

Article

Approaching Sustainability Transition in Supply Chains as a Wicked Problem: Systematic Literature Review in Light of the Evolved Double Diamond Design Process Model

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Abstract: Transition from the status quo to more sustainable supply chain management (SSCM) practices is a highly complex and non-linear process with multiple drivers, but also obstacles, on the way. The impending strict regulatory framework, particularly in terms of the environmental dimensions of sustainability development (SD), is single-handedly opening the door to rapid and potentially disruptive change. The research literature on SSCM has increased exponentially over the last decade to meet the mounting demand for information on how to tackle often conflicting sustainability-related requirements while satisfying all internal and external stakeholders. Due to the continuously evolving and *wicked* nature of SSCM, a limited number of scholars have approached the issue with design thinking problem solving methodologies (DTPSMs). The results of a systematic literature review (SLR) were mirrored with the Evolved Double Diamond (EDD) design process model to formulate a design thinking overview and trace potential research gaps of selected frameworks and models regarding the sustainability transition (ST) of supply chains (SCs). The research results demonstrate that modelling the ST in SC as a wicked problem can contribute to the creation of more structured and novel SSCM models and frameworks, which take into deeper consideration the evolving nature of the issue and improve facilitation practices of stakeholder engagement.

Keywords: sustainability transition; supply chain; wicked problem; framework; evolved double diamond; design thinking



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1. Introduction

In the early 2000s, supply chains were often still conceptualised in the research literature as linear networks where stakeholders interacted bilaterally in a rather controlled environment [1,2]. To date, the complexity and continuously evolving nature of supply chains have been widely recognised by numerous scholars [3,4], and the rapidly increasing trend of incorporating sustainability deeply into supply chain management structures has significantly aggregated the level of complexity and turbulence even further [5–7]. The alignment and interconnectedness of economic, social, and environmental dimensions is an increasingly apparent goal in the present SSCM [8].

In its aspiration to have a greenhouse gas net reduction in emissions goal of 55% below 1990 levels by 2030, and to come to be the world's first climate-neutral continent by 2050, the European Commission has implemented the European Green Deal as a new growth and development strategy [9]. Not only does this strategy demand emission reductions, it also stipulates the creation of green jobs and economic growth, including a pledge to mobilise at least EUR 1 trillion in sustainable investments in both the private and public sectors over the next decade. The EU has a particular concern to ensure that the transition is fair and leaves no one behind. Attention is likewise given to small and medium-sized

enterprises and to empowering industry in general in order to keep Europe competitive and sustainable.

Accordingly, embarking on a more sustainable course and fighting climate change require “new ways of producing and consuming, and changes in the way we work, use transport and live together” [9]. Thus, improving processes to mitigate or adapt to sustainability or climate change risks offers great potential for research, as many examples in process optimisation, new methods for managing processes, and performance increases through technology show (e.g., ref. [10] on the use of biofuel to study performance; ref. [11] on carbon dioxide replacement; [12] on power and heat sector coupling; ref. [13] on sustainable energy; ref. [14] on sustainable development through solar power; ref. [15] on carbon-negative economy; ref. [16] on energy development processes; and ref. [17] on life cycle processes in biofuel production).

Networks of companies, or supply chains, are at the forefront of the concerns because of their significance in socio-economic processes. The very existence of companies is inseparably allied to their supply chains [18,19]. Their integration allows the achievement of mutual improvements. However, the more tiers of suppliers and customers a supply chain has, the more complex processes become in the network. This leads to an increase in sustainability-related supply chain problems. Where—in addition to the primary goals of integration such as cutting costs or building relationships and in the light of sustainability challenges—so many different aspects and considerations need to be incorporated, the complexity inevitably grows. This shows that new approaches are needed to understand and to manage multidimensional challenges.

The challenges in sustainable supply chain management can take the form of a wicked problem [20], as the issues are, as one example, related to the current global warming [21]. It has been studied how participatory or co-creational strategies are more beneficial when tackling wicked problems [22,23] than competitive and authoritarian strategies, and service design can be used as an approach or service designers can be used to facilitate the common wicked problems at hand [24,25]. They themselves are trained not to represent themselves but rather the end-user or the actors in the system. Design and service design use the widespread design thinking or Double Diamond process models to create change, also in complex and wicked environments [26].

