RSC Sustainability

ROYAL SOCIETY OF CHEMISTRY

PAPER

View Article Online
View Journal | View Issue

Cite this: *RSC Sustainability*, 2024, **2**, 1948

The sustainability onion: a panoramic view of a parent concept, its paths, and progeny

Raphael Aryee

This study presents a comprehensive sustainability framework, showing the concept's different sides or perspectives and its derivatives based on extensive literature and industry experience. A common and broad concept of sustainability, its origin, drivers, agenda, benefits, risks, and how it meandered its way through various fields of study and industry is still patchy in extant literature. Consequently, a complete framework like this, which illustrates all sides of sustainability, is essential. This provides valuable information for business managers and broadens sustainability (and its derivatives) research. This study systematically discovered and validated the various components of sustainability with the aid of literature and sustainability experts. The result is a comprehensive framework termed "sustainability onion." This model gives practitioners and scholars a holistic or panoramic perspective of sustainability's various sides or components. To the best of the researcher's knowledge, this "sustainability onion" is the first attempt by a single study to comprehensively structure the various components of sustainability and derivatives in an integrated framework.

Received 7th October 2023
Accepted 20th May 2024

DOI: 10.1039/d3su00361b

rsc.li/rscsus

Sustainability spotlight

The call for sustainability has caused the concept to meander to various firms, disciplines, policies and studies. This study brings to bear a panoramic overview of the concept of sustainability and its effect on other concepts. The paper demonstrates the origin of sustainability and how is has percolated into various disciplines and industry. The study contributes toward our knowledge in sustainability, thereby aiding countries, firms, scholars *etc.* to choose the path of sustainability thereby helping to achieve the sustainable development goals. The study presents a comprehensive framework that captures the concept and its effects.

1. Introduction

There are approximately 333 million firms worldwide,[1] 7.8 million researchers,[2] and millions of policies globally. These firms, researchers, and policies may differ in their objectives, focus, and aspirations. However, one common denominator that may run through them is the concept of sustainability. That is, at the intersection of the three-set Venn diagram of academia (researchers), industry (firms), and policies (policymakers) is the concept of sustainability. Aryee and Adaku noted that researchers are gravitating toward sustainability.[3] Cozzolino and De Giovanni established that firms are taking the path of sustainability.[4] Besides, Alkaraan *et al.*, and Chen *et al.* illustrated that the doctrines of sustainability have percolated into policies and initiatives.[5,6] Examples of such initiatives or projects include Europe's largest public-private partnership dedicated to the development of manufacturing sustainable pharmaceuticals (CHEM 21),[7] the American Chemical Society Pharmaceutical Roundtable (ACS GCIPR),[8,9] the national centre for competence – sustainable chemical processes through catalyst design (NCCR catalysis),[10–13] that aims to develop technologies to make it possible to base the chemical industry on renewable resources and allow chemical production without waste.

This meandering sustainability[14] effect can be partly attributed to the various international conferences or agreements that made a *prima facie* case for adopting and implementing the phenomenon. Notable amongst these are the Brundtland Commission Report in 1987, the Earth Summit in 1992, the Kyoto Protocol in 1997, the Millennium Development Summit in 2000, the Paris Agreement on climate change in 2015, the World Summit on Sustainable Development Goals (SDGs) in 2002 at South Africa, the 2022 Stocholm+50 Summit (see Fig. 1). The effect of these conferences and other factors, such as stakeholder pressure and sustainability rents, have increased interest in researching this domain. Therefore, scholarly databases are flooded with thousands of studies on sustainability annually. These studies span concept description or definitions,[15–17] the importance of sustainability,[18,19] sustainability dimensions,[20,21] sustainable strategies or practices,[22–24] sustainability and performance,[25,26] *etc.* These studies and others investigated the concept of sustainability, its offspring

Faculty of Business Administration, Methodist University Ghana, Accra, Ghana. E-mail: raphael.aryee@st.gimpa.edu.gh

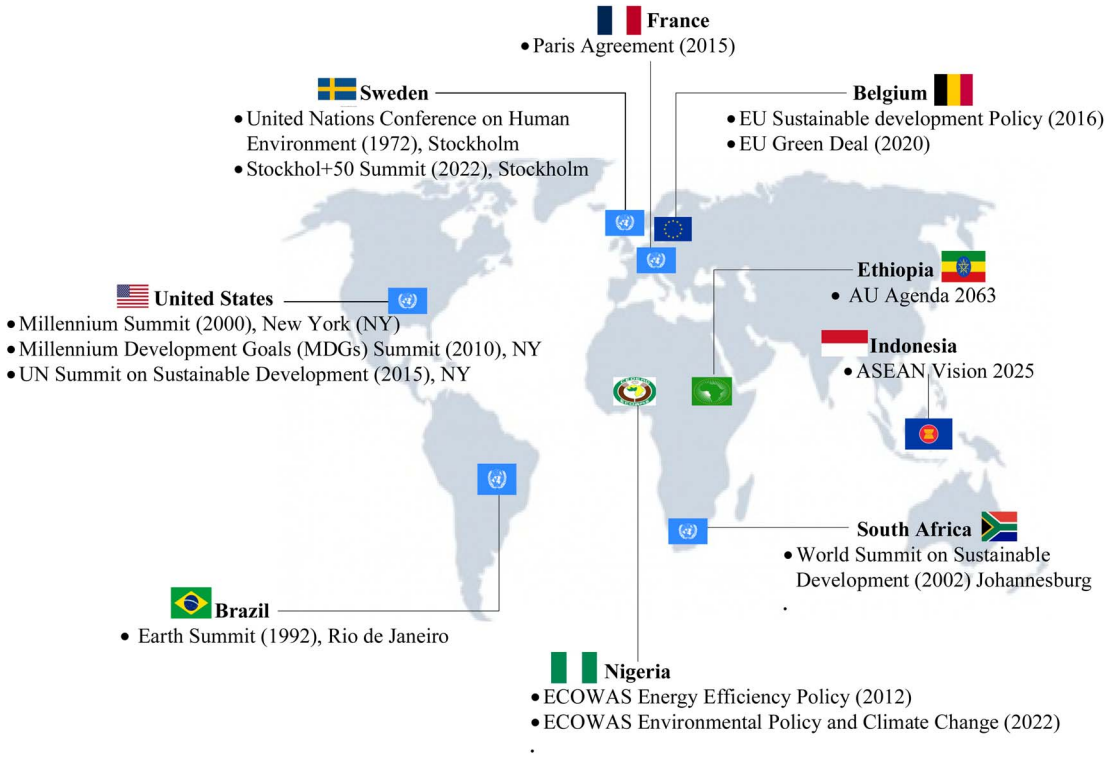

Fig. 1 A map showing some global and regional conferences and policies on sustainability.

concepts or derivatives, and their benefits or risks. Nevertheless, it appears that studies that integrate the various aspects of the sustainability concept, such as its drivers, barriers, structure, practices, benefits, and risks in a single research, have not been adequately addressed. A single study that demonstrates the origin of sustainability, its causes and effects, and how it has meandered its way (paths) into various domains and industries appears patchy.

This affects the assimilation of the phenomena into firms' operations and the general management of waste in communities. This situation could explain why Van Buren *et al.*, noted that the concept is vague and has started losing momentum.[27] Kirchherr *et al.*, and De Vries and Petersen added that concepts such as sustainability (and its derivatives such as the green economy) with so much traction will likely become blurred because various stakeholders employ them with different mindsets.[28,29] Therefore, a broad sustainability framework is required to aid researchers, practitioners, and policymakers to clearly understand the concept and its implications. Owing to this gap, this study seeks to provide a comprehensive framework called the "Sustainability Onion." That is, akin to the layers of an onion; this study offers a panoramic insight into the concept of sustainability and its derivatives.

This paper is structured into five sections. The first section introduces and makes a case for the study. The second section provides the literature review, definition and scope of the concept. The third section discusses the research methodology used for the study. In the fourth section, a panoramic insight into sustainability is depicted, dismembering and disinterring all sides and angles of the concept. The fifth section provided the conclusion and future research directions for the study.

2. Literature review, definition, and scope of sustainability

2.1 Literature review

Many scholars have contributed to the development of knowledge in the domain of sustainability. For example, Kuhlman and Farrington conducted an exposition on the concept of sustainability.[30] In this study, they discussed the original intention of the Brundtland report of 1987 in line with the triple bottom line and the sustainability problem by waging into the debate of weak and strong sustainability. Besides, using a systematic literature approach, Dienes *et al.*, reviewed and analysed the drivers of sustainability and discovered that ownership structure, media visibility, and firm size are the most relevant drivers of the disclosure of sustainability reports.[31] Häkkinen and Belloni examined the barriers and drivers of sustainability in the building industry, using a mixed method approach (case study, literature review, and interviews), and unearthed that new technologies are resisted because they require change, which comes with cost and risks.[32] They discovered other barriers, including economics, steering mechanism, lack of client comprehension, process (such as networking, cooperation, procurement, and tendering), and knowledge (lack of tools, common language, innovation). In another study, Owusu and Asumadu-Sarkodie reviewed sustainable issues, renewable energy sources, and climate

change mitigation.[33] In this study, the authors noted that the increase in globalisation and population has increased the energy demand and advocated for a shift to renewable energy sources to deal with climate change. They indicated that renewable energy sources have benefits such as energy security, access, and economic and social development. Recently, the concept was applied in specific domains such as hospitality education[34] higher education,[35] aquaculture,[36] *etc.* using bibliometric analysis and systematic review approach with data from Scopus. Piramanayagam *et al.*, explored the research landscape and themes in sustainable hospitality education.[37] It was discovered that sustainable hospitality education was more skewed toward developed countries and was scarce in developing counties. Leal Filho *et al.* examined the opportunities, benefits, and challenges of internationalising universities from the sustainability perspective.[35] After reviewing 27 case studies, it was discovered that internationalisation was a means for universities to achieve sustainability. Finally, Rector *et al.*, also studied the application of sustainability in aquaculture by reviewing relevant literature and discovered that it is a key means to achieve sustainable outcomes.[36]

2.2 Definition and scope of sustainability

Sustainability emerged several years ago. The first and most familiar definition was by the United Nations' Brundtland Commission in 1987, which defined the term as: "a development that meets the needs of the present without compromising the ability of future generations to meet their needs."[38] The terminology evolved from concerns about the depletion of natural resources for future and present generations, and it is now the focus of researchers and organisations worldwide.[39]

Sustainable development requires considering and integrating economic, social, cultural, political, and ecological factors.[40] It is a multi-scale approach (institutional, geographical, and temporal[41]) in decision-making to balance economic, social, and environmental development.[42] Mani established that sustainability is attaining equilibrium between economic development, environmental care, and social equity.[43] Indeed, there are several definitions of sustainable development in literature, but at the heart of all these definitions is the inclusion of the three dimensions and the guarantee of future evolution. The intersection of these three dimensions is also called the "triple bottle line."[44,45] Partial sustainability is the intersection of two dimensions.[46]

The environmental dimension of sustainability refers to the natural environment, comprising animals, plants, water, and land. Achieving environmental sustainability is vital because of its direct correlation with the existence of the human race. Furthermore, this goal relates to the ecological relevance of the economic use of energy and other resources.[47] The social dimension refers to human capital; enhancing this leg of sustainability involves employing fair and advantageous practices for employees and the firm's catchment area.[48,49] The economic dimension concerns the economic benefits firms acquire, including the community, the region and the nations where the operations occur. From the above discussion, it is evident that sustainable development is a relevant objective because of its significant role in promoting social, ecological and economic rents.

