



Managing the unmanageable challenge of sustainable development: An innovative framework

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ABSTRACT

Much organisational effort has been poured into the quest for sustainable development. However, several crucial challenges remain. The pursuit of sustainability means addressing dimensions as diverse as energy, ecology, psychology, society, and the economy. Then there is the question of optimisation of initiatives now and in the future. There is also the question of satisfying the full spectrum of stakeholders and their divergent, often conflicting interests. Right now, there is no perfect approach to the pursuit of sustainable development. The notion of global optimisation is practically impossible. Meanwhile, narrow-, short-sighted approaches ignore the myriad aspects that must be considered. This paper proposes a novel approach to sustainable development by presenting a conceptual framework built on several bodies of theory. Its novelty derives from its ability to guide critical reflection on the limitations of sustainable development efforts and thereby help manage the unmanageable challenge of sustainable development as effectively as possible.

Introduction

Deliberate development efforts in organisational contexts almost inevitably affect the social and natural order. Be it building a new office, establishing a new control system for a nuclear power station, changing healthcare processes, or granting permission for mining rare minerals, social and natural affairs are often affected in multiple ways, sometimes desirably but sometimes not. As a result, it is imperative to shift human activity towards sustainable development (Banelienė & Strazdas, 2025). To deal with this challenge, the sustainable development of human, social, and natural affairs seeks to ensure that human development can meet the needs of the present generation without compromising the ability of future generations to meet their own needs (Brundtland, 1987). Since the United Nations (UN) adopted the Sustainable Development Goals (SDGs) in September 2015, sustainable development has become a topic of intense debate among governments, practitioners, and policymakers worldwide (Khizar et al., 2023).

The public and academic discourses on sustainable development in recent decades reflect a range of sustainable development perspectives (Redclift, 1991; Williams & Millington, 2004). Such perspectives include: energy, materials, and chemicals; the biological and mental; the social, historical, and economic; and the legal and moral (Roorda,

2020). Given this diverse range of perspectives, the UN defined seventeen Sustainable Development Goals (SDGs) as part of its 2030 Agenda (Bernstein, 2017; Biermann et al., 2017).

Core competence and core resource features of the sharing economy positively influence SDG achievement. Distinctive competitive advantage and institutional support play mediating and moderating roles (Hsu, 2023). These relationships support the view that achieving sustainability requires the integrated use of multiple organisational capabilities and contextual enablers. Sustainability-minded development in any non-trivial area of human, social, and natural affairs must follow prior reflection on the following question: *How can the diversity and divergence of sustainable development perspectives be managed?* The objective of this paper is to suggest a tentative answer to this very question.

This question is challenging for several reasons. First, there are multiple sustainable development perspectives (Camacho, 2015; Hopwood et al., 2005). Thus, an obvious follow-up question is which perspective or perspectives should be considered in a given development initiative and why? Second, if several perspectives are considered simultaneously, how should their relative importance be managed? In a given situation, is the ecological impact of a development effort more important than the economic effects, or vice versa? Conversely, are they

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equally important? Third, what about the potential interactions between perspectives? For example, what happens when economic optimisation of some human activity degrades some natural resources (Scharlemann et al., 2020)? Yet another central question relates to how to deal with the different *time* perspectives associated with sustainable development. Something that is regarded as sustainable in the short term may not be sustainable in the long run. For instance, the use of nuclear power reduces the CO₂ emissions with respect to coal and gas, but it creates a physical danger of radioactivity thousands of years ahead. To date, no satisfactory solution to these and related problems has been found (Biermann et al., 2017; Hopwood et al., 2005). This study aims to make an initial attempt at finding one.

Methodologically, this study adopts a conceptual research design. An abductive approach iterates between theoretical insights and experiential knowledge from real-world sustainability initiatives identified by the authors. A framework is developed based on the conceptual synthesis of multiple bodies of theory, namely systems thinking theory, multi-aspectual sustainability, social practice theory, critical systems heuristics (CSH), and digital technology use theory. These bodies of theory are supported by iterative reflection on practical examples of attempted sustainable development in organisational contexts known to the authors. This abductive approach combines theory integration with experiential insights, enabling the formulation of a pragmatic and operational heuristic for reconciling the multiple perspectives of sustainability challenges.

This approach is based on the assumption that no single theory can encompass all perspectives of sustainable development, interactions between these perspectives, and short- and long-term approaches (Auty & Brown, 2021). Such a theory would require global optimisation of all situations now and long into the future, even though, as some scholars have noted, current systems cannot even predict weather accurately several weeks ahead (Ponstein, 2004). Another solution to the problems around sustainable development is a piecemeal approach, where one particular perspective (economic, biological, social, etc.) is prioritised within a development initiative (Hopwood et al., 2005). Another unpalatable approach is of course to give up on sustainable development.