Aims, Structure, and Presented Hypothesis of the Article

This paper aims to approach the ever-evolving challenge of implementing sustainable supply chain management (SSCM) practices with design thinking problem solving methodologies (DTPSMs), and evaluates the sustainability transition (ST) of supply chains (SCs) as a *wicked problem*. The hypothesis (1a) of this paper states that the ST of SCs has *wicked problem* characteristics; therefore (hypothesis 1b), using DTPSMs such as the *Evolved Double Diamond* design (EDD) process model can potentially provide novel and more structures to the framework and models. The second hypothesis (2) is that the current models may not cover all four stages of the EDD process model. To demonstrate the functionality and suitability of the EDD in this context, the findings of a systematic literature review (SLR) of existing models and frameworks are aligned with the EDD process model. Finally, the contextualised and summarised EDD process model is presented to visualise the coupling between the EDD process model and ST of SCs to provide insights for future implications.

In this article, we first discuss what wicked problems are, and in what way SSCM is a wicked problem. We then describe our process of performing an SLR, the data collected, and our aim to find current models and frameworks on how to handle SSCM as a wicked problem in the context of ST. We wished to mirror the models and frameworks found with the EDD process model and see what kind of novelties this could bring to the field. Thus, we ask how the current methods or frameworks mirror or differ from the EDD process model. The relevant research questions (RQ 1a–2) and the research flowchart are summarised in Figure 1.

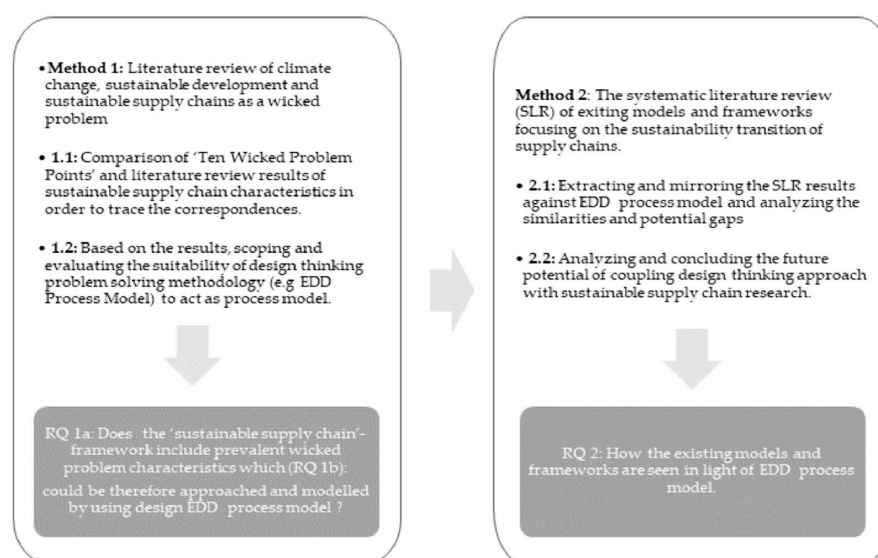


Figure 1. Summarised research flowchart.

2. Literature Review

2.1. Sustainable Supply Chains as a Wicked Problem

Supply chains integrate corporate activities of supply, disposal, and recycling. In contrast to pure logistics, the management of supply chains also includes money and information flows. It extends from the source of supply to the point of consumption. Naturally, the supply chain also includes the various levels of the suppliers' suppliers and the customers' customers. According to [27], supply chain management refers both to the processes of a company itself and to the networking with its environment. A supply chain is—as part of the business and engineering realm—commonly understood from an objective perspective. For example, considering sustainability in the supply chain, the activities between supply chain nodes, which involve all suppliers and customers, might be seen predominantly by taking into account *go* and *stop* or transportation and storage activities [28].

Wicked problem as a phenomenon was firstly introduced by [29], but it was [20] who noted the points that make a problem a wicked one. Arguably, supply chain management can be a wicked problem in several ways. The following Table 1 explains what a wicked problem is based on ten criteria. Subsequently, these criteria can be related to sustainable supply chain management.