3. Research methodology

This study adopted the qualitative research method, particularly the systematic literature review (SLR) approach. This approach is the best for structuring an area of study.[50] It helps researchers to discover all the aspects of a phenomenon being studied. This study followed the unambiguous processes used in Guandalini.[51] Chalmeta and Santos-deLeon, Govindan & Bouzon and Osei-Kyei and Chan.[52–54] This method included a comprehensive approach (data collection, inclusion and exclusion criteria, data extraction and synthesis, and data analysis) to identify studies that dealt with specific sustainability ideas and further synthesise the outcome into various compartments. The stages of the study were: (1) data collection, (2) screening of targeted papers, and (3) content data analysis (thematic analysis and model validation), as shown in the research process framework in Fig. 2.

3.1 Stage 1: data collection

This is the first phase of the methodology. At this stage of the study, five leading publishers were identified from where data was collected. These were Elsevier, Emerald, Springer, Wiley, and Taylor and Francis. These were chosen due to the quality of their published peer-reviewed articles.[55,56] Consequently, journals from these publishers were deemed to be credible. However, the search proved that most of the sustainability papers identified were in Elsevier and Emerald; hence, most papers used were from these publishers. The key search words or codes used in this study were "sustainability," "sustainable practices," and "sustainable development." Conference papers and grey literature sources were not included because such papers have not gone through the peer-review process and may fall short of the prerequisite quality standards for publications. In all, 228 articles were identified from the above-mentioned publishers from 2000 to April 2024.

3.2 Stage 2: data screening

After identifying the data sources, the next phase was article screening. This screening activity was done with the aid of inclusion and exclusion criteria to ensure that the right or contextually relevant articles were used for the study. In this study, the unique tool of multiple filtering or screening was adopted as used by Nuss *et al.*[57] (see Fig. 3). The exclusion criteria were: (1) conference and grey literature, (2) non-English papers, and (3) contextually irrelevant papers. The inclusion criteria were that (1) articles should focus on sustainability (sustainable development) or any of its derivatives or practices. (2) Articles should focus on the effects of sustainability. The journals considered in this study were the leading journals in sustainability studies, as illustrated in Table 1. In all, 228 articles were identified. Then, 19 duplicate articles were screened out. Nine non-English articles were removed, 72 contextually

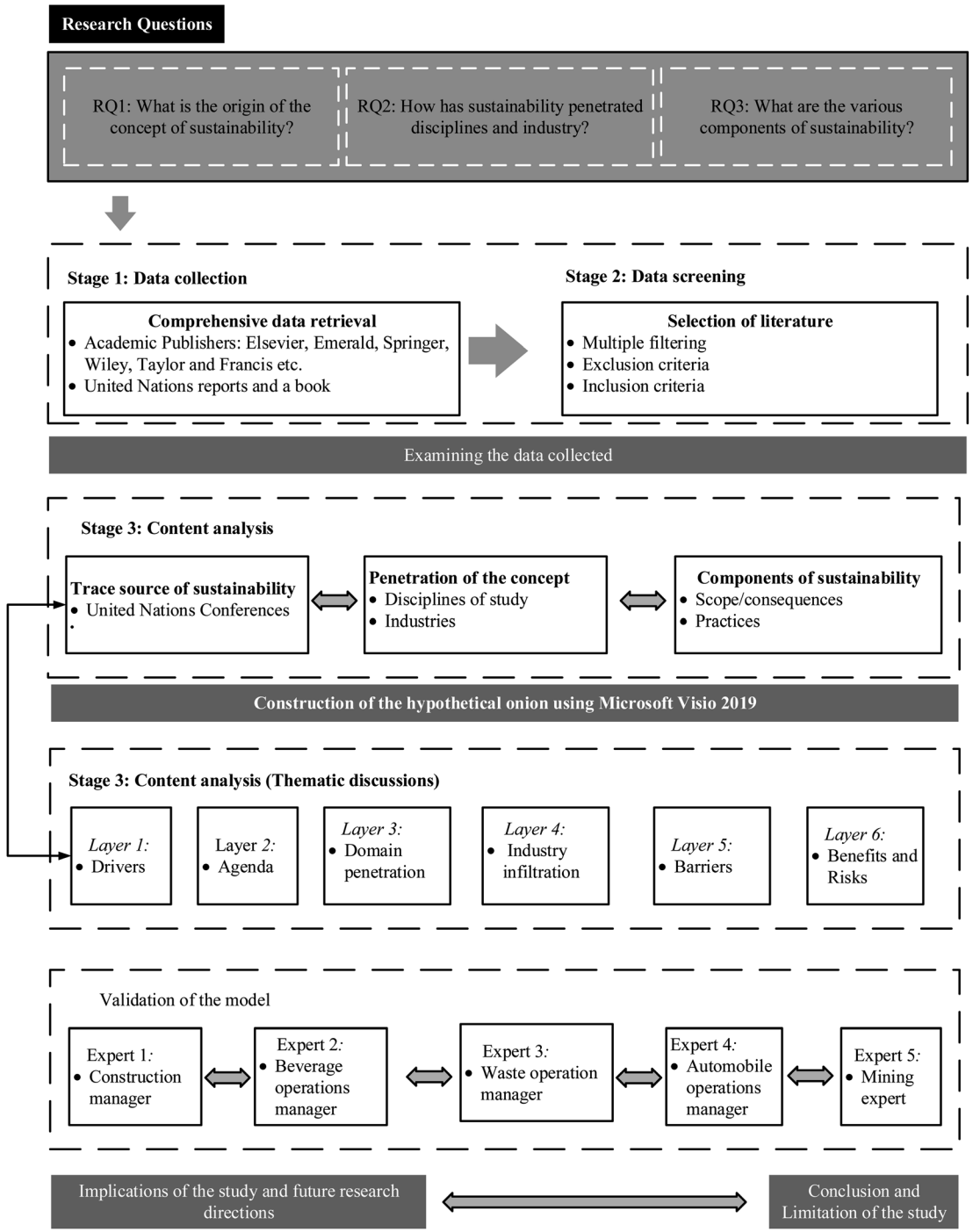

Fig. 2 Research process.

irrelevant were eliminated, and 44 articles whose primary focus was not sustainability were removed, as shown in multiple filtering in Fig. 3. This reduced the number of articles to 84. These 84 articles were supplemented with 14 other articles outside the five named publishers, 15 articles from the Royal Society of Sustainability (RSC) and the American Society of Chemistry (ASC) and 6 books and reports identified *via* snowballing. Consequently, 119 materials were used to construct the sustainability model, as shown in Table 1 (and Fig. 3).

3.3 Stage 3: data analysis

After successfully identifying suitable data sources and collecting the data, the next logical stage is to make sense of the data. This process is called data analysis.[58] Some tools used to analyse data in an SLR context are thematic (pattern) analysis, bibliometric or Scientometric analysis, discourse analysis, and content analysis.[59–61] The content analysis approach was employed because this study sought to provide a panoramic perspective of the sustainability phenomenon and an

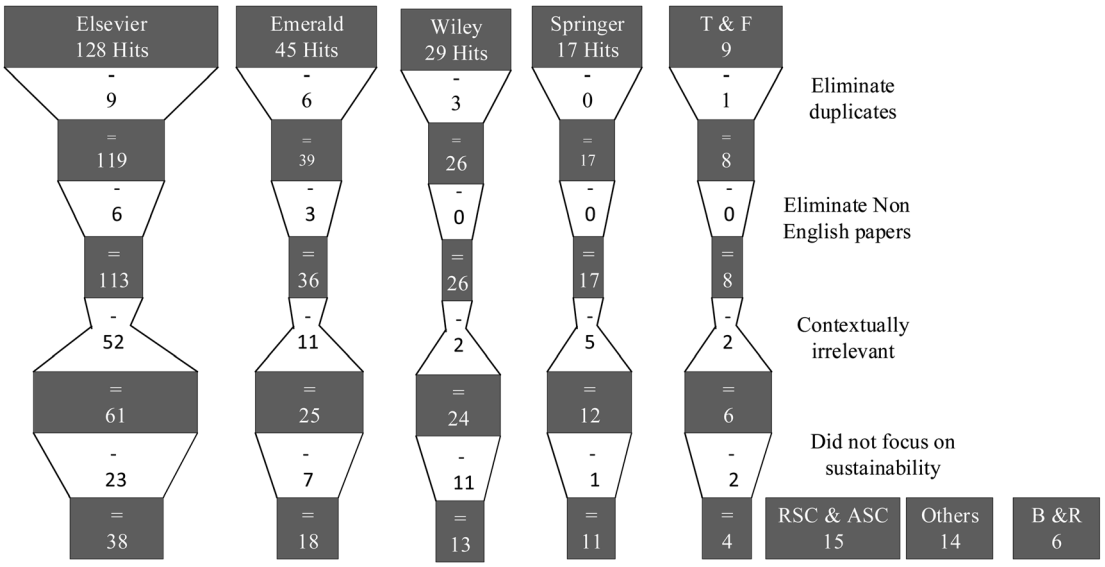

Fig. 3 Multiple filtering process.

anatomical view of the subject matter and its progeny. Content analysis is a methodology that aids in assessing a high volume of data in a structured and systematic manner using either deductive or inductive strategies. This study employed the deductive approach. Consequently, keywords were defined in advance before scrutinising the content to identify the essential attributes the study seeks to address.[62] Here, the articles were the units of analysis and were classified into their major themes, such as drivers, agendas, benefits, effects, and risks. These themes were used to construct an oval framework with various layers. After the construction of the framework, it was sent to five industry experts from the construction, beverage, waste, automobile, and mining industries for validation. These experts were purposively selected owing to their expertise in the study area. Their feedback helped trim the proposed model's rugged edges. For example, the first and third experts suggest that different layers should capture sustainability penetration and industry infiltration. The second expert indicated that the benefits of sustainability should be captured from the perspective of the triple bottom-line principle. The fourth and fifth experts suggested the inclusion of the derivative or strategies of sustainability into the model. After inculcating all relevant suggestions from the experts, the current model (in Fig. 4) was resent to all the experts again. They unanimously agreed the model is a true reflection of the concept of sustainability and its related concepts.

