using Eq.(4), in which I is the identity matrix.

$$T = N + N^2 + N^3 + ...N^q = N(\mathrm{I} + N^2 + . + N^{q-1})[(\mathrm{I} - \mathrm{N})^{-1}]$$

$$= \mathrm{N}\,(\mathrm{I} - \mathrm{N}^q)(\mathrm{I} - N)^{-1} \quad (4)$$

Then $T = N\ (\mathrm{I} - \mathrm{N})^{-1}$, when $q \to \infty$, $N^q = [0]_{m*n}$,

where $N = \lfloor e_{ij} \rfloor_{m*n}, 0 \le e_{ij} < 1, 0 < \left(\sum_{j=1}^{n} e_{ij}, \sum_{i=1}^{n} e_{ij}\right) \le 1$ and then one summation equation must be equivalent to 1, that is $\sum_{j=1}^{n} e_{ij}$ or $\sum_{i=1}^{n} e_{ij}$ but not all, since one can guarantee that $\lim_{m-\infty} N^q = [0]_{m*n}$.

Step 4: Analyze the results: Here, the sum of the rows and the sum of the columns as vector D and R by using Eqs. (5) – (7). In this step $i, j \in \{1, 2, ..., n\}$ and $i = j$ the horizontal axis $(d + r)$ is obtained by adding vector d to vector, r which reveals the relative importance of each criterion. Similarly, the vertical axis $(d - r)$ is made by subtracting vector r from the vector d, which may divide criteria into cause and effect groups. In general, the value $(d - r)$ is positive, then the criterion belongs to the cause group, and it $(d - r)$ is negative; then, the criterion belongs to the effect group. Therefore, the casual diagram can be obtained by mapping the data set of $(d+r)$ and $(d-r)$, and this can provide some insight for making valuable decisions.

$$T = \lfloor t_{ij} \rfloor_{m*n'}\ i, j \in \{1, 2, \ldots n\} \qquad (5)$$

$$d = [\sum_{j=1}^{n} t_{ij}]_{n*1} = [\mathrm{t}_i]_{n*1} = [\mathrm{d}]_{n*1} \qquad (6)$$

$$r = [\sum_{j=1}^{n} t_{ij}]_{n*1} = [\mathrm{t}_i]_{n*1} = [\mathrm{r}]_{n*1'} \qquad (7)$$

where d and r denote the sum of rows and the sum of columns based on the total-influence matrix $T = \lfloor t_{ij} \rfloor_{m*n'}$, respectively.

3.2 The fuzzy DEMATEL Technique

The fuzzy theory was proposed by Lotfi A Zadeh (1965) to address uncertainty, imprecision and fuzziness that characterize experts' opinions are expressed in Triangular Fuzzy Numbers (TFNs) and an ordinary Likert scale with a specific degree of membership indicated in the fuzzy set (X. Wu et al. 2019; Chung and Kim 2014). In applying fuzzy logic for a study, all the values between 0 and 1 are considered as imperfect results of [0,1], and membership degree in a fuzzy set. The following are a few definitions of fuzzy arithmetic provided. Here, let $\tilde{A}$ be a fuzzy number. In this case, the Triangular Fuzzy Numbers (TFNs) $\tilde{A}$ are expressed as a triplet (l, m, u) a membership function of $\mu_A(x)$, it is assumed that, $\mu_A(x)$ is denoted as $\mu_A(x): \mathrm{X} \in [0,1]$, where $\mu_A(x)$=1. This indicates that x is a member of $\tilde{A}$. If, the $\mu_{\tilde{A}}(x) = 0$, then x is not a member of $\tilde{A}$.the Therefore, membership function is defined as:

$$u_A(x) = \begin{cases} 0 & x < l \\ (x-l)/(m-l) & l \le x \le m \\ (u-x)/(u-m) & m \le x \le u \\ 0 & x > u \end{cases} \qquad (8)$$

Where l, m,and u are all real numbers. Again m, indicate that center l,and u are the upper and the lower bound of $\tilde{A}$, whiles member function is express as $\mu_{\tilde{N}}(x) = 0$. According to prior studies

(L. A. Zadeh 1975; Zhang and Su 2019), triangular fuzzy numbers (TFNs) and extension principals are characterized by the following operational laws. Hence, let $\tilde{F}_1 = (a_1, a_2, a_3)$ whiles $\tilde{F}_2 = (b_1, b_2, b_3)$.

(a) Addition of two TFNs is express as: $\oplus$

$$F_1 \oplus F_2 = (a_1 + b_1, a_2 + b_2, a_3 + b_3) \qquad (9)$$

(b) Subtraction of two TFNs:

$$F_1 - F_2 = (a_1 - b_1, a_2 - b_2, a_3 - b_3). \qquad (10)$$

(c) Multiplication of two TFNs:

$$F_1 \otimes F_2 = (a_1 \otimes b_1, a_2 \otimes b_2, a_3 \otimes b_3). \qquad (11)$$

(d) Division of two TFNs:

$$F_1 \div F_2 = (a_1 \div b_3, a_2 \div b_2, a_3 \div b_1) \qquad (12)$$

For accurate and useful fuzzy aggregation, it is significant to address any ambiguity and subjectivity in human cognition under fuzzy environment. Therefore, decision making determines, using fuzzy linguistic variables through fuzzy numbers; this is to ensure that fuzzy analysis requires a defuzzification phase to simplify fuzzy numbers into crisp values. Thus, the present study adopts a variation of the CFSC (Converting Fuzzy data into Crisp Scores) proposed by (Opricovic and Tzeng 2003),which is based on establishing the low (l) and higher (h) values through the fuzzification of the maximum and the minimum. Therefore, the actual total value is obtained at the weighted average by the member function. Several scholars discerned on applying this approach because it is a more effective and straightforward way of obtaining crisp values as compared to the centroid approach (Bakir et al. 2018; Chung and Lee 2009). Hence, lets $A_{ij} = (l_{ij}^{n}, m_{ij}^{n} r_{ij}^{n})$, with the mean degree being criterion i that criterion j and fuzzy questionnaires $n(n = 1, 2, 3, ..\text{p})$, . The following are the Converting Fuzzy data into Crisp Scores techniques five steps algorithm:

Step 1: Normalization for each comparison

$$xr_{ij}^{ij} = (r_{ij}^{n} - minl_{ij}^{n}) / \Delta_{min}^{max} \quad (13)$$

$$xm_{ij}^{ij} = (r_{ij}^{n} - minl_{ij}^{n}) / \Delta_{min}^{max} \quad (14)$$

$$xl_{ij}^{ij} = (r_{ij}^{n} - minl_{ij}^{n}) / \Delta_{min}^{max} \quad (15)$$

Where $\Delta_{min}^{max} = maxr_{ij}^{n} - minl_{ij}^{n}$ (16)

Step 2: here we compute right (rs) and left (ls) normalized values

$$xrs_{ij}^{n} = xr_{ij}^{n} / (1 + xr_{ij}^{n} - xm_{ij}^{n}) \quad (17)$$

$$xls_{ij}^{n} = xm_{ij}^{n} / (1 + xm_{ij}^{n} - xl_{ij}^{n}) \quad (18)$$

Step 3: Compute total normalized crisp values

$$x_{ij}^{n} = [xls_{ij}^{n}(1 - xls_{ij}^{n}) + xrs_{ij}^{n} * xrs_{ij}^{n}]/[1\text{-}xls + xrs_{ij}^{n}] \quad (19)$$

Step 4: After, the crisp values are computed

$$z_{ij}^{n} = minl_{ij}^{n} + x_{ij}^{n} * \Delta_{min}^{max} \quad (20)$$

Step 5: Integration of crisp values

$$z_{ij} = \frac{1}{p}(z_{ij}^{1} + z_{ij}^{2} + ... + z_{ij}^{p}) \quad (21)$$

Based on previous studies, (Muhammad and Cavus 2017; Jeng 2015), the following fuzzy DEMATEL steps are employed for this study:

Step 1: Define the fuzzy linguistic scale for pairwise comparison, as presented in Table 3, to deal with subjectivity, imprecision, and lack of information. At the first stage, all the criteria were briefly defined in the questionnaire for easy understanding by the decision-makers. After thorough examined by experts, 12 drivers were considered for the study as the critical drivers of PHL in the RCNs supply network. A linguistic scale with corresponding Triangular fuzzy numbers (TFNs) of (0) “no influence”, (1) “very low influence”, (2) “low influence”, (3) “high importance” and (4) “very high influence” were assigned to the experts to perform pairwise comparisons of the drivers of PHL in the RCNs supply network.

Table 3 The fuzzy linguistic scale

Linguistic terms	Fuzzy influence score	Triangular fuzzy numbers
No influence (NO)	0	(0,0,0.25)
Very low influence (VL	1	(0,0.25,0.5)
Low influence (L)	2	(0.25,0.5,0.75)
High influence (H)	3	(0.5,0.75, 1.00)
Very high influence (VH)	4	(0.75,1.00,1.00)

Step 2: Determine fuzzy direct relation matrix T. The direct relation matrix is obtained based on the opinion of the experts using the linguistic scale, as indicated in Table 4 below. The experts were then asked to assess the direct relations between the influential drivers based on the linguistic scale. Hence the fuzzy direct relation matrix $\tilde{D}$ was determined using Eq. (21).

$$\tilde{D} = \left[\tilde{d}_{ij}\right]_{n\times n} (i, j = 1,2,3..., n), \text{ where } \tilde{d}_{ij} = (l_{ij}, m_{ij} r_{ij}). \quad (22)$$

Step 3: Normalized fuzzy direct-influence matrix: Here, we normalized fuzzy direct relation matrix D based on fuzzy direct relation matrix $\tilde{D}$, using Eq. (22).

$$u = \max_{ij}\left\{\max_{i}\sum_{j=1}^{n} d_{ij}, \max_{j}\sum_{i=1}^{n} d_{ij}\right\}, (i, j = 1,2,3..., n) \quad (23)$$

$$\tilde{D} = \left[\tilde{d}_{ij}\right]_{n\times n}, \tilde{d}_{ij} = (\tilde{d}_{ij}^{l}, \tilde{d}_{ij}^{m}, \tilde{d}_{ij}^{r},)$$

Step 4: Obtaining the fuzzy total relation matrix: After determining the normalized fuzzy direct-influence matrix through $\tilde{D} = (D^{l}, D^{m}, D^{r})$, where $D^{l} = \left[d_{ij}^{l}\right]_{n\times n}$, $D^{m} = \left[d_{ij}^{m}\right]_{n\times n}$ and $D^{r} = \left[d_{ij}^{r}\right]_{n\times}$. Hence, the fuzzy total relation matrix $(\tilde{T})$ is calculated using Eq. (23), with the I being expressed as the identity matrix.

$$(\tilde{T}) = [\tilde{t}_{ij}]_{n\times n}, \text{ where } \tilde{t}_{ij} = (t_{ij}^{l}, t_{ij}^{m}, t_{ij}^{r}) \quad (24)$$

$$T^{l} = [t_{ij}^{l}]_{n\times n} = N^{l}(I - N^{l})^{-1}, T^{m} = [t_{ij}^{m}]_{n\times n} = N^{m}(I - N^{m})^{-1}$$

and $T^{r} = [t_{ij}^{r}]_{n\times n} = N^{r}(I - N^{r})^{-1}$. At stage, the element in TFNs are in the total relation matrix $(\tilde{T})$ is divided into T^{l}, T^{m} and T^{r}, where $T^{l} = [t^{l}_{ij}]_{n\times n} \propto T^{m} = [t^{m}_{ij}]_{n\times n} \propto T^{r} = [t^{r}_{ij}]_{n\times n}$, when $d^{l}_{ij} < d^{m}_{ij} < d^{l}_{ij}$, for $i, j \in \{1, 2, \ldots, n\}$.

Step 5: Defuzzification of fuzzy relation matrix into crisp values through CFCS (W. W. Wu and Lee 2007; Xia et al. 2015) technique from Eqs. (13) – (21).

Step 6: Analysis and determination of drivers into cause and effect group of the structural model, to aid in the drawing of causal digraph corresponding to classic DEMATEL technique. Figure 1 shows the development stages of the proposed approach.