Table 1. Summary of the Ten Wicked Problem Points, adapted from [20,30] and [23] (p. 29).

Points	Definitions
1	"There is no definite formulation of a wicked problem."
2	"Wicked problems do not have a "final solution" because the resolution can always be improved."
3	"Solutions to wicked problems are not true-or-false, but good or bad."
4	"There is neither a final test nor an immediate solution to a wicked problem."
5	"Each solution tentative to a wicked problem is a <i>one-time operation</i> and each attempt counts significantly."
6	"Wicked problems do not have enumerable sets of potential (or exhaustively descriptive) solutions."
7	"Each wicked problem is essentially unique."
8	"Each wicked problem can be considered a symptom of another problem."
9	"The existence of discrepancies in the representation of a wicked problem can be explained in several ways. Choosing an explanation determines the nature of the problem resolution."
10	"The planner has no right to be wrong, because there are consequences."

First, the barrier to even fully understanding an issue is a typical characteristic when dealing with a wicked problem. This is especially the case when dealing with certain SSCM problems. For example, the ninth item mentioned in the table is very closely linked to the type of statement that defines what the wicked problem is and how it can be tamed. Consistently, stakeholder participation is crucial from the outset, as they will be the ones to define it. As [31] points out, the company as an organisation can be understood as a complex regime, and in this context different environmental spheres, stakeholder groups, interaction topics, structures, processes, and forms of development can be distinguished [31].

Even if we describe a company in its supply chain as a complex structure, the entrepreneurial value creation activities do not of course run completely randomly, but in principle in an orderly manner. However, one sign of complexity is the high environmental dynamics, a reflection of the continuous change caused by curiosity, innovation, and science [32]. This attitude is reflected in several criteria that characterise the wicked problem, including the first, which states that there is no clear formulation of a wicked problem; the second, which expresses that improvements are always possible; and the sixth, which holds that there is no enumerable set of possible solutions.

At the same time, there are a variety of stakeholders, i.e., organised or unorganised groups of people, organisations, and institutions that are affected by entrepreneurial value creation activities. Sometimes, we might also speak of harmful activities here, if we are talking about negative effects of entrepreneurial activity. Moreover, the potential negative impacts are not without significance, but actually reflect the awareness that the supply chain manager bears responsibility for the consequences of decisions. This conclusion arguably points to the tenth characteristic that defines a wicked problem.

Stakeholders are all different, and because sustainability is a multidimensional challenge, it is possible that some stakeholders consider a situation sustainable whereas others do not. Given the complexity and diversity of a supply chain organisation, ensuring sustainability in all dimensions, including reducing harmful activities, appears as an unsolvable problem [33–35]. Although supply chains and their management can be subject to all kinds of key performance indicators, only two of them are considered as fundamental in relation to sustainability [35]. One indicator is responsiveness and the other is efficiency. Responsiveness refers to the ability to deliver—whether a product or a service—to consumers. Efficiency, in turn, is the ability to provide that benefit at the best possible price or cost. It follows that if performance in either of the two dimensions mentioned, responsiveness or efficiency, is not what is expected of it, then supply chain management would need to draw the consequences and develop a new strategy to improve performance. Indeed, the wicked character of supply chain management implies, in the fifth point mentioned in the table, that since there is no way to know in advance what the right solution is, every action is important and requires careful planning as they can carry positive or negative counteractions in a system.

Given that supply chains are subject to a high dynamic due to their exposure to continuous change and innovation, the clear counteraction on the management side is to look at the role of knowledge. Knowledge input is the obvious response in order to improve the performance of a given supply chain. Solutions in this sense always depend on knowledge. Sometimes it takes new ways to develop solutions that are necessary to enable the sustainability of a supply chain. This mainly concerns the co-creation of knowledge because—reflecting the seventh criterion that defines the wicked problem—a unique mix of stakeholders determines a unique set of problems to sustainability. Enabling this co-creation is a challenging management task.

The result, however, is a transformative process aimed at creating a strategic advantage. In fact, the introduction of such a method means that a supply chain is subject to continuous change, i.e., constant transformation. Knowledge and knowledge sharing become part of the objective within the supply chain.