4. The sustainability onion

The main sustainability themes were discovered in cognisance with the outlined research process. They were classified and delineated in an outer-inner logic framework, as done in the case of Saunders *et al.*'s[63] research onion. The framework was segmented into six (6) layers, each capturing a specific theme. The first layer (the outermost layer) is termed the exo-layer, whereas the inner layers are described as the *endo-layers*. The first layer refers to the *drivers of sustainability*. In another lexicon, it refers to the issues that led to the coinage and introduction of the sustainability term. The second layer refers to the various *discourses or sustainability agendas* set to achieve sustainability. The third layer of the onion illustrates *domain penetration*. This layer describes how the diverse agendas or plans influenced different domains or disciplines of study. The fourth layer represents the birth of operational sustainability tools (strategies) from various fields of study. The fifth layer is about *barriers* to the implementation of sustainability. The sixth layer is about the *benefits and the risks* associated with sustainability. The resultant framework or onion is illustrated in Fig. 4. In reality, the logic in the framework shows that some specific drivers (looming factors), have caused or influenced stakeholders (policy makers) to organise specific agendas (such as conferences) to avert the pending challenge. Thorough these conferences, the concept of sustainability was discovered to be the panacea to the approaching challenge. This situation has then forced scholars and practitioners to consider sustainability (the sustainability strategies) in all their endeavours. Hence, they now perceive things from sustainability perspective. However, the quest to achieve this feat is not without barriers or opposition. And overcoming these barriers promised some returns to the stakeholders. But on the other side of the sustainability coin is risks, that associated with the implementation of the concept of sustainability. The details of each layer of the proposed onion are discussed in the proceeding sections.

4.1 First layer: sustainability drivers

Generally, drivers can be described as factors that causes a specific phenomenon to occur or develop.[31] Without a driver or a cause an effect cannot exist. In other words, they can be no effect without a cause. So just like any other effect, sustainability

Table 1 Distribution of journals (and materials) used in the study

Type	Journal name	Publisher	Frequency
Journals	*Journal of Cleaner Production*	Elsevier	13
	Resources, conservation and recycling	Elsevier	2
	International Journal of Information Management	Elsevier	2
	Journal of Retailing and Consumer Services	Elsevier	2
	Journal of King Saud University-Science	Elsevier	1
	Energy Economics	Elsevier	1
	Composites Part B: Engineering	Elsevier	1
	Reliability Engineering & System Safety	Elsevier	1
	Current Opinion in Psychology	Elsevier	1
	Environmental Technology & Innovation	Elsevier	1
	European Journal of Operational Research	Elsevier	1
	Ecological Economics	Elsevier	1
	Ain Shams Engineering Journal	Elsevier	1
	Biotechnology Reports	Elsevier	1
	Agriculture, Ecosystems & Environment	Elsevier	1
	Environment International	Elsevier	1
	Agricultural Water Management	Elsevier	1
	Geography and Sustainability	Elsevier	1
	International Journal of Production Economics	Elsevier	1
	Transportation Research Part D: Transport and Environment	Elsevier	1
	Current Opinion in Green and Sustainable Chemistry	Elsevier	1
	Separation and Purification Technology	Elsevier	1
	Renewable and Sustainable Energy Reviews	Elsevier	1
	The International Journal of Logistics Management	Emerald	4
	International journal of productivity and performance management	Emerald	2
	Sustainability Accounting, Management and Policy Journal	Emerald	2
	Journal of Manufacturing Technology Management	Emerald	1
	World Journal of Entrepreneurship, Management and Sustainable Development	Emerald	1
	International Journal of Physical Distribution & Logistics Management	Emerald	1
	Social Responsibility Journal	Emerald	1
	Management of Environmental Quality: An International Journal	Emerald	1
	Asia-Pacific Journal of Business Administration	Emerald	1
	The Electronic Library	Emerald	1
	The TQM Journal	Emerald	1
	International Journal of Organizational Analysis	Emerald	1
	Journal of Physical Distribution & Logistics	Emerald	1
	Green Chemistry	RSC	2
	RSC Sustainability	RSC	8
	The Journal of Organic Chemistry	ASC	2
	Sustainable Chemistry & Engineering	ASC	1
	Journal of the American Chemical Society	ASC	1
	Organic process research & development	ASC	1
	Business Strategy and the Environment	Wiley	8
	British Journal of Management	Wiley	1
	Sustainable development	Wiley	1
	People and Nature	Wiley	1
	The Chemical record	Wiley	1
	Small	Wiley	1
	Environmental Science and Pollution Research	Springer	2
	Journal of business ethics	Springer	1
	International Journal of Environmental Science and Technology	Springer	1
	Flexible Services and Manufacturing Journal	Springer	1
	Sustainability Science	Springer	1
	Environment, Development and Sustainability	Springer	1
	Climatic Change	Springer	1
	Operations Management Research	Springer	1
	Competitiveness Review	Springer	1
	Risk Management	Springer	1
	World Archaeology	Taylor and Francis	2
	Maritime Policy & Management	Taylor and Francis	1
	International Journal of Construction Management	Taylor and Francis	1
	Others	Others	14

Table 1 (*Contd.*)

Type	Journal name	Publisher	Frequency
Books and reports	*John Wiley and Sons*	John Wiley and Sons	1
	United Nations reports	*Others*	5
Total			119

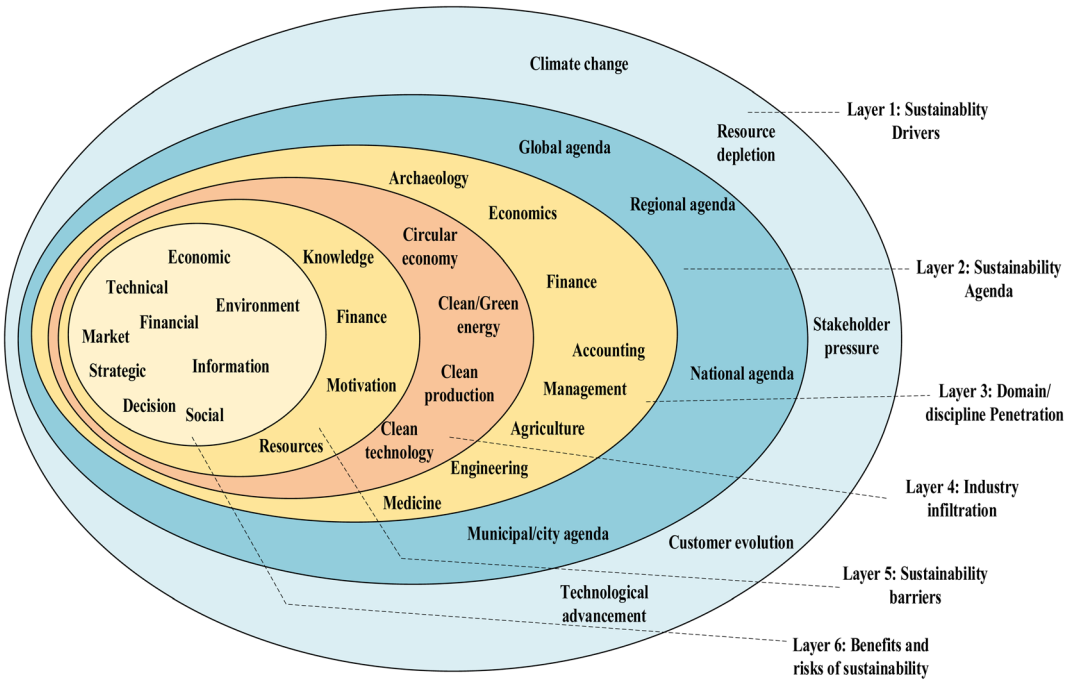

Fig. 4 The sustainability onion.

is not without a cause. Indeed, many factors has led to the formulation of this phenomenon, and these are described as drivers of sustainability,[32] which was captured in the hypothetical onion as first layer (specifically it is called the *sustainability driver*). This layer indicates various factors that have caused policymakers, such as the United Nations, European Union (EU), Africa Union (AU), the Association of Southeast Asia Nations (SEAN), *etc.*, to adopt sustainability in their operations. In other words, this can be described as policymakers' motivation for introducing the concept of sustainability. These drivers are a combination of actions meant to save the earth and future generations.[41] These issues include climate change,[64,65] depletion of natural resources,[66] stakeholder pressure[67] and customer evolution.[68] Dwivedi *et al.* and Salam noted that climate change, which leads to global warming, is one of the drivers of sustainability.[64,65] Kumari and Pandey added that a relationship exists between sustainability and climate change. Cassamo *et al.* concluded that climate change is a critical global phenomenon that affects sustainability. In a recent study,[69] Cassamo *et al.*, (p. 1) established that "climate change is a main global phenomenon, with a worldwide impact on natural and agricultural ecosystems."[69] Another driver of the concept is the depletion of natural resources. Opuala *et al.*, and He *et al.*, noted that the over-consumption of natural resources (especially non-renewable energy) justifies the introduction of sustainability.[70,71] Specifically, Zhang and Oki established that improving water resource management leads to sustainability.[72] Another driver of sustainability is pressure from stakeholders.[73] This pressure can be mimetic (pressure from competitors or peers), coercive (pressure from regulators or government) and normative (pressure from norms specified by professional bodies).[74] The next driver of sustainability is customer evolution.[75] This driver refers to continually changing customers' tastes and preferences.[76] Indeed, the continual chorusing of the effects of climate change, over-dependence on primary resources, and their negative impact on the environment have made customers conscious of the products they buy. Whether at the firm or individual level, the customer is shifting from non-eco-products to environmentally friendly ones. Customers have become sustainability-conscious, further pushing the wheels of sustainability beyond its current perimeters.[77]