In contrast, this paper provides an alternative approach denoted *critical multi-aspectual sustainability heuristics*. Its position is that critical reflections on the lack of sustainable development offer a way out of the dilemma of not being able to apply the global optimisation, piecemeal, or ignorance approaches. Although the current approach does not guarantee an ideal of sustainable development, it guards against the lack of such an ideal. This approach is a novel contribution to sustainable development because it recognises the need for sustainable development practices that are practically feasible. Empirical research has confirmed the need for holistic approaches that combine marketing, innovation, and systems thinking in the pursuit of sustainability. Chen et al. (2024) found that green marketing practices, mediated by eco-innovation and moderated by the adoption of a circular economy, significantly enhance environmental, economic, and social performance in manufacturing industries. This finding supports the guiding principle of the current approach, namely that effective sustainable development strategies must address multiple, interacting dimensions rather than focusing on a single one.

In sum, this paper provides a conceptual framework for those who wish to pursue sustainable development. This framework offers a set of recommended considerations in sustainable development efforts. The formulation of this framework is motivated by challenges experienced by the authors in practical attempts at achieving sustainable development. These challenges are also highlighted in the literature (Geels et al., 2023). The proposed framework is an eclectic, pragmatic construction that merges several bodies of theory into one model. The framework rests on several notions derived from systems theory and the subarea of second-order cybernetics. These notions highlight the key distinction between the observed or developed system and the observing or developing system in sustainable development. This conceptual

foundation is combined with social practice theory to conceive operations by the developed and the developing systems. Next, critical systems heuristics (CSH) is adopted to enable critical reflections on the unavoidable lack of sustainability in complex situations. Finally, multi-aspectual theory guides the identification and inclusion of the many perspectives that non-trivial sustainable development presents.

The next two sections present and integrate these bodies of theory. The Discussion and Conclusions sections highlight the potential of using digital technologies such as blockchain and machine learning to pursue sustainable development, given that such technologies enable data collection, transfer, analysis, learning, and continuous adaptation in a way that would be impossible with other techniques. In sum, the aim of this study is to present a critical multi-aspectual sustainability heuristics framework that integrates multiple theoretical traditions and practical insights to address the research gap of offering guidance in sustainable development under its inherent complexity. Overall, the proposal contributes by suggesting a novel approach to guide sustainable development actions.

Formulation of critical multi-aspectual sustainability heuristics: theoretical foundations

Individuals, groups, organisations, and societies cannot help but seek to intervene in the state of affairs by preserving current social and natural paradigms or by changing them through deliberate initiatives (Ulrich, 1983). Preserving the many aspects of a current non-trivial state is practically impossible for several reasons. For instance, underlying dynamic forces influence the social and the natural, or current unsustainable states would be conserved (Jarvis, 2006). Meanwhile, deliberate development may establish an alternative state of affairs that may or may not have sustainable characteristics.

The proposed conceptual framework for sustainable development, denoted *critical multi-aspectual sustainability heuristics*, is formed stepwise. Before presenting the elements of the proposed framework, it is important to note that this research does not contain a standalone literature review section. Instead, the review of the relevant literature is embedded within the discussion of each body of theory that makes up the framework. This structure is deliberate. It allows for direct inclusion of existing academic research in the conceptual creation process, enabling the theoretical foundations to be deeply examined in context and immediately connected to the development of the framework. The first body of theory, systems thinking, provides basic concepts and distinctions that underpin the framework's capacity to address the complexity inherent in sustainable development.

Systems thinking

The first concept comes from systems theory (Le Moigne, 1977; von Bertalanffy, 1969). This concept refers to the distinction between an *observed* system and an *observing* system (Le Moigne, 1977). The notion of an *observed* system is adopted from general systems theory (GST), whereas the notion of *observing* system comes from second-order cybernetics. Starting with the observed system, GST was a reaction to the dualism of biological studies in defining life at the end of 19th century and beginning of the 20th century (Le Moigne, 1977; von Bertalanffy, 1969). On one side of that dualism, atomists argued that all life could be explained by its constituent components such as atoms. In contrast, vitalists argued that a hidden force transcended the elementary components of a living entity, providing it with its ability to be a living entity. Although GST did not provide any definitive answer to what life is as such, it proposed a third alternative. Several of its conceptualisations are adopted in this research, namely: the distinction between closed and open systems; the notion of wholes with emergent properties; and the notion of an evolutionary system. The notion of soft systems thinking is also adopted, whereby systems are regarded as epistemic devices rather than ontological entities.