A supply chain that desires to be successful in the long term will understand and combine the sustainability requirements of all stakeholders, according to [35]. The con-

sequence is a product that is responsive in a sustainable sense. The participants in the supply chain will also go to great lengths to produce a cost-effective product or service at the same time. Additionally, at the same time, the creation of a shared value proposition is also involved, an aspect that should not be underestimated in an increasingly complex world. It also makes sense that continuous improvement in performance will and must be a matter for the entire supply chain. It follows that a strategy shaped by all participants will lead to the formation of sustainable products, services, and processes. At the same time, the continuous nature of the management and its constant adaptation also reflect the fact that sustainable development in the supply chain is an ongoing process, showing that there are no definite formulations and that any management can always be improved.

2.2. Climate Change as a Wicked Problem

Climate change is a prime example of a multidimensional challenge. It is widely viewed as a complex problem in terms of managing its consequences. In addition, climate change, combined with economic globalisation and the extensive interconnectedness of supply chains, creates a double burden. While there are, of course, large uncertainties, this regimen clearly touches multiple groups due to the uneven nature of climate change and economic linkage processes. Stakeholders of multidimensional challenges of this type thus comprise both winners and losers [36]. In this context, the ability to mitigate and adapt to the impacts of the described process receives a high valuation. Mitigation is the attempt to control the accelerating industrial causes of climate change and their harmful effects. This refers particularly to controlling emissions of greenhouse gases, but includes other substances as well. In addition, mitigation also comprises measures to improve or create sinks for greenhouse gases in order to remove the gases from the atmosphere [37]. As [37] continue to point out, climate change mitigation measures are very complex and arise under many different conditions and forms of uncertainty. One of the most important issues here is economic development. This includes the development and application of new technologies and the evolution of prices. Social policies that affect costs and benefits, as well as institutional robustness and its evolution in different countries over time, also contribute to uncertainty and complexity. As a result, policy development strategies need to emphasise adaptability over time to incorporate new evidence and respond to new developments.

Adaptation as a strategy, as opposed to mitigation, refers to adaptation to actual or expected environmental conditions, i.e., in the case of climate change, to the corresponding impacts. Ultimately, it is about avoiding harm. Particularly in the case of social systems, measures should help reduce impacts to such an extent that the function is guaranteed or can be restored to a normal level in the shortest possible time. In the context of development, it can also be a question of making advantageous use of new opportunities, such as technologies, for example for the purpose of increasing competitiveness [38].

Based on common scenarios and the dynamic changes over time, some scholars [39] conclude that in reality there can be no optimal mitigation, adaptation, or combination of both. This must be due to the large uncertainties in the available data, the methods used, and the models developed. This means that the scientific scenarios developed become less relevant when it comes to human action. Consequently, as shown, climate change has arguably been a problem that is significantly difficult to solve, be it for incomplete knowledge, differing views, or a variety of complex interactions that make it seem subject to endless discussions. This is because the topic spans many, if not most, different dimensions such as scientific, economic, social, ethical, political, and religious. The extent of the complexity makes it hard to comprehend, and commonly only parts of the problem are dealt with. Part of this problem is surely that from a management perspective there exists no central authority that can control the variety of dimensions involved. In addition, the lack of such an authority will cause the dimensions to evolve further in a complex and seemingly chaotic way [20,40]. At best, any attempt to address climate change remains

fragmented. Therefore, climate change has been termed a wicked problem [41–44] or even a super wicked problem [45].

2.3. Sustainable Development as a Wicked Problem

While sustainable development has often been defined “as a form of development which meets the needs of the present without compromising the ability of future generations to meet their own needs [46]”, this concept can be seen as a wicked problem as well. In principle, sustainable development is understood as a kind of balance between economic development, social development, equity and justice, and environmental protection. Concrete goals have been and remain inconsistent and controversial. At the same time, there is a lack of methods to measure sustainability convincingly [47,48].

There are undoubtedly many overlapping aspects between the aforementioned climate change and sustainable development. One important aspect is the expectation that climate change will have negative impacts on the improvement of living conditions. In addition, there are of course certain conflicting goals between environmental protection in general and climate protection in particular on the one hand, and development on the other [49]. Similarly, responses to mitigate or adapt to climate change could have a variety of impacts on development opportunities, both positive and negative [48].

