Research Policy 55 (2026) 105533

Contents lists available at ScienceDirect

Research Policy

journal homepage: www.elsevier.com/locate/respol

Business model innovation for disruptive sustainability: A theorizing review on how interdependencies between business model components reshape the problem-solution nexus☆

Maria Schmidt [a,*], Aoife Brophy [b,c], Philipp Trotter [b,d,e]

[a] Institute for Technology and Innovation Management, RWTH Aachen University, Kackertstraße 7, 52072, Aachen, Germany
[b] Smith School of Enterprise and the Environment, University of Oxford, South Parks Road, OX1 3QY, Oxford, United Kingdom
[c] Said Business School, University of Oxford, Park End Street, OX1 1HP, Oxford, United Kingdom
[d] Schumpeter School of Business and Economics, University of Wuppertal, Gaußstraße 20, 42119, Wuppertal, Germany
[e] African Institute of Sustainable Energy and Systems Analysis (AISESA), Cor des Almadies, Dakar, Senegal

ARTICLE INFO

Keywords:
Disruptive sustainability
Business model innovation
Sustainable development
Low-income countries
Last mile
Review

ABSTRACT

Global sustainability challenges demand large, rapid and systemic transformation of the systems that underpin modern life. Disruption is increasingly discussed as a trigger of these transformations, but the drivers of disruption have remained unclear. While much of the existing literature focuses on technological innovation as a potential driver, limited although growing attention has been paid to non-technological sources. This paper explores business model innovation as a non-technological driver of disruptive sustainability. We define disruptive sustainability as far-reaching changes in more than one dimension of socio-technical systems, triggered by a high-intensity effect, towards realising environmental, social and economic goals. We conduct a theorizing review of academic literature on the last mile in low-income and lower-middle income countries. We develop an explanatory model of how interdependencies between business model innovation components drive disruptive sustainability by re-defining the problem-solution nexus at different depths. Our contributions are threefold. First, we expand the conceptualization of disruptive sustainability by unpacking the crucial aspect of depth of change. We suggest that disruptions can trigger shallow, medium or deep change within and across dimensions of socio-technical systems. Second, we explain how the interdependencies between different business model innovation components drive disruptive sustainability by changing the problem-solution nexus at different depths. Third, based on these contributions, we develop a tool which guides stakeholders in driving disruptive sustainability in three distinct steps linked to different degrees of depth.

1. Introduction

Global sustainability challenges such as climate change, biodiversity loss and food insecurity demand sustainability transitions, often defined as far-reaching changes in socio-technical systems towards realising environmental, social and economic goals (Markard et al., 2012; Köhler et al., 2019). Disruption is increasingly discussed as a trigger of such changes. It was originally theorized in innovation studies to describe how new entrants challenge incumbent actors by introducing novel, superior value propositions (Christensen, 1997; Tushman and Anderson, 1986). More recently, disruption has been positioned as crucial to sustainability transitions because of its ability to drive rapid system-level change (Kivimaa et al., 2021; Tarlan et al., 2024; Geels, 2018a). There are five dimensions of disruption, namely technology and infrastructure, markets and business models, regulations and policy, actors, networks and ownership structures, and/or behaviours, practices, and cultural models (Kivimaa et al., 2021). Discontinuities set in motion particularly broad and rapid change (Kivimaa et al., 2021; Streeck and Yamamura, 2003). In this context, we build closely on Kivimaa et al. (2021) and define *disruptive sustainability* as far-reaching changes in socio-technical systems towards realising environmental, social and economic goals, triggered by a high-intensity effect in more than one dimension of technology and infrastructure, markets and business models, regulations and policy, actors, networks and ownership structures, and/or

☆ This article is part of a Special issue entitled: 'Towards Disruptive Sustainability' published in Research Policy.

* Corresponding author.
E-mail addresses: Maria.schmidt@time.rwth-aachen.de (M. Schmidt), Aoife.brophy@sbs.ox.ac.uk (A. Brophy), Philipp.trotter@smithschool.ox.ac.uk (P. Trotter).

https://doi.org/10.1016/j.respol.2026.105533
Received 12 September 2024; Received in revised form 17 April 2026; Accepted 16 May 2026
Available online 11 June 2026

behaviours, practices, and cultural models. That is, disruptive sustainability is the subset of sustainability transitions (Markard et al., 2012; Köhler et al., 2019) which are triggered by a disruption (high-intensity effect) across dimensions. Arguably, disruptive sustainability is especially critical in low-income and lower-middle income countries (LMICs), where sustainability gaps such as secure access to sufficient food, clean water, health care and electricity are the largest, most pressing and most structurally entrenched (World Bank, 2022; Trotter et al., 2023).

However, despite an increased understanding of disruptive sustainability, existing literature has paid limited conceptual and empirical attention to its drivers (Kivimaa et al., 2021; Tarlan et al., 2024; Geels, 2018b; McDowall, 2018; Kuokkanen et al., 2019). While analytical approaches have somewhat widened recently to include more system-wide factors, the literature continues to focus on technological innovations as drivers of disruptive sustainability (Kivimaa et al., 2021; Tarlan et al., 2024), building on the close connection to the concept of disruption from the innovation literature. Yet, while this focus produces important insights, it is often limited in its ability to study different system dimensions, with changes in behaviours, practices and cultural models being a particular blind spot (Kivimaa et al., 2021; Kuokkanen et al., 2019). Other, non-technological sources such as novel approaches to farming, cooking or mobility have been argued to have high potential for cross-dimensional disruption and are beginning to receive increasing conceptual and empirical attention (Kivimaa et al., 2021; Mylan et al., 2019).

To address this gap, this paper investigates a potential non-technological source of disruptive sustainability, namely business model innovation (BMI). BMI has recently been proposed as a promising lens to understand the potential for disruptions that extend beyond the firm (Snihur and Bocken, 2022). Rather than seeing a business model (BM) as a passive dimension to be disrupted (Kivimaa et al., 2021; Tarlan et al., 2024), examples such as community energy or the sharing economy suggest that BMI may itself be a source of disruptions in systems: Innovative business models re-define value creation (Martin, 2016), alter actor networks (Wainstein and Bumpus, 2016), create new markets (Trotter and Brophy, 2022), and, in some cases, cause shifts towards sustainability beyond their original sector (Lazarevic and Valve, 2020). Specifically, we conduct a systematic and theorizing review of academic literature on last mile BMI in LMICs to explore the connection between BMI and disruptive sustainability. The term "last mile" means people and often remote rural areas or regions where "development needs are greatest, and where resources are most scarce" (Pedrajas and Choritz, 2016, p.3). While "last mile" innovation may sound incremental, the opposite is usually true: By directly providing first-time access to basic goods and services with immediate sustainable development impact such as energy access (Sustainable Development Goal (SDG) 7), water access (SDG 6), personal banking (SDG 8), cooling to avoid food loss (SDG 12, SDG 13), quality education (SDG 4) or modern health care (SDG 3), successful last-mile BMI causes a discontinuity that triggers substantive change in established markets, actors and networks, as well as behaviours, practices, and cultural models (Trotter and Brophy, 2022; Diochon and Ghore, 2016). Following our definition, the reviewed articles thus describe cases where BMI drives disruptive sustainability: it drives a high-intensity effect (i.e. first-time access to basic goods and services) which triggers far-reaching changes across multiple socio-technical system dimensions while realising sustainability goals. Importantly, last-mile BMI does not have to coincide with technological innovation or policy changes but could originate from entrepreneurial activities largely based on existing technologies and within existing policy regimes (Trotter and Brophy, 2022; Goyal et al., 2017; Palaon et al., 2020).

We contribute to the literature by developing an explanatory model that shows how BMI drives disruptive sustainability. This allows us to make two key theoretical and one practitioner-oriented contribution. First, we expand the conceptualization of disruptive sustainability by unpacking the dimension of depth of change. While the literature has mainly conceptualized disruptions in terms of speed and breadth of change (Kivimaa et al., 2021; Johnstone et al., 2020; Johnstone and Kivimaa, 2018), our results illustrate how disruptions may trigger change at different depths from shallow to deep within and across dimensions. This links to the systems intervention literature which suggests that fundamental system shifts are more likely where deep change occurs, namely in the rules, norms and/or goals of a system (Meadows, 1999; Abson et al., 2017; Luederitz et al., 2017). Second, our findings show how the interdependencies between different BMI components drive disruptive sustainability at different depths. The degree of depth is associated with the extent to which the BMI component interdependencies reshape the problem-solution nexus. We show that BMs are not just a separate domain to be disrupted (Kivimaa et al., 2021; Bidmon and Knab, 2018), but that BMI can be a source of disruptive sustainability. Third, our results and theoretical contributions allow us to develop a tool that guides different key stakeholders in designing system-level innovation approaches to drive disruptive sustainability.

2. Background

2.1. Disruptive sustainability

The concept of disruption originated in the innovation management literature of the 1980s and 1990s (Christensen, 1997; Tushman and Anderson, 1986). Christensen introduced disruption as a process where new entrants challenge incumbent firms by offering products or services that reach new market segments (Christensen, 1997; Christensen and Raynor, 2003). Early work focused on "disruptive technology" (Christensen, 1997), emphasizing the potential of new technologies to undermine established industry leaders who pursue more incremental types of innovation to cement existing market leadership (Abernathy and Clark, 1985; Christensen and Rosenbloom, 1995; Si and Chen, 2020; Ferràs-Hernández et al., 2017). Scholars subsequently broadened the concept, with disruptive innovation comprising products and business strategies in addition to technological advancements (Markides, 2006; Hang et al., 2015; Ho and Chen, 2018).

Motivated by its ability to overcome incumbent structures, a growing body of literature has sought to explore how disruption can enable sustainability transitions (Kivimaa et al., 2021; Ripple et al., 2020; Waddell, 2016), especially when they offer scalable solutions with positive ecological, economic, and social outcomes (Tarlan et al., 2024; Turker and Ozdemir, 2020). Moving beyond the general disruption literature's technological focus (Bower and Christensen, 1995), the recent and emerging literature on sustainable disruption explores areas including renewable energy technologies or electric vehicles from an increasingly holistic perspective (Kuokkanen et al., 2019; Sovacool et al., 2019). This perspective is important to ensure that socio-institutional and cultural factors are given adequate weight alongside techno-economic aspects in shaping sustainability transitions (Kivimaa et al., 2021; Coenen et al., 2012; Markard and Truffer, 2008).

In response to this emerging empirical work, several recent conceptual papers have examined the broader role disruption can play for sustainability transitions (Kivimaa et al., 2021; Tarlan et al., 2024; Geels, 2018a). Sustainability transitions are defined as far-reaching shifts to new kinds of socio-technical systems (Markard et al., 2012; Köhler et al., 2019), where socio-technical systems describe the state of and interplay between system components including technology, infrastructure, industry, markets, user preferences, science and policy (Geels, 2018a, 2004). This perspective broadens the view of disruption from individual technologies or firms to encompass system-wide changes involving multiple actors, institutions, and societal practices (Kivimaa et al., 2021; Geels, 2018a). Building closely on Kivimaa et al. (2021), we define *disruptive sustainability* as far-reaching changes in socio-technical systems towards realising environmental, social and economic goals, triggered by a high-intensity effect in more than one

dimension of technology and infrastructure, markets and business models, regulations and policy, actors, networks and ownership structures, and/or practices, behaviour and cultural models. In essence, this combines the concepts of sustainability transitions with disruptions by implying that disruptive sustainability are those sustainability transitions (Markard et al., 2012; Köhler et al., 2019) which are triggered by disruptions (high-intensity effects) across different dimensions. In keeping with Kivimaa et al. (2021), different types of disruptive sustainability have been conceptualized according to the associated breadth and speed of change (Kivimaa et al., 2021). Firstly, Kivimaa et al. (2021) assert that a broad change implies that several of the dimensions of disruptive sustainability are affected, namely technology and infrastructure, markets and business models, regulations and policy, actors, networks and ownership structures, and/or practices, behaviour and cultural models (Kivimaa et al., 2021). Crucially, because of the systemic nature of disruptions for sustainability transitions, non-linear feedback loops exist that imply that technologies, policies or other factors can be both a source of disruption as well as an outcome as part of a shifting socio-technical system (Kivimaa et al., 2021). For instance, technological disruptions such as electric vehicles with their ability to provide grid stabilisation services to local network operators can disrupt established incumbent combustion engine technologies and mobility infrastructure, as well as automotive and energy markets, business models and underlying policy regimes (Uddin et al., 2018). Similarly, actors and networks can also either be a dimension that is being disrupted, for instance through integrating grid operators into incumbent automotive industry networks (Kivimaa et al., 2021; Skeete, 2018), or themselves cause disruptions, such as when new entrants with certain skill sets develop disruptive technologies (Geels, 2018a). Finally, disruption can change individual behaviours (e.g. electric vehicles change fuelling behaviours (Hoekstra et al., 2017)), socially embedded practices (e.g. lifestyle changes linked to choosing cycling instead of car-based commuting for urban transport (Valentini et al., 2023)) and underlying cultures (e.g. new business cultures that support employees' willingness to accept disruptive changes (Throop and Mayberry, 2017)). Secondly, in terms of speed of change, global sustainability challenges like climate change, biodiversity loss or food insecurity require rapid change in order to avoid system collapse. Rapid and broad socio-technical system change often features a notable discontinuity which acts as the source for breakdown and transformation of the system (Kivimaa et al., 2021; Streeck and Yamamura, 2003).

Yet, while the importance of this kind of disruptive sustainability has been discussed in the literature with some detail, its drivers remain unclear (Kivimaa et al., 2021; Tarlan et al., 2024; Geels, 2018b). This is especially the case for change triggered by disruptions manifesting itself across the different dimensions of disruptive sustainability identified by Kivimaa et al. (2021). For instance, cross-dimensional disruptions have been described in the context of community energy. These community-based approaches disrupt incumbent energy distribution business models, they reimagine actor constellations by enabling citizens to become energy producers, and they challenge established energy consumption patterns through fostering new demand-side management practices (Kivimaa et al., 2021; Hargreaves et al., 2013). Similarly, car sharing challenges market structures through access-based value propositions that reduce ownership demand, while also promoting shifts in urban mobility governance networks and daily user-specific mobility routines (Martin, 2016). Indeed, many new technologies can only be disruptive for sustainability transitions in the sense of achieving long-term, systemic shifts if they are accompanied by substantial changes in behaviours, practices and cultures (Geels, 2010; Upham et al., 2025), a dimension we know particularly little about (Kivimaa et al., 2021). Several disruptive technological innovations which the literature has focused on such as electric vehicles, carbon capture and sequestration or biofuels can instead reinforce established mobility practices and consumption behaviours (Kivimaa et al., 2021; Upham et al., 2025; Kanda and Kivimaa, 2020; Budinis et al., 2018). Notably in this context, the empirical literature has overlooked a set of empirically rich contexts where multiple non-technological disruptions occur frequently: Kivimaa et al. (2021), in their review, do not manage to identify a single academic study on disruption for sustainability transitions in any low-income country, and only one study on a lower-middle income country (the Philippines), a set of countries where a combined half of the global population resides (World Bank, 2022). Pressing sustainable development gaps in LMICs include secure access to food (SDG 2), health care (SDG 3), education (SDG 4), water (SDG 6) and energy (SDG 7) (Trotter et al., 2023). Sustainability transitions at the last mile specifically where people gain first-time access to such types of fundamental goods and services are directly linked to deep shifts in incumbent market structures through the creation of entirely new supply options (Trotter and Brophy, 2022; Saeed et al., 2016; Terrapon-Pfaff et al., 2018), redrawing the actors and networks engaged in value delivery (Coenen et al., 2012; Mulugetta et al., 2022; Johnson et al., 2019; Batidzirai et al., 2021), as well as changing behaviours, practices and even cultural models to adjust to new opportunities associated with improved availability of food, health care, education and productive means (Johnson et al., 2019; Ilie et al., 2021; Mazzone et al., 2023; Khalid et al., 2023).

In summary, studying disruption for sustainability transitions requires conceptual approaches that can account for the connections between dimensions of disruptive sustainability at different levels from individual behaviour to the activities of incumbents and new entrants, all the way to changes in regulation. In the following section, we suggest that a focus on business model innovation offers a promising yet underutilized lens to analyse these disruptions across particularly non-technological dimensions.

2.2. Business model innovation and disruptive sustainability

The concept of a business model (BM) lends itself to looking at connections between a focal firm or organization, the individuals for whom a product or service is being developed and the other actors whose activities are critical to delivering value (Foss and Saebi, 2017). At its core, a BM describes the logic of how a firm creates, delivers, and captures value (Teece, 2010; Zott et al., 2011). While different definitions exist, a simple and widely used understanding of BM components suggests that BMs consist of an organization's value proposition, value capture approach and value network (Foss and Saebi, 2017; Teece, 2010; Zott et al., 2011; Bohnsack et al., 2014; Wesseling et al., 2020; Richardson, 2005; Bocken et al., 2014). The value proposition defines what type of value is created and for whom; value capture describes how that value is monetized or otherwise internalized; and the value network encompasses the partners and broader institutional arrangements involved in delivering and realising value. These components and the underlying logic of focusing on value creation locate organizations within wider socio-economic and technological contexts (Zott and Amit, 2010).