Any attempt to pursue sustainable development in some area of human and natural affairs can be conceived in the classical Newtonian manner as a closed entity, where the context is largely disregarded. A key limitation of such a closed system conception in sustainable development results from the understanding that any non-trivial endeavour in social and natural affairs is influenced by and influences, at least partially, its context. The implication is that sustainable development should account for context. Otherwise, sustainable development of whatever is being developed will be impossible because it may give rise to unsustainable consequences for its context. Likewise, its context may also affect it, creating unsuitable consequences for whatever is being developed. The thing that is being sustainably developed is denoted as the *system of interest*, and its context is simply denoted as the *context*.

The second key concept from GST is the notion of *wholeness due to emerging properties* (Le Moigne, 1977). A key message is that an organised whole tends to manifest some properties that cannot be associated only with a single part of the whole. For example, a crucial property of an aeroplane is that it can fly. Yet none of its parts can fly on its own. The ability of flying results from the interactions of the parts of the system (aeroplane) and its context. By implication, any analysis of a system (i.e. disassembling it into its constituent parts) will not explain how some of its key properties emerge (in the example, how an aeroplane flies). Instead, a synthesis of the system with its environment can provide such an explanation. In the example, the characteristics of air and the aeroplane jointly allow it to fly.

The third key concept from GST is the *evolutionary* nature of a system. Initially conceived from observation of biological beings, a system is typically understood in terms of its lifecycle of several phases such as birth, growth, maturity, decline, and termination (von Bertalanffy, 1969). This concept is important for sustainable development because it means that a sustainable development process can be regarded in terms of the full lifecycle of a system and its context rather than only the initial design or development. The concept of the lifecycle expands the systems view of sustainability to regard it throughout its existence and beyond. An illustration is a nuclear power station, which produces radioactive waste that may require management for thousands of years, well beyond the life of the power station itself. The concept of the lifecycle also highlights the idea that a strict separation of the work tasks of a system is not necessarily the most fruitful approach for sustainable development. Rather than distinguishing between design, construction, deployment, use, maintenance, support, and termination of a system, it can be regarded in terms of continuous development and operation,⁴ (Leite et al., 2019), for its sustainable management.

The next concept comes from a subarea of systems thinking known as second-order cybernetics (Glanville, 2004; von Foerster, 2003a). It refers to understanding the *observing* system rather than the *observed* system, as is the case with the notion from GST. Focusing on the observing system recognises the active role of observers in the perception, conception, understanding, and, ultimately, management of an observed system (von Foerster, 2003b). The observing system may be understood in similar terms as the observed system (i.e. an open system that interacts with its environment, manifests emerging properties, and evolves over time). Similarly, to an observed system, the observing system has certain cognitive and affective capabilities, a history, interests and intentions, and context. Hence, managing the sustainable development of a system should also account for its developers. This distinction between observing and observed, or developing and developed, is conceptual. Therefore, in some instances, the same individuals and entities may be regarded as both part of the system that is being developed and the system that is doing the developing.

Finally, the present adoption of systems thinking concepts does not commit to the original position of GST. Under this original position, systems are understood in their ontological nature as existing, physically separated, tangible entities much like organisms (Checkland & Haynes, 2019). A particular school of thought within systems thinking, soft systems thinking, regards systems concepts as intellectual or epistemic

devices serving only to help observers organise their understanding of the world (Checkland & Scholes, 1999). Hence, the sustainable development of a prison, say, may be conceived in multiple ways by various stakeholders. It may be conceived as a means to protect the public from dangerous people, rehabilitate criminals into lawful citizens, or provide a school for lawbreaking where unskilful criminals become masters of crime. Each actor with a distinct interest (i.e. each stakeholder) has different motivations, history, culture, and understandings, so systems concepts act as intellectual lenses for developing perceptions and conceptions. Accordingly, there may be crucial differences between stakeholders' perceptions and conceptions.

One noteworthy idea is that green entrepreneurship is shaped by evolving policy frameworks, market dynamics, and sustainability imperatives, requiring entrepreneurs to integrate environmental goals with viable business models. This idea reinforces the claim that sustainable development strategies must align diverse drivers and stakeholder interests to be effective (Singh et al., 2025). Such potential differences should not be regarded as undesirable but as assets. When confronted with each other, they can show the direction for sustainable development to take.