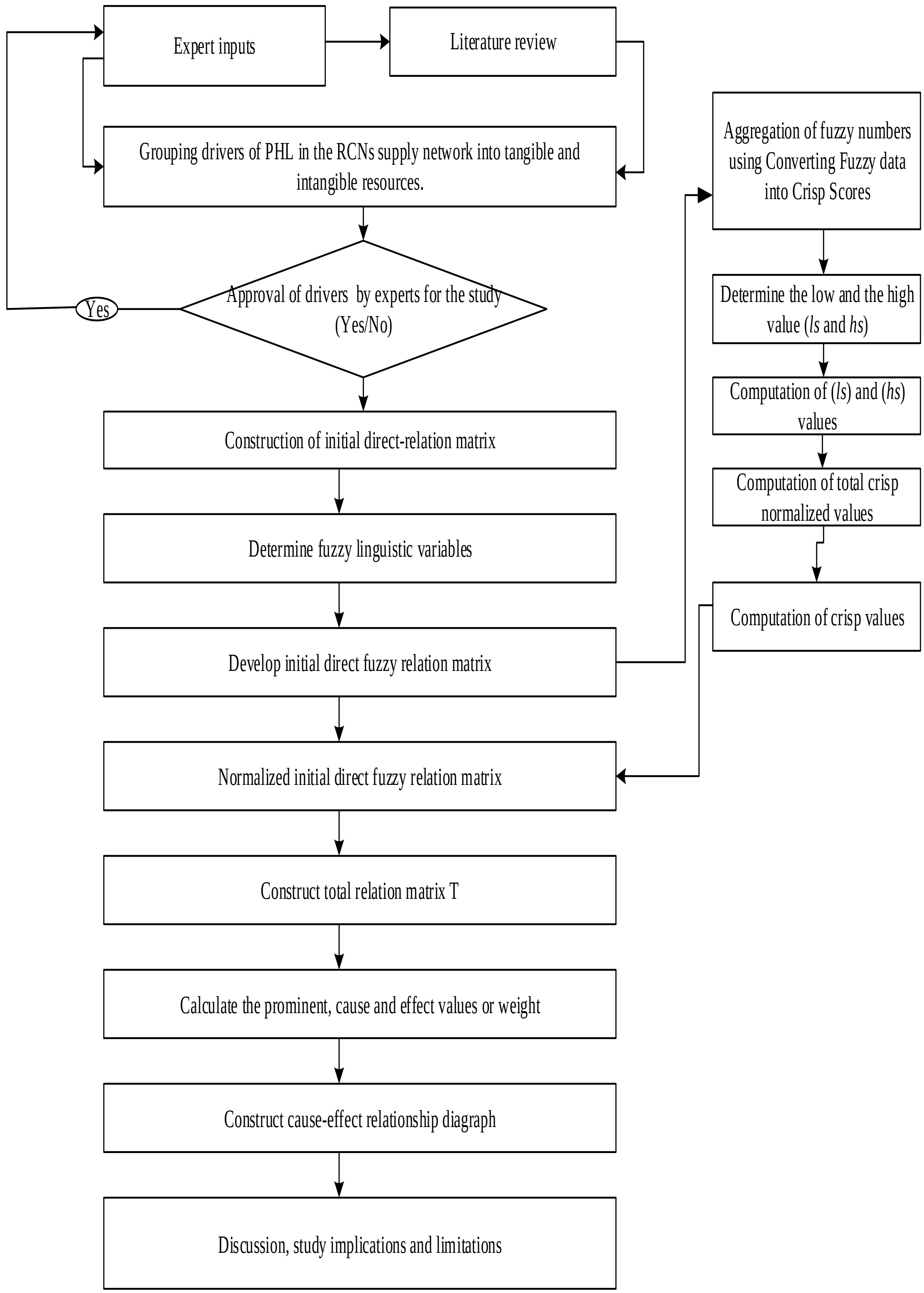

Figure 1 Framework of fuzzy DEMATEL technique applied for the study.

3.3 Data Collection

Ghana is located in West Africa along the Gulf of Guinea and the Atlantic Ocean. Ghana lies on land masses of 238,535 km^2 (92,099 sq mi) and share boundaries with Ivory Cost in the West, Burkina Faso in the north, Togo in the east and the Gulf of Guinea in the south. Raw cashew nuts cultivation in Ghana is increasingly important, profitable business, a source of livelihood for the majority of smallholder farmer's in Ghana and contribute significantly to the GDP. For instance, in 2008, RCNs exported from Ghana, contributed about 6.1% of GDP to Ghana's economy (Ackah et al. 2020; Boafo et al. 2019). Raw cashew nuts are grown all over Ghana (ACA 2015), however production for commercial purpose is common in locations shown in Figure 2 . Cashew nut production in these districts is the dominant farming crop due its enormous benefits as a source of household income and economic development. Again, the cashew value chain brings a wide range of opportunities from production, through processing to the export of raw nuts (Agyemang et al. 2020).

To achieve the objectives of the study and comprehensively understand the critical drivers of PHL in the RCNs supply network, data were collected. Based on purposive sampling and guided by prior studies (Cui et al. 2019; Hwang et al. 2017; Giunipero et al. 2012; Chen et al. 2020), nine experts with an average of fifteen years' experience each in the cashew sector were contacted in Ghana. The experts were considered based on their knowledge and understanding of the study objectives. They were selected from various sectors, including academia, cashew farmers, development agencies, government and private institutions. The selection of the number for the study is justifiable because several authors who applied DEMATEL technique used three, four and five experts inputs for a study (Agyemang et al. 2018; Raj and Sah 2019; Govindan et al. 2015; Chen et al. 2020). Again, fewer experts' inputs help in achieving consistency and make the study findings realistic.

The experts selected for the study were engaged in four different rounds by the authors to obtain sufficient data for the study. Through the literature review, drivers of PHL in the RCNs supply network were identified and shortlisted. In the first engagement, the identified drivers were then presented and discussed with the experts for their perusal. Subsequently, they approved and recommended addition of new driver(s) for the study. Secondly, after the experts' approval on the drivers of PHL in the cashew supply network, fuzzy DEMATEL questionnaires were designed along fuzzy linguistic scale as indicated in Table 3 for the pairwise of the drivers by the experts to generate the 12×12 fuzzy direct-relation matrix as presented in Table 5 and also in appendix A1-A3.In the third engagement, the completed 12×12 fuzzy direct-relation matrix and completed questionnaires were sent back to the experts for final verification before the subsequent analysis. In the fourth and final engagement with the experts, the study experts were asked to validate the study findings for their recommendation. The data collection lasted for five weeks. Due to the experts' time schedules, eight experts were directly interviewed in a face to face interaction while the other one was interviewed on phone.

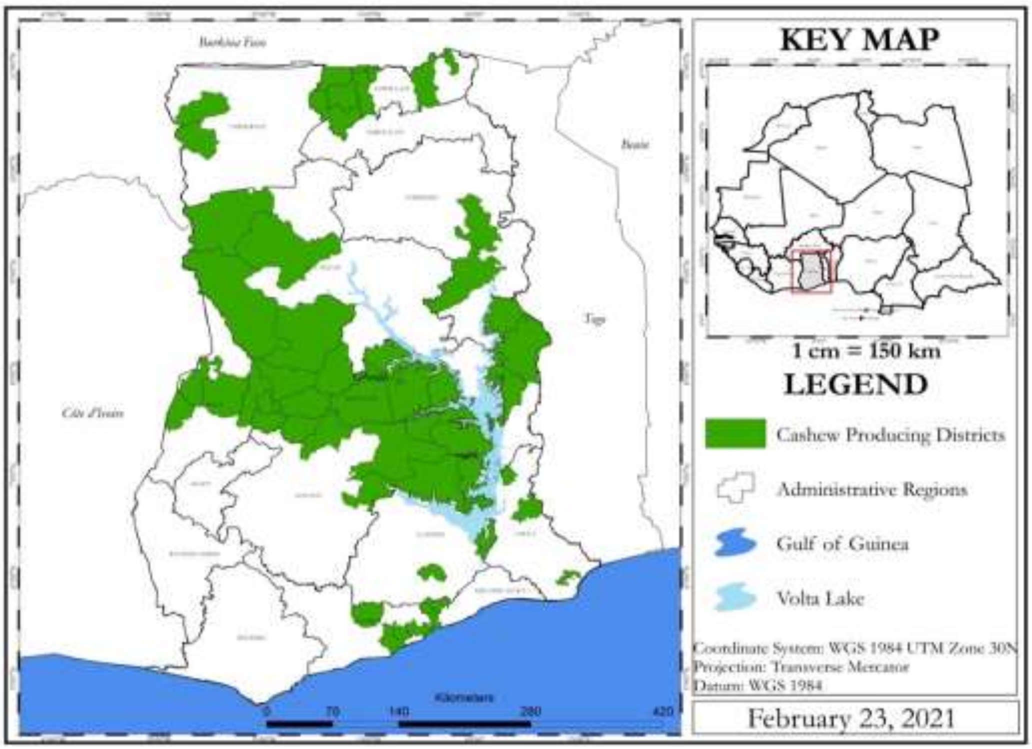

Figure 2 Cashew growing areas in Ghana.

4.0 Results and Sensitivity Analysis

4.1 Results

After, generating the 12×12 fuzzy direct-relation matrix D through the fuzzy lingustic terms, the lingsutics terms were translated into corresponding fuzzy values for easy understanding and futher computation. In this study, we applied the arithmetic mean method to calculate each pairwise impact degree in the fuzzy set of all the nine responses, hence the maximum value was calculated for the normalization of total direct D relation matrix. We then normalized the total direct D fuzzy matrix using Eq. (23) to obtain fuzzy total direct matrix $(\tilde{T})$ as shown in Table 4. We subsequently applied the principals of the CFCS technique using Eqs. (13) – (21), to aggregate all the fuzzy data. Following the conversion of the direct-relation matrix $(\tilde{T})$ into transformation fuzzy, we determined the cause and effects groups (drivers) respectively, as shown in Table 4. The d values denote the impact exerted and then r represents the degree of impact received. Hence, based on the determination of positive and negative categories of the drivers a casual digraph network was drawn to give a visualized understanding of the study as shown in Fig. 2. With the casual digraph network, $(d + r)$ indicates the degree of influence exerted and received. All the drivers in $(d - r)$ with positive values are expressed as the causal drivers. It indicates the degree at which they affect other drivers in the RCNs supply network. Again, to determine the inter-dependency between the drivers, a threshold value of (α) ***0.2172*** was set in order to eliminate relatively insignificant drivers. Thus, based on the $(d - r)$ values, the following casual drivers were the most significant drivers of PHL in the RCNs supply network: $D_2 > D_5 > D_6 > D_1 > D_{10}$ and D_9 shown in Table 7.

The drivers with negative values were also expressed as effect drivers of PHL in the RCNs supply network and were arranged as following: $D_8 > D_3 > D_{11} > D_7 > D_{12} > D_4$, as indicated in Table 7. The causal drivers exert significant influence on the effective drivers. In this study, the importance order of the drivers of PHL in the RCNs supply network were identified as: $D_{12} > D_{10} > D_{11} > D_8 > D_2 > D_4 > D_9 > D_7 > D_6 > D_5 > D_3 > D_1$ has shown in Table 7 based on the $(d + r)$ values . The findings of the fuzzy DEMATEL were further shared with the experts for final validation. The experts comprehensively examined the findings and agreed with the study outcomes and indicated that this study would be helpful for tackling critical drivers of PHL in the RCNs supply network particularly in the cashew growing countries which are threatened with PHL in the cashew sector.