BMI is generally understood as the process of introducing novel, non-trivial changes to one or more of these components or their configuration (Foss and Saebi, 2017), thus expanding the notion of innovation beyond the product or process level. The scope of BMI ranges from modular, where changes occur in individual components, to architectural where change affects the interdependencies between components (Foss and Saebi, 2017). Architectural forms of BMI are thus more complex and require attention to the nature of relations between components. For example, complementarity provides a basis for the components of a business model to be combined in ways that generate more value than the sum of the parts (Zott and Amit, 2010). But there could also be conflicts between components that require substitution (Adner and Kapoor, 2010). Interdependencies between components are thus central to architectural BMI. And yet studying these interdependencies has been a challenge due to limited conceptualization of their complexity and of the complexity of identifying links between BMI and other outcomes such as performance (Foss and Saebi, 2017).

In the late 2000s and early 2010s, several seminal papers linked the BM concept to sustainability to explore how firms create environmental and social value alongside economic returns (Bocken et al., 2014; Stubbs and Cocklin, 2008; Schaltegger et al., 2012; Boons and Lüdeke-Freund, 2013). Empirical studies on sustainable BMIs have frequently focused on scaling the deployment of new, more sustainable technologies such as electric vehicles (Bohnsack et al., 2014), mobility (Cohen and Kietzmann, 2014; Hall et al., 2022), renewables (Huijben et al., 2016), off-grid energy (Knuckles, 2016) or digital platforms that enable circular material flows (Bocken et al., 2014).

While these studies largely understand sustainable business models to capture social and environmental value beyond organizational boundaries (Schaltegger et al., 2016), they mostly focus empirically on firm-internal effects as to how value is created, delivered, and captured (Foss and Saebi, 2017; Schaltegger et al., 2012). In response, recent conceptual studies on sustainable BMI and on disruption are calling for extending the analytical focus of BMI beyond the firm, suggesting that BMI could provide a conceptual connection between different system elements in sustainability transitions (Kivimaa et al., 2021; Snihur and Bocken, 2022). Rather than seeing a BM as one separate and passive dimension which needs to be disrupted for sustainability transitions (Kivimaa et al., 2021; Tarlan et al., 2024), examples such as community energy or car sharing suggest that BMI may itself be a source of disruptive sustainability. While BMI has been found to be somewhat limited in terms of its ability to disrupt policies and institutions (Wesseling et al., 2020; Bolton and Hannon, 2016), Kivimaa et al.'s other disruption dimensions, specifically markets, actors and networks, as well as behaviours and practices can be directly affected by successful sustainable BMI (Kivimaa et al., 2021; Snihur and Bocken, 2022; Martin, 2016; Hargreaves et al., 2013, also see Section 2.1): New BMs can constitute discontinuities that immediately challenge markets through the introduction of radically different value logics (Bocken et al., 2014), change actors and networks through new alliances with businesses, NGOs, cooperatives, public and/or informal sector actors (Upward and Jones, 2016), and are able to shift behaviour, practices and cultural models through customer engagement strategies that normalize sufficiency, sharing, or stewardship (Bocken and Short, 2016; Lüdeke-Freund et al., 2024). While incumbent system structures often persist (Wells and Nieuwenhuis, 2012), this general view of BMI is consistent with Kivimaa et al.'s (2021) suggestions that BMs have the potential themselves to be sources of multiple cross-dimensional disruption.

Hence, viewing BMI as a driver rather than only an outcome of disruptive sustainability opens up important conceptual and empirical avenues for sustainability transitions research. Specifically, by examining how BMs initiate and shape rapid change across multiple dimensions, BMI can be positioned as a central mechanism for understanding disruptive sustainability (Kivimaa et al., 2021; Snihur and Bocken, 2022). This framing allows for a more dynamic theorization of BMs as tools of transitions characterised by rapid and deep change. At the same time, it has the potential to contribute to the BMI literature itself by answering calls to extend research beyond internal firm outcomes and to assess how business models affect systemic structures and societal practices (Snihur and Bocken, 2022; Boons and Lüdeke-Freund, 2013; Schaltegger et al., 2016).

3. Methods and data

To explore the connection between BMI and disruptive sustainability, we undertook a review of academic literature on the last mile in LMICs. We combine a systematic and theorizing approach to our review, informed by recent advances in review research in the social sciences (Kunisch et al., 2023). Doing so allows us to go beyond what has been identified in the primary studies on which our review is based and to help us to focus on a practical question rather than a "body of literature" (Kunisch et al., 2023; Rynes and Bartunek, 2017).

For the systematic component of our review, we chose academic work on the phenomenon of the last mile for two reasons. First, although the term may give the impression of an incremental change, providing services that address sustainable development challenges at the last mile instead requires disruptive approaches. The last mile is a term commonly used in the literature and practice to refer to people and places that are "under-served and excluded, where development needs are greatest, and where resources are most scarce" (Pedrajas and Choritz, 2016, p.3). Continuing to follow existing, often centralized approaches is unlikely to address sustainable development at the last mile due to this combination of remoteness and resource scarcity. Instead, approaches that have been able to provide services to the last mile, and by doing so address multiple SDGs, often challenge dominant paradigms. For example, mobile money innovations came about through attempts to provide financial services to those typically excluded. M-Pesa in Kenya and other examples of mobile money have enabled low-income countries to leapfrog existing approaches by challenging the idea of the need for a physical infrastructure that relies on banks (Lashitew et al., 2019). Similarly, off-grid energy emerged as an approach to delivering access to electricity for remote and resource-constrained communities where centralized grid infrastructure has been unable to deliver (Bisaga et al., 2021). Furthermore, both mobile money and off-grid energy solutions emerged from a focus on the last mile but have widespread implications for service delivery across the board and as a result for addressing several SDGs. This makes the last mile a unique setting to study disruptive sustainability which is composed of both disruptions (e.g., access where there was none before) and change in different dimensions of systems.

Second, due to the resource-scare nature of last mile settings, disruption is often driven by business model innovation. Technological innovation alone has been insufficient in addressing the last mile (Rolffs et al., 2015). Systemic barriers such as a lack of access to finance often prevent customer access to these technologies and/or hinder the alignment of technologies with customers' needs. BMI can enable the availability of existing technologies in areas where they were previously inaccessible or ways of adapting deployment to address context-specific barriers and needs (Trotter and Brophy, 2022). These two features of the last mile, i.e. the need for disruptive approaches that go beyond technological innovation, make this phenomenon an ideal case for us to investigate the connection between BMI and disruptive sustainability.

3.1. Search strategy and sample – systematic review process

Systematic literature reviews draw from prior knowledge as the main source of data to develop new insights (Kunisch et al., 2023). A key feature of these reviews is the importance of applying a rigorous and transparent approach to searching for and then choosing the data to include and exclude from the sample (Hiebl, 2023). This process involved three main steps. First, we conducted a comprehensive search using Scopus and Web of Science to identify relevant literature. Alternative academic search engines were not used as they did not allow for our comprehensive search string.

Our focus was on articles that explicitly used the term "last mile" in low-income countries. We chose this term because it is commonly used to describe a specific phenomenon across multiple empirical settings where access to services has been difficult to date to deliver (Pedrajas and Choritz, 2016). An alternative search approach would be to use terminology such as marginal, remote or rural which would lead to a more general set of studies that would then need to be narrowed down by including additional terms for different types of services. The use of a key term that is relevant and widely used in the literature across different empirical settings reduces the bias we might introduce towards specific services such as sanitation, electricity, transport if we were to follow this alternative approach.

We applied a Boolean keyword search using the term "last mile" in the title, keywords and abstract fields. We decided not to include search terms relating to BMs or BMI to avoid the risk of unwillingly excluding

studies that discuss relevant types of innovativeness or novelty, but do not explicitly use these terms. We included all low-income countries (LIC) and lower-middle income countries listed by the World Bank individually to avoid missing relevant studies that do not use a categorization such as "LIC" or "LMIC" as a key term (World Bank Country and Lending Groups, 2022). Additionally, we included the terms "low income countr*", "low middle income countr*", LIC, LMIC, "emerging econ*", "emerging market*", "developing econ*", "developing market*", {bottom of the pyramid}, {base of the pyramid}, "BOP" in the search string for instances in which an article quotes observations for a group of countries. The terms "bottom of the pyramid" and alternative terms commonly used synonymously to low-income or lower-middle-income countries were put in brackets to also find documents that contained this exact phrase. All terms were placed in quotation marks to ensure articles were not included based on grammatical coincidence.[1]

Second, we developed inclusion and exclusion criteria to identify the sample of papers for our initial analysis. We included peer-reviewed articles and reviews, across disciplines, with a focus on innovation, appearing in databases from the earliest available year until 31st of August 2023. We searched across subject areas, including, among others, social sciences, business and management, medicine, and energy. We chose not to restrict our search to select disciplines as innovation of BMs can occur across fields and we wanted our process to challenge our preexisting beliefs (Hiebl, 2023). We explored a wide range of journals to consider the chance that a new field might develop either from the margins or within specialized areas of mainstream discussion (Beckman et al., 2023). Although the journal rating is often used to assess the quality of the article in management research, this is a debated issue (Hiebl, 2023). Relying on journal rating alone in our case would have restricted the geographical coverage due to the limited attention to LMICs in top-tier journals (Wickert et al., 2024). Instead, we developed three main exclusion criteria. First, we excluded books, book chapters, conference proceedings, working papers, and reports and non-English language papers (Ojong et al., 2021), articles where the term last mile was used in a way that did not apply to service provision, or where the country in focus was not low-income or lower-middle income. Second, we excluded grey literature to reduce quality issues with the sample (Hiebl, 2023). Although grey literature could provide a rich source of data on a variety of last mile contexts, we decided to focus our attention instead on broad range of journals, many of which are applied and as a result also close to the context.

Third, we reviewed the journal list and removed any articles published in journals known to have questionable publishing practices, i.e. where the journals prioritize their own self-interest over scholarship (Cukier et al., 2020). Although multiple lists exist to identify these journals, it is not always clear which lists to use and on which criteria they are based (Rice et al., 2021). Where we were unclear, we read through specific articles to discuss any quality concerns. We focused in particular on ensuring that the papers we included transparently explained both their conclusions and their process in reaching these conclusions, a key feature in quality assurance distinguishing scholarly studies from grey literature (Adams et al., 2017). Overall, the search yielded 483 results: 271 on Scopus and 212 on Web of Science. After removing duplicates from the sample, and applying all exclusion criteria, 228 unique papers remained. To ensure the validity of the databases used and to avoid potential bias in the sample, we checked for country of first author affiliation. Nearly 60% of final sample papers were authored by scholars with an affiliation in a low-income or lower-middle income country, which also corresponded with the country of investigation. Fig. 1 provides an overview of the sampling process.

Fourth, we narrowed down this sample of 228 papers to identify a final sample that focuses specifically on business model innovation for sustainable development. We used existing theory to guide this part of the process. We agreed as an author team on the definitions for codes to identify changes in components of business models or in the structure linking these components, building on the seminal paper of Foss and Saebi (2017). The full text of each paper was then coded by the first author and as the coding advanced, examples were discussed with the other authors allowing for any inconclusive examples to be identified, discussed and jointly evaluated until full agreement was reached. During this step, we also assessed to what extent the sample engages with sustainable development. We operationalized sustainability by coding the primary focus dimension (environmental, social, and governance) of each article. In addition, we went beyond this initial categorization by systematically identifying which of the 17 SDGs each article addresses. All reviewed articles engage with at least one SDG, confirming that sustainability considerations are a core element across the literature analysed. This resulted in a final sample of 68 papers.[2] Table 1 provides illustrative examples for the coding of the business model innovation components.

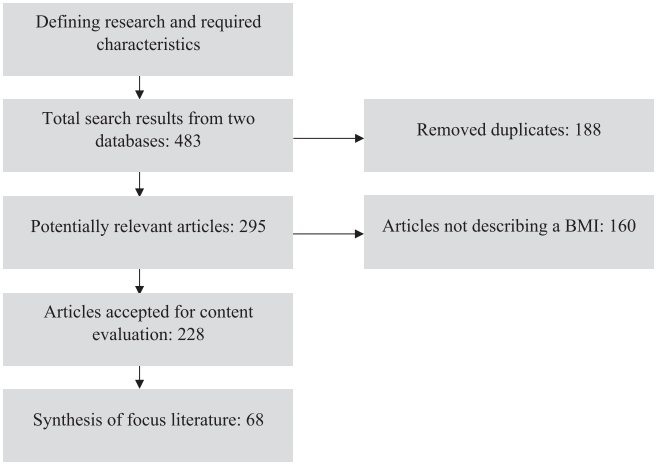

Fig. 1. Sampling process.

3.2. Data analysis – theorizing review process

The theorizing part of our review allows us to analyse the connection between BMI and disruptive sustainability which is our key question of interest. This required us to analyse our final sample using multiple cycles of coding. First, we started with thematic open coding for BMI interdependencies and disruptive sustainability. Two authors coded the papers individually to identify possible codes that could be used for describing the interdependencies between components of the business model and the categories of disruptive sustainability. Once this was completed, we discussed the identified themes together. If there were any discrepancies, we went through the article in question again together to come to a common understanding. During this cycle of coding, we noticed overlap between our emerging coding and the dimensions of disruptive sustainability identified by Kivimaa et al. (2021). Second, we decided to proceed inductively with the coding of BMI interdependencies. For the dimensions of disruptive sustainability, we drew from Kivimaa et al. (2021) and narrowed down on the dimensions of actors, networks, and ownership structures, markets, and behaviour, practices, and cultural models. As before, this was discussed iteratively in the author team. In the latter dimension, we follow Reckwitz's (2002) practice theory approach, implying that "behaviour" refers to individual acts or choices, while "practices" are socially embedded, routinized patterns of activity which shape how behaviours are enacted (Reckwitz, 2002).

[1] The full search string is provided in Appendix A.

[2] The full list of journals and articles is provided in Appendix B.

Table 1
Illustrative examples for innovation of business model components.

Exemplary reference	Value proposition innovation	Value capture innovation	Value network innovation
(Heuër, 2017)	Solar technologies for rural households, businesses, and institutions	Grant funding and sale of solar technologies to female micro-entrepreneurs on micro-consignments	Local women entrepreneurs sell products to communities; work with NGOs to expand network of micro-entrepreneurs
(Pamela et al., 2021)	High-protein complementary foods for children in affordable sizes	Sale of complementary foods in repackaged affordable sizes in poor communities	Local women entrepreneurs sell product to social network while educating parents on the benefits of ready to use complementary foods
(Nyqvist et al., 2019)	Provide basic curative and preventative health services and increase access to low-cost, high-impact health products	Cross-subsidization of product prices; Sale of basic health products to community health promoters (CHPs) at wholesale price (on average 30% below market prices); CHPs sell them to community members below market prices (on average 10% below); small performance-based incentives to encourage CHPs to register pregnant women and visits of newborns (~ $0.65 per registration/newborn visit)	The programme relies on "Avon-like" networks of door-to-door mobile CHPs who conduct home visits within their community, educate households on essential health behaviours, provide basic medical advice, and refer the more severe cases to the closest health center
(Diochon and Ghore, 2016)	Distribution platform for farm inputs such as high quality seeds, fertilizers, chemicals, animal feed, medicines, etc. and services	Not-for-profit trust; supported by donor funding; building a micro-franchise network based on wholesale margin	Franchisees, i.e. agro-dealers who converted their shop to a Farm Shop Franchise; producers and suppliers of the agricultural inputs
(Yadav et al., 2019)	Diverse solar PV products	Payment plan with an initial upfront deposit followed by daily/weekly/monthly payments for up to one year to own the system	Joint marketing with mobile network partners; strong dealer networks, customer helplines, remote monitoring, digital technology platform M-KOPAnet

Importantly, we coded across all dimensions of disruptive sustainability, including technology and infrastructure as well as regulation and policy. However, we focused the analysis on the most salient forms of change, in line with our definition of disruptive sustainability as requiring change across more than one dimension. With respect to high-intensity effects occurring in the dimension of technology and infrastructure, we applied a deliberately strict definition. The studies under review rarely involved the introduction of entirely novel technologies and, as a result, variation along this dimension was limited. Instead, disruption most often occurred through changes in access to, delivery of, or use of existing technologies (e.g., solar home systems, mobile phones). We also explicitly captured shifts across the dimension of regulation and policy. For instance, in the case of free school meal provision in India, regulators introduced an ICT-based monitoring reform that involved daily, randomized calls to designated teachers to collect information on meal uptake, thereby addressing leakage in a newly implemented welfare distribution mechanism (Debnath et al., 2023). Further, our analysis indicated that innovations in regulation and policy could enable disruption across other dimensions, for instance promoting the offtake of the solar energy sector by introducing tax exemptions (Bisaga et al., 2021). At the same time, our analysis showed that disruptive sustainability at the last mile frequently emerges in contexts characterised by absent or insufficient policy intervention, creating space for non-state actors to innovate. In some cases, such bottom-up innovations subsequently informed policy change. For instance, in the context of community health workers, programme design elements informed the design of a national community health programme (Luckow et al., 2017). Overall, however, instances of disruption in this dimension were relatively rare, offering limited variability and motivating our decision to focus the analysis on dimensions where disruptive change was most pronounced.