4.2 Second layer: sustainability agenda

The term agenda usually refers to things that an individual or group of individuals deem as important and want to achieve or solve. An issue becomes agenda if is a very relevant matter that

when not addressed may have dying consequences. Therefore, this possible danger causes stakeholders to meet and consider the matter. That is, the matter becomes an agenda (priority) for stakeholders. In this context, this study theorised that the looming consequence of unsustainable practices such as pollution,[78] climate change,[64,65] *etc.* made sustainability an agenda for stakeholders (especially world leaders and decision makers). After world leaders and decision-makers discovered the need to go on the path of sustainability owing to the effect of unsustainable practices on economies, societies and the environment, various *sustainable agendas* have been birthed at multiple conferences, as previously mentioned. This agenda is intended to provide a blueprint or roadmap for all to achieve sustainability or sustainable development. These agendas can be classified as global, regional, national, and municipal. At the world level, sustainable development was first explained as "the development that meets the needs of the present without compromising the ability of future generations to meet their own needs" in the document "Our Common Future" by the United Nations Commission on Environment and Development. The object was to address humanity's aspirations to obtain a better life within the limitations imposed by nature. The chief global agenda set to achieve sustainability is the sustainable development goals (SDGs).[79] Notably, in 2015, the United Nations adopted the 2020 Agenda for Sustainable Development, which provides the framework for peace and prosperity for people and the planet, now and the future, in line with the triple bottom theory.[80] The agenda included 17 action points that illustrate a shared expression of the need for stakeholders to balance economic, social and environmental development. It contained themes such as eliminating poverty, improving healthcare and education, and implementing sustainable cities to reduce climate change and its effects by 2020.[81] Moreover, in 2021, the United Nations Climate Change Conference (COP26) held in Glasgow, United Kingdom,[64] brought together world leaders to address the severe climate change issues. The conference's purpose was to obtain a commitment to sustainable growth toward the Paris Agreement and the United Nations Convention of limiting increased global temperature to 1.5 degrees Celsius above pre-industrial levels.[64]

Additionally, beyond the global level agenda, regional bodies such as the EU, AU, ASEAN.[82,83] and other regional bodies have further developed action plans to achieve sustainability (see Fig. 1). The EU has a sustainable development policy (2016) to aid its members in attaining global sustainability objectives. Specifically, the union has the EU Sustainable Energy Policy,[84] the EU Green Deal and the EU Common Agricultural Policy. In 2013, the AU established the AU Agenda 2063, a concrete manifestation of how the continent will achieve its objectives of social inclusion and sustainability (SDGs). ASEAN Vision 2025 is a plan to achieve sustainability among its member nations. Also, the Economic Community of West African States (ECOWAS) Energy Efficiency Policy and the ECOWAS Environmental Policy and Climate Change Strategy are conscious efforts by the sub-regional group to help its members achieve sustainability.

Also, the agenda is not only at the global and regional levels but has also permeated down to the national and municipal or city levels. So many developing and developed countries have sustainable development policies and laws. For instance, the US and the United Kingdom (UK) have National Environmental policies,[85] which seek to create and maintain conditions under which humans and nature can live in unity, allowing the balance of economic, social, and environmental rents. In Africa, many countries have developed policies and laws to aid them in achieving sustainability. Specifically, in Ghana, the government created a National Plastic Management Policy in 2020 to deal with the plastic menace in the country. Also, the Ghana Renewal Energy Master Plan in 2022 is a deliberate effort to woo the country off fossil fuels to a sustainable energy path. At the municipal level, the various municipalities and metropolitans in Accra have recently introduced an environmentally sustainable operation dubbed: "Clean your frontage.[78]" This initiative is an agenda aimed at holding business enterprises responsible for the cleanliness of their environment.

4.3 Third layer: domain penetration

There are several domains of study. The arrival of the knowledge-based economy has accelerated the number of domains of study or disciplines in academia. It is imperative to note that these domains have not been insulated from the heat of sustainability. The heat of sustainability has infiltrated these domains of study. That is, the concept of sustainability has not only remained in the minds and on the lips of world, regional, or municipal leaders but has also been introduced to almost every field of study. The penetration of this phenomenon into various fields is captured by the third layer, referred to as *domain penetration*. Sustainability has recently become a strategic tool for almost all businesses owing to its contribution to profitability, growth, and survival.[86] Now, it is evident that the concept of sustainability has introduced its head into many disciplines. The evidence of interest in this concept is seen in the increasing number of websites, conference papers, conferences, and publications dedicated to the idea.[39,87]

Sustainability has percolated into many fields, from archaeology through nursing to zoology. It is seen in the social sciences, natural sciences (physical and biological), and applied sciences. From the social science perspective, owing to the penetration of this terminology, we now have sustainable anthropology,[88] sustainable archaeology,[89] sustainable economics[90] sustainable geography,[91] sustainable criminology,[92] green chemistry,[93–96] which includes green solvents,[97] green chemical processes,[98–100] sustainable electrochemistry,[101] chemical recycling,[102] sustainable metallurgy,[103,104] sustainable compounds and materials[105–107] *etc.* Other sustainable fields include green ecology,[108] sustainable physics,[109] sustainable microbiology,[110] sustainable engineering,[111] sustainable technology,[112] sustainable agriculture,[113] which has agronomy as one of its strategies. Other fields of study included project management,[114] sustainable construction,[115] sustainable marketing[116] or green marketing,[117] green accounting,[118] green banking,[119] green finance,[120] risk management strategy,[121] governance,[122] green taxation,[123] technology,[124] sustainable supply chain management[125] which includes: reverse logistics,[126] green logistics,[127] green packaging,[128] green

warehousing,[129] green procurement,[130] green operations or production,[131] green transportation,[132] *etc.*

4.4 Fourth layer: industrial infiltration (new business models)

Generally, academia has been saddled with the onus to disseminate knowledge to society (primarily *via* formal education). In line with this responsibility, academia often serves as the bridge between society and new agendas. Academia often translates information to the members of society who enrol as students at their institutions. And this is precisely what happened to the sustainability concept. The normal progression of the outputs of the academic domain is that they end up in the industry. The concept of sustainability accompanied the assimilation of academic products into industry. In another words, absorbing academic or educational products introduces sustainability into the industry fabric. This absorption led to the interrogating of existing business processes or models. The investigations proved that existing business models were discovered to be not sustainable. Besides, experts and practitioners found that existing business models do not care about future generations and the environment; hence, they called for new business models that consider future generations in their operations by producing eco-friendly products and promoting responsible consumption of resources.[133]

Consequently, a paradigm shift was advanced from the existing non-sustainable *modus operandi* to a new sustainable path[134] to balance rents from the businesses' economic, social, and environmental dimensions. This shift introduced new manufacturing and production philosophies or strategies for achieving sustainability, such as the circular economy,[135] clean production,[136] clean technology, green energy,[137] *etc.* Circular economy is a business model intended to mitigate pressure on the environment and improve the supply of primary raw materials by using new paradigms such as recycling, reducing, and reusing.[135] This explains why many beverage firms (one of the polluters of the environment in Ghana) have taken the path of sustainability. In 2017, when Ghana co-chaired the SDG, the United Nations Secretary-General's Sustainable Development Goals Advocates, the government of Ghana, through its ministry and agencies, aggressively encouraged firms to go the way of sustainability. Therefore, some firms in the Association of Ghana Industries formed the Ghana Recycling Initiative by Private Enterprise to integrate sustainable waste management solutions to the plastic waste menace in the country. This could explain why Accra Brewery Ltd launched a new returnable glass bottle for its soft drink products in 2017. Similarly, Voltic Ghana Ltd, with the aid of some nongovernmental agencies, launched a sustainable strategic initiative captioned "IRecycle" to collect used plastic bottles from the environment. Guinness Ghana Breweries Plc. It uses cleaner energy to fuel its boilers and reuses the carbon dioxide from its operations instead of flaring it into the atmosphere. Coca-Cola and its peers are embarking on a circular economy to mitigate the effects of their products on the environment.

4.5 Fifth layer: barriers to sustainability

Barriers are those that oppose something.[74] Basic knowledge of physics shows that every motion faces some opposition. In other words, there is no progression without opposition. The progression to achieve sustainability is not an exception, illustrated in this study using the logic (or the physics) of cutting an onion. The fundamental knowledge of the physics of cutting an onion shows that as the cutting device passes through the layer, by exerting pressure or force, it experiences an equal opposing force, as posited by Newton's third law of motion. With this phenomenon of opposition, the next layer of the hypothetical sustainability onion was christened as *barriers to sustainability*. The barriers refer to the factors that impede the assimilation of sustainability or its derivatives into firms' operations.[135] Neves and Marques noted that there are drivers and barriers to achieving sustainability.[135] They found that a country's age distribution is a crucial predictor of a circular economy. They said that young people embrace the change to sustainability more than older ones.