Social practices

GST offers a conceptual tool derived from empirical studies of organisms (Checkland, 1984; von Bertalanffy, 1969). Accordingly, insights into biological entities may enrich the understanding of non-living entities (Ulrich, 1983). However, biological conceptions can be limiting when used to conceive social affairs, including the use of material and natural resources (De Raadt, 1989). To develop such concepts more profoundly, the notion of *social practices* is adopted as a way to conceive the developed and the developing domains, their relations, and their context. Hence, these domains are understood in terms of performance of social practices.

In short, the notion of social practices refers to the idea that the social world consists of real actions (Nicolini, 2012) and, more generally, to the patterns of recurring actions such as showering in warm water before going to the bed, discarding certain items, driving a car from home to the supermarket, and leaving the engine running to power the air conditioning. The notion of social practices emerged as a reaction to polarisation in social thoughts, including those between structure vs. agency, system vs. meaning, thinking vs. acting, and explicit theoretical knowledge vs. tacit and bodily know-how (Schatzki et al., 2001).

A practice-based understanding of the social world is distinctive for several reasons. First, it recognises that the apparently durable patterns in the world are produced and reproduced by the actions performed by human individuals and material entities in time and space (Nicolini, 2012). Social reality can thus be conceived as endless configurations, assemblages, or nexuses of actions that recur and change. Second, the notion of social practices recognises the central role of the human body and material things in all social affairs. Indeed, practices cannot be conceived without human bodies and material things. Third, understanding social intercourse in terms of social practices is performative in that it is carried out by humans and material objects. This view contrasts with an atomic understanding of social affairs, where individuals' agency is understood as the driving force of social affairs. Meanwhile, in structuralist understandings, norm-following acts and role-playing individuals bring the social world to life. The primary focus of practices is therefore on actions performed in the real world rather than on individuals' characteristics and intentions or on norms, although the importance of the latter two for social practice are still acknowledged.

Because practice theory thinkers offer several alternative notions of social practices (Nicolini, 2012), for clarity, the notion described by Schatzki (1996) is adopted. Under this notion, social practices are a set of actions that are real doings and sayings, linked by practical understandings, rules, and teleo-affective structures. Meanwhile, general understandings are all temporally evolving and open-ended (Schatzki,

2002). This notion makes it possible to conceive both the sustainability of the system that is being developed and the sustainability of the system that directs the development in terms of their respective lifecycles.

A simple illustration of such a notion of social practices is making scrambled eggs for breakfast. An individual learns from the individual's parents to put the frying pan on maximum heat on the stove for a few minutes before putting butter into the pan and again waiting a few minutes before adding two eggs and then scrambling them while frying. This practice, repeated and perfected many times over the years, has the intention of producing a certain style of scrambled eggs. This practice acquires a certain normativity in relation to the resulting look, feel, and taste of the scrambled eggs and the process of making them. This normativity challenges attempts to modify this process to reduce energy consumption by, for example, not pre-heating the pan and waiting less time before adding the eggs. This example illustrates the interplay between history, intentions and norms, practical and abstract knowledge, human bodies and material entities, and the systemic nature of such assemblages.

Multi-aspectual sustainability

These conceptions of the observed and observing systems in terms of social practices mean that their constituent parts and workings can be thought of as social and material affairs. This understanding is important because it might explain how (un)sustainable situations arise, are encouraged, and can be managed. However, social practices have many characteristics. A key question is thus which characteristic, or characteristics, can be considered criteria for the sustainable development of a system. Meanwhile, the many academic and managerial discourses around sustainability debate numerous ecological, psychological, social, economic, and other aspects of sustainability (Williams & Millington, 2004).

The question is thus how to deal with these multiple aspects. Should the criteria that are voiced most loudly by the most powerful stakeholders of a given system prevail? Two complementary answers are offered. The first results from the adoption of the theory of multi-aspectual experiences, detailed in this section. The second results from adopting the framework of critical systems heuristics (CSH), detailed in the next section.

The theory of multiple aspects of human experience proposes that humans can experience any phenomenon in terms of 15 aspects of meaningfulness (Basden, 2007; Dooyeweerd, 1935, 1997; Eriksson, 2001). These aspects are listed in Table 1. This meaningfulness should be regarded in terms of both the observed and observing systems.