Following these arguments, the 17 Sustainable Development Goals (SDGs), as proposed by the United Nations, set an agenda for action. The goals range from poverty alleviation and quality of education to economic growth, sustainable cities, responsible consumption and production, and climate action. Accordingly, eradicating poverty goes hand in hand with economic growth and combatting climate change in both developed and developing countries. In a sense, the individual development goals provide substantive support for capacity building to address sustainable development as a whole [50]. Several of these SDGs are of paramount importance for the sustainability of supply chains, economically, socially, and environmentally. These include promoting sustainable and sustainable economic growth and productive employment (Goal 8: Decent work and economic growth). These also include building resilient infrastructure and promoting sustainable industrialisation, including measures and initiatives to support sustainable transport (Goal 9: Industry, innovation and infrastructure). In addition, the procurement of environmentally friendly and energy-efficient products and more socially responsible procurement practices and sustainable supply chains are to be promoted (Goal 12: Responsible consumption and production). It is also clear that reducing emissions of pollutants in the context of climate action is an important development goal for the management of sustainable supply chains (Goal 13: Climate action) [50].

On the other hand, complexity mirrors well the diversity of the SDGs, the positive features of which reflect ambition and vision but are also met with criticism. These include the fact that they can contradict each other, and their entire implementation is not realistic for this reason alone. It is not in vain that the SDGs are also seen as wicked in nature [51]. Conflicts exist, for example, between normative goals such as the elimination of inequality and progressive goals such as economic development with simultaneous protection of the environment. Where policy is required, it often focuses on risk management and control of procedures, organisations, or people. In general, the tendency remains to emphasise market opportunities, which is understandable from a policy point of view, as no politician could afford a deliberately induced economic crisis [48]. This confirms somewhat the predicament that with the triple bottom approach, where all dimensions such as economy, ecology, and society ought to be weighted equally, the economy is usually seen as an overarching goal. For instance, from a company’s perspective, all actions in a sustainability context must be necessarily of economic value [52].

With respect to the wicked nature, there is no *one-size-fits-all solution* available for what is considered the best kind of implementation for sustainable development [53]. Sustainable development consists of seemingly contradictory goals, such as economic development and climate action, to be implemented simultaneously. Henceforth, sustainability is highly