Table 4 Direct-relation matrix D using linguistic variables

Drivers	D_1	D_2	D_3	D_4	D_5	D_6	D_7	D_8	D_9	D_{10}	D_{11}	D_{12}
D_1	0	NO	VL	L	H	VL	H	L	H	NO	L	VL
D_2	NO	0	H	VL	VL	H	L	VL	VL	VL	H	NO
D_3	VL	H	0	H	H	VL	VH	H	L	VH	L	VL
D_4	H	VL	H	0	VL	H	VL	VH	L	H	VL	L
D_5	H	L	NO	H	0	VH	H	L	VL	H	H	VH
D_6	L	VL	H	VL	H	0	VL	VH	VH	VH	L	H
D_7	VL	VH	L	H	VH	NO	0	VL	H	L	VH	NO
D_8	V	NO	H	H	NO	L	VH	0	H	VH	H	L
D_9	H	VL	NO	VL	L	VL	H	L	0	VH	VL	VH
D_{10}	L	VH	L	NO	VH	VL	NO	H	VH	0	L	H
D_{11}	NO	H	VL	H	VH	H	VH	L	NO	H	0	H
D_{12}	VL	VH	H	L	VL	H	L	NO	VH	VL	H	0

Table 5 Generalized direct-relation matrix

Drivers	D_1	D_2	D_3	D_4	D_5	D_6	D_7	D_8	D_9	D_{10}	D_{11}	D_{12}
D_1	0	0.07661	0.07733	0.08945	0.08180	0.07416	0.06265	0.07661	0.05234	0.09247	0.06130	0.07321
D_2	0.09032	0	0.09247	0.08053	0.06742	0.08036	0.10867	0.08915	0.09322	0.08585	0.10856	0.10158
D_3	0.06813	0.07432	0	0.07128	0.05303	0.03478	0.09765	0.07931	0.08645	0.10776	0.12906	0.08718
D_4	0.07302	0.07734	0.10560	0	0.03875	0.10888	0.08662	0.06223	0.12339	0.08332	0.04325	0.10158
D_5	0.09032	0.07932	0.07733	0.05731	0	0.07661	0.07560	0.10410	0.10809	0.09219	0.06610	0.11607
D_6	0.09057	0.08767	0.05431	0.10673	0.11242	0	0.06458	0.07335	0.09278	0.10106	0.08896	0.07661
D_7	0.07661	0.06820	0.05982	0.09932	0.05920	0.07661	0	0.04516	0.07661	0.10993	0.11182	0.11372
D_8	0.06265	0.04874	0.07751	0.12002	0.10593	0.10439	0.10000	0	0.02967	0.07661	0.12042	0.12099
D_9	0.07318	0.08404	0.09491	0.11005	0.12377	0.06087	0.12364	0.03235	0	0.04330	0.06338	0.07321

D_{10}	0.06948	0.07896	0.08974	0.08945	0.11768	0.09462	0.08728	0.07931	0.05850	0	0.12282	0.11099
D_{11}	0.07466	0.10011	0.12557	0.08459	0.06158	0.09986	0.07944	0.09247	0.08645	0.08332	0	0.08588
D_{12}	0.07984	0.12062	0.06158	0.08528	0.06742	0.07659	0.08575	0.10563	0.12551	0.10011	0.07483	0

Table 6 Total relation-matrix T

Drivers	**D_{1}**	**D_{2}**	**D_{3}**	**D_{4}**	**D_{5}**	**D_{6}**	**D_{7}**	**D_{8}**	**D_{9}**	**D_{10}**	**D_{11}**	**D_{12}**
D_{1}	0.2054	0.031	0.0464	0.1282	0.0146	0.0156	0.0867	0.9694	0.0502	0.1168	0.1004	0.1818
D_{2}	0.1686	0.1522	**0.2542**	**0.3305**	0.1893	0.2088	**0.3318**	0.1577	**0.2842**	**0.3166**	**0.3490**	**0.4268**
D_{3}	**0.2422**	0.1086	0.0569	0.1990	0.066	0.0593	0.2022	0.0439	0.1600	0.2131	**0.2450**	**0.2844**
D_{4}	0.0555	0.1198	0.1576	0.1430	0.0647	0.1282	0.2024	0.0348	0.2027	0.2016	0.1796	**0.3043**
D_{5}	0.1146	0.1682	0.1816	**0.2485**	0.0728	0.1486	**0.2428**	0.1176	**0.2365**	**0.2593**	**0.2501**	**0.3729**
D_{6}	0.1214	0.1815	0.1705	**0.2958**	0.1792	0.0855	**0.2389**	0.0973	**0.2320**	**0.2732**	**0.2735**	**0.3469**
D_{7}	0.0586	0.1136	0.1212	**0.2319**	0.0799	0.1041	0.1206	0.0232	0.1638	**0.2247**	**0.2364**	**0.3157**
D_{8}	0.1192	0.1728	0.2126	**0.3324**	0.1927	0.2043	**0.2919**	0.0527	0.2046	**0.2809**	**0.3270**	**0.4124**
D_{9}	0.0319	0.0988	0.123	0.2105	0.1064	0.0618	0.2046	0.9863	0.0672	0.1409	0.1657	**0.2522**
D_{10}	0.1577	**0.2330**	**0.2586**	**0.3434**	**0.2378**	**0.2283**	**0.3192**	0.1585	**0.2640**	**0.2456**	**0.3674**	**0.4434**
D_{11}	0.1318	**0.2180**	**0.2570**	**0.3067**	0.1603	0.2000	**0.2810**	0.1377	**0.2528**	**0.2880**	**0.2252**	**0.3846**
D_{12}	0.1474	**0.2468**	**0.2148**	**0.3212**	0.1792	0.1934	**0.3001**	0.1584	**0.2973**	**0.3123**	**0.3056**	**0.3198**

Table 7 The degree of cause and effect values

Drivers	d	r	$(d+r)$	**Ranking**	$(d-r)$	**Rankings**	**Category (drivers)**	**Rankings**
Cause drivers of PHL in the RCNs								
D_1	1.9465	1.5543	3.5008	12	0.3922	4	Tangible	3
D_2	3.1697	1.8443	5.0140	5	1.3254	1	Tangible	1
D_5	2.4135	1.5429	3.9564	10	0.8706	2	Tangible	2
D_6	2.4957	1.6379	4.1336	9	0.8578	3	Intangible	1
D_9	2.4493	2.4153	4.8646	7	0.034	6	Intangible	3
D_{10}	3.2569	2.873	6.1299	2	0.3839	5	Intangible	2
Effects drivers of PHL in the RCNs								
D_3	1.8806	2.0544	3.9350	11	-0.1738	8	Tangible	1
D_4	1.7942	3.0911	4.8853	6	-1.2969	12	Tangible	2
D_7	1.7937	2.8222	4.6159	8	-1.0285	10	Intangible	4
D_8	2.8035	2.9375	5.7410	4	-0.1340	7	Intangible	1
D_{11}	2.8431	3.0249	5.8680	3	-0.1818	9	Intangible	2
D_{12}	2.9963	4.042	7.0383	1	-1.0457	11	Intangible	3

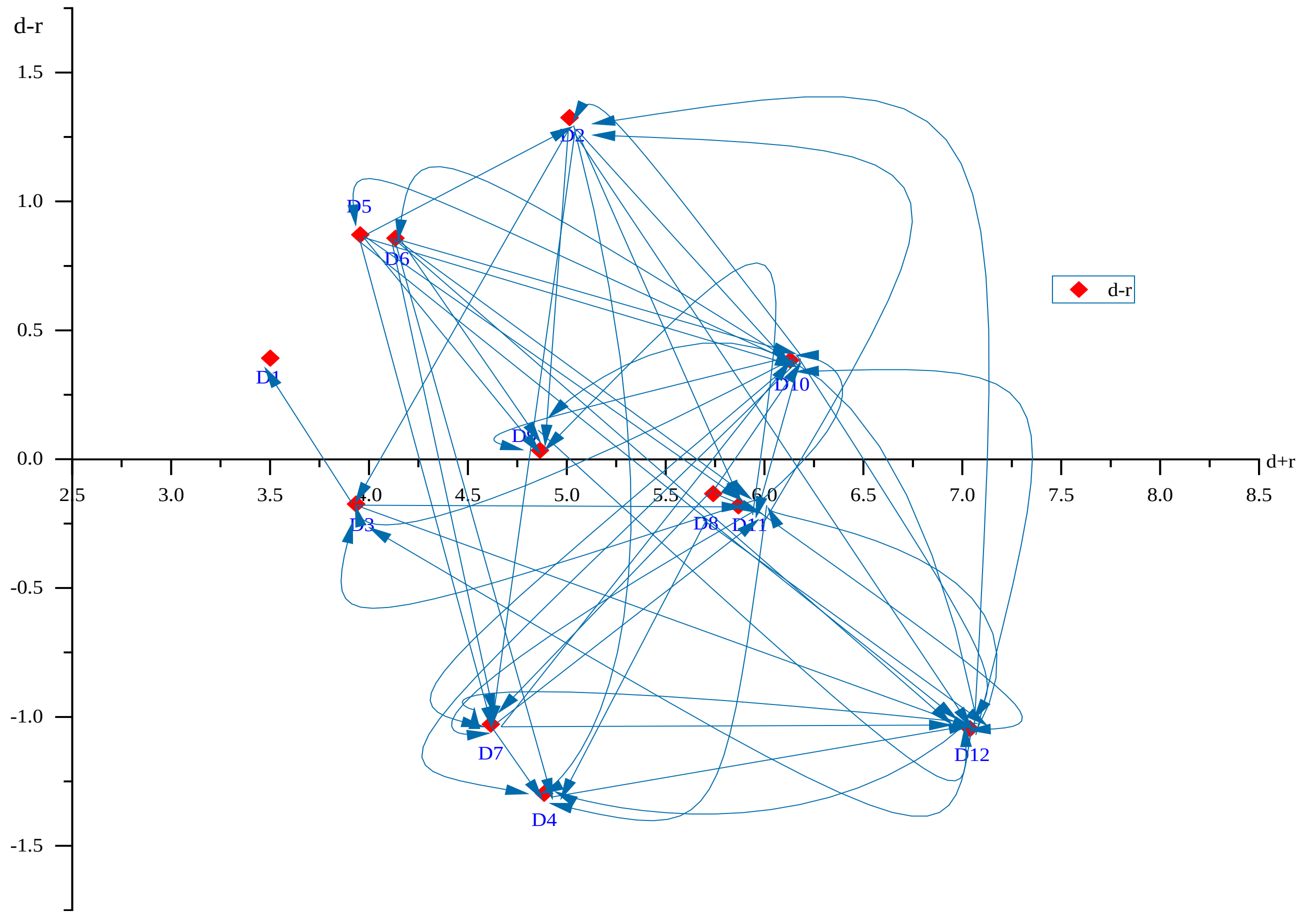

Figure 3 The causal relationship diagram of drivers in the RCNs supply network.

4.2 Sensitivity Analysis

Sensitivity analysis can be conducted in several ways and is aimed at to eliminating any potential biasness and to check the robustness of the results. Hence, we conducted a sensitivity analysis as employed in previous studies (Hwang et al. 2017). In this study, a sensitivity analysis was carried out by altering the first and last weights of the linguistics scale with 0,0.0.0, 0.4, and 0.80,1.0.1.0, with the other weights remaining the same. The weights were sent to the experts for re-pairwise comparison of the drivers considered for the study. The results of the sensitivity analysis are presented in causal diagram network in Fig. 4 and 5. The results shows that there were no deviations in the rankings of drivers, which indicate that our study result is robust and consistent as indicated in Fig. 3.