During this stage, we noticed the salience of different depths of changes within these dimensions, and a correspondence of these different depths to Meadows (1999, 2008) seminal work on systems interventions (Meadows, 1999, 2008). Meadows work on the nature of system change suggests that individual, observable system elements like a single actor, a single market transaction or a behaviour are the most basic components of systems. Changes that occur at this system element level are comparably shallow as they do not immediately lead to deep system change by themselves and can easily be reverted (Meadows, 1999) at little cost. At a medium level, systems theory describes networks of actors (with interconnections and feedback loops between them), market structures and more deeply engrained practices. According to Meadows (1999), change in these interactions between elements drive new internal dynamics of the system which are more effective means to create change. Finally, Meadows discusses the social structures and unpinning world views, which in our terms of Kivimaa et al.'s (2021) dimensions correspond to underlying ownership structures, market logics and cultural models, as the deepest ways to change systems. Indeed, Kivimaa et al. (2021) themselves invoke the notion of "deepening of the dimensions", albeit without further developing this explicitly.

Third, the first author coded the full sample, and the second author coded a sub-sample (O'Connor and Joffe, 2020). Inter-coder reliability was initially 75% and increased to 98% after examples were discussed and agreed upon. During this process, we also clarified the definitions for our codes and documented these to facilitate the replication of our approach. Finally, we used our coding to help us to compare examples in similar and different settings to understand the patterns connecting interdependencies in BMI to disruptive sustainability. This allowed us to derive mechanisms and associated sub-mechanisms enabling BM to contribute to disruptive sustainability at the last mile. Mechanism-based explanations are rooted in sociology and highlight how two constructs (in our case BMI and disruptive sustainability) are related by describing the means through which they are linked (Trotter and Brophy, 2022). This approach allows us to develop a middle-range theory to support theory building on the basis of semi-generalizable phenomena (Hedström and Wennberg, 2017). The identification of mechanisms thus helps to expand existing theory related to disruptive sustainability and inform emergent theory at the intersection between BMI and disruptive sustainability (Johnson and Schaltegger, 2020). Table 2 and Table 3 illustrate the coding structure we developed for disruptive sustainability and for the interdependencies between business model innovation components.

3.3. Limitations

There are five key limitations of our work that provide opportunities for future research. First, we are unable to provide clear evidence for connections between BMI and all dimensions of disruptive sustainability. The setting of the last mile is particularly suited to studying connections to behaviours, practices, and cultural models, actors, networks

Table 2
Overview of coding structure for dimensions of disruptive sustainability.

Aggregate dimension	Dimension-specific system depth	Second-order codes	First-order codes
Markets	Shallow	Market elements	Product design approach Parts of supply chain
	Medium	Market structures	Product and service delivery models Customer relationships and experience Supply chains
	Deep	Market logics	Market dynamics and interactions New market opportunities
Behaviour, practices, cultural models	Shallow	Behaviours	Economic empowerment Social and personal agency shifts
	Medium	Practices	Co-benefits across different practices Novel service practices Knowledge systems shifts
	Deep	Cultural models	Trust in and acceptance of novel products, services, approaches Gender norm shifts
Actors, networks, ownership structures	Shallow	Actors	Focal actors of disruption Supporting actors of disruption
	Medium	Networks	Recombination of different actor groups Roles and dominance of system actors
	Deep	Ownership structures	Ownership over ideas Alternative ownership models

and ownership structures, and markets. We decided to focus on these three as we could not find extensive evidence for the technology and infrastructure as well as regulation and policy dimensions of disruptive sustainability. This provides an opportunity for future research to adapt our approach to other phenomena and to explore whether the same patterns apply. Second, and relatedly, our setting is particularly well suited in generalizing to settings where existing technologies are available but have struggled to have desired impact, and where policy intervention has struggled or been absent to date. This limits the generalizability of our findings and suggests further research on the connection between BMI and disruptive sustainability in settings where new technologies are in the early stages of development and where policy interventions have been more widespread. At the same time, the focus on existing technologies provides us with the opportunity to highlight the non-technological dimensions of disruptive sustainability which have been underexplored to date (Kivimaa et al., 2021). Third, we are unable to observe long-term change through our coding of disruptive sustainability. While we find strong evidence of positive contributions to the SDGs and our coding allows us to identify a trigger, we cannot determine whether this trigger will lead to long-term impact. Future longitudinal, empirical research on specific settings and across settings would be required to understand these impacts. Fourth, our final sample is drawn from diverse journals which is both a strength and limitation, particularly in terms of differences in article quality. In addition to our exclusion criteria described in the methods, we address this quality concern by using our coding as a way of identifying patterns across studies rather than relying on the insights from any specific study. In fact, this is a feature of theorizing reviews, where the answer to the question of interest is not a focus of any individual study but emerges from comparisons across studies on a phenomenon. Fifth, our analysis focuses on expanding the key dimension of depth regarding disruptive sustainability. While we argue in the paper that this dimension is critical but has been largely missed up to this point, our manuscript does not study the relationship between depth, speed and breadth in detail. We see a lot of potential for future work to assess the extent to which depth, speed and breadth of disruptive sustainability are trade-offs, or can indeed be synergetic and potentially self-reinforcing, following a positive tipping point logic (Farmer et al., 2019a). It will be crucial to study

Table 3
Overview of coding structure for how interdependencies between business model innovation components influence the problem-solution nexus in the context of disruptive sustainability.

Business model component interdependencies	Problem-solution nexus mechanisms	Second-order themes	First-order codes
Value proposition - value network	Re-define boundary conditions of problem-solution space	●Broadening scope of problem-solution nexus	●Integrating interlinked services ●Including local perspectives on problems and solutions
		●Resetting the purpose of the problem-solution nexus	●Fostering needs-informed approach to problems/solutions ●Increasing awareness of problems/solutions
Value proposition – value capture	Enable new problem-solution match	●Facilitating superior products/services	●Facilitating economic benefits ●Facilitating social benefits
		●Monetizing local needs	●Distilling valuable product features ●Reducing the costs of access
Value capture – value network	Facilitate implementation	●Ensuring resilience of solutions	●Activating network to sustain affordability ●Sustaining the ability to offer the solution
		●Ensuring scale of solutions	●Increasing geographic reach ●Increasing time efficiency
Value proposition - value capture - value network	Iterate	●Experimenting continuously	●Fostering problem-solution immersion ●Institutionalizing continuous problem-solution evaluation

how much this is shaped by different contexts.

4. Results

In this section, we first unpack three dimensions of disruptive sustainability that emerged from our analysis. We then explain how the different interdependencies between the BMI components of value proposition, value capture and value network innovation drive disruptive sustainability at the last mile in LMICs by re-defining the associated problem-solution nexus. Exemplary evidence for each dimension of disruptive sustainability and the interdependencies between BMI components are provided in Appendices C–E and F–I, respectively.

4.1. Disruptive sustainability

We focus on a range of examples where a disruption happens in the way that access is provided. We identify three dimensions of disruptive sustainability, which refer to the associated change in systems connected to the disruption: (1) behaviours, practices, and cultural models, (2) actors, networks, and ownership structures, and (3) market logics, structures and elements. We observe that shifts within each dimension happen at three levels: shallow, medium, and deep. In the dimensions we examine, BMI component interdependencies cause disruptions that trigger shallow shifts across the dimensions of disruptive sustainability affecting behaviours, specific actors, or market elements. Medium-level shifts affect practices, networks, or market structures. In contrast, BMI component interdependencies causing disruptions that trigger deep shifts challenge foundational paradigms, including cultural models, ownership structures, and/or market logics.

4.1.1. Behaviours, practices, and cultural models

First, we identify behaviours, practices and cultural models as a dimension of disruptive sustainability. Changes in behaviours represent a shallow shift in this dimension and manifest in *economic empowerment* and *social and personal agency structures. Economic empowerment* is related to income generation and income diversification of marginalized populations. For instance, while last mile households have traditionally relied on subsistence farming for income, business training often triggers shifts in behaviour towards engaging in micro-entrepreneurship that supplements existing income-generating activities. Rather than replacing agricultural livelihoods, these micro-entrepreneurs often complement existing economic activities, contributing to greater income stability (Bensch et al., 2021). *Economic empowerment* thus reflects a gradual behaviour shift away from sole reliance on farming towards more diversified and sustainable economic strategies. Changes in *social and personal agency structures* are associated with increased social empowerment of marginalized groups. For instance, in households not connected to the electricity grid, gaining access to solar power triggers changes in behaviours by enabling women to manage their time more freely. Specifically, as solar power reduces the need for time-consuming tasks like traveling far to obtain fuel, women can adjust their schedules by engaging in more daytime work outside the home, and in the evening, improved lighting enables greater mobility and productivity, while also enhancing the sense of security (Bisaga et al., 2021).

Changes in practices represent a medium-level shift and manifest by enabling *co-benefits across practices,* improving support for *novel service practices,* and *knowledge system shifts. Co-benefits across practices* refer to the simultaneous advantages that arise when improvements in one domain create positive ripple effects in others. For instance, the disruption created through access to off-grid energy in remote and low-resource settings generates significant co-benefits across other practices such as food security, education, health, gender equity, and personal safety (Bisaga et al., 2021). Specifically, solar-powered irrigation and cooking technologies enhance practices in agricultural productivity and improve food preparation, thereby supporting household nutrition and food security. In the health sector, solar energy facilitates essential practices such as reliable storage of temperature-sensitive medicines and vaccines in rural clinics, strengthening primary healthcare delivery. Educational outcomes are also positively impacted as extended lighting hours allow children to study in the evenings, creating safer and more conducive learning environments that support academic achievement (Bisaga et al., 2021).

Novel service practices refer to the adoption and scaling of novel product or service delivery models, often requiring targeted capacity-building and incentives. For example, providing physicians with targeted training and financial incentives has increased their engagement with novel healthcare delivery practices such as telemedicine (Chakraborty et al., 2018). In parallel, increasing demand-side awareness is equally critical. Low immunization coverage is frequently attributed to "lack of knowledge and ignorance among population" (Luckow et al., 2017, p.2). Addressing this gap, training programmes for traditional birth attendants have proven effective: "they felt empowered in counselling parents… [They] believed parents have become aware and responsible. Initially, [traditional birth attendants] had to work hard to motivate parents but now parent's attitudes have improved and they were coming to [the traditional birth attendants] for vaccination" (Luckow et al., 2017, p.5). These examples illustrate how BMIs that incorporate incentives, training and engagement between community members and health providers can cause disruptions that trigger shifts in healthcare practices and increase their uptake (Lahariya et al., 2020).

Knowledge system shifts refer to the transformation of conventional understandings by introducing new sources or forms of knowledge dissemination. In the agricultural sector, for example, farmers often face limited choices and inadequate guidance on the correct use of agricultural inputs. By coupling quality inputs with farmer education, organizations like Farm Shop are improving agricultural outcomes by providing the know-how needed to "increase production and income, which ultimately results in a better quality of life." (Diochon and Ghore, 2016, p.5).

Changes in *cultural models* represent the deepest shift in this dimension of disruptive sustainability. These shifts involve a fundamental change in values, norms and social expectations. They are particularly visible in the creation of *trust in and acceptance of novel products, services and approaches* and in *gender norm shifts* that shape power dynamics within households and communities. One prominent manifestation of cultural model shifts is the increasing trust in off-grid energy solutions and their providers. Many energy access projects in low-resource contexts have failed not due to technical shortcomings, but because of a lack of community buy-in due to protective scepticism towards external actors and unfamiliar technologies (Heuër, 2017). However, these deep-seated cultural factors can be overcome through community-based strategies that build relational trust. Awareness-raising and education around new technologies, particularly when led by locally embedded actors, play a crucial role in changing cultural norms and values, thereby enhancing acceptance (Heuër, 2017).

In parallel, *gender norm shifts* reflect another key aspect of cultural model shifts. Historically, cultural models in many rural and remote communities have positioned men as the primary economic actors and decision-makers, limiting women's control over household assets and financial decisions, particularly in areas such as health, education, and nutrition. These cultural norms are intensified by geographic, political, and economic isolation that often characterizes such regions, compounding the marginalization of women and restricting their autonomy (Hedström and Wennberg, 2017, p.988). Our findings indicate significant shifts in these cultural models. Notably, where women have gained access to financial and social capital through entrepreneurial initiatives, there is evidence of meaningful shifts in gender dynamics (Tiwari et al., 2019). As women engage more actively in income-generating activities, their ability to make independent decisions about household spending increases. This has translated into measurable gains in expenditures on children's education, healthcare, and nutrition (Tiwari et al., 2019). Further, as women's businesses grow and their contributions become

more visible and valued, prevailing cultural norms are challenged. In many cases, "men adapt to and accept their partners' changing role" (Hedström and Wennberg, 2017, p.995), signalling a potential emergence of more equitable decision-making practices within households and communities.

4.1.2. Actors, networks, ownership structures

Second, we identify actors, networks, and ownership structures as a dimension of disruptive sustainability. Changes in actors represent shallow shifts, including *focal actors of disruption* and *supporting actors of disruption. Focal actors of disruption* are those who either directly implement or benefit from the solutions, such as an off-grid energy company providing first-time access to electricity or nurses that administer first-time quality health care. For instance, Essmart's distribution platform solution addresses gaps in last mile product dissemination and knowledge flow, strengthening the overall infrastructure for technological innovation (Farmer et al., 2019a, p.1637). In humanitarian contexts, changes in refugee registration processes illustrate how actors who were external originally can be focal actors of disruption. Initially, registration was "very time and resource intensive", relying on manual data entry and paper cards that were prone to damage, loss, theft, and fraud (Johnson and Schaltegger, 2020, p.1005). The multinational shipping company UPS offered support by customizing a digital solution, resulting in "distributions cut from eight hours to three. Violence dropped significantly. The cards were impossible for gang members to copy" (Johnson and Schaltegger, 2020, p.1006). Thus, actors supporting disruptive sustainability can facilitate efficiency and accountability gains.

Supporting actors of disruption are those whose existing roles, technologies, or infrastructures enable the emerging solutions. In the decentralized energy sector, telecommunications companies have played an influential role by broadening the availability and functionality of mobile payment systems, which underpin the growth of pay-as-you-go solar home system providers (Yadav et al., 2019). An example from Rwanda highlights how educational institutions have responded to the growing off-grid solar market by integrating solar energy courses into university and vocational curricula, aligning with and supporting emerging labour demands (Bisaga et al., 2021).

Medium-level shifts in this dimension impact established networks by *recombining different actor groups* and changing *roles and dominance of system actors. Recombining different actor groups* involves the strategic alignment of organizations with existing local structures to scale innovations rapidly and inclusively. For example, instead of establishing new grassroots networks, GNFC partnered with local organizations to build an extensive network of over 220,000 rural women as neem seed collectors across 4000 villages within two years of initiating the programme (Bensch et al., 2021, pp.14-15).

Shifts in *roles and dominance of system actors* refer to changes in responsibility and influence within a network, particularly when conventional actors are replaced or complemented by other actors in the network. An illustrative example stems from the healthcare sector, where the responsibilities typically held by formal health workers were redistributed to traditional birth attendants (Sahito et al., 2020). Traditional birth attendants were perceived as more effective in promoting vaccination due to their gender, local embeddedness, and stronger relationships with mothers. Their familiarity with community norms and access to homes meant that including them in the distribution network made it possible to reach newborns and their mothers more effectively than external vaccinators, who often lacked comparable access or local knowledge (Sahito et al., 2020).

Changes in ownership structures represent the deepest shift in this dimension of disruptive sustainability. We identify two central aspects: shifts in *ownership over ideas* and the emergence of *alternative ownership models. Ownership over ideas* highlights the transition from passive beneficiaries or customers to active co-stakeholders. For instance, the Self-Employed Women's Association (SEWA), a cooperative-based organization in India, has established village-level centres managed by local women working in the informal economy. These centres serve as hubs for disseminating health-related information, enabling women to reclaim control over public health entitlements by both becoming informed and educating others. Moreover, the centres function as platforms for civic engagement, facilitating interaction with local authorities and fostering women's active contribution to shaping how public health services are accessed and improved. This initiative has thus catalysed voice and agency among marginalized groups (Meadows, 2008, p.86).

Alternative ownership models challenge conventional asset control structures by introducing more flexible and equitable forms of ownership. For instance, in the pay-as-you-go solar energy sector, consumers gradually acquire full ownership of energy systems by completing a payment plan at which point the device is permanently unlocked for their use (Yadav et al., 2019; Barry and Creti, 2020). Additionally, through the integration of existing solar home systems into peer-to-peer microgrids, users are enabled to trade surplus electricity with one another. This "swarm electrification" approach transforms consumers into prosumers and underscores how shifts in ownership structures, both conceptual and material, can help unsettle traditional hierarchies and contribute to disruptive sustainability (Sahito et al., 2020, p.84).