As an illustration of this multi-aspectual understanding, consider the artificial object of a particular family-owned dining table. A member of the family perceives only one table (quantitative) standing in the middle

of the dining room (spatial) of the family house. The table stands still, although it may be moved to another place when needed (kinematic). The table happens to be made of cherry wood (physical aspect) that is now dead (biotic). Accordingly, the table can be active itself within the listed aspects (until the physical aspect). From the biotic aspect onwards, it is the observer who attributes aspects to the table. The family member can perceive the table and use a hand to touch and feel it (psychic aspect) or distinguish (analytical aspect) its design as Victorian and not Art Deco. The family can use the table as a functioning dinner table (formative aspect) and can speak about it, calling it different things in one or more languages (lingual aspect). When eating dinner, the family members sit at the table and socialise, using and discussing the table itself, which motivates social interaction (social aspect). As the table happens to be old (formative aspect) and in good shape, it holds high economic value (economic aspect) and is regarded as beautiful because of its Victorian design (aesthetic aspect). The table was bought by the family, which has legal ownership of it (juridical aspect), which can be transferred to another owner if sold. However, the family feels a duty (ethical aspect) to preserve the table for years ahead because it is one of very few of its kind still existing today. The family does not know (and will probably never know for sure) but believes (pistic aspect) that this table was used by Winston Churchill to draft some of the most famous speeches of the Second World War.

Each of the listed aspects can offer criteria for sustainability. For example, questions can be asked about whether the sustainable design of an elderly healthcare service is: *economically sustainable* because its costs must be met through, for example, tax or insurance; *socially sustainable* because the provision and operation of the service should be equally accessible for all seniors without excluding those with low digital literacy, for example; *analytically sustainable* because the use of such a service must be intelligible for all seniors; *psychologically sustainable* because the use of the service must not cause users stress and anxiety; *legally sustainable* because the use of the service must not violate current regulations by, for example, illegally gathering and using personal data; and *pistically sustainable* because seniors (dis)trust of modern digital services contributes to the (un)sustainable use of such a service.

Although the originator of this theory of multiple aspects of human experiences does not conclude that this list of aspects must be definitive, it is a stable, well-justified, and critically evaluated proposal (Dooyeweerd, 1997). Its key message is that humans experience the social and natural world in terms of multiple aspects that need attention. From situation to situation, each aspect may vary in meaning and importance depending on humans' situations and intentions. A second key message from this theory is not to attempt to reduce one aspect to another by trying to explain it solely in terms of the other. One example would be attempting to explain *moral duty* in terms of *legal regulations* (e.g. an attempt to legislate that an individual who marries another person ought to love that person and vice versa). Similarly, the position that humans can be defined purely in terms of physical matter and atoms and that their free will is an illusion, as argued by some authors (Basden, 2007), would lead to the pursuit of antimony by denying the existence of the psychic aspect, to borrow a concept from that very aspect (i.e. *illusion*, which has no meaning within the physical aspect).

In the pursuit of sustainable development, this multi-aspectual framework may serve as a guide to search for sustainability criteria of social practices of the observed and observing systems. This framework does not stipulate which exact criteria should be assumed as sustainable development criteria. Instead, it suggests what kinds of criteria are available and posits that there are multiple criteria that cannot be reduced to each other without eliminating part of the meaningfulness of whatever is being developed.

Critical systems heuristics

Critical systems heuristics (CSH) is a conceptual framework to guide reflective practice of any kind of social affairs (Ulrich, 1983). CSH is

Table 1
Multiple aspects for consideration in sustainable development.

#	Aspect	Its Meaning
1	Quantitative	amount
2	Spatial	continuous extension
3	Kinematic	flowing movement
4	Physical	energy, matter
5	Biotic	life functions, self-maintenance
6	Psychic	feeling and response
7	Analytical	distinction, conceptualisation
8	Formative	formative power, achievement, technology
9	Lingual	symbolic communication
10	Social	social interaction
11	Economic	frugal use of resources
12	Aesthetic	harmony, surprise, fun
13	Juridical	due rights, responsibility
14	Ethical	self-giving love
15	Pistic aspect	faith, vision, commitment, belief

Notes. Source: (Basden, 2007).

adopted in this study to raise critical awareness in the pursuit of sustainable development. In its basic form, CSH offers 12 questions to reflect on judgements during the sustainable development process (see Table 1).

All normative proposals, including designs for the sustainable development of social and natural affairs, make assumptions (Ulrich, 1983). These assumptions can be conscious or subconscious, may develop intentionally or unintentionally, and exert varying degrees of influence or control over proposals and consequently sustainability actions. To gauge the influence of these assumptions, the 12 questions in CSH encourage the identification, discovery, debate, and critical scrutiny of these assumptions.