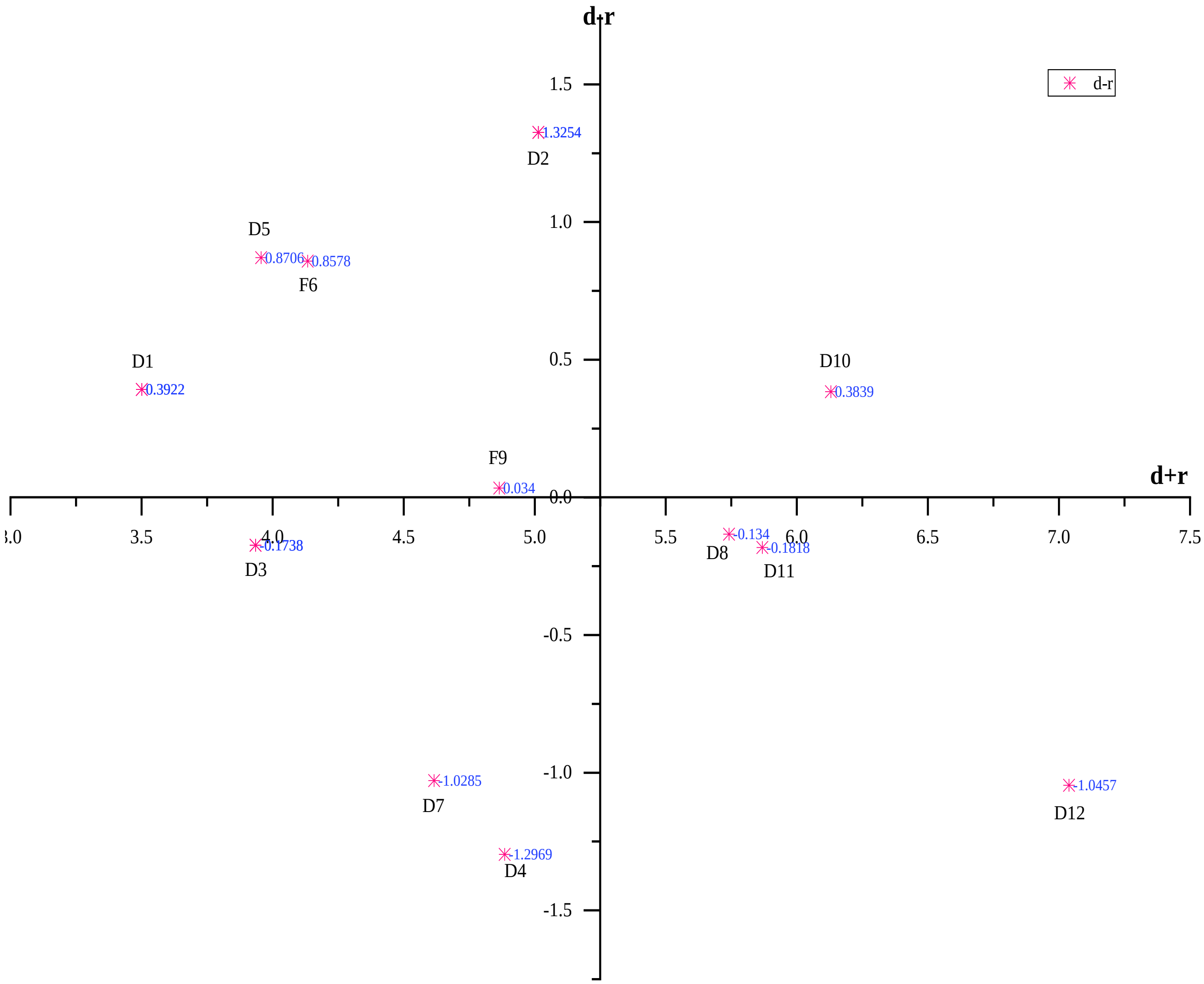

Figure 4 Results of sensitivity analysis of causal relationship diagram ***(0.0,0.0, 0.4)***

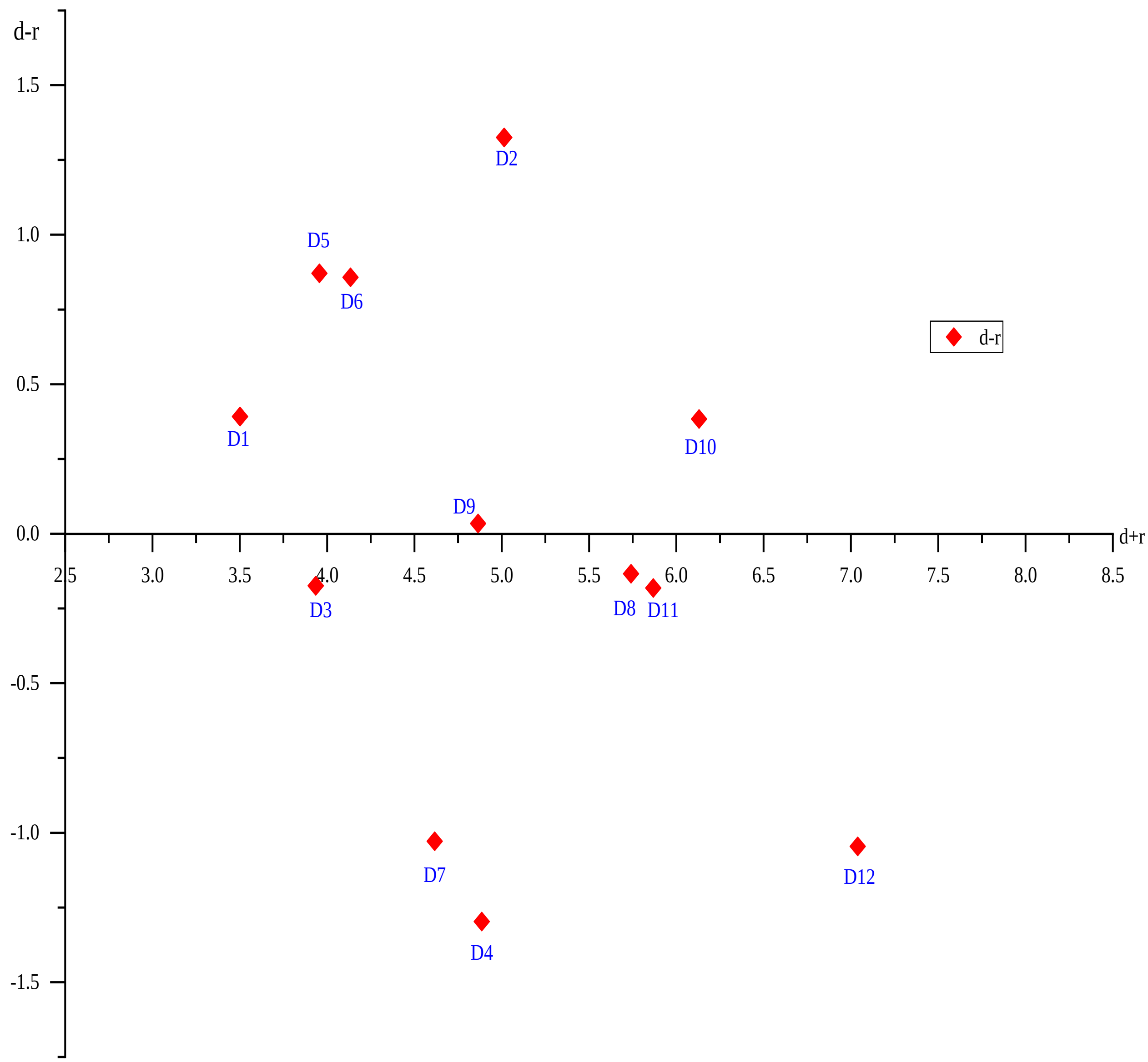

Figure 5 Results of sensitivity analysis of causal relationship diagram ***(0.80,1.0.1.0)***

5.0 Discussion and implications

5.1 Discussion

This section discusses the results and insights on drivers of PHL in the RCNs supply network, obtained based on fuzzy-DEMATEL analysis in section 4. The outcome of the analysis indicates that the tangible and intangible resources drivers of PHL in the RCNs supply network can be categorized into cause and effect groups of drivers. From the results in Table 7 and Fig. 3., after employing a fuzzy-DEMATEL technique for the analysis, the drivers were evenly spread across both the cause and effect datasets groups. The cause drivers of PHL in the RCNs supply network include lack of appropriate storage facility D_1, lack/insufficient of proper packaging materials D_2, driver related to financial and economic constraints D_5, premature/green harvesting of RCNs D_6, lack of information dissemination on PHL within RCNs suppliers D_9 and insufficient/Lack of management support and commitment D_{10}.

The finding shows that three of the drivers of PHL in the cause dataset group are intangible resources and are arranged in descending order based on their weight values as, premature/green harvesting of RCNs D_6, insufficient/lack of management support and commitment D_{10} and lack of information dissemination on PHL within RCNs suppliers D_9. Again, tangible resources drivers in the cause dataset group include lack/insufficient proper packaging materials D_2, financial and economic constraints D_5 and lack of appropriate storage facility D_1. From the study findings, the following drivers of tangible and intangible resources are categorized in the effect dataset group as shown in Fig. 4. The lack/insufficient drying technologies and materials D_3, lack of availability/proximity to selling centers/marketplace D_4, inadequate knowledge about post-harvest technologies D_7, improper handling of RCNs and detaching fruit D_8, lack/inadequate partnership among industry players, agriculture intermediaries, and NGOs D_{11} and lack/insufficient of commitment and trust among cashew suppliers/enterprise and industry actors D_{12}. All the tangible and intangible drivers in the cause dataset group exert significant influence on the drivers of tangible and intangible resources in the effect dataset group, as indicated in Table 7. As a result, much effort and urgent attention from various types of resources need to be channeled to systematically address the relevant PHL drivers in the cause dataset group. The first ranked intangible resource driver, premature/green harvesting of RCNs D_6, have a significant impact on the tangible and intangible resources drivers in the effect dataset including lack of availability/proximity to selling centers/marketplace D_4, improper handling of RCNs and detaching fruit D_8 and lack/inadequate partnership among industry players, agriculture intermediaries, and NGOs D_{11}. RCNs should be allowed to fall to the ground rather than plucking it off from the tree, picked RCNs should be separated from the apples the same day by simply twisting (Plaza et al. 2019) and pulling the apple from the nut (I. Das and Arora 2017).

The second-ranked intangible resources driver in the cause dataset group is insufficient/lack of management support and commitment D_{10}. Without management support and commitment, no regulations, initiatives and directives can be made, implemented and enforced to minimize/eliminate PHL in the RCNs supply network at the downstream and upstream of the cashew supply chain (Dendena and Corsi 2014; hasith Priyashantha et al. 2020; Ponnuswami et al. 2011). Several studies found that management support and commitment is paramount for implementing any strategic initiatives geared towards easing PHL problems since they are the arbiter of rules and regulations (Agyemang et al. 2018; Restrepo et al. 2020). Based on the study findings, the insufficient/lack of management support and commitment D_{10} is an influential driver on lack/insufficient of commitment and trust among cashew suppliers/enterprise and industry actors D_{12}, and inadequate knowledge about post-harvest technologies D_7 are the intangible resource drivers in the effect dataset group. The third most influential and ranked intangible resource driver in the cause dataset group is lack of information dissemination on PHL within RCNs suppliers D_9. The implementation of an efficient and strategic initiatives rests mainly upon the flow of information among and within RCNs producers and supply chain managers (Cardoen et al. 2015). This can aid in the sharing of essential information to help reduce PHL in the RCNs supply network. If information traceability system is robust, it enhances smooth access, dissemination, and free flow of information from various actors in the cashew industry, particularly information to smallholder cashew farmers becomes easy (Gardas et al. 2018; Macheka et al. 2017; Parimalarangan et al. 2011). Agyemang et al. (2018), highlighted that lack of information dissemination within RCNs suppliers can be a barrier for the implementation of measures to minimize/eliminate PHL in the RCNs supply network. Based on the study findings, lack of information dissemination on PHL within RCNs suppliers D_9 has significant impact on tangible resource drivers lack/insufficient drying technologies and materials D_3, lack of availability/proximity to selling centers/marketplace D_4 and intangible lack/inadequate partnership among industry players, agriculture intermediaries, and NGOs D_{11} in the effect dataset drivers of PHL in the RCNs supply network as shown in Table 7.

The first ranked tangible resource driver in the cause dataset group is lack/insufficient of proper packaging materials D_2 as shown in Table 7 and Fig. 3. Proper packaging materials used to store RCNs help marinate cashew kernel quality for a period (Kaminski and Christiaensen 2014), prevent insect infestation and facilitate easy transportation to market places (Raut et al. 2018; Ellis et al. 2020; Ponnuswami et al. 2011). According to de Oliveira Alves Sena et al. (2019), jute bags are best for storing dried cashew, due to its ability to prevent a buildup of moisture to cause fermentation than the use of rice bags. Additionally, filled jute bags packed on wooden pellets or logs, prevent moisture entering the RCNs from the floor. Packed sacks that are well spaced enough to allow ventilation and free movement for regular checking (Masarirambi et al. 2010). Lack/insufficient of proper packaging materials D_2 is a component of tangible resource driver in the cause dataset group which exerts significantly on intangible resource drivers of lack of availability/proximity to selling centers/marketplace D_4 and tangible resource drivers of lack/insufficient of commitment and trust among cashew suppliers/enterprise and industry actors D_{12} and inadequate knowledge about post-harvest technologies D_7 in the effect dataset group as presented in Fig. 4. Again, based on the study findings, the second-ranked tangible resource driver in the cause dataset group is financial and economic constraints D_5. Smallholders cashew farmers/enterprise will be fixated employing appropriate practices to reduce PHL, if only such practices will inure to financial benefits. This is because implementing strategic practices to address PHL concerns in the cashew sector depends greatly on tangible and intangible resources, which are capital intensive to obtain (I. Das and Arora 2017). According to the experts, this makes it more difficult for RCNs enterprise to commit to addressing PHL in the RCNs supply network in Ghana. This driver impacts both tangible and intangible resources drivers in the effect dataset group, as indicated in Table 7 and Fig. 3.