Moreover, another barrier to sustainability is the lack of motivation.[138] Some firms, especially in developing countries, do not appreciate the benefits of sustainability. Indeed, some have been unrepentant worshipers in the unholy temple of linear economy. For example, no amount of the gospel of sustainability preached by the apostle of circular (sustainability) can cause them to repent. They readily sacrifice the benefits of the environment on the economic altar. This lack of motivation can be traced to the lack of evidence from their environment about the accruals from sustainability. Other firms only practice sustainability because of regulations but not because they believe in the concept.[53] According to experts, this explains the illegal mining menace in mining countries such as Ghana and South Africa. Despite the continuous preaching of sustainable mining, these miners play deaf and continue to destroy lands, virgin forests, and water bodies in the name of mineral resources. For example, in Ghana, unsustainable mining has led to environmental degradation, increased unemployment and health risks.[139–141]

Another barrier to the successful implementation of sustainability is the lack of resources. Aryee and Adaku noted that resources that affect the performance of sustainable strategies include: (1) financial resources; the lack of financial resources can impede a firm from adopting sustainability; (2) knowledge-related resources such as personal norms, information and consumer characteristics are known to affect reverse or green logistics. (3) Human resources refer to sustainability resources such as managers, staff, officials, the general workforce and customers who give products another life. (4) Socio-organisational resources include convenience, distance, design, culture, RL network design, cooperation, and regulatory or stakeholder pressures. (4) Physical or material resources consist of collection devices, inspection and separating resources, containers, collection trucks, collection methods, technology and returned product (or waste) characteristics.[78]

4.6 Sixth layer: benefits and risks of sustainability

Most of the time, the benefits (reward or returns) promised in activity is that which motivate individuals to pursue such acts.[31]

But fundamental knowledge in finance shows that returns are associated with risks (dangers). That is to say that risks and returns are the two sides of the same coin.[31,74] When returns are high risks are also high. Like other any concept, sustainability comes with some benefits and risks, (as captured in the sixth layer of the proposed onion). This layer deals with the benefits and risks of the percolation of sustainability (or the arrival of new sustainable business models). These rents induce policymakers and firms to go on the path of sustainability. Fundamentally, the rents of sustainability can be observed from three dimensions: economic or value creation,[23] society,[49] and environment.[44] From an economic standpoint, sustainability and its derivatives have proven to correlate with firm performance positively.[68] For instance, sustainability and its derivatives, green logistics, reverse logistics, green HRM, *etc.*[129,142] by reducing the cost of operations, increasing profits, improving inventory management, and enhancing competitiveness. These benefits are not only the accruals they get but also motivate other firms to adopt and implement sustainable practices. Sustainability is an effective tool for recapturing the value produced in conventional supply chains.[75] For example, the traditional forward supply chain (with its linear economy mentality) only makes and delivers value-added goods to customers with no aim of recapturing this value. However, with the arrival of the philosophy of looping the supply chain (forming a closed-loop supply chain, a derivative of sustainability), focal firms (manufacturers) in a supply chain can recapture values from returned or waste (or used) items from customers using sustainable recovery strategies such as recycling, reuse, remanufacturing, repackaging, reduction, repair *etc.*

From the ecological standpoint, sustainability *via* strategies such as disposal (or incineration) of non-recoverable waste substances that can negatively affect the environment (plants and animals) are appropriately disposed of, with minimised impact on the environment. Moreover, from a societal perspective, sustainability ensures that workers work in decent and healthy workplaces and upholds workers' rights.[143] Besides, it is essential to add that sustainability practices such as circular economy, green logistics, and reverse logistics tend to enhance firms' reputations. They position the firms in the eyes of the public as good stewards of the environment. This impression can lead to customer citizenship behaviour. That is when customers perceive that a firm is concerned about the environment; hence, they practice (say, reverse logistics), and the customers or consumers are likely to voluntarily participate in collecting and sorting waste. Also, when a firm practices sustainability, it can lead to organisational citizen behaviour[144] in line with the theory of planned behaviour. That is, employees will voluntarily engage in such altruism (assisting others to practice sustainability), courtesy (being mindful of customer complaints), sportsmanship (bringing new ideas to recover products or nurture green culture), conscientiousness (being thoughtful about the environment), civic virtue (project the firm well to the public). These can enhance firms' environmental and financial performance.[144]

Additionally, knowledge from the kitchen demonstrates how the biological onion (especially those with sulphuric substances) stings the eyes as a knife drive through its layers, especially as the knife reaches the inner core near the roots. In the same vein, this study suggests that the hypothetical sustainability onion also stings the *eyes* of the implementers. That is to say that implementing sustainability comes with some risks.[145] Consequently, the sixth (core most) layer was also named sustainability risks. Sustainability risk[146,147] can be explained as an unforeseen environmental or social event or condition that, if it happens, can negatively affect the firm's financial position.[145] This assertion is in line with the theory of risks and return. A positive association exists between returns (benefits) and risks.[148] Sustainability guarantees benefits, but the opposite side of the coin is risks. Generally, sustainability risks can be seen from social, environmental and economic perspectives.[3] For instance, social responsibility risks threaten the license to operate in the mining sector. This also includes the risks tied to the perception of over-consumption of resources and reputational risk linked to investment in projects with potentially damaging ecological effects. Also, sustainability risks relate to financial performance risks from volatile energy prices and compliance risks triggered by new carbon regulations. Another risk is the risk of product substitution as customers switch to more sustainable ones.[149] The operational risks include supply, process, demand, and corporate-level risks. The supply chain environmental risks include human health, ecosystem quality and resource depletion. The supply chain social risk consists of the global social and governance indexes.[149]

Another risk is information risk,[150] which deals with losing important information due to sustainability. The risks can also be strategic; this deals with how firms lose their core functions to third-party providers because of sustainability.[151] For example, sustainability may require subletting some functions to other market players. If this is not managed correctly, it can lead to losing some critical roles to third parties, negatively affecting the firm. Another risk that is seen at the strategic level is the lack of commitment from sustainability implementation partners. For example, from a supply chain perspective, some players will fully commit to the call to balance people, the planet and profits. These risk elements can be mitigated by taking steps, such as reducing the impact or the probability of occurrence.[75] Besides, using our kitchen analogy, it knows that onions are cut under water to reduce stinging to the eyes. Similarly, it recommended the firm practice sustainability under the right culture to mitigate the risks associated with implementing the concept. This could explain why Kwarteng *et al.* noted their firms practice a circular economy under the right organisational culture.[152] Organisational culture helps a firm mitigate sustainability risks.[153]

5. Practical implications and directions for future research

The proposed framework sought to provide a holistic perspective on sustainability relevant to theory, practice and

policy. First, from the theoretical angle, this model lengthens the perimeters of the knowledge area in sustainability by providing compressive information about the term's origin, its evolutions and how it has affected academia and industry. This model will serve as a reference point for the concept of sustainability regarding barriers, benefits, and risks scattered in the existing literature. From a practical viewpoint, sustainability (and its derivatives or strategies) is uncommon amongst firms in developing countries, especially SMEs. Therefore, it is unsurprising that such firms do not go toward sustainability owing to the lack of knowledge in the area. Hence, suggesting such a study will provide motivation and expertise for firms to embrace the concept of sustainability. Specifically, this will expose them to sustainability strategies such as a circular economy, clean production, and clean technology, which enable firms to reduce carbon emissions, thereby improving climate change, pollution and ozone layer depletion. From the side of government and policy, this framework provides an arena of sustainable practices that may require policy support and direction to give sustainability to encourage the usage of clean or green energy and green technologies to reduce the depletion of natural resources and the negative impact of the linear economic activities in the traditional production systems.

The framework proposed by this study provides prospects to expand the frontiers of sustainability studies. First, the impact of the six layers of the onion (*i.e.* the sustainability drivers, sustainability agenda, domain penetration, industry infiltration, barriers, benefits and risks) on the financial and environmental or social performance of firms is still patchy. Consequently, future studies can explore this avenue. Two, though the long roots of the sustainability tree are reaching every industry and field of study, one cannot describe the extent of percolation in the soils of the fields and industries. Future studies can explore the degree of penetration of sustainability in various fields of study and industries. This will inform policymakers about the domain of study that is leading and lacking. Future studies can empirically investigate the effect of sustainability agendas on the SDGs. Four, future studies can explore the impact of the barriers or resources on implementing sustainable practices such as circular economy (CE) and reverse logistics (RL). Future studies should examine the effects of sustainability derivatives (such as CE and RL) on the sustainable supply chain and firm performance from the perspective of large and small businesses in developing economies. Six, future studies should explore the degree of usage of new business models such as CE, clean or green energy, and clean technology in emerging economies. Finally, since sectors differ in their operations, this study proposes that future studies may want to produce similar "onions" from the perspective of specific industries such as construction, pharmaceutical, automobile, medicine, textiles, beverages, mining, tourism, agriculture, engineering, *etc.* Future studies may also construct similar onions or specific frameworks for specific derivatives. For example, RL onion or CE onion may be proposed to illustrate the components of CE and RL.

6. Conclusion and limitations of the study

The holistic knowledge of the concept of sustainability is essential for successfully adopting and implementing the concept. In this study, several perspectives of the concept were discovered and further grouped into a comprehensive framework. The various insights gathered from existing literature were used to create the "sustainability onion," which provides an extensive perspective of the sustainability concept. Borrowing the "knife and onion" analogy, this study provided a panoramic view of a parent phenomenon and its progeny. This study presented a detailed description of the concept in terms of its drivers, agenda, percolations, strategies, barriers, benefits, and risks associated with its implementation. The sustainability onion comprises six (6) layers labelled sustainability drivers, the sustainability agenda formulation, domain penetration, industry infiltration, sustainability barriers, sustainability benefits, and sustainability risks. This onion is equivalent to the "research onion" by Saunders *et al.*[63] It provides a comprehensive insight into sustainability and its various derivatives. The model was constructed based on well-structured literature knowledge supplemented with industrial insights. Therefore, scholars and practitioners stand a chance to benefit from the insights provided by this onion. The general implication of this onion is that it structures the entire area of sustainability and provides a deep perspective of the concept originated and how it became a global, regional, national, and municipal agenda. It further explains how the concept has percolated into various academic and industrial domains. Finally, the model presents the barrier to successfully implementing sustainability, its benefits, and the risks of embracing the phenomenon. To the best of the researcher's knowledge, this is the first attempt to compressively structure the sustainability concept, its characteristics, and consequences in a single or distinct model. This framework provides scope for sustainability scholars to discover the possible research areas in sustainability.

Moreover, future studies in the sustainability domain may benefit from this onion regarding possible sustainability research. This study can aid firm managers by providing them with a panoramic view of sustainability, its characteristics and its derivatives. Also, previous studies illustrate that most companies, especially in developing countries, sacrifice the benefits of sustainability on the altar of economic benefits and that they only react (not proactive) to sustainability due to the uncertainties about sustainability. Hence, a study like this consolidates the knowledge in the area and especially assures firms in developing economies that they can overcome the qualms shrouded in the area.