These questions focus on a design's inherent *values and motivations*, *power structures*, *knowledge basis*, and *moral basis*. Values and motivations are built into a proposed system design, typically to improve and change a situation in some way. Such values and motivations drive and justify design proposals. Social power structures influence what is considered an issue, problem, opportunity, situation, or system and what may be done to it. Individuals with more power tend to have a stronger influence. Knowledge basis refers to what is regarded as legitimate and relevant data, information, and knowledge. In this case, knowledge covers both scientific, professional knowledge and everyday, tacit knowledge, including skills and experiences. Moral basis is about justifying the consequences borne by those affected by but not involved in the design process.

These four kinds of judgements can be contrasted across *four key stakeholder groups*: *beneficiaries* (Questions 1 to 3), *decision makers* (Questions 4 to 6), *experts* (Questions 7 to 9), and *witnesses* (Questions 10 to 12). Combining the four kinds of design judgements and the four stakeholder groups gives rise to the 12 CSH questions in Table 2. Crucially, each question is posed in two modes of inquiry: ideal or normative (i.e. how a focused situation ought to be) and descriptive (i.e. how the focal situation is understood to be). By contrasting answers to the 12 questions in their descriptive and normative modes, the inherent design assumptions surface and may be critically debated.

An underlying theme of CSH is to address the unconditional dual partiality of any system design. One form of partiality stems from aspirations for a comprehensive understanding of a design. Any such aspiration will ultimately exclude some considerations of the system and its environment because of complexities and omissions. The second form of partiality is the near impossibility of considering the perspectives of all parties (i.e. all stakeholders). Hence, the use of the 12 CSH questions enables identification of the conceptual and normative boundaries of the system design and thereby leads to reflection on their limitations. For example, the use of CSH provides guidance in sustainable development by posing the 12 questions across the two modes of inquiry and encouraging critical reflection on the answers. These 12 questions are listed in Table 2. It is hoped that CSH can help identify the assumptions

of the design proposal that have not been reflected on, challenge them, and potentially modify the corresponding system designs. For example, is it acceptable for the nuclear waste produced by a nuclear power station to affect the lives of future generations?

Through the articulation of key stakeholders and their concerns, the 12 CSH questions reflect the observed and observing systems. These concerns are broad categories designed to capture any content that stakeholders may propose. However, this situation is potentially limiting because ideology, institutionalisation, and path dependency may condition stakeholders' concerns. The multi-aspectual framework can help resolve such limitations by providing an external set of categories for stakeholders' reflections on their concerns. The example in the next paragraph illustrates how stakeholders can be guided by the multi-aspectual framework.

Food consumers who buy food at the supermarket are institutionalised into a social structure where wealthier individuals can afford to consume more organic food, which tends to be more expensive. In their everyday lives, consumers of non-organic food may believe that this consumption norm is positive and may never view it as a concern. The multi-aspectual framework can help these consumers challenge such a view using 15 aspects that guide reflections on the food consumption system. Consumers may thus reflect on current and ideal characteristics of food production and consumption (biological aspect), current and ideal patterns of thinking and values about food production and consumption (psychic aspect), current and desired stakeholder interactions related to food production and consumption (social aspect), current and ideal costs for stakeholders of food production and consumption (economic aspect), and so on. Such reflections can help consumers answer each of the 12 CSH questions, ensuring that no aspect is ignored.

Digital technology use

The final component of the proposed conceptual framework to guide sustainable development is related to the concept of affordances of digital technology in use (Anderson & Robey, 2017). Digital technologies, which are understood as symbol manipulation by machines (Lyytinen, 2022), offer capabilities that enable humans to conceive and implement sustainable development in a manner that would otherwise not be possible (Falcke et al., in press). This section discusses several examples of such digital capabilities.

New technologies have shown that absorptive capacity, strategic flexibility, and knowledge integration, combined with digital transformation, significantly enhance sustainable innovation. These findings support the view that diverse capabilities must be integrated to address the complexity in sustainability (Aslam et al., 2024).

One technological capability is connectivity, enabled by broadband, 5 G, and internet-of-things (IoT) devices (Porter & Heppelmann, 2014). These technologies can gather and transfer large sets of data for virtually

Table 2
The 12 questions provided by CSH to guide critical reflection on design.