Furthermore, the third ranked tangible resource driver in the cause dataset group is lack of appropriate drying and storage facility D_1. Drying of RCNs on cement floors or sheets such as tarpaulin, mats and bamboo in an evenly and thinly spread, turned at least four times a day is the recommended approach (ACA 2016; Dendena and Corsi 2014; Gyedu-Akoto et al. 2014). From the study findings lack/insufficient of proper packaging materials D_2, in the cause dataset group is the most prominent driver in the RCNs supply network, that requires a short-term attention to overcome by government agencies in-charge of agriculture, industry bodies, non-governmental organization and development agencies. As shown in Table 7 and Fig. 2 above, premature/green harvesting of cashew nuts D_6, financial and economic constraints D_5 and lack of appropriate storage facility D_1, need to be addressed by key stakeholders, RCNs suppliers and policy makers in the short-medium term. Additionally, insufficient/lack of management support and commitment D_{10} and lack of information dissemination on PHL within RCNs suppliers should be addressed in the medium, but effort needs to be continually made to eventually address these barriers in the long-term. As indicated in Table 7 and Fig. 3, the evenly inter-despised pattern of the drivers, shows that industry bodies and key stakeholders in the cashew industry need to continually support RCNs enterprises in implementing appropriate innovative practices to overcome PHL in the RCNs supply network. According to the experts, training, workshops and seminars should be organized should be at the district and regional levels in cashew cultivation areas to equip smallholders' cashew farmers and enterprises to acquire, particularly intangible and sophisticated ideas, about surmounting PHL in the RCNs.

Comparison of study results with existing studies is often strenuous due to differences in areas of study, methods, perspective approach, and policy direction (Mithun Ali et al. 2019; Mangla et al. 2018). Nonetheless, our study findings are in tandem with prior studies (Raut et al. 2018; hasith Priyashantha et al. 2020). For instance, Raut et al. (2018), considering the fruit and vegetable sector in India, revealed that lack of proper packaging facilities is among the critical drivers contributing to PHL in developing countries. The study suggested that, government should provide and subsidize appropriate packaging materials. Furthermore, hasith Priyashantha et al. (2020), highlighted the causes of PHL in the RCNs supply network in Sri Lanka. The study underscored that industry actors should organize training programs and workshop to enlighten and broaden cashew suppliers' understanding and knowledge on the implementation of innovative approaches and also creates awareness on management of cashew plantations and proper pre and post-harvesting practices are some of the vital aspects to address PHL in RCNs supply network. The present study provides decision support to managers and policymakers to develop an appropriate and systematic strategy to address PHL in the RCNs supply network. It shows groups most prominent resources and for which appropriate strategies can be taken to implement innovative measures and address PHL in the RCNs supply network. Thus, the study contributes to strategies to eradicate extreme poverty and hunger in a broad sense, as stipulated in the SDGs 1 (no poverty).

5.2 Practical and theoretical implications of the study

The study presents a significant and general impact of PHL drivers in RCNs supply network. Therefore, the key theoretical contribution of this research is the identification of PHL drivers from the tangible and intangible resources perspective as well as the implications for addressing PHL drivers in the RCNs supply network. The study findings show that the framework of PHL drivers can be evaluated to establish the relationships among the drivers of tangible and intangible resources. The study categorized the drivers into cause and effect dataset groups, where the drivers in the cause dataset groups were identified to be influential on the drivers in the effect dataset as shown in Fig. 3. The drivers in both data sets were prioritized to enable supply managers, policy makers, government, and industry actors to implement strategic initiatives appropriate to address drivers that contribute to PHL in the RCNs supply network. Thus, the study highlights tangible and intangible resources drivers that require short term, medium and long attention from policy makers to surmount the drivers of PHL in the RCNs supply network.

In addition, the study proposed fuzzy set theory and Decision-Making Trial and Evaluation Laboratory (DEMATEL) methodology for ratings, prioritization, and construction of relationship diagram to distinguish between drivers of tangible and intangible resources of PHL in the RCNs supply network. The technique performs better to provide more accurate and unbiased results, by addressing uncertainties, subjectivity, and incomplete information under fuzzy environment. Thus, fuzzy-DEMATEL can provide more accurate and realistic results to address PHL in the RCNs supply network in the cashew industry.

Based on the findings, the tangible and intangible PHL drivers in the RCNs supply network are significantly intermixed across the cause and effect groups. Therefore, to eliminate/minimize PHL drivers in the RCNs supply network, especially those identified in the cause group, actors need to ensure tangible and intangible resources, strategically complement each other (Fabbri et al., 2018; Hodges et al., 2011). This has important implications. First, among the various industry actors, collaboration need to be enhanced to address PHL. Agyemang et al. (2018), established that strengthening collaboration among stakeholders in the RCN supply network is essential to address sustainability issues in the sector. The result suggests that tangible resource accessibility to address PHL is capital intensive, which requires government and development agencies to support cashew enterprises obtain such resource. Also, enterprises develop intangible resource through complex social and organizational processes which are idiosyncratic and path dependent (Barney, 1991; Winter, 2003). As such, the actors in the RCN supply networks need to be committed in developing such unique intangible resource to address PHL. Secondly, despite the fact that tangible and intangible PHL drivers in the RCNs supply network are intermixed, it is noteworthy that the outcome of tangible driver, lack/insufficient of proper packaging materials D_2, remains the most urgent driver which needs attention. Many studies suggest that, increasingly intangible resources are forming the basis of competitive advantage for many enterprises (Bianchi 2017), especially in large enterprises in developed countries (Manikas et al. 2019; Shin et al. 2017). However, in the context of small and medium-scale agro-food enterprises in developing countries, tangible resources remain key for competitive advantage (Hodges et al. 2011).

6. Conclusion, limitation and future research scope

Over the past decades, PHL challenges have gained substantial attention from practitioners, scholars, government, and stakeholders. PHL have become central to the discussion in food security, livelihood, and sustainable development. Addressing PHL requires a holistic and integrated approach, since, contributing factors in the supply chain is not a single cause but a combination of interdependent factors. Existing studies posit that economic, technical, and resources related factors are the significant factors of PHL in the agro-food industry. Therefore, to eliminate/minimize losses in the supply network, an in-depth case-by-case analysis is required, to facilitate tailored solutions by managers and policymakers.

In the cashew industry, global consumption is surging. This pattern is estimated to continue with the growing demand for RCNs from emerging global markets such as China and India. However, the PHL concern in the cashew industry continues to be a critical challenge. This study is premised on evaluating PHL drivers in the RCNs supply network grounded on tangible and intangible resources perspective. Two main objectives underscored the study. We systematically identified and categorized twelve PHL drivers in the RCNs supply network under tangible and intangible resources perspective through extensive literature review and nine experts' opinions. Subsequently, data were generated from the nine experts assembled from the cashew industry. The experts were purposively selected based on their experience in the cashew industry and understanding of the method employed. The data obtained were analyzed with the aid of the fuzzy-DEMATEL technique to establish the relationship between the identified PHL drivers. The study results provide decision support to industry actors, including RCNs suppliers, managers, and policymakers to draw effective strategic approaches for implementing appropriate and innovative actions to minimize/eliminate PHL drivers in Ghana's cashew sector. The findings show that PHL drivers in the RCNs supply network were evenly interspersed across both cause and effect dataset group. Hence, addressing PHL in the RCNs supply network relies immensely on both tangible and intangible resources in the cashew sector.

The study findings reveal that urgent and short-term attention to address PHL in the RCNs supply network should be given to the primary tangible driver of lack/insufficient proper packaging materials. In addition, in medium-term strategies, RCNs suppliers and government agencies in charge of agriculture and industry bodies need to overcome three key cause drivers: premature/green harvesting of cashew nuts, financial and economic constraints, and lack of appropriate storage facility. Furthermore, drivers such as insufficient/lack of management support and commitment and lack of information dissemination on PHL within RCNs suppliers should be addressed in the long term. The results suggest that, support from agriculture intermediaries, non-governmental organizations and international development agencies are essential for effective implementation of innovative related practices to address PHL problems in the RCNs supply network. Also, there may be potential in a decision makers' effort to set up intermediary associations that can serve as liaise between smallholder's cashew farmers, enterprises and governments to deliberate and develop policies to extensively address PHL in RCNs supply network. In this present study, a sensitivity analysis was carried out to check the robustness of the methodology and to address any level of bias during the data collection.

There are limitations associated with this study, which are provided with the drive to discuss opportunities for further research. The first limitation is the input of experts from one country, which may not reflect what pertains in other cashew growing regions. Further studies can be conducted in other countries or geographical regions and compared. The study primarily focuses on tangible and intangible resources drivers contributing to PHL in RCNs supply network. Future study can focus on investigating PHL drivers in other agriculture sector and compare the results. Similarly, this study can be extended by including other significant drivers contributing to PHL in the RCNs supply network from different perspectives such as dynamic capabilities and stakeholder perspectives. Again, although the sample of respondents employed in the study is sufficient compared to previous studies, more experts can be considered for future study. The present study employed fuzzy-DEMATEL technique for the analysis; future studies can use other MCDM techniques such as fuzzy TOPSIS and BWM. It is envisaged that this study will act as an impetus for policymakers to formulate and implement appropriate systems to surmount PHL in the cashew sector.

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Appendices

Appendix A

Table A1 The pairwise comparison of the drivers by **expert 1**

Drivers	$\mathbf{D_1}$	$\mathbf{D_2}$	$\mathbf{D_3}$	$\mathbf{D_4}$	$\mathbf{D_5}$	$\mathbf{D_6}$	$\mathbf{D_7}$	$\mathbf{D_8}$	$\mathbf{D_9}$	$\mathbf{D_{10}}$	$\mathbf{D_{11}}$	$\mathbf{D_{12}}$
$\mathbf{D_1}$	0	0.75,1.00,1.00	0.25,0.5,0.75	0.75,1.00,1.00	0.25,0.5,0.75	0.75,1.00,1.00	0.25,0.5,0.75	0.25,0.5,0.75	0.25,0.5,0.75	0.75,1.00,1.00	0.25,0.5,0.75	0.75,1.00,1.00
$\mathbf{D_2}$	0.25,0.5,0.75	0	0.25,0.5,0.75	0.25,0.5,0.75	0.5,0.75, 1.00	0.25,0.5,0.75	0.75,1.00,1.00	0.5,0.75, 1.00	0.5,0.75, 1.00	0.25,0.5,0.75	0.5,0.75, 1.00	0.75,1.00,1.00
$\mathbf{D_3}$	0.75,1.00,1.00	0.25,0.5,0.75	0	0.25,0.5,0.75	0.25,0.5,0.75	0.5,0.75, 1.00	0.25,0.5,0.75	0,0.25,0.5	0.25,0.5,0.75	0.5,0.75, 1.00	0.25,0.5,0.75	0.25,0.5,0.75
$\mathbf{D_4}$	0.25,0.5,0.75	0.25,0.5,0.75	0.5,0.75, 1.00	0	0,0.25,0.5	0.25,0.5,0.75	0.5,0.75, 1.00	0.5,0.75, 1.00	0,0.25,0.5	0.75,1.00,1.00	0.25,0.5,0.75	0.75,1.00,1.00
$\mathbf{D_5}$	0.5,0.75, 1.00	0.5,0.75, 1.00	0.25,0.5,0.75	0.75,1.00,1.00	0	0.25,0.5,0.75	0.25,0.5,0.75	0.25,0.5,0.75	0.5,0.75, 1.00	0.25,0.5,0.75	0.5,0.75, 1.00	0.25,0.5,0.75
$\mathbf{D_6}$	0.25,0.5,0.75	0,0.25,0.5	0.25,0.5,0.75	0,0.25,0.5	0.75,1.00,1.00	0	0.75,1.00,1.00	0.5,0.75, 1.00	0,0.25,0.5	0.5,0.75, 1.00	0,0.25,0.5	0.5,0.75, 1.00
$\mathbf{D_7}$	0.25,0.5,0.75	0.5,0.75, 1.00	0.5,0.75, 1.00	0.5,0.75, 1.00	0.25,0.5,0.75	0.75,1.00,1.00	0	0.25,0.5,0.75	0.5,0.75, 1.00	0.25,0.5,0.75	0.5,0.75, 1.00	0.25,0.5,0.75
$\mathbf{D_8}$	0.5,0.75, 1.00	0.25,0.5,0.75	0.25,0.5,0.75	0,0.25,0.5	0.5,0.75, 1.00	0.75,1.00,1.00	0.75,1.00,1.00	0	0.25,0.5,0.75	0.5,0.75, 1.00	0.25,0.5,0.75	0,0.25,0.5
$\mathbf{D_9}$	0,0.25,0.5	0.75,1.00,1.00	0,0.25,0.5	0.75,1.00,1.00	0.25,0.5,0.75	0.75,1.00,1.00	0.25,0.5,0.75	0,0.25,0.5	0	0.25,0.5,0.75		0.75,1.00,1.00
$\mathbf{D_{10}}$	0.5,0.75, 1.00	0.25,0.5,0.75	0.75,1.00,1.00	0.25,0.5,0.75	0.25,0.5,0.75	0,0.25,0.5	0.5,0.75, 1.00	0.5,0.75, 1.00	0.25,0.5,0.75	0	0.75,1.00,1.00	0.25,0.5,0.75
$\mathbf{D_{11}}$	0.25,0.5,0.75	0.25,0.5,0.75	0.25,0.5,0.75	0.5,0.75, 1.00	0.25,0.5,0.75	0.5,0.75, 1.00	0.25,0.5,0.75	0,0.25,0.5	0.5,0.75, 1.00	0.25,0.5,0.75	0	0.25,0.5,0.75
$\mathbf{D_{12}}$	0,0.25,0.5	0.75,1.00,1.00	0.5,0.75, 1.00	0.25,0.5,0.75	0.75,1.00,1.00	0.25,0.5,0.75	0,0.25,0.5	0.25,0.5,0.75	0.25,0.5,0.75	0.75,1.00,1.00	0.75,1.00,1.00	0