4.1.3. Markets

Third, we identify shifts in markets as a key dimension of disruptive sustainability. This dimension can be further disaggregated into three components: shifts in *market elements, market structures,* and *market logics*. Changes in *market elements* represent shallow shifts in this dimension, involving localized market inefficiencies such as limited access or monopolized distribution, without yet altering broader market structures. Two primary subcategories are: *novel product design approach* and *partial supply chain adaptation. Novel product design approach* emphasizes the need for tailored innovations, particularly for last mile customers in LMICs. The complexity of socio-economic and cultural conditions in these contexts renders standardized market offerings ineffective. Instead, a strategy of continuous prototyping and iteration is essential to develop offerings that meet local needs (Goyal et al., 2017). Crucially, BMIs that enable product designers to learn to recognize and respond to the nuanced preferences of marginalized customers are key as customers may be willing to pay more for products or services with higher perceived utility (Lahariya et al., 2020, p.1636).

Partial supply chain adaptation involves redesigning or integrating supply chain elements to improve efficiency and expand access in underserved regions. For example, in the healthcare sector, delivery and inventory systems for tuberculosis medication were significantly improved by integrating them with existing logistics for antiretroviral treatments, streamlining operations and thus extending the reach of the supply chain (Odume et al., 2020). Similarly, decentralized water systems serviced by mobile water delivery trucks have extended water access to remote areas that lie beyond the reach of traditional infrastructure (Li et al., 2022).

Changes in *market structures* refer to medium-level shifts. Unlike shallow shifts in *market elements*, these reshape how stakeholders interact within market structures, often redefining the flow of information and goods and the terms of participation. This includes changes in *product and service delivery models, customer relationships and experience,* and *supply chains.* Changes in *product and service delivery models* often involve leveraging digital and mobile technologies that shift market access structures to bypass traditional physical infrastructure. For example, mobile health solutions use widespread mobile coverage to facilitate data collection, enable remote care coordination, and support healthcare delivery in resource-constrained settings (Bhatt et al., 2018). Similarly, telemedicine facilitates changes in conventional healthcare models by enabling remote diagnosis and reducing the reliance on in-person consultations (Chakraborty et al., 2018).

Customer relationships and experience entails a shift from transactional

to relational models of engagement. In agriculture, farmers' mobile phone numbers have become identifiers linked to tailored services such as educational content, purchase tracking, and personalized follow-ups (Diochon and Ghore, 2016). This personalization improves customer experience and supports a deepening market participation by building sustained relationships and enabling targeted interventions. In public health, communication tools like text message reminders are used to improve vaccination adherence, demonstrating how digital solutions can enhance patient-provider interaction and service uptake among communities through low-cost, scalable methods (Mekonnen et al., 2021).

Changes in *supply chains* involve addressing market barriers to improve access and efficiency, while distributing value more equitably. For instance, organizations that integrate community actors into their supply chains are creating more inclusive value flows that benefit local stakeholders across the entire value chain (Heuër, 2017). Another example from Kenya demonstrates how an initiative tackled a distribution bottleneck at the last mile by negotiating with the manufacturer to package goods in smaller, affordable units at the production stage (Pamela et al., 2021). This approach challenged traditional market structures by altering the supply chain to respond to spending patterns of low-income consumers.

At the deepest level, shifts in market logics involve change in the underlying norms, rules, and institutional structures underpinning how markets function. This includes *market dynamics and interactions* and *new market opportunities*. Changes in *market dynamics and interactions* involve altering established patterns of control and agency within existing market systems. This often includes enhancing consumer agency and reducing the dependence on monopolistic practices. For instance, in contexts where households face unreliable and expensive grid electricity, the growing adoption of pay-as-you-go off-grid solutions represents a substantive shift in energy market logics. These decentralized models enable consumers to bypass traditional utility providers in favour of more flexible services (Barry and Creti, 2020). Similarly, in India, digital "portability" schemes within public food distribution systems give beneficiaries more control over where and when to access entitlements. This reduces the monopolistic power previously held by local store owners, thereby mitigating persistent inefficiencies and abuses such as overcharging or poor service (Barry and Creti, 2020, p.4).

Creating *new market opportunities* refers to shifts in *market logics* by driving productivity or the emergence of novel business models. In sub-Saharan Africa, the limited geographic coverage of national electricity

Table 4
Illustrative example of relationship between business model innovation component interdependencies and depth of disruption for the case of off-grid energy.

	Dimensions of disruptive sustainability		
Interdependencies	Behaviour, practices, and cultural models	Actors, networks and ownership structures	Markets
Value proposition - value capture innovation	**Behaviours: Economic empowerment** (e.g., savings by customers can be spent on education and other items)	**Actors supporting disruption** (e.g., telecommunications provider extending mobile lines and thereby pay-as-you-go (PAYG) solutions)	**Market logics: New market opportunities** (e.g., increased productivity and competition, and secondary businesses)
	Practices: Co-benefits across different practices (e.g., benefits to education, agriculture, health practices) *"The money that both the women entrepreneurs and the (female) customers are able to earn/save from the Solar Sister products generates additional income for the household, which can be used for the children's education, health care, clothing or food."* (Lahariya et al., 2020, p.5)	*"A wider implementation of PAYG SHSs in rural Kenya was led by telecommunication operators who supported the development of innovative mobile payment platforms with the expansion of mobile telephony."* (Yadav et al., 2019, p.143)	**Market logics: Market dynamics and interactions** (e.g., substitution effect) *"our results point out a substitution effect from expensive and unreliable on-grid electricity service to off-grid devices allowing lighting, radios, mobile charging"* (Goyal et al., 2020, p.2)
Value proposition - value network innovation	**Cultural models: Trust in novel products, services, approaches** (e.g., via women-to-women networks) *"PAYG enterprises must work extensively … for deeper engagement to build trust and address community apprehension to use mobile money, which is often a mindset issue."* (Yadav et al., 2019)	**Ownership structures: Ownership over ideas** (e.g., via community engagement and participatory decision-making) *"Paramount to the process, is local engagement from the outset, including in the decision making process, so as to create ownership among the local communities, without which the longevity of the operations can be at risk."* (Heuër, 2017)	**Market logics: Market dynamics and interactions** (e.g., feedback feeding into manufacturer's design of products) *"d.light, Greenlight Planet, Barefoot Power, Bboxx provide a range of solar products… Through these various partners, Solar Sister has access to a wide range of high quality clean energy products that they can tailor to the communities' needs and the tech partners benefit from Solar Sister's last mile reach and real time feedback …."* (Heuër, 2017)
Value capture - value network innovation	**Behaviours: Social and personal agency shifts** (e.g., female micro-entrepreneurs earn greater respect from husbands)	**Actors supporting disruption:** (e.g., universities adapting curricula)	**Market structures: Customer relationships and experience** (e.g., extensive aftercare increases lifetime of products)
	Behaviours: Economic empowerment (e.g., additional income generated by entrepreneurs) *"As a result, women depend less on their husbands and beneficiaries have reported that it has led to greater respect and influence in the household decision-making process"* (Heuër, 2017)	*"The growth of the off-grid solar sector has also created demand for solar energy vocational courses, which have gradually entered the Rwandan curriculum at universities and vocational training centres (Targets 4.3, 4.4)"* (Bisaga et al., 2021)	**Market structures: Supply chain** (e.g., extending supply chain) *"Solar Sister's training goes beyond business training; it includes on-going technical training that enable the micro-entrepreneurs to provide quality customer care and repair the products. This ensures long term quality and usage of the products and the sustainability of the model."* (Heuër, 2017)
Value proposition – value capture – value network innovation	**Practices: Knowledge system shifts** (e.g., demonstrating different possible solutions)	**Ownership structures: Ownership over ideas** (e.g. value co-creation with villagers)	**Market elements: Novel product design approach** (e.g., channeling field-based findings)
	"Selco's focus on experimentation and innovation led to integrating the social mission, sustainability, solution design philosophy and acceptance at the BoP. It adopted a unique two-dimensional approach towards building experimentation and innovation capacity. The first dimension involved establishing an innovation department to channel the field-based findings and solutions within different branches of Selco as well as among key partners (suppliers, academic and technology institutions). The second dimension involved instituting the rural innovation lab (Selco Labs). This served as a platform to demonstrate the different energy solution prototypes to the villagers and encouraged them to provide feedback thereby leading to customer engagement and value co-creation." (Goyal et al., 2017, p.102)		

grids has fuelled the rapid expansion of off-grid solar energy solutions (Bisaga et al., 2021). Recent advances in solar home systems have also enabled the development of novel business models. These shifts extend beyond technical innovation to encompass broader market formation processes. For instance, they support the creation of complementary enterprises (e.g., pig farming or producing iced treats for children), generate employment opportunities, and intensify competition in previously underserved areas (O'Connor and Joffe, 2020, p.4).

4.2. Interdependencies between business model components and how they shape the problem-solution nexus

Having unpacked three dimensions of disruptive sustainability, the subsequent subsections explore how the interdependencies between BMI components drive disruptive sustainability. Exemplary evidence for each interdependence between BMI components is provided in Appendices F–I. As our findings below show, there is an emerging pattern across the interdependencies, namely that they drive disruptive sustainability by influencing the problem-solution nexus of last mile needs and innovative solutions at different and complementary depths. This ranges from deep changes of re-defining the fundamental boundary conditions of the problem-solution space itself, medium-depth changes that create new matches between problem and solution, and more shallow changes that steward implementation. Crucially, the deeper an interdependence influences the problem-solution nexus, the deeper the shift it tends to generate across dimensions of disruptive sustainability. We explain these effects in detail in the subsequent four sub-sections on individual business model component interdependencies which all close with an illustrative case of off-grid energy as an example of last-mile business model innovation. Another illustration of the patterns emerging between the interdependencies and the dimensions of disruptive sustainability for the case of healthcare can be found in the appendix (see Appendix J). Table 4 provides an overview of the relationship between each interdependence and depth of disruption across each dimension for the illustrative example of off-grid energy. We introduce this table here to help guide the reader and explain it step by step in the following sub-sections.

4.2.1. Value proposition – value network: re-define boundary conditions of problem-solution space

The interdependence between value proposition and value network innovation drives disruptive sustainability by re-defining the boundary conditions of the associated problem-solution space. It does so by both (1) *broadening the scope of the problem-solution nexus* and (2) *resetting the purpose of the problem-solution nexus*. Defining the scope and purpose of the problem-solution space is key for organizations to not only conceptualize what needs to be addressed but also understand the space within which solutions can be operationalized. In our case, successful re-definitions of the problem-solution space drive deep shifts in the dimensions of disruptive sustainability, causing changes across cultural models, ownership structures, and market logics. Below, we focus on how these deep shifts in the dimensions of disruptive sustainability occur and draw from examples across the three dimensions.

First, *broadening the scope of the problem-solution nexus* entails *integrating interlinked services* and *including local perspectives on problems/solutions*. In last mile contexts, interlinked, multi-dimensional challenges render a narrowly defined product offering ineffective if it lacks the complementary services or infrastructure needed for its use (Goyal et al., 2017). Hence, an effective value proposition must be embedded within a value network capable of *integrating interlinked services*. For example, in healthcare, the distribution of HIV self-testing kits in rural, stigmatized communities proved significant in combination with telehealth support services, such as remote counselling and treatment referrals. It transformed a hitherto isolated solution approach into a comprehensive care package that simultaneously addressed several different health-related problems that had not comprehensively been addressed before (Horvath et al., 2022). This approach increased trust in and acceptance of novel services by at-risk individuals, indicating a shift in cultural models. The *inclusion of local perspectives on problems/solutions* through participatory decision-making is essential for understanding the diverse needs of local communities. In the healthcare sector, for instance, shifts in ownership structures emerged as local input was integrated into planning processes. This was achieved by creating space for "the hitherto voiceless [to] speak out" (Meadows, 2008, p.85). Such participatory mechanisms contributed to a "degree of equalization of power" (Meadows, 2008, p.85) between officials and community members, allowing individuals to actively shape their health entitlements.

Second, in our context, *resetting the purpose of the problem-solution nexus* describes a process of locally embedded value networks helping to identify solutions that address the context-specific needs, constraints, and challenges of the last mile segment. It consists of two mechanisms: *Fostering a needs-informed approach to problems/solutions* and *increasing awareness of problems/solutions. Fostering a needs-informed approach* towards serving people who live in last mile contexts is hindered by their geographic remoteness and infrastructural gaps, which pose challenges to conventional market analysis. However, frontline staff embedded in these areas offer critical insight into adoption barriers, usage patterns, and evolving user needs and preferences (Parameswar and Dhir, 2022). In the off-grid energy sector, for instance, energy entrepreneurs play a multifaceted role by "(a) promoting solar solutions among the rural communities to which they belong; (b) assisting clients in installing their solar solutions, when needed; (c) raising clients' awareness on the good use and maintenance of the solar solution; and (d) facilitating after-sales services …" (Odume et al., 2020, p.140). Their embeddedness not only is key to a needs-informed understanding of the problem and potential solutions, but also enhances trust in novel services. This represents a shift in cultural models, as local sales agents are valued for speaking the local language, living in close geographic proximity, and being socially embedded (Allet, 2016).

Increasing awareness of problems/solutions refers to the process of actively informing and educating community members about relevant issues and available solutions. In healthcare, for instance, "[w]hen context-specific infant feeding messages promoting the use of local foods are delivered directly to mothers through counselling, significant improvements in complementary feeding practices and dietary intake are possible" (Goyal et al., 2020, p.3). Over time, this process also catalyses cultural change. In this example, the initiative noted that "[o]nce the project had a stronghold, men in the community got interested and wanted to be involved in the sale of complementary foods." (Goyal et al., 2020, p.6). This mechanism thus not only improves programme outcomes but also challenges traditional gender norms.

The interdependence between value proposition and value network innovation drives deep change across all three dimensions of disruptive sustainability. The case of off-grid energy offers a compelling illustration of this dynamic. With regards to cultural models, this interdependence deepens community engagement. This fosters trust and shifts mindsets, particularly when confronting hesitations around the use of new technologies such as mobile money: "PAYG enterprises must work extensively … for deeper engagement to build trust and address community apprehension to use mobile money, which is often a mindset issue." (Farmer et al., 2019a, p.150). Ownership structures also change through the interdependence. In the Solar Sister model, a deeply localized approach from the outset supports community ownership: "When approaching new communities, Solar Sister always consults with the community leaders first, and it is a joined community decision to start taking part in the Solar Sister Network." (O'Connor and Joffe, 2020, p.4). Community ownership is then strengthened through seed capital grants that enable local women to distribute clean energy products, thus fostering individual agency, economic empowerment and community benefits.

Finally, the interdependence drives disruptive sustainability by shifting market logics, specifically in terms of market dynamics and

interactions. Engaging women as energy entrepreneurs provides real-time insights into customer needs, contributing to product refinement. These micro-entrepreneurs operate within their own communities, acting as a direct channel for market intelligence that flows back to technology partners: "d.light, Greenlight Planet, Barefoot Power, Bboxx provide a range of solar products…Through these various partners, Solar Sister has access to a wide range of high quality clean energy products that they can tailor to the communities' needs and the tech partners benefit from Solar Sister's last mile reach and real time feedback" (O'Connor and Joffe, 2020, p.122). This multidirectional information flow supports shifting market dynamics and interactions.

4.2.2. *Value proposition – value capture: enable new problem-solution match*

The interdependence between value proposition and value capture innovation serves as a critical facilitator of disruptive sustainability by enabling new matches between problems and solutions. Specifically, it manages to find new desirable and viable matches between problem and solution by *facilitating superior products/services* and by finding new crucial ways of *monetizing local needs* which unlock these new problem-solution matches. The interdependence integrates the development of products and services tailored to local needs with innovative monetization models that are viable within specific contextual constraints. When effectively aligned, this interdependence not only addresses unmet demands but also outperforms existing alternatives in terms of relevance and accessibility. In terms of disruptive effect, our findings suggest an association across the different levels of depth of disruptions, but most frequently at medium-level depth, namely practices, market structures and networks.

Facilitating superior products/services includes *facilitating economic benefits* and *facilitating social benefits.* This BMI interdependence often yields tangible economic benefits by offering cost-effective and improved solutions. For instance, to improve tuberculosis care in rural areas, mobile tuberculosis clinics were offered on market days to reduce travel costs for patients and thereby facilitated shifts in conventional market structures (Muller et al., 2022). Beyond economic benefits, the interdependence can *facilitate social benefits*. In densely populated urban areas, drone delivery services represent a shallow shift in market elements and offer not only faster alternatives to conventional road-based distribution but also a more environmentally sustainable approach with lower carbon emissions (Bhatt et al., 2018, p.267). Similarly, access to nutritious complementary foods enhances children's health outcomes, giving parents more options to support early childhood development, thereby facilitating personal agency, a shallow level a shift in behaviours (Pamela et al., 2021).