Sources of influence	Boundary judgements informing a system of interest			
	Social roles (stakeholders)	Specific concerns (stakes)	Key problems (stakeholder issues)	
Sources of motivation	<i>Beneficiary</i> : who is / ought to be the intended beneficiary of the system?	<i>Purpose</i> : what is / ought to be the purpose of the system?	<i>Measure of improvement</i> : what is / ought to be the system's measure of success?	The involved
Sources of control	<i>Decision maker</i> : who is / ought to be in control of the conditions of success of the system?	<i>Resources</i> : what conditions of success are / ought to be under the control of the system?	<i>Decision environment</i> : what conditions of success are / ought to be outside the control of the decision maker?	
Sources of knowledge	<i>Expert</i> : who is / ought to be providing relevant knowledge and skills for the system?	<i>Expertise</i> : what are / ought to be relevant new knowledge and skills for the system?	<i>Guarantor</i> : what are / ought to be regarded as assurances of successful implementation?	
Sources of legitimacy	<i>Witness</i> : who is / ought to be representing the interests of those negatively affected by but not involved with the system?	<i>Emancipation</i> : what are / ought to be the opportunities for the interests of those negatively affected to have expression and freedom from the worldview of the system?	<i>Worldview</i> : What space is / ought to be available for reconciling differing worldviews regarding the system, among those involved and affected?	The affected

Notes. Source: Ulrich and Reynolds (2010).

instantaneous analysis, enabling monitoring and generating insights. They also enable the remote control of devices, so that systems can constantly adapt to emerging situations. Another key technology is blockchain, which can make cooperation between strangers possible, as exemplified by bitcoin trading (Gregory et al., in press). This capability has major potential because it means that complex systems can influence and be influenced by many remote stakeholders, with blockchains enabling efficient cooperation in a way that would be practically impossible otherwise. A third technology is machine learning and other such artificial intelligence (AI) technologies. These technologies enable unparalleled learning and optimisation of systems (Abdolrasol et al., 2021). This technological capability is important because sustainable development is built on assumptions about future states within and outside a system. Such assumptions and their underlying predictions are inherently limited. In addition, the process of continuous data gathering, analysis, and learning enables real-time adaptation to emerging conditions within and outside systems, thereby optimising their sustainability. Collectively, these and other digital technologies enable real-time insights, learning, control, command, and adaption of systems to an unprecedented extent. This technological capability is important because, however well-meant and comprehensive sustainable designs of systems are, such designs have inherent limitations and rest on flawed assumptions.

Online media, especially social media, are increasingly recognised as important for sustainable entrepreneurship by facilitating networking, the transfer of information, and innovation. Recent research has shown how social media adoption can improve entrepreneurial opportunity identification, resource mobilisation, and the creation of sustainable business models in Fintech (Gupta, Gaurav, Arya & Chui, 2023). Whether the goal is optimising fuel consumption, easing mental stress, or reducing social exclusion, correctly designed systems can detect such situations early and remedy them using digital technologies.

The proposed critical multi-aspectual sustainability heuristics framework

The result of the formulation process detailed in the previous section is summarised in this section in terms of a set of questions. These questions are designed to serve as heuristics for sustainable management. The questions are as follows:

- What possible conceptions of the system of interest are relevant to the aspects of sustainability?
- What is the context of the system of interest?
- What is the evolutionary path of the system of interest?
- What configurations of practices constitute the system of interest?
- How is each aspect manifested in the system of interest?

Based on these questions:

- What are the possible answers to the 12 CSH questions in descriptive mode?
- What are the possible answers to the 12 CSH questions in normative mode?
- How can digital technologies be used to make the system of interest sustainable?

The main purpose of these questions is not to elicit a perfect answer straight away. Instead, these questions are meant to stimulate thought among those who manage sustainable development. By allowing for multiple answers in each case, these questions are a way of challenging preconceptions and path dependencies of a given social setting. Thus, the proposed framework consisting of this list of questions can help its users identify and critically reflect on the sustainability limitations of any sustainable development endeavour.

These heuristics are not intended to be rules but prompts for critical

reflection and adaptive decision making in diverse sustainability contexts. The following discussion examines their broader implications, theoretical contributions, and practical relevance for advancing sustainable development strategies.

Discussion

Sustainable development is on the agenda of most business or government organisations (Auty & Brown, 2021). There is ample consensus that sustainable development is an urgent need for society, as reflected by the 17 SDGs (Brundtland, 1987). However, confusion remains over what kind of sustainability should be prioritised, with public and academic discourses emphasising diverse priorities, including energy, ecology, psychology, and society (Redclift, 1991; Williams & Millington, 2004).