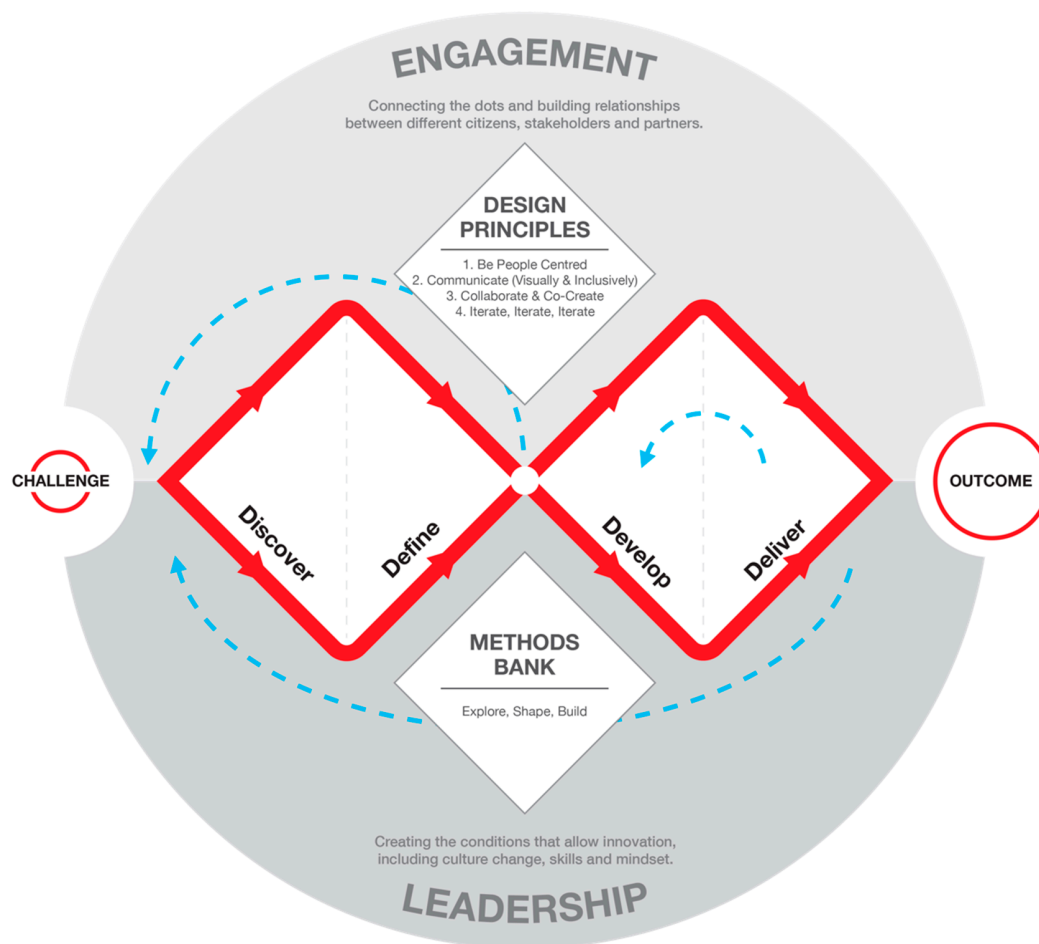
subjective. Where one suggests successful completion of a goal, the other claims further dismay. Given the scientific uncertainty about the future coupled with the difficulties involved, sustainable development could be described as a continuous adaptation in managing complexity. SD has also been criticised by scholars for being too political and general [54]. As a result, recent sustainability research literature has begun to focus on ST that is providing more explicit methods and governing especially the transformative character of the SD process for long-term sustainability [55]. Regardless, the situation remains complex, resonances are not easy, and uniform solutions towards some kind of assured equilibrium or final status are not in sight. Approaches and discourses fall short of their potential, as [48] point out. This obviously leaves significant room for improvement.

2.4. Evolved Double Diamond Service Design Process Model to Handle Wicked Problems

The most commonly used design process models in service design are design thinking and Double Diamond models to handle problems and challenges [56,57]. The widespread use of the methods speaks for the popularity and success of how they work in practice. The two models have gained solid ground in different design fields, but also in fields of design such as management [58,59], engineering [60], marketing [61], and more recently education [62]. The process models have been applied in situations of complexity and wicked problems [63]. They are also methods to create innovations [61] and strategy [64,65], which itself can be a wicked problem [66].

The design process model that we will present here is the Evolved Double Diamond model (EDD) created specifically for complexities and used by service designers. There has been an increasing discussion in service design of how the fields it facilitates are complex or wicked in nature, depending on what the problem is [24,25,67]. Service design as an approach is well suited to handling wicked problems, as they are always centred on the different stakeholders and how to take them into the process [68]. Service designers aim to visualise the complexities of the processes, making intangible issues more tangible, thus evidencing and sequencing for the stakeholders what is happening in the processes. Co-creation is in the heart and listening to end-users is important. Here, we place service design as it has sprung up in art and design [69], but we recognise and use the perspective from service dominant logic in the marketing field, because it acknowledges all actors in the service ecosystem as important stakeholders, and it is relevant to investigate their needs as well and not solely those of the end-users [70]. Both design thinking and EDD models are similar, but what distinguishes the EDD process model from design thinking is the visualised divergent and convergent thinking in the process (Figure 2) presented by the British Design Council [57]. The guiding steps are similar in both processes. In the EDD, the first diamond begins with familiarising, discovering, and empathising with the problem or challenge at hand. This may be performed through interviews or collective workshops with the stakeholders. The process is bottom-up and aspires to have all actors involved, and thus may even help to break silos [25]. The knowledge and information require divergent thinking to open the diamond. In the next stage, it is important to begin to analyse the collected data and thus practice convergent thinking, narrowing down the information. Normally, here the initial brief is rechecked and rewritten if needed.