Monetizing local needs involves *distilling valuable product features* and *reducing the costs of access.* The identification of commercially viable features requires a deep understanding of user preferences. Essmart's approach highlights this mechanism's strategic value in last mile markets. By systematically gathering data on user demographics, product satisfaction, and purchase behaviour, and then evaluating new technologies over a one-month trial period, the firm can distil the essential features customers value and are willing to pay for, thereby identifying products with real commercial potential (Jue and Pruter, 2015). Its "closed-loop feedback system that incorporates all relevant supply chain actors" from customers to producers thus represents a shift away from the dominant market logic towards a "more egalitarian" market system (Lahariya et al., 2020, p.1631). *Reducing the costs of access* is critical in last mile contexts. In rural health delivery, offering eye-care services through a video conferencing platform eliminated the need for patients to travel up to 40 km, which would otherwise result in lost wages (Venkataswamy and Seetharam, 2020). Similarly, medical specialists are less likely to serve rural areas due to inadequate living conditions, limited opportunities for professional development, and a lack of medical infrastructure (Venkataswamy and Seetharam, 2020). By improving support for novel services in this way, the interdependence fosters shifts in established healthcare practices. These mechanisms collectively suggest that the alignment of product relevance and affordability is critical to drive disruptive sustainability in underserved markets.

The interdependence between value proposition and value capture innovation most frequently drives changes at medium-level depth, namely practices, market structures and networks. In the case of off-grid energy, the interdependence leads to shifts in behaviours through economic empowerment by enabling customers to meet their needs in ways that create savings for customers that can be spent on education and other items. It also enables co-benefits across different practices as savings, or earnings as in the case of energy micro-entrepreneurs, can be spent on children's education, health care and nutrition (Heuër, 2017). The effect of this interdependence is supported by actors in the telecommunications industry who develop mobile payment platforms that expand mobile telephony (Yadav et al., 2019). Finally, in the market dimension, by *facilitating superior products/services* and *monetizing local needs*, profound market logics shift in that new market opportunities are derived from increased productivity, competition and the emergence of secondary businesses. Similarly, market dynamics and interactions are affected by the substitution effect of off-grid energy: Offering a superior product at a more affordable price point can incentivize customers to permanently switch to off-grid solar energy products (Barry and Creti, 2020).

4.2.3. *Value capture – value network: steward implementation*

The interdependence between value capture and value network innovation drives disruptive sustainability at the last mile by stewarding the implementation of the BMI. It does so by (1) *ensuring resilience of solutions* and (2) *facilitating scale of solutions.* This implementation-focused interdependence is thus mostly solution-oriented, supporting the sustainability and expansion of access and delivery. It ensures that limited financial resources among end users do not restrict access to essential goods and services, while also protecting the financial sustainability of organizations delivering these services. In such contexts, affordability must be embedded within the value capture strategy itself. However, such a strategy is only viable when it is operationally supported by the value network. Our findings suggest that this interdependence is also associated with varying depths of disruptive sustainability, but we find a tendency towards shallow shifts, primarily influencing behaviours, actors, and market structures.

First, *resilience of solutions* is ensured by *activating network to sustain affordability* and *sustaining the ability to offer the solution.* Affordability in last mile contexts often depends on leveraging existing networks to reduce operational costs or financial barriers for end users. For instance, partnerships with regional rural banks allowed the social enterprise Selco to offer "door-step financing" with customized repayment schedules aligned to rural households' income cycles (Goyal et al., 2017, p.105). This approach introduced novel actors supporting disruptions by making products and services financially accessible for low-income communities. Similarly, in one case, concerns over hygiene and scalability led an initiative to engage with the manufacturer to modify packaging operations, enabling the distribution of complementary foods for young children in smaller, more affordable sachets (Goyal et al., 2020). This change reflects a medium-level shift in the market dimension by altering and extending the supply chain to better align with the needs and constraints of low-income consumers.

Organizations also build resilience by *sustaining the ability to offer the solution* through integrating flexibility and intelligence in their business models. Seasonal income fluctuations, common in agricultural contexts, pose significant risks to both the organizational stability and the affordability of services for farmers, who constitute a major customer segment for off-grid energy companies (Barrie and Cruickshank, 2017). In response, some off-grid energy providers have implemented digitally enabled value networks that include forecasting, remote monitoring, and control functions. Forecasting tools utilize user data to anticipate demand and financial risk (Sahu et al., 2022), while remote monitoring

flags technical issues and payment lapses early (Barry and Creti, 2020). Additionally, remote control mechanisms, such as the ability to disable solar home systems upon non-payment, help maintain payment discipline and minimize resource drain (Yadav et al., 2019). This example supports a shift in customer relationship and experience of the market dimension by shifting the interaction from reactive, in-person engagement to a more proactive, data-driven, and automated process. Collectively, these examples demonstrate how this BMI component interdependence reinforces the resilience of the business model.

Second, *facilitating scale of solutions* is achieved through two mechanisms: *increasing geographic reach* and *increasing time efficiency*. Organizations expand reach by leveraging localized actors within the value network in a cost-beneficial manner. In the context of agri-processing, organizations achieved scale by integrating grassroots stakeholders across the value chain. For instance, collecting and processing neem seeds at community levels improved cost efficiency and quality control. Similarly, in financial service delivery, providers avoided the need for physical bank branches by collaborating with local retailers acting as mobile money agents. These micro-enterprises delivered financial services like transfers and airtime purchases, effectively extending the service network by recombining different actor groups to reach remote regions with minimal capital investment (Palaon et al., 2020). The interdependence not only facilitates scale by increasing geographic reach but also by *increasing time efficiency*. In telemedicine, for instance, the use of digital platforms eliminated travel for both providers and patients, allowing more patients to be treated in less time and increasing user satisfaction, shifting product and service delivery models (Chakraborty et al., 2018).

Our results suggest that the interdependence between value capture and value network innovation causes disruption that triggers varying depths of disruptive sustainability, albeit with a clear tendency towards shallow shifts, primarily influencing behaviours, actors, and market elements as well as structures. In the case of off-grid energy, shallower shifts in behaviour are facilitated through economic empowerment, for instance via micro-entrepreneurship. However, through these additional income-generating activities, female micro-entrepreneurs not only generate additional household income but also earn increased respect from their husbands and greater influence in decision-making (Heuër, 2017). This shift is a direct outcome of inclusive value capture strategies enabled by a localized value network. Further, educational institutions adapting curricula to meet emerging market needs exemplify actor disruption (Bisaga et al., 2021). By aligning labour supply with new demand created by decentralized service models, such institutions become active participants in the value network, contributing to the scalability and viability of the business model. Finally, the interdependence alters traditional market structures by shifting customer experience and relationships. In the case of Solar Sister, for instance, training programmes extended beyond sales to include ongoing technical and customer service skills. This approach not only ensured long-term product usage and therefore continuous value capture but also deepened customer relationships through the local network model (Heuër, 2017).

4.2.4. *Value proposition – value capture – value network: iterate*

The interdependence between value proposition, value capture and value network drives disruptive sustainability at the last mile by allowing companies to *iterate* within the problem-solution nexus over time. This interdependence is both problem and solution oriented by ensuring an ongoing revisiting of the *problem-solution boundary conditions*, *problem-solution match*, and *implementation approach*. Our findings suggest two sub-mechanisms, namely *fostering problem-solution immersion* and *institutionalizing continuous problem-solution evaluation.* While *problem-solution immersion* enables deep, context-specific understanding at the last mile through continuous engagement, *institutionalizing continuous problem-solution evaluation* ensures that such learning becomes repeatable and structured over time.

First, through *problem-solution immersion,* organizations are embedded in the problem context and the solution space at the same time, rather than treating them as separate or sequential steps. Through continuous interaction with customers, data, and contextual constraints, organizations surface evolving needs and rapidly explore and test solution ideas. For instance, a manager at an organization providing clean energy solutions described a strongly field-driven approach in which the team engages directly with communities, participates in local cultural events, pilots solutions, and uses these interactions to understand unmet needs, acceptance levels, and price sensitivities (Goyal et al., 2017). Similarly, a provider platform for development technologies relied on extensive collaboration and communication between end users and technology suppliers, directly linking local needs with supplier capabilities (Jue and Pruter, 2015). In a related example, Solar Sister, an enterprise operating a last mile energy distribution model, receives direct, real-time feedback on which products and solution characteristics resonate most strongly with the community to meet their unique energy needs by working with community based micro-entrepreneurs (Heuër, 2017).

Second, *institutionalizing continuous problem-solution evaluation* is facilitated by establishing routines and mechanisms that ensure the systematic revisiting of both problems and solutions over time. By routinizing feedback loops and adaptation, *institutionalizing continuous problem-solution evaluation* supports the continuous refinement of problem definitions, solution designs and last mile implementation practices. For instance, a social enterprise serving smallholder farmers leveraged regular “clinic days,” during which veterinarians and agronomists provided free diagnostics and advice to farmers. These sessions not only helped farmers address immediate problems but also enabled the organization to gain deep insight into recurring challenges faced by customers (Diochon and Ghore, 2016). Another organization *institutionalized continuous problem-solution evaluation* by combining a dedicated innovation function that aggregated field-based insights across branches and partners with a rural innovation lab that enabled customer feedback and value co-creation around energy solution prototypes (Goyal et al., 2017). Similarly, an enterprise serving as a technology distribution platform in rural India systematically collects end-user feedback through product demonstrations, follow-up interactions, and direct customer contact, while also using its distribution network to run randomized trials that tested pricing, marketing, and warranty design across last mile customers (Jue and Pruter, 2015). Together, these mechanisms enable organizations to make iteration a repeatable and sustained organizational practice.

Our results suggest that the interdependence between all three business model innovation components helps to sustain disruptive sustainability by enabling firms to iterate their business model solutions to re-define and navigate the problem-solution space as it evolves over time. In the off-grid energy case, for instance, as PAYG has become a widely accepted value capture approach in the sector, several companies have defined a new value proposition and value network interdependence which work with new value chains in agriculture, manufacturing and health care to create new value through productive uses of energy (Trotter and Brophy, 2022). This move beyond the household re-defines the boundary conditions of the problem-solution space (Goyal et al., 2017). Coupling this new value proposition and its associated beyond-the-household productive value networks with servitization value capture approaches (e.g. where farmers pay for off-grid energy services for instance milling or food cooling) enables a new match between these widened problem and solution realms. Companies then use their widened value networks to deliver this value capture approach, thereby again using this specific business model component interdependence to facilitate implementation (Goyal et al., 2017).

5. Discussion and conclusion

5.1. Explanatory model: how business model innovation drives disruptive sustainability

Illustrating our results discussed in Section 4, this section presents an explanatory model of how the four different interdependencies between business model innovation components drive disruptive sustainability via a set of four associated mechanisms which all influence the problem-solution nexus (Fig. 2). Crucially, our analysis reveals that across the different dimensions of disruptive sustainability, the business model component interdependencies predominantly drive change at different levels of depth. We formulate four associated propositions which we discuss in turn:

P1. Value proposition and value network interdependence facilitates deep disruptive sustainability through enabling the problem-solution space to be redefined

Firstly, on a deep level, the interdependence between value proposition and value network *re-defines the boundary conditions of the problem-solution space* (Section 4.2.1). Using their value networks and close connection to the complexities of the problem at hand, firms are able to define and adjust their value proposition accordingly, thereby broadening the scope and resetting the purpose of the problem-solution nexus. This focus on the problem-solution boundary conditions enables the simultaneous redefinition of what constitutes value and how that value is delivered, often through embedded, participatory networks. Innovations of the interdependence between value proposition and value networks thus expand the problem-solution space in ways that alter underlying, deep system logics, affecting ownership structures, market logics and cultural models in the disruptive sustainability dimensions. For example, in cases from the healthcare, retail, and agriculture sectors, solution design is co-developed with local actors, allowing these models not only to challenge existing product offerings or service delivery structures but also to transform socially embedded practices and market logics, such as hierarchical to more egalitarian marketplaces (Jue and Pruter, 2015) or gender-based role expectations (Heuër, 2017).

P2. Value proposition and value capture interdependence facilitates medium-level depth of disruptive sustainability through matching problems and solutions

Secondly, at medium depth, the interdependence between value proposition and value capture drives disruptive sustainability by *enabling new problem-solution matches* (Section 4.2.2). Linking value proposition with an adequate value capture approach enables aligning product or service relevance with adequate monetization approaches for resource-constrained last mile settings. While such alignment can break access barriers and generate new demand patterns, it is mostly tied to medium-level changes in actor networks, market structures as well as behaviours and practices. For example, health providers leveraging mobile phone coverage enable shifts in market structures in terms of health care delivery models, ultimately improving the management of the medical supply chain, but typically do not alter deeper market logics in the health care sector. The tendency for value capture to focus on firm-internal monetization mechanisms limits its standalone capacity to change entrenched ownership dynamics.

P3. Value capture and value network interdependence facilitates shallow forms of disruptive sustainability through a focus on solutions and implementation

Thirdly, while the value capture – value network interdependence is crucial for *facilitating implementation* of new solutions, it is generally associated with shallower changes across the different dimensions of disruptive sustainability (Section 4.2.3). This mechanism ensures that once the problem-solution nexus boundary conditions are defined and a match between problem and solution is clear, this solution can scale and be resilient. For instance, companies use financial incentives to motivate micro-entrepreneurs in their value network to scale their sales activities, thus causing behaviour shifts and making essential services accessible to those previously excluded. Hence, it primarily affects certain specific, targeted and observable system elements within markets, individual actors or a limited set of behaviours.

P4. Value proposition, value capture and value network interdependence facilitates various depths of disruptive sustainability by enabling companies to iterate

Finally, the interdependence between all three business model components allows companies to *iterate* (Section 4.2.4). The cases in our sample suggest that companies stay immersed in the problem-solution nexus throughout their operations, and often put processes in place that allow them to continuously evaluate this nexus. As new problems get discovered, or new solutions become apparent, either through

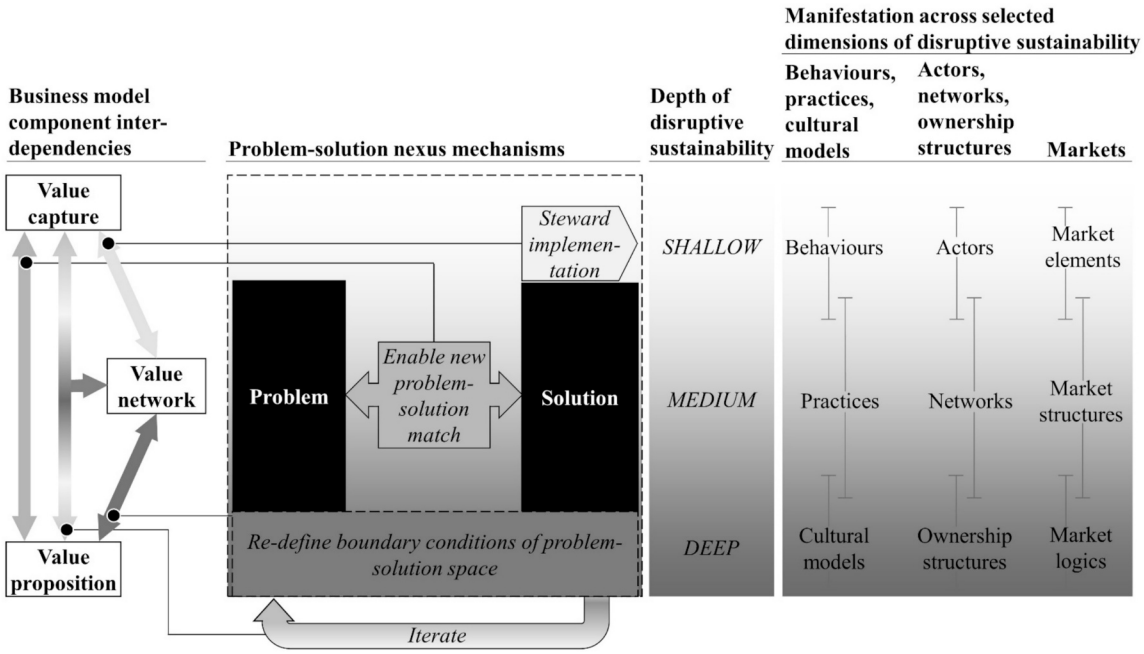

Fig. 2. Explanatory model how interdependencies between business model innovation components drive different depths of disruptive sustainability.

innovation from within the firm or from other actors, firms can re-assess their business model components, and with them, their respective interdependencies to drive disruptions at different depths of the problem-solution nexus. For instance, first-time access to electricity or health care can unlock new combinations of value proposition (e.g. poverty alleviation through productive use of energy for the fishing industry), value capture approaches (e.g. servitization of electricity-powered ice machines for fish cooling) and value networks (e.g. fishers and fish traders) that re-defines the problem-solution space, creates new matches between these new problems and solutions, and facilitates implementation according to the pairwise business model component mechanisms described above.

Our framework thus provides a conceptual approach to understanding how BMI component interdependencies drive different depths of disruptive sustainability. The visualized error bars in the accompanying figure reflect empirical variation (rather than theoretical absolutes), demonstrating that some BMI interdependencies tend to generate notable cross-dimensional changes due to their ability to connect with both problem and solution simultaneously.