Note: No influence (NO) = (0,0,0.25), Very low influence (VL) = (0,0.25,0.5), Low influence (L) = (0.25,0.5,0.75), High influence (H) = (0.5,0.75, 1.00) and Very high influence (VH) = (0.75,1.00,1.00)

Table A2 The pairwise comparison of drivers by **expert 2**

Drivers	D_1	D_2	D_3	D_4	D_5	D_6	D_7	D_8	D_9	D_{10}	D_{11}	D_{12}
D_1	0	0.25,0.5,0.75	0,0,0.25	0.25,0.5,0.75	0.25,0.5,0.75	0.5,0.75, 1.00	0.25,0.5,0.75	0,0,0.25	0.5,0.75, 1.00	0.25,0.5,0.75	0,0,0.25	0,0,0.25
D_2	0.75,1.00,1.00	0	0.25,0.5,0.75	0,0.25,0.5	0.75,1.00,1.00	0,0,0.25	0.5,0.75, 1.00	0.25,0.5,0.75	0,0,0.25	0,0,0.25	0.25,0.5,0.75	0.75,1.00,1.00
D_3	0,0,0.25	0.5,0.75, 1.00	0	0,0,0.25	0,0,0.25	0.25,0.5,0.75	0,0.25,0.5	0,0.25,0.5	0.5,0.75, 1.00	0.75,1.00,1.00	0.5,0.75, 1.00	0.5,0.75, 1.00
D_4	0.5,0.75, 1.00	0,0.25,0.5	0.25,0.5,0.75	0	0.5,0.75, 1.00	0,0,0.25	0.25,0.5,0.75	0.75,1.00,1.00	0.25,0.5,0.75	0,0.25,0.5	0.25,0.5,0.75	0.25,0.5,0.75
D_5	0.25,0.5,0.75	0.75,1.00,1.00	0.5,0.75, 1.00	0.25,0.5,0.75	0	0,0.25,0.5	0.25,0.5,0.75	0.25,0.5,0.75	0,0.25,0.5	0,0,0.25	0,0,0.25	0,0,0.25
D_6	0,0.25,0.5	0,0,0.25	0,0.25,0.5	0.5,0.75, 1.00	0.5,0.75, 1.00	0	0.5,0.75, 1.00	0.5,0.75, 1.00	0,0.25,0.5	0,0.25,0.5	0.5,0.75, 1.00	0,0.25,0.5
D_7	0,0,0.25	0.25,0.5,0.75	0.5,0.75, 1.00	0.25,0.5,0.75	0,0.25,0.5	0,0.25,0.5	0	0.25,0.5,0.75	0.75,1.00,1.00	0,0.25,0.5	0,0.25,0.5	0.25,0.5,0.75
D_8	0,0.25,0.5	0,0,0.25	0.25,0.5,0.75	0.75,1.00,1.00	0,0,0.25	0.75,1.00,1.00	0.25,0.5,0.75	0	0.25,0.5,0.75	0.25,0.5,0.75	0,0,0.25	0,0.25,0.5
D_9	0.5,0.75, 1.00	0,0.25,0.5	0.25,0.5,0.75	0,0,0.25	0.5,0.75, 1.00	0.25,0.5,0.75	0,0.25,0.5	0.5,0.75, 1.00	0	0.5,0.75, 1.00	0,0.25,0.5	0,0,0.25
D_{10}	0,0,0.25	0.5,0.75, 1.00	0,0.25,0.5	0,0,0.25	0,0,0.25	0.5,0.75, 1.00	0.75,1.00,1.00	0,0.25,0.5	0.25,0.5,0.75	0	0,0.25,0.5	0.5,0.75, 1.00
D_{11}	0.75,1.00,1.00	0,0.25,0.5	0.5,0.75, 1.00	0.5,0.75, 1.00	0.25,0.5,0.75	0,0.25,0.5	0.25,0.5,0.75	0.25,0.5,0.75	0.5,0.75, 1.00	0,0,0.25	0	0.25,0.5,0.75
D_{12}	0.25,0.5,0.75	0.5,0.75, 1.00	0,0,0.25	0,0,0.25	0.25,0.5,0.75	0,0,0.25	0.5,0.75, 1.00	0.5,0.75, 1.00	0,0,0.25	0.25,0.5,0.75	0.75,1.00,1.00	0

Note: No influence (NO) = (0,0,0.25), Very low influence (VL) = (0,0.25,0.5), Low influence (L) = (0.25,0.5,0.75), High influence (H) = (0.5,0.75, 1.00) and Very high influence (VH) = (0.75,1.00,1.00)

Table A3 The pairwise comparison of drivers by **expert 3**

Drivers	**D_1**	**D_2**	**D_3**	**D_4**	**D_5**
D_1	0	0,0,0.25	0.5,0.75, 1.00	0.25,0.5,0.75	0.5,0.75, 1.00
D_2	0.5,0.75, 1.00	0	0,0,0.25	0.5,0.75, 1.00	0,0.25,0.5
D_3	0,0.25,0.5	0,0,0.25	0	0,0,0.25	0,0,0.25
D_4	0,0,0.25	0.25,0.5,0.75	0.25,0.5,0.75	0	0.5,0.75, 1.00
D_5	0.5,0.75, 1.00	0.5,0.75, 1.00	0.5,0.75, 1.00	0.25,0.5,0.75	0
D_6	0,0,0.25	0.25,0.5,0.75	0.5,0.75, 1.00	0.5,0.75, 1.00	0.25,0.5,0.75
D_7	0.25,0.5,0.75	0,0,0.25	0,0.25,0.5	0,0.25,0.5	0.5,0.75, 1.00
D_8	0.25,0.5,0.75	0.5,0.75, 1.00	0,0,0.25	0.5,0.75, 1.00	0,0.25,0.5
D_9	0.5,0.75, 1.00	0,0.25,0.5	0.5,0.75, 1.00	0.25,0.5,0.75	0.5,0.75, 1.00
D_{10}	0,0.25,0.5	0,0,0.25	0.5,0.75, 1.00	0.25,0.5,0.75	0.25,0.5,0.75
D_{11}	0,0,0.25	0,0.25,0.5	0,0.25,0.5	0,0.25,0.5	0.25,0.5,0.75
D_{12}	0.5,0.75, 1.00	0,0.25,0.5	0.5,0.75, 1.00	0.5,0.75, 1.00	0,0.25,0.5

D_6	**D_7**	**D_8**	**D_9**	**D_{10}**	**D_{11}**	**D_{12}**
0.5,0.75, 1.00	0,0,0.25	0.25,0.5,0.75	0.25,0.5,0.75	0,0,0.25	0.75,1.00,1.00	0,0,0.25
0,0.25,0.5	0.5,0.75, 1.00	0,0.25,0.5	0.5,0.75, 1.00	0.5,0.75, 1.00	0,0,0.25	0.5,0.75, 1.00
0.5,0.75, 1.00	0,0.25,0.5	0.75,1.00,1.00	0,0.25,0.5	0.25,0.5,0.75	0.5,0.75, 1.00	0.75,1.00,1.00
0.75,1.00,1.00	0,0,0.25	0,0,0.25	0.5,0.75, 1.00	0.5,0.75, 1.00	0.25,0.5,0.75	0.25,0.5,0.75
0.25,0.5,0.75	0,0.25,0.5	0.5,0.75, 1.00	0.25,0.5,0.75	0.75,1.00,1.00	0,0.25,0.5	0,0,0.25
0	0,0.25,0.5	0.25,0.5,0.75	0.25,0.5,0.75	0.25,0.5,0.75	0.25,0.5,0.75	0.5,0.75, 1.00
0.25,0.5,0.75	0	0,0.25,0.5	0,0.25,0.5	0.5,0.75, 1.00	0,0,0.25	0,0,0.25
0,0,0.25	0.25,0.5,0.75	0	0.5,0.75, 1.00	0.25,0.5,0.75	0.5,0.75, 1.00	0.25,0.5,0.75
0.25,0.5,0.75	0.25,0.5,0.75	0,0,0.25	0		0.25,0.5,0.75	0.25,0.5,0.75
0.5,0.75, 1.00	0,0,0.25	0.25,0.5,0.75	0,0.25,0.5	0	0.25,0.5,0.75	0,0.25,0.5
0.25,0.5,0.75	0.5,0.75, 1.00	0.5,0.75, 1.00	0.25,0.5,0.75	0.5,0.75, 1.00	0	0.25,0.5,0.75
0,0.25,0.5	0.25,0.5,0.75	0.25,0.5,0.75	0.25,0.5,0.75	0,0,0.25	0.25,0.5,0.75	0

Note: No influence (NO) = (0,0,0.25), Very low influence (VL) = (0,0.25,0.5), Low influence (L) = (0.25,0.5,0.75), High influence (H) = (0.5,0.75, 1.00) and Very high influence (VH) = (0.75,1.00,1.00).