In the second diamond, at the convergent stage many pilots or prototypes are made, which will be tested and re-prototyped. In the end, solutions will be delivered, but we need to bear in mind that for wicked problems the solutions will be better or worse, as final or ultimate tests or solutions are not possible [20]. This is probably why in the EDD the word at the end is outcome and not solution. To complement this model, we have used Nessler's Double Diamond model [71], which describes in greater detail what the different stages are inside the diamonds, ripping the brief at the start and questioning whether it is the right way to approach the challenge or iterative prototyping and testing at the end. It served as a guide when analysing different models and frameworks found in the subsequent literature review.



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Figure 2. Evolved Double Diamond model (permission from the British Design Council [57]).

The British Design Council [57] (Figure 1) created the EDD process model to better address these complex problems. What is different from the previous Double Diamond model is that it contains a methods bank below and design principles that guide the work as being people-centred, communicating visually, practising collaboration and co-creation and iterativeness. The aim is to engage with the different stakeholders, partners, and the public. These principles resonate strongly with service design principles. Using the Double Diamond model in the context of *sustainable supply chain management* is not mainstream literature and we were able to find only 11 results in Google Scholar in October 2021.

3. Materials and Methods

It was determined that an SLR would make the study more rigorous [72]. We searched Google Scholar and Scopus for relevant conference publications in August and September 2021. One of the downsides of performing an SLR is that it is time-bound and varies from one month to the next. A research protocol (Appendix A) was created to make the study replicable [73]. The selected search words were: *framework* OR *model* AND *wicked* AND *supply chain management* AND *sustainability transition*. We used only the word *wicked* and not *wicked problem* or *wicked issue* because there are many variations of how it is used, and

we wished to find all of them. Another important focus was *sustainability transition* and we made a conscious choice to add *transition* and not have *sustainability* alone. We wanted to know specifically how the ST is being handled today in the realm of wicked problems and what are the current models or frameworks applied to it.

The analysis was performed in two cycles [74], using Excel as the platform for analysis. In the first cycle, the articles were filtered by the four key search terms. Only the publications that had the four elements were selected for the second round. In the second cycle, a closer look was taken on what kinds of models and frameworks were presented and how they could be mirrored with the four stages of Double Diamond: discover, define, develop, and deliver, but also with the iterative nature of the model. The analysis and selection of articles were performed in peer-review style meetings between the authors.

In total, 50 publications were found during the first cycle and five were selected for the second. Table 2 shows the publications found by each search engine. The publications that did not meet our selection criterion, which was that the article would handle all four themes of *sustainable transition*, *supply chain management*, *wicked problems*, and whether it presented a *model* or a *framework*, were removed. The selected articles are listed in Appendix B. This selection, the first cycle of analysis [74], was performed systematically using an Excel table. Parts of the article text were copy-pasted into the respective fields and discussed among the authors to ensure that they handled the themes we were searching for.

Table 2. Publications found by each search engine and selection of publications between the two cycles.

Search Engine	1st Cycle	2nd Cycle
Google Scholar	32	3
Scopus	18	2
Total	50	5

For the second cycle of analysis, another Excel table was created in which the models and frameworks were opened in greater detail. As we wished to analyse them through the EDD and mirror them to it, the four columns created were: discover, define, develop, and deliver, but the iterative nature of the processes was also considered.

The selected publications were all written between 2015 and 2020, even though no time limit was set, which may indicate the novelty of this study field. Our search in Scopus revealed how the wicked problem literature has continued to rise since 2005, and that on SSCM since 2007 (Figure 3; Scopus). Using the terms *sustainable supply chain management* AND *wicked problem*, Scopus only found two results [34,35], and when the terms *sustainable supply chain management* AND *double diamond* were used, no results were found in Scopus (October 2021).