5.2. Implications of the model

Kivimaa et al. (2021) define BMI as a dimension of disruptive sustainability which can either be a driver or an outcome of disruption. While we similarly feature it in our definition as one of the dimensions of disruptive sustainability, our model underscores and theorizes BMI as a driver of disruptive sustainability, challenging existing literature that view it predominantly as an outcome of disruption (Johnstone and Kivimaa, 2018; Berkeley et al., 2017; Matschoss and Heiskanen, 2018). This allows us to make two key theoretical contributions, namely (1) expanding the conceptualization of disruptive sustainability by unpacking the crucial characteristic of depth, and (2) explaining how the interdependencies between different business model innovation components drive disruptive sustainability. These contributions allow us to (3) develop a tool for practitioners and policymakers with implications for fostering disruptive sustainability in LMICs and other settings.

First, our results expand the conceptualization of disruptive sustainability by pointing to the critical importance of depth of change. Attention to the depth of change enables action-oriented, actor-specific insights to be developed that can help to direct speed and breadth towards fundamental transformation. Kivimaa et al. (2021) in their foundational work have advanced our prior understanding of disruption in the context of sustainability transitions (Johnstone et al., 2020; Johnstone and Kivimaa, 2018) by arguing that narrow change, i.e. where only one dimension is affected, does not constitute socio-technical system change. Instead, they suggest rapid and broad change across multiple system elements or dimensions is the most obvious form of disruptive sustainability as it fundamentally transforms the socio-technical system. Gradual and broad change similarly leads to shifts in socio-technical systems, albeit through less intense system re-configuration processes (Kivimaa et al., 2021; Geels, 2018a). Based on our findings, we propose extending this conceptualization of disruptive sustainability by emphasizing depth as a complementary third characteristic to speed and breadth. Fig. 3 schematically illustrates how these three characteristics of speed, breadth and depth, combine to shape whether disruptive sustainability is incremental or fundamental. We suggest that the depth of change plays a key role in determining how fundamental or transformative the socio-technical system change is in disruptive sustainability. In fact, some disruptions can be associated with rapid and broad change across dimensions, but without the required depth to overcome system inertia, implying limited ability to drive long-term change (Abson et al., 2017; Luederitz et al., 2017). For instance, the murder of George Floyd in 2020 was a disruption that triggered rapid and broad change across different dimensions, notably the rise of diversity, equity and inclusion (DEI) policies, re-positioning of private sector actors, and societal behaviour changes visible through the

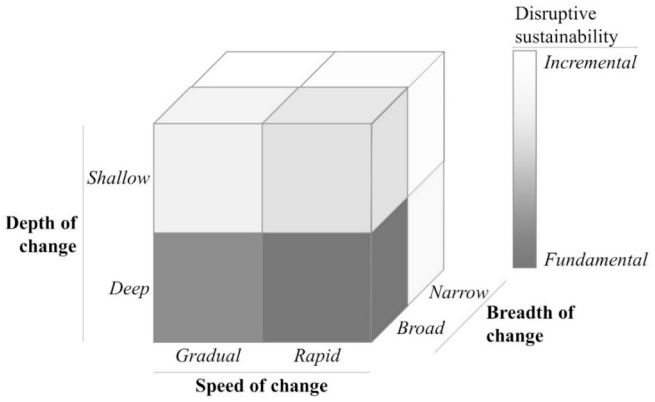

Fig. 3. Schematic illustration of speed, breadth and depth of change in disruptive sustainability.

Black Lives Matter movement (Armstrong et al., 2023). However, immediately following the inauguration of Donald Trump, the government and many private sector actors in the US rolled back DEI programmes with limited resistance (Ng et al., 2025). Thus, this case is an incremental form of disruptive sustainability as the disruption did not lead to deep changes in cultural models, market logics or institutional norms. Our findings show that disruptions trigger different depths of change within and across dimensions, ranging from shallow behaviour changes to altered cultural models, or from modified market elements to deep changes in market logics.

Adding depth to the conceptualization of disruptive sustainability offers opportunities to connect with the literature on systems change. Deep changes have been argued to be critical for fundamental systems change to occur. Meadows (1999) in her seminal work on the typology of leverage points for changing systems, for example, discusses shallow and deep leverage points (Meadows, 1999). In both general systems theory and sustainability transitions, shallow intervention points are typically easier to implement but usually result in only incremental changes to the system (Meadows, 1999; Abson et al., 2017; Luederitz et al., 2017). In contrast, deeper intervention points are harder to implement but have the potential to bring about more fundamental changes to system rules, norms, goals and paradigms, i.e. how the system behaves (Meadows, 1999; Abson et al., 2017; Luederitz et al., 2017). Identifying the depth of potential changes drawing on this work, could allow opportunities for sustainability transitions pathways to be uncovered as they unfold rather than being identified only ex-post (Köhler et al., 2019). In general, while sustainability transitions and systems theory are closely linked (Geels, 2004), the nexus between different depths of leverage points in systems (Meadows, 1999; Abson et al., 2017) and different depths of disruptive sustainability warrants further investigation. In the extant literature on sensitive intervention points, brief and high-intensity effects, or "kicks" (Farmer et al., 2019b), are usually viewed as distinct from intervention points that shift the underlying system dynamic (Farmer et al., 2019b). Our results and conceptualization suggest that "kicks" might indeed themselves trigger deep changes in the system, linking the two in new ways. One interesting avenue for future research could thus be to study how different disruptions activate intervention points at varying depths to develop a more complete picture of the nature of disruptive sustainability.

Second, our results show that it is not individual BMI components, but specifically their interdependencies through the connection to problems and solutions, that drive disruptive sustainability. While the literature on BMI has acknowledged the importance of value propositions, value capture, and value networks individually (Trotter and Brophy, 2022; Foss and Saebi, 2017; Bocken et al., 2014; Schaltegger et al., 2016), most studies have treated these as modular and analytically separable (Foss and Saebi, 2017, 2018). For instance, studies on circular

or social BMs typically propose reconfigurations in multiple BM elements yet often treat these elements as modular or additive rather than interdependent (Upward and Jones, 2016; Lozano, 2018). In contrast, our findings suggest that disruption depends on the innovations in different BM components and their interdependencies. We identify a key mechanism that explains how these interdependencies connect to disruptive sustainability. Our results suggest that it is the focus on problem and solution simultaneously that drives deep disruptive sustainability. This finding resonates closely with the management literature on addressing grand challenges such as climate change and inequality, where a key aim has been to connect innovative approaches more closely to the features of these challenges (George et al., 2016). The focus on problems and solutions simultaneously over time is important due to the complexity, uncertainty and lack of clear definitions. These features require approaches that can allow for iteration in the understanding of problems and potential solutions (Ferraro et al., 2015; Gray et al., 2022), particularly through connecting new actors and networks to ensure more pluralistic problem framing and solution design (Stadtler et al., 2024).

This perspective on the connection between problem and solution helps us to assess and explain the interdependencies between BMI components in ways that can further advance emerging scholarship on the impact of BM beyond the firm (Snihur and Bocken, 2022). For example, interdependencies which feature the value capture component drive comparably more shallow disruptive sustainability due to the weighting of the focus on solutions over problems. Indeed, arguably, value capture is the BM component most tightly coupled with firm-centric financial performance, implying that its capacity to generate system-level change may be comparatively constrained. Despite this limitation, the BMI literature often focuses on firm-level value capture innovations (Foss and Saebi, 2017; Stubbs and Cocklin, 2008; Boons and Lüdeke-Freund, 2013; Schaltegger et al., 2016). This value capture focus in BMI studies is similarly salient in the Base of the Pyramid (BOP) literature in LMICs where analyses focus primarily on affordability approaches and adaptation to local markets (Dembek et al., 2016; Prahalad and Hart, 2002; Lashitew et al., 2022). By contrast, interdependencies between value proposition and value network drive deep shifts across the dimensions of disruptive sustainability because of their ability to simultaneously focus on problems and solutions. These BM components are outward-facing, combining understanding of social needs with new ways of value delivery beyond the firm (Snihur and Bocken, 2022), and thereby offer greater leverage for driving systemic transformation. Arguably, in last-mile contexts in LMICs, where incumbents are often absent and market infrastructure underdeveloped, this interplay is particularly powerful: Firms do not merely participate in a market. The interdependence between value proposition and value network helps to define the structures and paradigms of new markets, shaping understandings of both problems and solutions. Studying these interdependencies has allowed us to identify a pathway for BMI to function as a mechanism for disruptive sustainability rather than a firm-level innovation tool (Kivimaa et al., 2021; Snihur and Bocken, 2022).

Third, these contributions, and most notably the intersection between problem-solution focus and depth, provide a basis for developing a diagnostic and prognostic tool for designing system-level innovation approaches which help relevant stakeholders to drive disruptive sustainability (Table 5). This tool guides stakeholders along three subsequent steps which each involve a diagnostic and an associated prognostic component. We explain these steps below in turn, and illustrate them for both firms and policymakers.

In a first step, rather than prioritizing the implementation of existing solutions, the diagnosis focuses on deep levels of the problem-solution nexus. A focus solely on solutions at an early stage of system disruption would limit the opportunities for disruptive sustainability. Instead, we suggest for stakeholders to first ask: *What is the problem-solution space, and is a change of purpose or scope needed?* Critically assessing the prevailing understanding of the extant problem-solution space is key to understand whether current solutions are able to deliver on desired sustainability goals, or whether a new scope or purpose is required to do so. Conceiving approaches for deep forms of disruptive sustainability requires problem-oriented work. For instance, in the off-grid energy sector, a focus on providing energy access to low-income communities has often failed to deliver sustained socio-economic development (Terrapon-Pfaff et al., 2018; Lenz et al., 2017). This is a result of a narrow problem-solution space shaped by the SDG 7-informed provision of energy access (Trotter and Brophy, 2022), rather than a broad and integrated approach connecting energy to income generation and/or improved health care services (Trotter, 2021). Creating new problem-specific knowledge in the context of the multi-variant goals present in sustainability transitions requires a deep engagement with relevant stakeholders, and, where possible, learning from other organizations active in similar domains. Critically, our results suggest that if this first diagnostic step reveals significant opportunities to re-define the

Table 5
A diagnostic and prognostic tool for driving system-level innovation for disruptive sustainability, intended for repeated and iterative usage.

			Selected dimensions of disruptive sustainability		
			Behaviours, practices and cultural models	Actors, networks and ownership structures	Markets
Level	*Diagnosis steps*		*Prognosis (in case of diagnosis revealing existing dimension-specific barriers)*		
Deep	1. What is the problem-solution space, and is a change of purpose or scope needed?	Firms	What could a reframing of the value proposition look like to encourage trust/acceptance/agency?	How could other actors in the value network be engaged in novel ways to define the problem-solution space?	How do changes in value proposition and value network overlap to support new market logics?
		Policy	How can spaces for co-creation be supported/designed for inclusion?	How can policymakers challenge their own understanding of the problem-solution space?	How can changes in policy strategy combine both support and constraints for new market logics required to address the key problems?
Medium	2. Are new matches between problems and solutions needed?	Firms	How could innovative monetization approaches support value proposition?	Which actors might be needed to support innovative monetization?	How can the monetization approach enhance the ability to meet a need?
		Policy	How can newly emerging practices be institutionalized?	Which actors might need incentives to become involved in new networks?	Where can the policy strategy be adapted to clarify specific problems/needs?
Shallow	3. Is implementation well facilitated?	Firms	Where could existing monetization approaches be adapted to meet specific needs?	Where could value network interactions be improved to support monetization?	How can value capture approach and value networks work together to make market transactions more efficient?
		Policy	How could the instrument mix connect more clearly with a policy strategy?	How could the instrument mix ease market interactions?	How could the instrument mix ease market transactions?

problem-solution space for more sustainable outcomes, this would provide a basis for overcoming deep systemic barriers relating to cultural models, ownership structures and/or market logics.

For firms, the problem-solution lens provides an opportunity to identify when and how to strategically engage in activities beyond the firm's own boundaries to drive disruptive sustainability. At the deep level, this work requires leaning on, or extending, the firm's value network to engage with customers, communities, policymakers and other stakeholders in new ways, as well as a willingness to adjust the value proposition to capture emerging context-specific environmental, social and economic priorities in order to build trust and agency (Schneider and Clauß, 2020). For instance, off-grid energy entrepreneurs in East Africa deeply engaged with rural fishing value chains, empowered marginalized women self-help groups in fish value chains and gradually shifted their value proposition from household energy provision to driving energy-enabled rural development which challenges existing energy market logics (Trotter and Brophy, 2022). Policymakers and other support actors in the ecosystem such as donors and NGOs are well placed to conduct detailed diagnostic assessments of barriers at varying levels of depth which could be shared openly to support innovation for disruptive sustainability. For instance, the UN entity UN Women and the NGO African Women's Development and Communications Network facilitate knowledge sharing and advocacy on including gender inequality problems in wider development initiatives, helping to overcome barriers for deep re-calibration towards gendered impacts of basic service provisions (Njoh et al., 2018). Based on these assessments, support actors can challenge their own understanding of ownership and agency, design spaces for meaningful co-creation of knowledge, and implement policy and finance guidelines that promote new market logics, for instance through institutionalizing shared governance mechanisms between the energy and fishing sectors in Uganda (Trotter et al., 2023).

In a second step, if these deep issues are already being addressed, or if there is no or limited evidence of deep barriers to begin with, the diagnosis continues to medium depth. In order to meet context-specific needs and deliver against sustainability outcomes, the question here is: *Are new matches between problems and solutions needed?* In the off-grid energy example from above, initially, no existing solution was available that combined value capture in energy and fishing to deliver on the idea to drive energy-enabled rural development (Terrapon-Pfaff et al., 2018). While designing new matches between problem and solution may involve various degrees of depth across disruptive sustainability dimensions, our results suggest that this level mostly relates to practices, networks and market structures.

The prognoses at this second stage hinge on re-defining the interdependence between value proposition and value capture. Guiding questions include how new monetization approaches can support the desired value proposition, how they can be implemented such that market structures emerge which are best able to address the problems, and which new sets of actors are required for this match. In the off-grid energy example, companies defined a servitization approach which sold ice by the kilogram to fishers (as fishers were unable to afford ice machines themselves). This changed the fishers' practices of preserving fish, adjusted the value network through new fish trading routes, and created a market structure that effectively monetized productivity gains in the fishing industry through an energy service (Trotter and Brophy, 2022). Policymakers in this step can search for ways to institutionalize and safeguard newly emerging practices required for the problem-solution match, creating tailored incentives for different actors to join new actor networks, and adjusting underlying policy strategies which enable new market structures to form.

The third step follows once deep barriers are already being addressed or the diagnosis has revealed no such barriers. In this stage, stakeholders focus on solutions and ask: *Is implementation well facilitated?* In the off-grid energy example, this may involve improving the efficiency of the solution by refining payment methods to incentivize desired payment behaviours of fishers (Knuckles, 2016). The focus on solutions in this step deliberately addresses shallow aspects of the disruptive sustainability dimensions primarily aimed at overcoming current behavioural, actor-level and/or transaction-level barriers for growth of the solution.

For firms, this means that the interdependence between value capture and value network takes priority as a basis for developing prognoses. Firms test whether new monetization approaches can lead to behaviour change of customers and suppliers, assess where value network interactions can be improved to support individual actors and foster efficient market transactions. Complementarily, the questions for policymakers and other support organizations focus on improving and adapting existing policy instruments to guide desirable behaviours and improve the ease with which actors can engage in market transactions. In the off-grid example, this could include easing regulatory burdens for integrated solutions across sectors or providing micro-loans to energy companies for ice machines.

This combined diagnostic/prognostic tool closely connects BMI interdependencies with disruptive sustainability dimensions and depth in ways that generate specific and targeted actions. Compared to existing business model approaches building on the BM canvas that map BM components (Keane et al., 2018) or separately assess the environmental and social aspects that connect with the BM (Joyce and Paquin, 2016; Sparviero, 2019), starting with a problem-solution focus ties BM interdependencies directly to system-level change. If the diagnosis reveals deep barriers, the focus for collaboration requires more open-ended activities to work with and explore a range of actors in the value network, engaging in shaping how the problem-solution space is even understood. These insights expand the practical guidance for policymakers on approaches to supporting complex BMI, where the importance of balancing support and constraint to enable complex BMI has been identified (Trotter and Brophy, 2022). They also build on the policy mix literature which underlines the importance of coherence between a policy strategy and an instrument mix in supporting sustainability transitions (Mavrot et al., 2019; Kern et al., 2019). The policy interventions in our tool corresponding to different degrees of depth, range from institutionalizing new governance structures to fine-tuning existing instruments mixes. Notably, in our specific case of international development, this would somewhat require a departure from the current risk-minimising approach to donor-funded initiatives (Duffield, 2010; Trotter and Abdullah, 2018) as deep system change is complex and not always successful. For instance, dominant BMs in such initiatives of providing access to energy such as the European Union's EnDev or the US Power Africa initiative often have comparably limited value proposition ("Provide energy access") and value network ("partner with mobile money provider to improve sales efficiency") innovations as these approaches minimize short-term risks for funders (Trotter and Brophy, 2022; Trotter and Abdullah, 2018; Trotter, 2019). But this limits their potential for deep disruptive sustainability (Mulugetta et al., 2022; Batidzirai et al., 2021; O'Connor and Joffe, 2020).