This study is limited in that the study used only articles published in English. Moreover, the articles used in this study were mainly from Elsevier, Emerald, Springer, Wiley, and Taylor and Francis publishers. Future studies can consider studies in other equally relevant publishers.

Conflicts of interest

The author declared no conflicts of interest with respect to the research, authorship, and publication of this article.

Acknowledgements

The author wishes to express his profound gratitude to the five industry experts who participated in the study. Their invaluable contributions helped to trim the rugged edges of the sustainability onion. I also thank the three anonymous reviewers for their valuable contribution to the study.

References

1 *Statista*, **https//www.BusinessStatistics**, accessed, February 2023.
2 UNESCO, **https//www.statisticsandresources**, accessed October, 2023.
3 R. Aryee and E. Adaku, *Flex. Serv. Manuf. J.*, 2023, 1–30, DOI: **10.1007/s10696-023-09493-y**.
4 A. Cozzolino and P. De Giovanni, *Int. J. Logist. Manag.*, 2023, **34**(7), 24–49, DOI: **10.1108/IJLM-03-2022-0132**.
5 F. Alkaraan, M. Elmarzouky, K. Hussainey and V. G. Venkatesh, *Technol. Forecast. Soc. Change*, 2023, **187**, 122–187, DOI: **10.1016/j.techfore.2022.122187**.
6 C. C. Chen, F. M. Sukarsono and K. J. Wu, *J. Ind. Prod. Eng.*, 2023, 1–17, DOI: **10.1080/21681015.2022.2162616**.
7 D. Prat, A. Wells, J. Hayler, H. Sneddon, C. R. McElroy, S. Abou-Shehada and P. J. Dunn, *Green Chem.*, 2016, **18**(1), 288–296, DOI: **10.1039/C5GC01008J**.
8 B. L. Andrews, F. D. Antia, S. B. Brueggemeier, L. J. Diorazio, S. T. Koenig, M. E. Kopach and A. L. Watson, *J. Org. Chem.*, 2020, **86**(1), 49–61, DOI: **10.1021/acs.joc.0c02291**.
9 I. Andrews, J. Cui, J. DaSilva, L. Dudin, P. Dunn, J. Hayler and F. Zhang, *Org. Process Res. Dev.*, 2009, **13**(3), 397–408, DOI: **10.1021/op900082k**.
10 H. Fan, C. Chen, J. Lu, C. Tan, P. Wang, J. Hu and X. Huang, *Sep. Purif. Technol.*, 2024, **335**, 126196, DOI: **10.1016/j.seppur.2023.126196**.
11 P. B. Green, O. Segura Lecina, P. P. Albertini, M. A. Newton, K. Kumar, C. Boulanger and R. Buonsanti, *J. Am. Chem. Soc.*, 2024, **146**(15), 10708–10715, DOI: **10.1021/jacs.4c00538**.
12 P. R. Murthy and P. Selvam, *Chem. Rec.*, 2019, **19**(9), 1913–1925, DOI: **10.1002/tcr.201800109**.
13 S. G. Amos, D. Cavalli, F. Le Vaillant and J. Waser, *Angew. Chem.*, 2021, **133**(44), 24020–24027, DOI: **10.1002/ange.202110257**.
14 B. A. Serrano, L. C. Gheorghe, T. Exner, S. Resch, C. Wolf, M. Himly and I. Lynch, *RSC Sustainability*, 2024, **2**(5), 1378–1399, DOI: **10.1039/D3SU00148B**.
15 M. Arena, N. D. Ciceri, S. Terzi, I. Bengo, G. Azzone and M. Garetti, *Int. J. Prod. Lifecycle Manag.*, 2009, **4**(1–3), 207–251, DOI: **10.1504/IJPLM.2009.031674**.
16 J. Kirchherr, D. Reike and M. Hekkert, *Resour., Conserv. Recycl.*, 2017, **127**, 221–232, DOI: **10.1016/j.resconrec.2017.09.005**.
17 R. Sharma, C. J. C. Jabbour and A. B. Lopes de Sousa Jabbour, *J. Enterp. Inf. Manag.*, 2021, **34**(1), 230–266, DOI: **10.1108/JEIM-01-2020-0024**.
18 B. M. Brand, T. M. Rausch and J. Brandel, *Sustainability*, 2022, **14**, 9–5689, DOI: **10.3390/su14095689**.
19 T. M. Rausch, D. Baier and S. Wening, *J. Retail. Consum. Serv.*, 2021, **63**, 102681, DOI: **10.1016/j.jretconser.2021.102681**.
20 H. S. Kristensen and M. A. Mosgaard, *J. Cleaner Prod.*, 2020, **243**, 118531, DOI: **10.1016/j.jclepro.2019.118531**.
21 L. Seghezzo, *Environ. Polit.*, 2009, **18**(4), 539–556, DOI: **10.1080/09644010903063669**.
22 R. Agrawal, A. Majumdar, K. Majumdar, R. D. Raut and B. E. Narkhede, *Bus. Strateg. Environ.*, 2022, **31**(7), 3669–3687, DOI: **10.1002/bse.3057**.
23 C. P. Jayarathna, D. Agdas and L. Dawes, *Bus. Strateg. Environ.*, 2023, **32**(1), 704–720, DOI: **10.1002/bse.3170**.
24 S. A. R. Khan, Z. Yu, M. Umar and M. Tanveer, *Bus. Strateg. Environ.*, 2022, **31**(4), 1719–1729, DOI: **10.1002/bse.2979**.
25 M. A. Hoque, R. Rasiah, F. Furuoka and S. Kumar, *J. Fash. Mark. Manag.*, 2023, **27**(1), 182–200, DOI: **10.1108/JFMM-06-2021-0147**.
26 S. B. Park, *J. Cleaner Prod.*, 2023, 136012, DOI: **10.1016/j.jclepro.2023.136012**.
27 N. Van Buren, M. Demmers, R. Van der Heijden and F. Witlox, *Sustainability*, 2016, **8**(7), 647, DOI: **10.3390/su8070647**.
28 B. J. De Vries and A. C. Petersen, *Ecol. Econ.*, 2009, **68**(4), 1006–1019, DOI: **10.1016/j.ecolecon.2008.11.015**.
29 J. Kirchherr, N. H. N. Yang, F. Schulze-Spüntrup, M. J. Heerink and K. Hartley, *Resour., Conserv. Recycl.*, 2023, **194**, 107001, DOI: **10.1016/j.resconrec.2023.107001**.
30 T. Kuhlman and J. Farrington, *Sustainability*, 2010, **2**(11), 3436–3448, DOI: **10.3390/su2113436**.
31 D. Dienes, R. Sassen and J. Fischer, *Sustain. Account. Manag. Policy J.*, 2016, **7**(2), 154–189, DOI: **10.1108/SAMPJ-08-2014-0050**.
32 T. Häkkinen and K. Belloni, *Build. Res. Inf.*, 2011, **39**(3), 239–255, DOI: **10.1080/09613218.2011.561948**.
33 P. A. Owusu and S. Asumadu-Sarkodie, *Cogent Eng.*, 2016, **3**(1), 1167990, DOI: **10.1080/23311916.2016.1167990**.
34 S. Piramanayagam, J. Mallya and V. Payini, *Worldw. Hosp. Tour. Themes*, 2023, **15**(3), 254–268, DOI: **10.1108/WHATT-02-2023-0021**.
35 W. Leal Filho, L. Viera Trevisan, M. A. P. Dinis, S. Sivapalan, Z. Wahaj and O. Liakh, *Int. J. Sustain. High. Educ.*, 2023, **24**(7), 1416–1429, DOI: **10.1108/IJSHE-10-2022-0333**.
36 M. E. Rector, R. Filgueira, M. Bailey, T. R. Walker and J. Grant, *Rev. Aquac.*, 2023, **15**(2), 840–852, DOI: **10.1111/raq.12763**.
37 S. Piramanayagam, J. Mallya and V. Payini, *Worldw. Hosp. Tour. Themes*, 2023, **15**(3), 254–268, DOI: **10.1108/WHATT-02-2023-0021**.
38 *United Nations Brundtland Report*, **http://www.undocuments.net/our-common-future.pdf**, accessed on November 2019.