Table A4 The pairwise comparison of drivers by **expert 4**

Drivers	**D**$_1$	**D**$_2$	**D**$_3$	**D**$_4$	**D**$_5$
D$_1$	0	0,0,0.25	0.25,0.5,0.75	0.25,0.5,0.75	0.5,0.75, 1.00
D$_2$	0,0,0.25	0	0.5,0.75, 1.00	0.5,0.75, 1.00	0,0.25,0.5
D$_3$	0.5,0.75, 1.00	0,0,0.25	0	0,0,0.25	0,0,0.25
D$_4$	0.25,0.5,0.75	0.25,0.5,0.75	0.5,0.75, 1.00	0	0.5,0.75, 1.00
D$_5$	0.25,0.5,0.75	0.5,0.75, 1.00	0.25,0.5,0.75	0.25,0.5,0.75	0
D$_6$	0.25,0.5,0.75	0.25,0.5,0.75	0.25,0.5,0.75	0.5,0.75, 1.00	0.25,0.5,0.75
D$_7$	0.25,0.5,0.75	0,0,0.25	0,0.25,0.5	0,0.25,0.5	0.5,0.75, 1.00
D$_8$	0.25,0.5,0.75	0.5,0.75, 1.00	0.5,0.75, 1.00	0.5,0.75, 1.00	0,0.25,0.5
D$_9$	0.5,0.75, 1.00	0,0.25,0.5	0,0.25,0.5	0.25,0.5,0.75	0.5,0.75, 1.00
D$_{10}$	0.5,0.75, 1.00	0,0,0.25	0,0.25,0.5	0.25,0.5,0.75	0.25,0.5,0.75
D$_{11}$	0,0.25,0.5	0,0.25,0.5	0.25,0.5,0.75	0,0.25,0.5	0.25,0.5,0.75
D$_{12}$	0,0,0.25	0,0.25,0.5	0.25,0.5,0.75	0.5,0.75, 1.00	0,0.25,0.5

D$_6$	**D**$_7$	**D**$_8$	**D**$_9$	**D**$_{10}$	**D**$_{11}$	**D**$_{12}$
0.5,0.75, 1.00	0,0,0.25	0.25,0.5,0.75	0.5,0.75, 1.00	0,0,0.25	0.75,1.00,1.00	0,0.25,0.5
0,0.25,0.5	0.5,0.75, 1.00	0,0.25,0.5	0,0,0.25	0.5,0.75, 1.00	0,0,0.25	0,0,0.25
0.5,0.75, 1.00	0,0.25,0.5	0.75,1.00,1.00	0.5,0.75, 1.00	0.25,0.5,0.75	0.5,0.75, 1.00	0.5,0.75, 1.00
0.75,1.00,1.00	0,0,0.25	0,0,0.25	0.25,0.5,0.75	0.5,0.75, 1.00	0.25,0.5,0.75	0,0,0.25
0.25,0.5,0.75	0,0.25,0.5	0.5,0.75, 1.00	0.5,0.75, 1.00	0.75,1.00,1.00	0,0.25,0.5	0,0,0.25
0	0,0.25,0.5	0.25,0.5,0.75	0.5,0.75, 1.00	0.25,0.5,0.75	0.25,0.5,0.75	0.5,0.75, 1.00
0.25,0.5,0.75	0	0,0.25,0.5	0,0.25,0.5	0.5,0.75, 1.00	0,0,0.25	0.5,0.75, 1.00
0,0,0.25	0.25,0.5,0.75	0	0,0,0.25	0.25,0.5,0.75	0.5,0.75, 1.00	0,0.25,0.5
0.25,0.5,0.75	0.25,0.5,0.75	0,0,0.25	0		0.25,0.5,0.75	0.25,0.5,0.75
0.5,0.75, 1.00	0,0,0.25	0.25,0.5,0.75	0.5,0.75, 1.00	0	0.25,0.5,0.75	0,0.25,0.5
0.25,0.5,0.75	0.5,0.75, 1.00	0.5,0.75, 1.00	0,0.25,0.5	0.5,0.75, 1.00	0	0.25,0.5,0.75
0,0.25,0.5	0.25,0.5,0.75	0.25,0.5,0.75	0.5,0.75, 1.00	0,0,0.25	0.25,0.5,0.75	0

Note: No influence (NO) = (0,0,0.25), Very low influence (VL) = (0,0.25,0.5), Low influence (L) = (0.25,0.5,0.75), High influence (H) = (0.5,0.75, 1.00) and Very high influence (VH) = (0.75,1.00,1.00).

Table A5 The pairwise comparison of drivers by **expert 5**

Drivers	D_1	D_2	D_3	D_4	D_5
D_1	0	0,0,0.25	0.25,0.5,0.75	0.5,0.75, 1.00	0,0,0.25
D_2	0,0.25,0.5	0	0,0.25,0.5	0,0,0.25	0.5,0.75, 1.00
D_3	0.5,0.75, 1.00	0,0.25,0.5	0	0.5,0.75, 1.00	0,0,0.25
D_4	0.75,1.00,1.00	0,0,0.25	0,0,0.25	0	0.25,0.5,0.75
D_5	0.25,0.5,0.75	0,0.25,0.5	0.5,0.75, 1.00	0.5,0.75, 1.00	0
D_6	0.5,0.75, 1.00	0,0.25,0.5	0.25,0.5,0.75	0.5,0.75, 1.00	0.25,0.5,0.75
D_7	0.25,0.5,0.75	0.5,0.75, 1.00	0,0.25,0.5	0,0.25,0.5	0,0,0.25
D_8	0,0,0.25	0.25,0.5,0.75	0.75,1.00,1.00	0,0,0.25	0.5,0.75, 1.00
D_9	0.25,0.5,0.75	0.25,0.5,0.75	0,0,0.25	0.25,0.5,0.75	0,0.25,0.5
D_{10}	0.5,0.75, 1.00	0,0,0.25	0.25,0.5,0.75	0.5,0.75, 1.00	0,0,0.25
D_{11}	0.25,0.5,0.75	0.5,0.75, 1.00	0.5,0.75, 1.00	0,0.25,0.5	0,0.25,0.5
D_{12}	0,0.25,0.5	0.25,0.5,0.75	0.25,0.5,0.75	0.5,0.75, 1.00	0,0.25,0.5

D_6	D_7	D_8	D_9	D_{10}	D_{11}	D_{12}
0.25,0.5,0.75	0.25,0.5,0.75	0.5,0.75, 1.00	0.5,0.75, 1.00	0.75,1.00,1.00	0,0.25,0.5	0,0.25,0.5
0.5,0.75, 1.00	0.5,0.75, 1.00	0,0.25,0.5	0,0,0.25	0,0,0.25	0,0,0.25	0.75,1.00,1.00
0.25,0.5,0.75	0,0,0.25	0,0,0.25	0.5,0.75, 1.00	0.5,0.75, 1.00	0.5,0.75, 1.00	0,0,0.25
0.5,0.75, 1.00	0,0.25,0.5	0.5,0.75, 1.00	0.25,0.5,0.75	0.25,0.5,0.75	0,0,0.25	0.5,0.75, 1.00
0.25,0.5,0.75	0.25,0.5,0.75	0.5,0.75, 1.00	0.25,0.5,0.75	0,0.25,0.5	0,0,0.25	0.25,0.5,0.75
0	0.5,0.75, 1.00	0.25,0.5,0.75	0.25,0.5,0.75	0.25,0.5,0.75	0.5,0.75, 1.00	0.25,0.5,0.75
0,0.25,0.5	0	0,0.25,0.5	0.25,0.5,0.75	0,0,0.25	0.5,0.75, 1.00	0.5,0.75, 1.00
0.5,0.75, 1.00	0.5,0.75, 1.00	0	0.25,0.5,0.75	0.5,0.75, 1.00	0,0.25,0.5	0,0.25,0.5
0,0.25,0.5	0.25,0.5,0.75	0.5,0.75, 1.00	0	0.25,0.5,0.75	0.25,0.5,0.75	0.5,0.75, 1.00
0,0.25,0.5	0.25,0.5,0.75	0.25,0.5,0.75	0.5,0.75, 1.00	0	0,0.25,0.5	0.25,0.5,0.75
0.25,0.5,0.75	0,0.25,0.5	0.25,0.5,0.75	0,0.25,0.5	0.25,0.5,0.75	0	0.25,0.5,0.75
0.25,0.5,0.75	0.5,0.75, 1.00	0,0.25,0.5	0,0,0.25	0.25,0.5,0.75	0.25,0.5,0.75	0

Note: No influence (NO) = (0,0,0.25), Very low influence (VL) = (0,0.25,0.5), Low influence (L) = (0.25,0.5,0.75), High influence (H) = (0.5,0.75, 1.00) and Very high influence (VH) = (0.75,1.00,1.00)

Table A6 The pairwise comparison of drivers by **expert 6**

Drivers	**D1**	**D2**	**D3**	**D4**	**D5**
D1	0	0,0,0.25	0.25,0.5,0.75	0.5,0.75, 1.00	0.25,0.5,0.75
D2	0,0.25,0.5	0	0,0.25,0.5	0,0,0.25	0.25,0.5,0.75
D3	0.5,0.75, 1.00	0,0.25,0.5	0	0.5,0.75, 1.00	0,0.25,0.5
D4	0.75,1.00,1.00	0,0,0.25	0,0,0.25	0	0.5,0.75, 1.00
D5	0.25,0.5,0.75	0,0.25,0.5	0.5,0.75, 1.00	0.5,0.75, 1.00	0
D6	0,0,0.25	0,0.25,0.5	0.25,0.5,0.75	0.5,0.75, 1.00	0,0.25,0.5
D7	0.25,0.5,0.75	0.5,0.75, 1.00	0,0.25,0.5	0,0.25,0.5	0.25,0.5,0.75
D8	0,0,0.25	0.25,0.5,0.75	0.5,0.75, 1.00	0,0,0.25	0.25,0.5,0.75
D9	0.25,0.5,0.75	0.25,0.5,0.75	0,0,0.25	0.5,0.75, 1.00	0.25,0.5,0.75
D10	0.5,0.75, 1.00	0,0,0.25	0.25,0.5,0.75	0.5,0.75, 1.00	0.25,0.5,0.75
D11	0.25,0.5,0.75	0.5,0.75, 1.00	0.5,0.75, 1.00	0,0.25,0.5	0,0.25,0.5
D12	0,0.25,0.5	0.25,0.5,0.75	0.25,0.5,0.75	0.5,0.75, 1.00	0.5,0.75, 1.00

D6	**D7**	**D8**	**D9**	**D10**	**D11**	**D12**
0,0.25,0.5	0.25,0.5,0.75	0.25,0.5,0.75	0.5,0.75, 1.00	0.25,0.5,0.75	0.25,0.5,0.75	0.5,0.75, 1.00
0.5,0.75, 1.00	0.25,0.5,0.75	0,0.25,0.5	0,0,0.25	0.5,0.75, 1.00	0.5,0.75, 1.00	0,0.25,0.5
0,0.25,0.5	0.5,0.75, 1.00	0.75,1.00,1.00	0.5,0.75, 1.00	0,0,0.25	0,0,0.25	0,0,0.25
0.5,0.75, 1.00	0,0.25,0.5	0,0,0.25	0.25,0.5,0.75	0.5,0.75, 1.00	0,0,0.25	0.5,0.75, 1.00
0.25,0.5,0.75	0.5,0.75, 1.00	0.5,0.75, 1.00	0.5,0.75, 1.00	0.25,0.5,0.75	0.25,0.5,0.75	0,0,0.25
0	0.25,0.5,0.75	0.25,0.5,0.75	0.5,0.75, 1.00	0.25,0.5,0.75	0.5,0.75, 1.00	0.25,0.5,0.75
0,0.25,0.5	0	0,0.25,0.5	0,0.25,0.5	0,0.25,0.5	0,0.25,0.5	0.5,0.75, 1.00
0.5,0.75, 1.00	0,0.25,0.5	0	0,0,0.25	0.5,0.75, 1.00	0.5,0.75, 1.00	0,0.25,0.5
0.5,0.75, 1.00	0.25,0.5,0.75	0.5,0.75, 1.00	0	0,0.25,0.5	0.25,0.5,0.75	0.5,0.75, 1.00
0.25,0.5,0.75	0.5,0.75, 1.00	0,0.25,0.5	0.5,0.75, 1.00	0	0.25,0.5,0.75	0.25,0.5,0.75
0.25,0.5,0.75	0.25,0.5,0.75	0.5,0.75, 1.00	0,0.25,0.5	0.25,0.5,0.75	0	0.25,0.5,0.75
0,0.25,0.5	0.5,0.75, 1.00	0.75,1.00,1.00	0,0,0.25	0.25,0.5,0.75	0.5,0.75, 1.00	0

Note: No influence (NO) = (0,0,0.25), Very low influence (VL) = (0,0.25,0.5), Low influence (L) = (0.25,0.5,0.75), High influence (H) = (0.5,0.75, 1.00) and Very high influence (VH) = (0.75,1.00,1.00).