More generally, transition scholars and development actors alike may benefit from treating BMI not just as a novel firm strategy, but as a tool for systems change. BMI can serve as a context-sensitive mechanism to change socio-technical systems from the ground up (Sarasini and Linder, 2018; Loorbach and Wijsman, 2013). Our findings suggest that a shift towards system-aware innovation support which recognises the interdependencies between business model components and their effect on value creation logics, actor networks, and behavioural change, is essential to harness the full disruptive potential of BMI for sustainable development (Luederitz et al., 2017; Stadtler et al., 2024).

CRediT authorship contribution statement

Maria Schmidt: Writing – review & editing, Writing – original draft, Visualization, Validation, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Aoife Brophy:** Writing – review & editing, Visualization, Validation,

Methodology, Investigation, Formal analysis, Supervision, Funding acquisition, Conceptualization. **Philipp Trotter:** Writing – review & editing, Visualization, Validation, Methodology, Investigation, Formal analysis, Resources, Supervision, Funding acquisition, Conceptualization.

Declaration of Generative AI and AI-assisted technologies in the writing process

During the preparation of this work, the authors used ChatGPT in a small number of instances in order to improve the readability and language of certain sentences within the manuscript in accordance with *Research Policy's* guidelines for authors. The authors have not used this tool in any other capacity, such as for idea generation, conceptualization, data analysis, generation of insights, or visualization. After using this tool, the authors reviewed and edited the content and take full responsibility for the content of the published article.

Declaration of competing interest

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

Acknowledgements

This research was partly funded by the Climate Compatible Growth Programme by the UK government. The views expressed herein do not necessarily reflect the UK government's official policies. We thank David Antons, Anna Kim, Panikos Georgallis, Itziar Castello as well as members of the INTERA Research Network and participants at PRME UK & Ireland, GRONEN conference, VHB conference, and the Academy of Management Annual Meeting 2023 for their constructive comments on earlier drafts of the paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.respol.2026.105533.

Data availability

Data will be made available on request.

References

Abernathy, W.J., Clark, K.B., 1985. Innovation: mapping the winds of creative destruction. Res. Policy 14, 3–22.
Abson, D.J., Fischer, J., Leventon, J., Newig, J., Schomerus, T., Vilsmaier, U., Von Wehrden, H., Abernethy, P., Ives, C.D., Jager, N.W., 2017. Leverage points for sustainability transformation. Ambio 46, 30–39.
Adams, R.J., Smart, P., Huff, A.S., 2017. Shades of grey: guidelines for working with the grey literature in systematic reviews for management and organizational studies. Int. J. Manag. Rev. 19, 432–454.
Adner, R., Kapoor, R., 2010. Value creation in innovation ecosystems: how the structure of technological interdependence affects firm performance in new technology generations. Strateg. Manag. J. 31, 306–333.
Allet, M., 2016. Energy entrepreneurs: an innovative model to reach the last mile. In: Field Actions Science Report 2016, pp. 138–147.
Armstrong, M., Edwards, E., Pinder, D., 2023. Corporate Commitments to Racial Justice: An Update (Washington D.C.).
Barrie, J., Cruickshank, H.J., 2017. Shedding light on the last mile: a study on the diffusion of Pay As You Go Solar Home Systems in Central East Africa. Energy Policy 107, 425–436.
Barry, M.S., Creti, A., 2020. Pay-as-you-go contracts for electricity access: bridging the "last mile" gap? A case study in Benin. Energy Econ. 90. https://doi.org/10.1016/j.eneco.2020.104843.
Batidzirai, B., Trotter, P.A., Brophy, A., Stritzke, S., Moyo, A., Twesigye, P., Puranasamriddhi, A., Madhlopa, A., 2021. Towards people-private-public partnerships: an integrated community engagement model for capturing energy access needs. Energy Res. Soc. Sci. 74, 101975.
Beckman, C.M., Rosen, J., Estrada-Miller, J., Painter, G., 2023. The social innovation trap: critical insights into an emerging field. Acad. Manag. Ann. 17, 684–709.
Bensch, G., Kluve, J., Stöterau, J., 2021. The market-based dissemination of energy-access technologies as a business model for rural entrepreneurs: evidence from Kenya. Resour. Energy Econ. 66, 101248.
Berkeley, N., Bailey, D., Jones, A., Jarvis, D., 2017. Assessing the transition towards battery electric vehicles: a multi-level perspective on drivers of, and barriers to, take up. Transp. Res. Part A Policy Pract. 106, 320–332.
Bhatt, S., Evans, J., Gupta, S., 2018. Barriers to scale of digital health systems for cancer care and control in last-mile settings. J. Global Oncol. 2018, 1–3. https://doi.org/10.1200/JGO.2016.007179.
Bidmon, C.M., Knab, S.F., 2018. The three roles of business models in societal transitions: new linkages between business model and transition research. J. Clean. Prod. 178, 903–916. https://doi.org/10.1016/J.JCLEPRO.2017.12.198.
Bisaga, I., Parikh, P., Tomei, J., To, L.S, 2021. Mapping synergies and trade-offs between energy and the sustainable development goals: a case study of off-grid solar energy in Rwanda. Energy Policy 149. https://doi.org/10.1016/j.enpol.2020.112028.
Bocken, N., Short, S.W., Rana, P., Evans, S., 2014. A Literature and Practice Review to Develop Sustainable Business Model Archetypes.
Bocken, N.M.P., Short, S.W., 2016. Towards a sufficiency-driven business model: experiences and opportunities. Environ. Innov. Soc. Trans. 18, 41–61.
Bohnsack, R., Pinkse, J., Kolk, A., 2014. Business models for sustainable technologies: exploring business model evolution in the case of electric vehicles. Res. Policy 43, 284–300.
Bolton, R., Hannon, M., 2016. Governing sustainability transitions through business model innovation: towards a systems understanding. Res. Policy 45, 1731–1742. https://doi.org/10.1016/j.respol.2016.05.003.
Boons, F., Lüdeke-Freund, F., 2013. Business models for sustainable innovation: state-of-the-art and steps towards a research agenda. J. Clean. Prod. 45, 9–19. https://doi.org/10.1016/J.JCLEPRO.2012.07.007.
Bower, J.L., Christensen, C.M., 1995. Disruptive technologies: catching the wave. Harv. Bus. Rev. 73, 43–53.
Budinis, S., Krevor, S., Mac Dowell, N., Brandon, N., Hawkes, A., 2018. An assessment of CCS costs, barriers and potential. Energ. Strat. Rev. 22, 61–81.
Chakraborty, S., Bhatt, V., Chakravorty, T., 2018. Is telemedicine best alternative to reaching last mile: investigation in the context of rural India. Indian J. Public Health Res. Dev. 9, 202–206. https://doi.org/10.5958/0976-5506.2018.01341.4.
Christensen, C.M., 1997. The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail.
Christensen, C.M., Raynor, M.E., 2003. The Innovators Solution.
Christensen, C.M., Rosenbloom, R.S., 1995. Explaining the attacker's advantage: technological paradigms, organizational dynamics, and the value network. Res. Policy 24, 233–257.
Coenen, L., Benneworth, P., Truffer, B., 2012. Toward a spatial perspective on sustainability transitions. Res. Policy 41, 968–979. https://doi.org/10.1016/j.respol.2012.02.014.
Cohen, B., Kietzmann, J., 2014. Ride on! Mobility business models for the sharing economy. Organ. Environ. 27, 279–296. https://doi.org/10.1177/1086026614546199.
Cukier, S., Helal, L., Rice, D.B., Pupkaite, J., Ahmadzai, N., Wilson, M., Skidmore, B., Lalu, M.M., Moher, D., 2020. Checklists to detect potential predatory biomedical journals: a systematic review. BMC Med. 18, 1–20.
Debnath, S., Nilayamgode, M., Sekhri, S., 2023. Information bypass: using low-cost technological innovations to curb leakages in welfare programs. J. Dev. Econ. 164, 103137.
Dembek, K., Singh, P., Bhakoo, V., 2016. Literature review of shared value: a theoretical concept or a management buzzword? J. Bus. Ethics 137, 231–267.
Diochon, M.C., Ghore, Y., 2016. Last mile farm inputs: farm shop delivers. In: Emerald Emerging Markets Case Studies, 9, pp. 1–22. https://doi.org/10.1108/EEMCS-03-2016-0025.
Duffield, M., 2010. Risk-management and the fortified aid compound: everyday life in post-interventionary society. J. Interv. Statebuild. 4, 453–474.
Farmer, J.D., Hepburn, C., Ives, M.C., Hale, T., Wetzer, T., Mealy, P., Rafaty, R., Srivastav, S., Way, R., 2019. Sensitive Intervention Points in the Post-carbon Transition.
Ferraro, F., Etzion, D., Gehman, J., 2015. Tackling grand challenges pragmatically: robust action revisited. Organ. Stud. 36, 363–390.
Ferràs-Hernández, X., Tarrats-Pons, E., Arimany-Serrat, N., 2017. Disruption in the automotive industry: a Cambrian moment. Bus. Horiz. 60, 855–863.
Foss, N.J., Saebi, T., 2017. Fifteen years of research on business model innovation: how far have we come, and where should we go? J. Manag. 43, 200–227. https://doi.org/10.1177/0149206316675927.
Foss, N.J., Saebi, T., 2018. Business models and business model innovation: between wicked and paradigmatic problems. Long Range Plann. 51, 9–21. https://doi.org/10.1016/j.lrp.2017.07.006.
Geels, F.W., 2004. From sectoral systems of innovation to socio-technical systems: insights about dynamics and change from sociology and institutional theory. Res. Policy 33, 897–920. https://doi.org/10.1016/j.respol.2004.01.015.
Geels, F.W., 2010. Ontologies, socio-technical transitions (to sustainability), and the multi-level perspective. Res. Policy 39, 495–510.
Geels, F.W., 2018a. Disruption and low-carbon system transformation: progress and new challenges in socio-technical transitions research and the multi-level perspective. Energy Res. Soc. Sci. 37, 224–231.
Geels, F.W., 2018b. Low-carbon transition via system reconfiguration? A socio-technical whole system analysis of passenger mobility in Great Britain (1990–2016). Energy Res. Soc. Sci. 46, 86–102.

George, G., Howard-Grenville, J., Joshi, A., Tihanyi, L., 2016. Understanding and tackling societal grand challenges through management research. Acad. Manage. J. 59, 1880–1895.
Goyal, S., Sergi, B.S., Kapoor, A., 2017. Emerging role of for-profit social enterprises at the base of the pyramid: the case of Selco. J. Manag. Dev. 36, 97–108. https://doi.org/10.1108/JMD-05-2015-0070.
Goyal, S., Kapoor, A., Sergi, B.S., 2020. Empowering rural women through shared value approach: study of GNFC Neem Project in India. In: World Review of Entrepreneurship, Management and Sustainable Development, 16, pp. 359–379. https://doi.org/10.1504/WREMSD.2020.109965.
Gray, B., Purdy, J., Ansari, S., 2022. Confronting power asymmetries in partnerships to address grand challenges. Organ. Theory 3, 26317877221098764.
Hall, S., Workman, M., Hardy, J., Mazur, C., Anable, J., Powell, M., Wagner, S.M., 2022. Doing business model innovation for sustainability transitions—bringing in strategic foresight and human centred design. Energy Res. Soc. Sci. 90, 102685.
Hang, C.C., Garnsey, E., Ruan, Y., 2015. Opportunities for disruption. Technovation 39, 83–93.
Hargreaves, T., Hielscher, S., Seyfang, G., Smith, A., 2013. Grassroots innovations in community energy: the role of intermediaries in niche development. Glob. Environ. Chang. 23, 868–880.
Hedström, P., Wennberg, K., 2017. Causal mechanisms in organization and innovation studies. Innovation 19, 91–102.
Heuër, A., 2017. Women-to-women entrepreneurial energy networks: a pathway to green energy uptake at the base of pyramid. Sustain Energy Technol Assess 22, 116–123. https://doi.org/10.1016/j.seta.2017.02.020.
Hiebl, M.R.W., 2023. Sample selection in systematic literature reviews of management research. Organ. Res. Methods 26, 229–261.
Ho, J.C., Chen, H., 2018. Managing the disruptive and sustaining the disrupted: the case of Kodak and Fujifilm in the face of digital disruption. Rev. Policy Res. 35, 352–371.
Hoekstra, A., Steinbuch, M., Verbong, G., 2017. Creating agent-based energy transition management models that can uncover profitable pathways to climate change mitigation. Complexity 2017, 1967645.
Horvath, K.J., Bwanika, J.M., Lammert, S., Banonya, J., Atuhaire, J., Banturaki, G., Kamulegeya, L.H., Musinguzi, D., Kiragga, A.N., 2022. HiSTEP: a single-arm pilot study of a technology-assisted HIV self-testing intervention in Kampala, Uganda. AIDS Behav. 26, 935–946. https://doi.org/10.1007/s10461-021-03449-9.
Huijben, J.C.C.M., Verbong, G.P.J., Podoynitsyna, K.S., 2016. Mainstreaming solar: stretching the regulatory regime through business model innovation. Environ. Innov. Soc. Trans. 20, 1–15. https://doi.org/10.1016/J.EIST.2015.12.002.
Ilie, S., Rose, P., Vignoles, A., 2021. Understanding higher education access: inequalities and early learning in low and lower-middle-income countries. Br. Educ. Res. J. 47, 1237–1258.
Johnson, M.P., Schaltegger, S., 2020. Entrepreneurship for sustainable development: a review and multilevel causal mechanism framework. Entrep. Theory Pract. 44, 1141–1173.
Johnson, O.W., Gerber, V., Muhoza, C., 2019. Gender, culture and energy transitions in rural Africa. Energy Res. Soc. Sci. 49, 169–179.
Johnstone, P., Kivimaa, P., 2018. Multiple dimensions of disruption, energy transitions and industrial policy. Energy Res. Soc. Sci. 37, 260–265.
Johnstone, P., Rogge, K.S., Kivimaa, P., Fratini, C.F., Primmer, E., Stirling, A., 2020. Waves of disruption in clean energy transitions: sociotechnical dimensions of system disruption in Germany and the United Kingdom. Energy Res. Soc. Sci. 59, 101287. https://doi.org/10.1016/j.erss.2019.101287.
Joyce, A., Paquin, R.L., 2016. The triple layered business model canvas: a tool to design more sustainable business models. J. Clean. Prod. 135, 1474–1486.
Jue, D., Pruter, M., 2015. Creating an essential marketplace to close the information gap for social impact technologies. Curr. Sci. 109, 1630–1638. https://doi.org/10.18520/v109/i9/1630-1638.
Kanda, W., Kivimaa, P., 2020. What opportunities could the COVID-19 outbreak offer for sustainability transitions research on electricity and mobility? Energy Res. Soc. Sci. 68, 101666.
Keane, S.F., Cormican, K.T., Sheahan, J.N., 2018. Comparing how entrepreneurs and managers represent the elements of the business model canvas. J. Bus. Ventur. Insights 9, 65–74.
Kern, F., Rogge, K.S., Howlett, M., 2019. Policy mixes for sustainability transitions: new approaches and insights through bridging innovation and policy studies. Res. Policy 48, 103832.
Khalid, R., Landini, S., Valasai, G.D., Khalid, F., Sandwell, P., 2023. Towards equitable and inclusive energy systems for remote off-grid communities: a socio-technical assessment of solar power for village Helario in Tharparkar, Pakistan. Renewable and Sustainable Energy Transition 4. https://doi.org/10.1016/j.rset.2023.100067.
Kivimaa, P., Laakso, S., Lonkila, A., Kaljonen, M., 2021. Moving beyond disruptive innovation: a review of disruption in sustainability transitions. Environ. Innov. Soc. Trans. 38, 110–126.
Knuckles, J., 2016. Business models for mini-grid electricity in base of the pyramid markets. Energy Sustain. Dev. 31, 67–82.
Köhler, J., Geels, F.W., Kern, F., Markard, J., Onsongo, E., Wieczorek, A., Alkemade, F., Avelino, F., Bergek, A., Boons, F., 2019. An agenda for sustainability transitions research: state of the art and future directions. Environ. Innov. Soc. Trans. 31, 1–32.
Kunisch, S., zu Knyphausen-Aufsess, D., Bapuji, H., Aguinis, H., Bansal, T., Tsui, A.S., Pinto, J., 2023. Using review articles to address societal grand challenges. Int. J. Manag. Rev. 25, 240–250.
Kuokkanen, A., Uusitalo, V., Koistinen, K., 2019. A framework of disruptive sustainable innovation: an example of the Finnish food system. Tech. Anal. Strat. Manag. 31, 749–764.
Lahariya, C., Roy, B., Shukla, A., Chatterjee, M., De Graeve, H., Jhalani, M., Bekedam, H., 2020. Community action for health in India: evolution, lessons learnt and ways forward to achieve universal health coverage. WHO South. East. Asia. J. Public Health 9, 82–91. https://doi.org/10.4103/2224-3151.283002.
Lashitew, A.A., Van Tulder, R., Liasse, Y., 2019. Mobile phones for financial inclusion: what explains the diffusion of mobile money innovations? Res. Policy 48, 1201–1215.
Lashitew, A.A., van Tulder, R., Muche, L., 2022. Social value creation in institutional voids: a business model perspective. Bus. Soc. 61, 1992–2037. https://doi.org/10.1177/0007650320982283.
Lazarevic, D., Valve, H., 2020. Niche politics: biogas, technological flexibility and the economisation of resource recovery. Environ. Innov. Soc. Trans. 35, 45–59.
Lenz, L., Munyehirwe, A., Peters, J., Sievert, M., 2017. Does large-scale infrastructure investment alleviate poverty? Impacts of Rwanda's electricity access roll-out program. World Dev. 89, 88–110.
Li, Q., Zhang, H., Tan, C., Lian, B., García-Pacheco, R., Taylor, R.A., Fletcher, J., Le-Clech, P., Ranasinghe, B., Senevirathna, T., Senevirathna, T., Leslie, G., 2022. Numerical and experimental investigation of a DC-powered RO system for Sri-Lankan villages. Renew. Energy 182, 772–786. https://doi.org/10.1016/j.renene.2021.10.056.
Loorbach, D., Wijsman, K., 2013. Business transition management: exploring a new role for business in sustainability transitions. J. Clean. Prod. 45, 20–28. https://doi.org/10.1016/J.JCLEPRO.2012.11.002.
Lozano, R., 2018. Sustainable business models: providing a more holistic perspective. Bus. Strateg. Environ. 27, 1159–1166.
Luckow, P.W., Kenny, A., White, E., Ballard, M., Dorr, L., Erlandson, K., Grant, B., Johnson, A., Lorenzen, B., Mukherjee, S., 2017. Implementation research on community health workers' provision of maternal and child health services in rural Liberia. Bull. World Health Organ. 95, 113.
Lüdeke-Freund, F., Froese, T., Dembek, K., Rosati, F., Massa, L., 2024. What Makes a Business Model Sustainable? Activities, Design Themes, and Value Functions.
Luederitz, C., Abson, D.J., Audet, R., Lang, D.J., 2017. Many pathways toward sustainability: not conflict but co-learning between transition narratives. Sustain. Sci. 12, 393–407.
Markard, J., Truffer, B., 2008. Technological innovation systems and the multi-level perspective: towards an integrated framework. Res. Policy 37, 596–615. https://doi.org/10.1016/J.RESPOL.2008.01.004.
Markard, J., Raven, R., Truffer, B., 2012. Sustainability transitions: an emerging field of research and its prospects. Res. Policy 41, 955–967.
Markides, C., 2006. Disruptive innovation: in need of better theory*. J. Prod. Innov. Manag. 23, 19–25. https://doi.org/10.1111/j.1540-5885.2005.00177.x.
Martin, C.J., 2016. The sharing economy: a pathway to sustainability or a nightmarish form of neoliberal capitalism? Ecol. Econ. 121, 149–159.
Matschoss, K., Heiskanen, E., 2018. Innovation intermediary challenging the energy incumbent: enactment of local socio-technical transition pathways by destabilisation of regime rules. Tech. Anal. Strat. Manag. 30, 1455–1469.
Mavrot, C., Hadorn, S., Sager, F., 2019. Mapping the mix: linking instruments, settings and target groups in the study of policy mixes. Res. Policy 48, 103614.
Mazzone, A., Fulkaxò Cruz, D.K., Tumwebaze, S., Ushigua, M., Trotter, P.A., Carvajal, A. E., Schaeffer, R., Khosla, R., 2023. Indigenous cosmologies of energy for a sustainable energy future. Nat. Energy 8, 19–29.
McDowall, W., 2018. Disruptive innovation and energy transitions: is Christensen's theory helpful? Energy Res. Soc. Sci. 37, 243–246.
Meadows, D., 1999. Leverage Points Places to Intervene in a System.
Meadows, D., 2008. Thinking in Systems: A Primer. Chelsea Green Publishing, White River Junction, VT.
Mekonnen, Z.A., Gelaye, K.A., Were, M., Tilahun, B., 2021. Effect of mobile phone text message reminders on the completion and timely receipt of routine childhood vaccinations: superiority randomized controlled trial in Northwest Ethiopia. JMIR Mhealth Uhealth 9. https://doi.org/10.2196/27603.
Muller, N., Ranjaharinony, F., Etrahagnane, M., Frühauf, A., Razafindranaivo, T., Ramasimanana, H., Emmrich, J.V., 2022. Crossing the last mile of TB care in rural southern Madagascar: a multistakeholder initiative. Glob. Health Sci. Pract. 10. https://doi.org/10.9745/GHSP-D-22-00101.
Mulugetta, Y., Sokona, Y., Trotter, P.A., Fankhauser, S., Omukuti, J., Somavilla Croxatto, L., Steffen, B., Tesfamichael, M., Abraham, E., Adam, J.-P., 2022. Africa needs context-relevant evidence to shape its clean energy future. Nat. Energy 7, 1015–1022.
Mylan, J., Morris, C., Beech, E., Geels, F.W., 2019. Rage against the regime: niche-regime interactions in the societal embedding of plant-based milk. Environ. Innov. Soc. Trans. 31, 233–247.
Ng, E., Fitzsimmons, T., Kulkarni, M., Ozturk, M.B., April, K., Banerjee, R., Muhr, S.L., 2025. The anti-DEI agenda: navigating the impact of trump's second term on diversity, equity and inclusion. Equal. Divers. Incl. 44, 137–150.
Njoh, A.J., Ananga, E.O., Ngyah-Etchutambe, I.B., Deba, L.E., Asah, F.J., Ayuk-Etang, E. N.M., Akiwumi, F.A., 2018. Electricity supply, and access to water and improved sanitation as determinants of gender-based inequality in educational attainment in Africa. Soc. Indic. Res. 135, 533–548.
Nyqvist, M.B., Guariso, A., Svensson, J., Yanagizawa-Drott, D., 2019. Reducing child mortality in the last mile: experimental evidence on community health promoters in Uganda. Am. Econ. J. Appl. Econ. 11, 155–192. https://doi.org/10.1257/app.20170201.
O'Connor, C., Joffe, H., 2020. Intercoder reliability in qualitative research: debates and practical guidelines. Int. J. Qual. Methods 19, 1609406919899220.
Odume, B., Meribe, S.C., Odusote, T., Ifunanya, M., Debem, H., Amazue-Ezeuko, I., Ogbanufe, O., Adamu, Y., Onotu, D., 2020. Taking tuberculosis preventive therapy