39 M. Alkahtani, A. Ziout, B. Salah, M. Alatefi, A. E. E. Abd Elgawad, A. Badwelan and U. Syarif, *Sustainability*, 2021, **13**(2), 548, DOI: **10.3390/su13020548**.
40 T. Rebs, M. Brandenburg and S. Seuring, *J. Cleaner Prod.*, 2019, **208**, 1265–1280, DOI: **10.1016/j.jclepro.2018.10.100**.
41 T. Gruchmann and S. Seuring, *Int. J. Logist. Manag.*, 2018, **29**(4), 1255–1278, DOI: **10.1108/IJLM-08-2017-0200**.
42 M. J. Maes, K. E. Jones, M. B. Toledano and B. Milligan, *Environ. Sci. Policy*, 2019, **93**, 181–188, DOI: **10.1016/j.envsci.2018.12.010**.
43 V. Mani, R. Agrawal and V. Sharma, *Procedia Soc. Behav. Sci.*, 2015, **189**, 234–251, DOI: **10.1016/j.sbspro.2015.03.219**.
44 S. Ahmad, K. Y. Wong and S. I. Butt, *Environ. Sci. Pollut. Res.*, 2023, **30**(15), 43068–43095, DOI: **10.1007/s11356-022-22172-z**.
45 K. F. Yuen, K. W. Ong, Y. Zhou and X. Wang, *J. Cleaner Prod.*, 2023, **382**, 135375, DOI: **10.1016/j.jclepro.2022.135375**.
46 A. L. Cunha Callado and J. E. Fensterseifer, *Int. J. Bus. Insights Transf.*, 2011, **3**(3), 44–53, DOI: **10.3390/su12104108**.
47 A. Zakari, L. Khan, D. Tan, R. Alvarado and V. Dagar, *Energy*, 2022, **239**, 122365, DOI: **10.1016/j.energy.2021.122365**.
48 E. Desiderio, L. García-Herrero, D. Hall, A. Segrè and M. Vittuari, *ustain. Prod. Consum.*, 2022, **30**, 527–540, DOI: **10.1016/j.spc.2021.12.015**.
49 D. O. Morais and B. S. Silvestre, *J. Cleaner Prod.*, 2018, **199**, 222–235, DOI: **10.1016/j.jclepro.2018.07.097**.
50 Y. Xiao and M. Watson, *J. Plan. Educ. Res.*, 2019, **39**(1), 93–112, DOI: **10.1177/0739456X17723**.
51 L. Guandalini, *J. Bus. Res.*, 2022, **148**, 456–471, DOI: **10.1016/j.jbusres.2022.05.003**.
52 R. Chalmeta and N. J. Santos-deLeon, *Sustainability*, 2020, **12**, 10–4108, DOI: **10.3390/su12104108**.
53 K. Govindan and M. Bouzon, *J. Cleaner Prod.*, 2018, **187**, 318–337, DOI: **10.1016/j.jclepro.2018.03.040**.
54 R. Osei-Kyei and A. P. Chan, *Int. J. Proj. Manag.*, 2015, **33**(6), 1335–1346, DOI: **10.1016/j.ijproman.2015.02.008**.
55 R. Pansare, G. Yadav, K. M and M. R. Nagare, *J. Eng. Des. Technol.*, 2023, **21**(1), 228–265.
56 Y. M. H. Hazaa, F. A. Almaqtari and A. Al-Swidi, *Cogent Business & Management*, 2021, **8**(1), 1878979, DOI: **10.1080/23311975.2021.1878979**.
57 C. Nuss, R. Sahamie and D. Stindt, *Int. J. Manag. Rev.*, 2015, **17**(4), 413–436, DOI: **10.1111/ijmr.12046**.
58 M. N. K. Saunders, P. Lewis, A. Thornhill and A. Bristow, *Understanding Research Philosophy and Approaches to Theory Development*, Pearson Education Harlow, 2015, **http://catalogue.pearsoned.co.uk/educator/product/**.
59 N. Umeokafor, T. Umar and K. Evangelinos, *Saf. Sci.*, 2022, **156**, 105897, DOI: **10.1016/j.ssci.2022.105897**.
60 N. Kazemi, N. M. Modak and K. Govindan, *Int. J. Prod. Res.*, 2019, **57**(15–16), 4937–4960, DOI: **10.1080/00207543.2018.1471244**.
61 R. Gill, *Discourse Analysis. Qualitative Researching with Text, Image and Sound*, Sage, London, 2000.
62 H. Abedinnia, C. H. Glock and M. D. Schneider, *Appl. Math. Model.*, 2017, **50**, 279–299, DOI: **10.1039/D3SU00382E**.
63 M. Saunders, and P. Lewis and A. Thornhill, *Doing Research in Business and Management*, Pearson, London, 2017.
64 Y. K. Dwivedi, L. Hughes, A. K. Kar, A. M. Baabdullah, P. Grover, R. Abbas and M. Wade, *Int. J. Inf. Manag.*, 2022, **63**, 102456, DOI: **10.1016/j.ijinfomgt.2021.102456**.
65 A. Salam, Internet of Things for Environmental Sustainability and Climate Change, In *Internet of Things for Sustainable Community Development. Internet of Things*, Springer, Cham, 2020, DOI: **10.1007/978-3-030-35291-2_2**.
66 C. S. Opuala, P. C. Omoke and E. Uche, *Int. J. Environ. Sci. Technol.*, 2023, **20**(1), 423–436, DOI: **10.1007/s13762-022-04019-9**.
67 M. Ashrafi, T. R. Walker, G. M. Magnan, M. Adams and M. Acciaro, *Marit. Policy Manag.*, 2020, **47**(8), 1027–1044, DOI: **10.1080/03088839.2020.1736354**.
68 S. Sachdeva, J. Jordan and N. Mazar, *Curr. Opin. Psychol.*, 2015, **6**, 60–65, DOI: **10.1016/j.copsyc.2015.03.029**.
69 C. T. Cassamo, D. Draper, M. M. Romeiras, I. Marques, R. Chiulele, M. Rodrigues and J. C. Ramalho, *Agric. Ecosyst. Environ.*, 2023, **346**, 108341, DOI: **10.1016/j.agee.2022.108341**.
70 C. S. Opuala, P. C. Omoke and E. Uche, *Int. J. Environ. Sci. Technol.*, 2023, **20**(1), 423–436, DOI: **10.1007/s13762-022-04019-9**.
71 Y. He, X. Li, P. Huang and J. Wang, *Sustainability*, 2022, **14**(3), 1579, DOI: **10.3390/su14031579**.
72 C. Y. Zhang and T. Oki, *Agric. Water Manag.*, 2023, **275**, 108045, DOI: **10.1016/j.agwat.2022.108045**.
73 A. Bello-Pintado, J. A. Machuca and P. Danese, *Bus. Strateg. Environ.*, 2023, **32**(7), 4084–4102, DOI: **10.1002/bse.3355**.
74 B. Latif, Z. Mahmood, O. Tze San, R. Mohd Said and A. Bakhsh, *Sustainability*, 2020, **12**, 11–4506, DOI: **10.3390/su12114506**.
75 S. Jia, *Sustainability*, 2021, **13**, 9–4981, DOI: **10.3390/su13094981**.
76 S. Sachdeva, J. Jordan and N. Mazar, *Curr. Opin. Psychol.*, 2015, **6**, 60–65, DOI: **10.1016/j.copsyc.2015.03.029**.
77 Q. Zhu and J. Sarkis, *Int. J. Prod. Econ.*, 2016, **181**, 289–302, DOI: **10.1016/j.ijpe.2016.06.006**.
78 R. Aryee and E. Adaku, *J. Manuf. Technol. Manag.*, 2023, **34**(3), 435–454, DOI: **10.1108/JMTM-06-2022-0226**.
79 L. M. Fonseca, J. P. Domingues and A. M. Dima, *Sustainability*, 2020, **12**, 8–3359, DOI: **10.3390/su12083359**.
80 J. Elkington, *Cannibals with Forks: The Triple Bottom Line of 21st Century Business*, John Wiley and Sons, London, UK, 1987.
81 UN-SDGs, *United Nations Sustainable Development Goals Platform*, 2019, **https://sustainabledevelopment.un.org/?menu¼1300**, accessed on February 2020.
82 L. D'Adamo, M. Gastaldi and P. Morone, *J. Cleaner Prod.*, 2022, **354**, 131730, DOI: **10.1016/j.jclepro.2022.131730**.
83 G. Nhamo, *Sustain. Dev.*, 2017, **25**(3), 227–241, DOI: **10.1002/sd.1648**.
84 D. Streimikiene and G. Šivickas, *Environ. Int.*, 2008, **34**(8), 1227–1240, DOI: **10.1016/j.envint.2008.04.008**.