Ultimately, the question is not only what people believe but also how they believe it in relation to sustainable development. For perfect sustainability, a coherent view of how people interact with their social and natural environment is needed not only now but also in the future to enable optimised solutions. However, it is neither likely nor perhaps even possible. Thus, existing strategies tend either to ignore the inherent complexity in sustainability or to become narrow- and near-sighted about a single facet of sustainability at this particular moment.

This paper responds to these limitations by offering an alternative approach, denoted here as critical multi-aspectual sustainability heuristics. This framework integrates systems thinking, multi-aspectual sustainability, social practice theory, critical systems heuristics (CSH), and digital technology use theory. It combines these bodies of theory with emerging tools such as predictive AI adoption, which can simultaneously drive innovation performance and sustainability by embedding data-driven insights into strategic decision making (Haftor et al., 2024). The inclusion of digital transformation is particularly relevant, given its increasing recognition as a driver of innovation performance. Studies have shown that firm digitalisation and the level of innovation in the regional digital industry significantly enhance innovation, while high regional innovation levels can reduce the marginal efficiency of firm-level digital investment through free-riding effects (Li et al., 2022). These findings support the argument that sustainable development strategies must integrate multiple, interacting technological and contextual factors rather than focusing only on internal capabilities.

Thanks to this duality, the framework embraces the inherent complexity of sustainable development challenges by combining theoretical pluralism with pragmatic considerations. This integrative decision-support tool helps raise awareness and promote self-reflection by stakeholders about values and assumptions of diverse sustainability dimensions. This outcome is of interest to scholars, policymakers, and nearly anyone looking to engage with complexity without succumbing to oversimplification.

Theoretical contributions

The framework contributes theoretically by integrating disparate bodies of theory (systems thinking, multi-aspectual sustainability, social practice theory, critical systems heuristics, and digital technology use theory) into an operational heuristics model. This synthesis extends beyond traditionally siloed approaches to sustainability by presenting an integrative model that deals with complexity, negotiation, and reflection regarding the trade-offs present in development decision making.

Practical implications

This research serves as a basis to put the critical multi-aspectual sustainability heuristics framework into practice. This framework can be used as a diagnostic and planning tool for organisations, policymakers, and community stakeholders. As a tool for systematic, multi-

dimensional (ecological, economic, social, and ethical) consideration of trade-offs, the framework can help identify typically ignored trade-offs, question entrenched assumptions, and design more resilient, inclusive, and context-sensitive strategies.

Limitations and future research

The framework is a conceptual contribution. However, it must be tested empirically. Studies are needed to understand the utility of this framework in practice based on detailed case studies, action research, and comparative analysis with other established frameworks. Empirical research can help refine its constituent elements, evaluate its effectiveness in different settings, and study if and how it can be adapted across sectors.

Conclusions

The main contribution of the proposed critical multi-aspectual sustainability heuristics framework is not to guarantee sustainable development per se but to provide a structured tool to (i) question prevailing assumptions, (ii) extend analytical and practical horizons, (iii) reveal hidden assumptions, and (iv) enable the design of more resilient and adaptable sustainability strategies. The framework integrates systems thinking, multi-aspectual sustainability, social practice theory, critical systems heuristics (CSH), and digital technology use theory to deliver a practical, theoretically grounded tool for guiding sustainability initiatives in complex, multi-perspective contexts. Its importance lies in addressing a persistent gap in sustainability research, namely an abundance of conceptual work but limited practical guidance. The framework is applicable in organisational, community, and policymaking settings where decision makers must reconcile the following aspects: (i) multiple and sometimes conflicting views on valuable outcomes, (ii) incompatible time horizons, and (iii) rapidly evolving social and environmental conditions.

The framework is currently conceptual. However, it lays the groundwork for future empirical research. Possible next steps include (i) deploying case studies in a range of organisational and social settings to assess the pragmatic usefulness of the framework, (ii) perfecting its components through empirical review, (iii) assessing its role in facilitating integrated and context-sensitive approaches to sustainable development, and (iv) considering how digital transformation and technology emergence can advance its application.

The critical multi-aspectual sustainability heuristics framework can be used as a diagnostic and programming tool for organisations, policymakers, and social stakeholders. Decision makers can uncover unforeseen trade-offs and challenge established beliefs by systematically considering different perspectives across various domains spanning ecological, economic, social, ethical, and technological dimensions, as well as their interactions. This research highlights the need to find holistic response to the complex challenges around sustainable development in an evolving world.

CRedit authorship contribution statement

Ricardo COSTA-CLIMENT: Validation, Methodology, Formal analysis. **Darek M. HAFTOR:** Writing – original draft, Supervision, Conceptualization.

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