implementation to national scale: the Nigerian PEPFAR program experience. Public Health Action 10, 7–10. https://doi.org/10.5588/pha.19.0033.
Ojong, N., Simba, A., Dana, L.P., 2021. Female entrepreneurship in Africa: a review, trends, and future research directions. J. Bus. Res. 132, 233–248. https://doi.org/10.1016/j.jbusres.2021.04.032.
Palaon, H., Wiryono, S.K., Faturohman, T., 2020. Branchless banking agents: business satisfaction, continuity, and viability. Cogent Bus. Manag. 7. https://doi.org/10.1080/23311975.2020.1823585.
Pamela, M., Joseph, K., Patrick, R., Florence, M., 2021. Last mile access to enriched children's complementary food: mitigating malnutrition in Kenya. Front. Public Health 9, 604864.
Parameswar, N., Dhir, S., 2022. Delhivery: fulfilling E-commerce delivery. Asian J. Manag. Cases 19, 93–105. https://doi.org/10.1177/09728201221080684.
Pedrajas, M., Choritz, S., 2016. Getting to the Last Mile in Least Developed Countries.
Prahalad, C.K., Hart, S.L., 2002. Strategy+ business. In: The Fortune at the Bottom of the Pyramid, 26, pp. 2–14.
Reckwitz, A., 2002. Toward a theory of social practices: a development in culturalist theorizing. Eur. J. Soc. Theory 5, 243–263.
Rice, D.B., Skidmore, B., Cobey, K.D., 2021. Dealing with predatory journal articles captured in systematic reviews. Syst. Rev. 10, 1–4.
Richardson, J., 2005. The Business Model: An Integrative Framework for Strategy Execution.
Ripple, W.J., Wolf, C., Newsome, T.M., Barnard, P., Moomaw, W.R., 2020. World scientists' warning of a climate emergency. Bioscience 70, 8–100.
Rolffs, P., Ockwell, D., Byrne, R., 2015. Beyond technology and finance: pay-as-you-go sustainable energy access and theories of social change. Environ. Plan. A. 47, 2609–2627.
Rynes, S.L., Bartunek, J.M., 2017. Evidence-based management: foundations, development, controversies and future. Annu. Rev. Organ. Psych. Organ. Behav. 4, 235–261.
Saeed, B.I.I., Yawson, A.E., Nguah, S., Agyei-Baffour, P., Emmanuel, N., Ayesu, E., 2016. Effect of socio-economic factors in utilization of different healthcare services among older adult men and women in Ghana. BMC Health Serv. Res. 16, 1–9.
Sahito, A., Ahmed, S., Fatmi, Z., 2020. Covering the last mile for vaccination: feasibility and acceptability of traditional birth attendant-based referral system in hard-to-reach areas in rural Pakistan. J. Glob. Health 10, 1–9. https://doi.org/10.7189/jogh.10.021303.
Sahu, S., Shyama, N., Chokshi, M., Mokashi, T., Dash, S., Sharma, T., Pal, A., Gupta, A., Saxena, G., 2022. Effectiveness of supply chain planning in ensuring availability of CD/NCD drugs in non-metropolitan and rural public health system. J. Health Manag. 24, 132–145. https://doi.org/10.1177/09720634221078064.
Sarasini, S., Linder, M., 2018. Integrating a business model perspective into transition theory: the example of new mobility services. Environ. Innov. Soc. Trans. 27, 16–31. https://doi.org/10.1016/J.EIST.2017.09.004.
Schaltegger, S., Lüdeke-Freund, F., Hansen, E.G., 2012. Business Cases for Sustainability: The Role of Business Model Innovation for Corporate Sustainability.
Schaltegger, S., Lüdeke-Freund, F., Hansen, E.G., 2016. Business models for sustainability: a co-evolutionary analysis of sustainable entrepreneurship, innovation, and transformation. Organ. Environ. 29, 264–289.
Schneider, S., Clauß, T., 2020. Business models for sustainability: choices and consequences. Organ. Environ. 33, 384–407.
Si, S., Chen, H., 2020. A literature review of disruptive innovation: what it is, how it works and where it goes. J. Eng. Technol. Manage. 56, 101568.
Skeete, J.-P., 2018. Level 5 autonomy: the new face of disruption in road transport. Technol. Forecast. Soc. Chang. 134, 22–34.
Snihur, Y., Bocken, N., 2022. A call for action: the impact of business model innovation on business ecosystems, society and planet. Long Range Plann. https://doi.org/10.1016/j.lrp.2022.102182.
Sovacool, B.K., Kester, J., Noel, L., de Rubens, G.Z., 2019. Energy injustice and Nordic electric mobility: inequality, elitism, and externalities in the electrification of vehicle-to-grid (V2G) transport. Ecol. Econ. 157, 205–217.
Sparviero, S., 2019. The case for a socially oriented business model canvas: the social enterprise model canvas. J. Soc. Entrep. 10, 232–251.
Stadtler, L., Seitanidi, M.M., Knight, H.H., Leigh, J., Clarke, A., Le Ber, M.J., Bogie, J., Brunese, P., Hustad, O., Krasonikolakis, I., 2024. Cross-sector partnerships to address societal grand challenges: systematizing differences in scholarly analysis. J. Manag. Stud. 61, 3327–3357.
Streeck, W., Yamamura, K., 2003. Introduction: convergence or diversity? Stability and change in German and Japanese capitalism. In: The End of Diversity? Prospects for German and Japanese Capitalism, pp. 1–50.
Stubbs, W., Cocklin, C., 2008. Conceptualizing a "sustainability business model.". Organ. Environ. 21, 103–127. https://doi.org/10.1177/1086026608318042.
Tarlan, A., Susanne, D., Taina, E., Maria, J., Aino, S., 2024. How far has research into disruptive innovations in the field of sustainability come to date? Heliyon 10.
Teece, D.J., 2010. Business models, business strategy and innovation. Long Range Plann. 43, 172–194. https://doi.org/10.1016/j.lrp.2009.07.003.
Terrapon-Pfaff, J., Gröne, M.-C., Dienst, C., Ortiz, W., 2018. Productive use of energy–pathway to development? Reviewing the outcomes and impacts of small-scale energy projects in the global south. Renew. Sustain. Energy Rev. 96, 198–209.
Throop, W., Mayberry, M., 2017. Leadership for the sustainability transition. Bus. Soc. Rev. 122, 221–250.
Tiwari, J., Schaub, E., Sultana, N., 2019. Barriers to "last mile" financial inclusion: cases from northern Kenya. Dev. Pract. 29, 988–1000. https://doi.org/10.1080/09614524.2019.1654432.
Trotter, P.A., 2019. Ambitions versus policy design: addressing issues of the Power Africa initiative's quantitative targets. Energy Policy 128, 900–906.
Trotter, P.A., 2021. From silos to systems: enabling off-grid electrification of healthcare facilities, households, and businesses in sub-Saharan Africa. One Earth 4, 1543–1545.
Trotter, P.A., Abdullah, S., 2018. Re-focusing foreign involvement in sub-Saharan Africa's power sector on sustainable development. Energy Sustain. Dev. 44, 139–146. https://doi.org/10.1016/j.esd.2018.03.003.
Trotter, P.A., Brophy, A., 2022. Policy mixes for business model innovation: the case of off-grid energy for sustainable development in six sub-Saharan African countries. Res. Policy 51, 104528.
Trotter, P.A., Becker, T., Renaldi, R., Wang, X., Khosla, R., Walther, G., 2023. The role of supply chains for the sustainability transformation of global food systems: a large-scale, systematic review of food cold chains. J. Ind. Ecol. 27, 1429–1446.
Turker, D., Ozdemir, G., 2020. Modeling social sustainability: analysis of hospitality e-distributors. Sustain. Account. Manag. Policy J. 11, 799–824.
Tushman, M.L., Anderson, P., 1986. Technological discontinuities and organizational environments. Adm. Sci. Q. 31, 439–465.
Uddin, K., Dubarry, M., Glick, M.B., 2018. The viability of vehicle-to-grid operations from a battery technology and policy perspective. Energy Policy 113, 342–347.
Upham, P., Kaufman, S., Bögel, P.M., Raven, R., 2025. Behaviours and Practices in Socio-technical Systems and Sustainability Transitions: Editorial to the Virtual Special Issue.
Upward, A., Jones, P., 2016. An ontology for strongly sustainable business models: defining an enterprise framework compatible with natural and social science. Organ. Environ. 29, 97–123.
Valentini, D., Wangel, J., Holmgren, S., 2023. Representations of urban cycling in sustainability transitions research: a review. Eur. Transp. Res. Rev. 15, 28.
Venkataswamy, V., Seetharam, B., 2020. The impact of software on Eyecare in India. IEEE Softw. 37, 99–106. https://doi.org/10.1109/MS.2020.2985789.
Waddell, S., 2016. Societal change systems: a framework to address wicked problems. J. Appl. Behav. Sci. 52, 422–449.
Wainstein, M.E., Bumpus, A.G., 2016. Business models as drivers of the low carbon power system transition: a multi-level perspective. J. Clean. Prod. 126, 572–585. https://doi.org/10.1016/J.JCLEPRO.2016.02.095.
Wells, P., Nieuwenhuis, P., 2012. Transition failure: understanding continuity in the automotive industry. Technol. Forecast. Soc. Chang. 79, 1681–1692. https://doi.org/10.1016/J.TECHFORE.2012.06.008.
Wesseling, J.H., Bidmon, C., Bohnsack, R., 2020. Business model design spaces in socio-technical transitions: the case of electric driving in the Netherlands. Technol. Forecast. Soc. Chang. 154, 119950. https://doi.org/10.1016/J.TECHFORE.2020.119950.
Wickert, C., Potočnik, K., Prashantham, S., Shi, W., Snihur, Y., 2024. Embracing Non-Western Contexts in Management Scholarship.
World Bank, 2022. World development indicators. https://databank.worldbank.org/source/world-development-indicators. (Accessed 22 August 2022).
World Bank Country and Lending Groups, 2022. https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups. (Accessed 22 August 2022).
Yadav, P., Heynen, A.P., Palit, D., 2019. Pay-As-You-Go financing: a model for viable and widespread deployment of solar home systems in rural India. Energy Sustain. Dev. 48, 139–153. https://doi.org/10.1016/j.esd.2018.12.005.
Zott, C., Amit, R., 2010. Business model design: an activity system perspective. Long Range Plann. 43, 216–226. https://doi.org/10.1016/j.lrp.2009.07.004.
Zott, C., Amit, R., Massa, L., 2011. The Business Model: Recent Developments and Future Research.