85 R. B. Noland and L. L. Lem, *Transp. Res. D Trans. Environ.*, 2002, **7**(1), 1–26, DOI: **10.1016/S1361-9209(01)00009-8**.
86 R. B. Isaksson, R. Garvare and M. Johnson, *International Journal of Productivity and Performance Management*, 2015, **64**(3), 334–355, DOI: **10.1108/IJPPM-09-2014-0139**.
87 A. P. Barbosa-Póvoa, C. da Silva and A. Carvalho, *Eur. J. Oper. Res.*, 2018, **268**(2), 399–431, DOI: **10.1016/j.ejor.2017.10.036**.
88 T. H. Eriksen, *Sustainability*, 2022, **14**(6), 36–74, DOI: **10.3390/su14063674**.
89 S. Turner, T. Kinnaird, E. Koparal, S. Lekakis and C. Sevara, *World Archaeol.*, 2020, **52**(4), 589–606, DOI: **10.1080/00438243.2021.1932565**.
90 S. Baumgärtner and M. Quaas, *Ecol. Econ.*, 2010, **69**(3), 445–450, DOI: **10.1016/j.ecolecon.2009.11.019**.
91 B. Fu, *Geogr. Sustain.*, 2020, **1**(1), 1–7, DOI: **10.1016/j.geosus.2020.02.003**.
92 J. Blaustein, N. W. Pino, K. Fitz-Gibbon and R. White, *Brit. J. Criminol.*, 2018, **58**(4), 767–786, DOI: **10.1093/bjc/azx061**.
93 B. Kopilovic, A. I. Valente, A. M. Ferreira, M. R. Almeida, A. P. Tavares, M. G. Freire and J. A. Coutinho, *RSC Sustainability*, 2023, **1**, 1314–1331, DOI: **10.1039/D3SU00062A**.
94 J. Becker, C. Manske and S. Randl, *Curr. Opin. Green Sustainable Chem.*, 2022, **33**, 100562, DOI: **10.1016/j.cogsc.2021.100562**.
95 T. Welton, *Curr. Opin. Green Sustainable Chem.*, 2018, **13**, A7–A9, DOI: **10.1016/j.cogsc.2018.09.005**.
96 T. Welton, *Natl. Sci. Rev.*, 2021, **8**(5), nwab037, DOI: **10.1093/nsr/nwab037**.
97 H. B. Kim, J. I. Yoo, S. C. Kang and J. K. Song, *Small*, 2024, **20**(4), 2304051, DOI: **10.1002/smll.202304051**.
98 I. Kekessie, K. Wegner, I. Martinez, M. E. Kopach, T. D. White, J. K. Tom, J. K. Kenworthy, L. J. van den Bos and L. J. Martin, *J. Org. Chem.*, 2024, **89**(7), 4261–4282, DOI: **10.1021/acs.joc.3c01494**.
99 D. Bhanderi, P. Lakhani and C. K. Modi, *RSC Sustainability*, 2024, **2**, 265–287, DOI: **10.1039/D3SU00382E**.
100 R. F. De Gregorio, R. Prado, C. Vriamont, X. Erdocia, J. Labidi, J. P. Hallett and T. Welton, *ACS Sustain. Chem. Eng.*, 2016, **4**(11), 6031–6036, DOI: **10.1021/acssuschemeng.6b01339**.
101 K. Periyapperuma, J. M. Pringle, L. Sanchez-Cupido, M. Forsyth and C. Pozo-Gonzalo, *Green Chem.*, 2021, **23**(9), 3410–3419, DOI: **10.1039/D1GC00361E**.
102 R. Golmohammadzadeh, F. Faraji, B. Jong, C. Pozo-Gonzalo and P. C. Banerjee, *Renew. Sustain. Energy Rev.*, 2022, **159**, 112202, DOI: **10.1016/j.rser.2022.112202**.
103 S. S. Chai, W. B. Zhang, J. L. Yang, L. Zhang, M. M. Theint, X. L. Zhang and X. J. Ma, *RSC Sustainability*, 2023, **1**(1), 38–71, DOI: **10.1039/D2SU00054G**.
104 C. Pozo-Gonzalo, *RSC Sustainability*, 2023, **1**(4), 662–664, DOI: **10.1039/D3SU90020G**.
105 S. L. Piper, C. M. Forsyth, M. Kar, C. Gassner, R. Vijayaraghavan, S. Mahadevan and D. R. MacFarlane, *RSC Sustainability*, 2023, **1**(3), 470–480, DOI: **10.1039/D2SU00111J**.
106 K. S. Raju, G. S. Das and K. M. Tripathi, *RSC Sustainability*, 2024, **2**(1), 223–232, DOI: **10.1039/D3SU00343D**.
107 S. P. M. Ung and C. J. Li, *RSC Sustainability*, 2023, **1**(1), 11–37, DOI: **10.1039/D2SU00015F**.
108 A. Fildani and A. M. Hessler, *Sediment. Rec.*, 2021, **19**(2), 1–4.
109 P. S. Ringrose, *Pet. Geosci.*, 2017, **23**(3), 287–297, DOI: **10.1144/petgeo2016-060**.
110 A. M. Mazotto, J. de Ramos Silva, L. A. A. de Brito, N. U. Rocha and A. de Souza Soares, *Environ. Technol. Inno.*, 2021, **23**, 101760, DOI: **10.1016/j.eti.2021.101760**.
111 K. T. Kit, *Int. J. Comput. Inf. Eng.*, 2022, **16**(4), 112–115, DOI: **10.3390/su12104108**.
112 M. Manna and S. Sen, *Environ. Sci. Pollut. Res.*, 2023, **30**(10), 25477–25505, DOI: **10.1007/s11356-022-19435-0**.
113 A. Paravar, R. Piri, H. Balouchi and Y. Ma, *Biotechnol. Rep.*, 2023, e00781, DOI: **10.1016/j.btre.2023.e00781**.
114 M. Stanitsas and K. Kirytopoulos, *Int. J. Constr. Manag.*, 2023, **23**(3), 434–448, DOI: **10.1080/15623599.2021.1887718**.
115 R. Maqbool, J. R. Namaghi, Y. Rashid and A. Altuwaim, *Ain Shams Eng. J.*, 2023, **14**(4), 101943, DOI: **10.1016/j.asej.2022.101943**.
116 M. R. Gleim, H. McCullough, N. Sreen and L. G. Pant, *J. Retail. Consum. Serv.*, 2023, **70**, 103124, DOI: **10.1016/j.jretconser.2022.103124**.
117 B. Nguyen-Viet, *Asia-Pac. J. Bus. Adm.*, 2023, **15**(1), 96–116, DOI: **10.1108/APJBA-08-2021-0398**.
118 C. Sukmadilaga, S. Winarningsih, L. Yudianto, T. U. Lestari and E. K. Ghani, *Int. J. Energy Econ. Policy*, 2023, **13**(2), 509, DOI: **10.32479/ijeep.14071**.
119 S. A. A. Bukhari, F. Hashim and A. Amran, *Int. J. Environ. Sustain. Dev.*, 2023, **22**(1), 13–31, DOI: **10.1504/IJESD.2023.127419**.
120 C. Jiakui, J. Abbas, H. Najam, J. Liu and J. Abbas, *J. Cleaner Prod.*, 2023, **382**, 135131, DOI: **10.1016/j.jclepro.2022.135131**.
121 N. Han and J. Um, *Risk Manag.*, 2024, **26**(2), 6, DOI: **10.1057/s41283-023-00138-w**.
122 C. Liao, J. Liu and A. Agrawal, *Sustain. Sci.*, 2024, **19**(1), 361–372, DOI: **10.1007/s11625-023-01422-0**.
123 M. N. Ahmad, X. Zhou, S. Muhammad and M. S. Shabbir, *Environ. Dev. Sustain.*, 2024, 1–11, DOI: **10.1007/s10668-024-04601-w**.
124 L. Van Boven and M. G. Burgess, *Clim. Change*, 2024, **177**(4), 1–6, DOI: **10.1007/s10584-024-03727-0**.
125 M. M. Hohn and C. F. Durach, *Int. J. Phys. Distrib. Logist. Manag.*, 2023, **53**(1), 13–34, DOI: **10.1108/IJPDLM-09-2021-0410**.
126 R. Aryee, E. Adaku, S. Quayson and E. O. A. Tetteh, *Bus. Strategy Dev.*, 2024, **7**(2), e364.
127 Z. M. Yingfei, L. Zeyu, B. Ki-Hyung, A. A. R. N. Avotra and A. Nawaz, *J. King Saud Univ. Sci.*, 2022, **34**(1), 101683, DOI: **10.1016/j.jksus.2021.101683**.
128 H. Moustafa, A. M. Youssef, N. A. Darwish and A. I. Abou-Kandil, *Composites, Part B*, 2019, **172**, 16–25, DOI: **10.1016/j.compositesb.2019.05.048**.

129 Y. Agyabeng-Mensah, E. Ahenkorah, E. Afum, E. Dacosta and Z. Tian, *Int. J. Logist. Manag.*, 2020, **31**(3), 549–574, DOI: **10.1108/IJLM-10-2019-0275**.

130 A. M. Dimand, *International Journal of Public Sector Management*, 2022, **35**(5), 584–602, DOI: **10.1108/IJPSM-10-2021-0239**.

131 M. Umar, S. A. R. Khan, H. M. Zia-ul-haq, M. Y. Yusliza and K. Farooq, *TQM J.*, 2022, **34**(2), 232–249, DOI: **10.1108/TQM-06-2021-0172**.

132 N. Li and H. H. Padwal, *The Electronic Library*, 2020, **38**(5/6), 997–1011, DOI: **10.1108/EL-07-2020-0210**.

133 S. Adomako, C. Simms, D. Vazquez-Brust and H. T. Nguyen, *Br. J. Manag.*, 2023, **34**(1), 299–320, DOI: **10.1111/1467-8551.12595**.

134 J. Korhonen, C. Nuur, A. Feldmann and S. E. Birkie, *J. Cleaner Prod.*, 2018, **175**, 544–552, DOI: **10.1016/j.jclepro.2017.12.111**.

135 S. A. Neves and A. C. Marques, *J. Cleaner Prod.*, 2022, **341**, 130865, DOI: **10.1016/j.jclepro.2022.130865**.

136 Y. Vasseghian, S. W. Joo, E. N. Dragoi, H. Kamyab, S. Chelliapan and J. J. Klemeš, *J. Cleaner Prod.*, 2022, 132702, DOI: **10.1016/j.jclepro.2022.132702**.

137 M. Madaleno, E. Dogan and D. Taskin, *Energy Econ.*, 2022, **109**, 105945, DOI: **10.1016/j.eneco.2022.105945**.

138 V. D. Kuppig, Y. C. Cook, D. A. Carter, N. J. Larson, R. E. Williams and B. I. Dvorak, *J. Cleaner Prod.*, 2016, **139**, 1529–1538, DOI: **10.1016/j.jclepro.2016.08.167**.

139 H. Alhassan and P. A. Kwakwa, *Management of Environmental Quality: An International Journal*, 2023, **34**(3), 605–623, DOI: **10.1108/MEQ-07-2022-0192**.

140 J. P. Hess, *Int. J. Organ. Anal.*, 2022, **30**(3), 760–777, DOI: **10.1108/IJOA-01-2020-2011**.

141 T. Y. Baah-Ennumh and J. A. Forson, *World J. Entrep. Manag. Sustain. Dev.*, 2017, **13**(3), 204–222, DOI: **10.1108/WJEMSD-09-2016-0042**.

142 P. J. Daugherty, R. G. Richey, S. E. Genchev and H. Chen, *Transp. Res. E: Logist. Transp. Rev.*, 2005, **41**(2), 77–92, DOI: **10.1016/j.tre.2004.04.002**.

143 D. F. Frey and G. MacNaughton, *Sage Open*, 2016, **6**(2), 2158244016649580, DOI: **10.1177/2158244016649580**.

144 S. Cop, U. V. Alola and A. A. Alola, *Bus. Strateg. Environ.*, 2020, **29**(8), 3495–3508, DOI: **10.1002/bse.2592**.

145 O. Boiral, D. Talbot and M. C. Brotherton, *Bus. Strateg. Environ.*, 2020, **29**(6), 2557–2571, DOI: **10.1002/bse.2520**.

146 D. Choudhary and I. Nandy, *Compet. Rev.*, 2024, DOI: **10.1108/CR-11-2023-0277**.

147 V. Kumar, R. Raj, P. Verma, J. A. Garza-Reyes and B. Shah, *Oper. Manag. Res.*, 2024, **17**(1), 233–252, DOI: **10.1007/s12063-023-00424-6**.

148 N. M. Nickel and M. C. Rodriguez, *Omega*, 2002, **30**(1), 1–18, DOI: **10.1016/S0305-0483(01)00055-X**.

149 M. Xu, Y. Cui, M. Hu, X. Xu, Z. Zhang, S. Liang and S. Qu, *J. Cleaner Prod.*, 2019, **225**, 857–867, DOI: **10.1016/j.jclepro.2019.03.307**.

150 W. Cramer, J. Guiot, M. Fader, J. Garrabou, J. P. Gattuso, A. Iglesias and E. Xoplaki, *Nat. Clim. Change*, 2018, **8**(11), 972–980, DOI: **10.1038/s41558-018-0299-2**.

151 J. Lackmann, J. Ernstberger and M. Stich, *J. Bus. Ethics*, 2012, **107**, 111–128, DOI: **10.1007/s10551-011-1026-3**.

152 A. Kwarteng, S. N. Y. Simpson and C. Agyenim-Boateng, *Soc. Responsib. J.*, 2022, **18**(7), 1311–1341, DOI: **10.1108/SRJ-01-2021-0045**.

153 C. Isensee, F. Teuteberg, K. M Griese and C. Topi, *J. Cleaner Prod.*, 2020, **275**, 122944, DOI: **10.1016/j.jclepro.2020.122944**.