Table A7 The pairwise comparison of drivers by **expert 7**

Drivers	D_1	D_2	D_3	D_4	D_5
D_1	0	0.25,0.5,0.75	0.5,0.75, 1.00	0.5,0.75, 1.00	0,0,0.25
D_2	0.5,0.75, 1.00	0	0,0.25,0.5	0,0.25,0.5	0.5,0.75, 1.00
D_3	0.25,0.5,0.75	0,0,0.25	0	0.5,0.75, 1.00	0,0.25,0.5
D_4	0.5,0.75, 1.00	0.25,0.5,0.75	0.5,0.75, 1.00	0	0,0,0.25
D_5	0.25,0.5,0.75	0.25,0.5,0.75	0,0,0.25	0.25,0.5,0.75	0
D_6	0.25,0.5,0.75	0.5,0.75, 1.00	0.25,0.5,0.75	0.75,1.00,1.00	0,0.25,0.5
D_7	0,0.25,0.5	0,0.25,0.5	0.5,0.75, 1.00	0.25,0.5,0.75	0,0.25,0.5
D_8	0.5,0.75, 1.00	0.5,0.75, 1.00	0,0.25,0.5	0,0,0.25	0.25,0.5,0.75
D_9	0,0.25,0.5	0.25,0.5,0.75	0.5,0.75, 1.00	0.25,0.5,0.75	0.25,0.5,0.75
D_{10}	0,0.25,0.5	0.25,0.5,0.75	0.25,0.5,0.75	0.5,0.75, 1.00	0,0,0.25
D_{11}	0.25,0.5,0.75	0,0.25,0.5	0.25,0.5,0.75	0.25,0.5,0.75	0.5,0.75, 1.00
D_{12}	0.25,0.5,0.75	0.5,0.75, 1.00	0,0.25,0.5	0,0.25,0.5	0.25,0.5,0.75

D_6	D_7	D_8	D_9	D_{10}	D_{11}	D_{12}
0.25,0.5,0.75	0.5,0.75, 1.00	0,0,0.25	0.75,1.00,1.00	0,0.25,0.5	0.25,0.5,0.75	0.5,0.75, 1.00
0,0.25,0.5	0,0,0.25	0.5,0.75, 1.00	0,0,0.25	0,0,0.25	0,0.25,0.5	0,0,0.25
0.75,1.00,1.00	0.5,0.75, 1.00	0.25,0.5,0.75	0.5,0.75, 1.00	0.5,0.75, 1.00	0.5,0.75, 1.00	0.5,0.75, 1.00
0,0,0.25	0.25,0.5,0.75	0.5,0.75, 1.00	0.25,0.5,0.75	0,0,0.25	0,0,0.25	0.5,0.75, 1.00
0.5,0.75, 1.00	0.5,0.75, 1.00	0.75,1.00,1.00	0,0.25,0.5	0,0,0.25	0.5,0.75, 1.00	0.5,0.75, 1.00
0	0.5,0.75, 1.00	0.25,0.5,0.75	0.25,0.5,0.75	0.5,0.75, 1.00	0.25,0.5,0.75	0.5,0.75, 1.00
0,0.25,0.5	0	0.5,0.75, 1.00	0,0,0.25	0.5,0.75, 1.00	0,0.25,0.5	0,0.25,0.5
0.25,0.5,0.75	0,0,0.25	0	0.5,0.75, 1.00	0,0.25,0.5	0.75,1.00,1.00	0,0,0.25
0,0,0.25	0,0.25,0.5	0,0,0.25	0	0.25,0.5,0.75	0,0,0.25	0.25,0.5,0.75
0.25,0.5,0.75	0.5,0.75, 1.00	0,0,0.25	0.25,0.5,0.75	0	0.25,0.5,0.75	0.5,0.75, 1.00
0.5,0.75, 1.00	0,0.25,0.5	0.5,0.75, 1.00	0,0,0.25	0.25,0.5,0.75	0	0,0.25,0.5
0.25,0.5,0.75	0.5,0.75, 1.00	0,0,0.25	0.25,0.5,0.75	0.5,0.75, 1.00	0.25,0.5,0.75	0

Note: No influence (NO) = (0,0,0.25), Very low influence (VL) = (0,0.25,0.5), Low influence (L) = (0.25,0.5,0.75), High influence (H) = (0.5,0.75, 1.00) and Very high influence (VH) = (0.75,1.00,1.00).

Table A8 The pairwise comparison of drivers by **expert 8**

Drivers	D_1	D_2	D_3	D_4	D_5
D_1	0	0,0,0.25	0.75,1.00,1.00	0,0.25,0.5	0.25,0.5,0.75
D_2	0,0,0.25	0	0,0,0.25	0,0,0.25	0,0.25,0.5
D_3	0.5,0.75, 1.00	0.25,0.5,0.75	0	0.5,0.75, 1.00	0.5,0.75, 1.00
D_4	0.25,0.5,0.75	0.5,0.75, 1.00	0.25,0.5,0.75	0	0,0,0.25
D_5	0.5,0.75, 1.00	0.75,1.00,1.00	0,0.25,0.5	0,0,0.25	0
D_6	0.5,0.75, 1.00	0.25,0.5,0.75	0.25,0.5,0.75	0.5,0.75, 1.00	0.25,0.5,0.75
D_7	0.5,0.75, 1.00	0.5,0.75, 1.00	0,0,0.25	0.5,0.75, 1.00	0,0.25,0.5
D_8	0,0,0.25	0.5,0.75, 1.00	0.5,0.75, 1.00	0,0.25,0.5	0.75,1.00,1.00
D_9	0,0.25,0.5	0,0,0.25	0.5,0.75, 1.00	0.25,0.5,0.75	0,0,0.25
D_{10}	0.5,0.75, 1.00	0,0,0.25	0.25,0.5,0.75	0,0,0.25	0.25,0.5,0.75
D_{11}	0,0.25,0.5	0.5,0.75, 1.00	0,0,0.25	0.25,0.5,0.75	0.5,0.75, 1.00
D_{12}	0.5,0.75, 1.00	0,0,0.25	0.25,0.5,0.75	0.5,0.75, 1.00	0.25,0.5,0.75

D_6	D_7	D_8	D_9	D_{10}	D_{11}	D_{12}
0.5,0.75, 1.00	0.5,0.75, 1.00	0.25,0.5,0.75	0.5,0.75, 1.00	0.5,0.75, 1.00	0,0,0.25	0.25,0.5,0.75
0,0,0.25	0.5,0.75, 1.00	0.5,0.75, 1.00	0,0.25,0.5	0,0.25,0.5	0.5,0.75, 1.00	0,0.25,0.5
0.5,0.75, 1.00	0.25,0.5,0.75	0,0,0.25	0,0.25,0.5	0.5,0.75, 1.00	0,0.25,0.5	0.75,1.00,1.00
0.5,0.75, 1.00	0.5,0.75, 1.00	0.25,0.5,0.75	0.5,0.75, 1.00	0.25,0.5,0.75	0,0,0.25	0,0,0.25
0.5,0.75, 1.00	0.25,0.5,0.75	0.25,0.5,0.75	0,0,0.25	0.25,0.5,0.75	0,0.25,0.5	0.5,0.75, 1.00
0	0.25,0.5,0.75	0.5,0.75, 1.00	0.25,0.5,0.75	0.75,1.00,1.00	0,0.25,0.5	0.25,0.5,0.75
0,0.25,0.5	0	0,0.25,0.5	0.5,0.75, 1.00	0.25,0.5,0.75	0,0.25,0.5	0,0.25,0.5
0,0,0.25	0.5,0.75, 1.00	0	0,0.25,0.5	0,0,0.25	0.25,0.5,0.75	0.25,0.5,0.75
0.25,0.5,0.75	0,0.25,0.5	0.25,0.5,0.75	0	0.25,0.5,0.75	0.25,0.5,0.75	0,0,0.25
0.5,0.75, 1.00	0,0.25,0.5	0.25,0.5,0.75	0.25,0.5,0.75	0	0,0,0.25	0.25,0.5,0.75
0,0.25,0.5	0.25,0.5,0.75	0,0.25,0.5	0.25,0.5,0.75	0.25,0.5,0.75	0	0.5,0.75, 1.00
0.5,0.75, 1.00	0.25,0.5,0.75	0.5,0.75, 1.00	0,0.25,0.5	0,0.25,0.5	0.25,0.5,0.75	0

Note: No influence (NO) = (0,0,0.25), Very low influence (VL) = (0,0.25,0.5), Low influence (L) = (0.25,0.5,0.75), High influence (H) = (0.5,0.75, 1.00) and Very high influence (VH) = (0.75,1.00,1.00).

Table A9 The pairwise comparison of drivers by **expert 9**

Drivers	**D1**	**D2**	**D3**	**D4**	**D5**
D1	0	0.25,0.5,0.75	0.5,0.75, 1.00	0.5,0.75, 1.00	0,0,0.25
D2	0.5,0.75, 1.00	0	0,0.25,0.5	0,0.25,0.5	0.5,0.75, 1.00
D3	0.25,0.5,0.75	0,0,0.25	0	0.5,0.75, 1.00	0,0.25,0.5
D4	0.5,0.75, 1.00	0.25,0.5,0.75	0.5,0.75, 1.00	0	0,0,0.25
D5	0.25,0.5,0.75	0.25,0.5,0.75	0,0,0.25	0.25,0.5,0.75	0
D6	0.25,0.5,0.75	0.5,0.75, 1.00	0.25,0.5,0.75	0.75,1.00,1.00	0,0.25,0.5
D7	0,0.25,0.5	0,0.25,0.5	0.5,0.75, 1.00	0.25,0.5,0.75	0,0.25,0.5
D8	0.5,0.75, 1.00	0.5,0.75, 1.00	0,0.25,0.5	0,0,0.25	0.25,0.5,0.75
D9	0,0.25,0.5	0.25,0.5,0.75	0.5,0.75, 1.00	0.25,0.5,0.75	0.25,0.5,0.75
D10	0,0.25,0.5	0.25,0.5,0.75	0.25,0.5,0.75	0.5,0.75, 1.00	0,0,0.25
D11	0.25,0.5,0.75	0,0.25,0.5	0.25,0.5,0.75	0.25,0.5,0.75	0.5,0.75, 1.00
D12	0.25,0.5,0.75	0.5,0.75, 1.00	0,0.25,0.5	0,0.25,0.5	0.25,0.5,0.75

D6	**D7**	**D8**	**D9**	**D10**	**D11**	**D12**
0.25,0.5,0.75	0.5,0.75, 1.00	0,0,0.25	0.75,1.00,1.00	0,0.25,0.5	0.25,0.5,0.75	0.5,0.75, 1.00
0,0.25,0.5	0,0,0.25	0.5,0.75, 1.00	0,0,0.25	0,0,0.25	0,0.25,0.5	0,0,0.25
0.75,1.00,1.00	0.5,0.75, 1.00	0.25,0.5,0.75	0.5,0.75, 1.00	0.5,0.75, 1.00	0.5,0.75, 1.00	0.5,0.75, 1.00
0,0,0.25	0.25,0.5,0.75	0.5,0.75, 1.00	0.25,0.5,0.75	0,0,0.25	0,0,0.25	0.5,0.75, 1.00
0.5,0.75, 1.00	0.5,0.75, 1.00	0.75,1.00,1.00	0,0.25,0.5	0,0,0.25	0.5,0.75, 1.00	0.5,0.75, 1.00
0	0.5,0.75, 1.00	0.25,0.5,0.75	0.25,0.5,0.75	0.5,0.75, 1.00	0.25,0.5,0.75	0.5,0.75, 1.00
0,0.25,0.5	0	0.5,0.75, 1.00	0,0,0.25	0.5,0.75, 1.00	0,0.25,0.5	0,0.25,0.5
0.25,0.5,0.75	0,0,0.25	0	0.5,0.75, 1.00	0,0.25,0.5	0.75,1.00,1.00	0,0,0.25
0,0,0.25	0,0.25,0.5	0,0,0.25	0	0.25,0.5,0.75	0,0,0.25	0.25,0.5,0.75
0.25,0.5,0.75	0.5,0.75, 1.00	0,0,0.25	0.25,0.5,0.75	0	0.25,0.5,0.75	0.5,0.75, 1.00
0.5,0.75, 1.00	0,0.25,0.5	0.5,0.75, 1.00	0,0,0.25	0.25,0.5,0.75	0	0,0.25,0.5
0.25,0.5,0.75	0.5,0.75, 1.00	0,0,0.25	0.25,0.5,0.75	0.5,0.75, 1.00	0.25,0.5,0.75	0

Note: No influence (NO) = (0,0,0.25), Very low influence (VL) = (0,0.25,0.5), Low influence (L) = (0.25,0.5,0.75), High influence (H) = (0.5,0.75, 1.00) and Very high influence (VH) = (0.75,1.00,1.00).