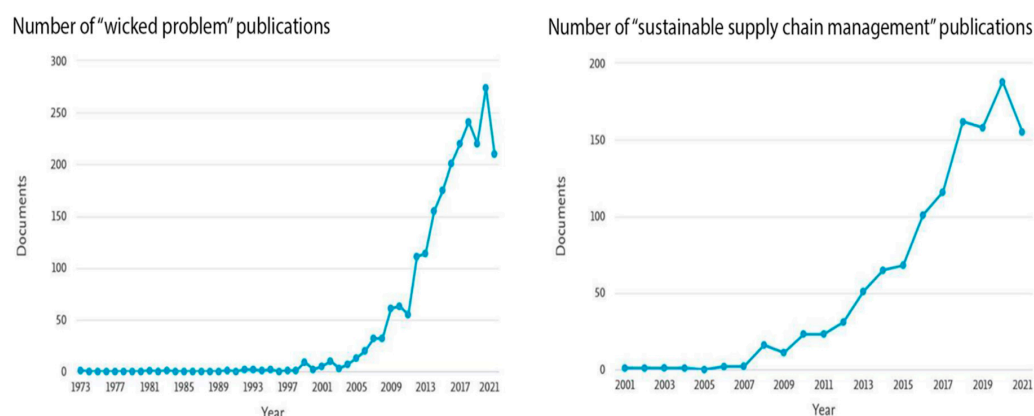


Figure 3. Amount of literature on wicked problems (left) and sustainable supply chain management (right) found via Scopus in September 2021.

4. Data and Results

From a total selection of five articles, we were able to find one framework and four models, as presented in Table 3. The following chapters look at them in more detail and explain how they were mirrored in the four stages and iterativeness of the EDD process model.

Table 3. Extraction of SLR results and mirroring to Evolved Double Diamond model.

Discover	Define	Develop	Deliver	Evolved
“Strategy 1 as co-creating change. Co-creation of change with different institutions and sectors, with varying perspectives [75]”	“Strategy 1 as co-creating change. Engaging multiple stakeholders by themselves alone are insufficient for systemic transformation [75]”	“Strategy 2 as supporting change/Strategy 3 as doing change. Concrete actions of doing change [75]”, “develop and support new initiatives that push sustainability [75]”, “creating alternatives [75]”, “piloting experiments [75]”	“Strategy 2 as supporting change”/“Strategy 3 as doing change”/“Strategy 4 of forcing change [75]”, “breaking status quo power structures [75]”	The article does not present a process model, but more a philosophical stance where values could be used in each stage. It does not refer much to the iterative process.
“Strategy formation process [76]”	“focusing on the relationship between planned and emergent action in enabling strategic sustainability orientation [76]”, “sustainability strategy making is neither purely directed nor exclusively emergent but rather evolves as a distributed, collective process [76]”	“Findings demonstrate how integration of planned and emergent strategy making can enable small firms to align core business objectives with sustainability goals [76]”, “strategy research needs to pay closer attention to the way planned and emergent actions are the result of distributed [76]”, “collective processes through which people form strategic orientation of their business [76].”	“Results highlight how (1) carefully planned actions support alignment between environmental, social, and economic value; (2) actions shaped by multiple actors through collective agency enable such value to be co-created, shared, and thus collectively owned; and (3) actions realized through emergent processes integrate the purpose of the organization with the meaning structures of the host context [76]”	The change process or cycle is between the information and innovation for sustainability. The text also speaks about circular thinking—cradle-to-cradle.
“Sustainable system change [77]”, “System perspective—looking in a holistic way to certain events/patters means trying to understand the context and interconnections between different themes [77].”	“Collaboration [77]”, “Sustainability should be regarded as an objective that will become a crucial element in the strategy with the potential to re-direct, re-frame, re-think [77]”, “holistic systems thinking approach is needed [77]”, “Triple Bottom Line (People, Planet and Profit) enables to act as a change agent [77]”	“New collaborative models [77]”, “Fair new models of adding value [77]”, “Fair profit sharing [77]”, “Supplier power patterns [77]”, “Circular thinking [77]”	“Empirical findings [77]: Mission driven organisations: 1. have a clear sustainable mission, 2. employ new business models with a focus on collaboration for innovation, 3. collaborate in ecosystems with a wide range of organisations that help them to achieve their sustainable mission, 4. need to have the ability to think big and being operational at the same time”	The process image is cyclical and contains various cycles inside a wider time perspective. The emergent nature makes the iterations.
“Systems thinking is an attempt to explicitly map the observer into the system observed [78]” Systems thinking underpins the concept of resilience and questions the reliance on lineal, and predictive, managerial thinking [78]. Resilience thinking as referenced here begins from a different set of assumptions proposing that any system has multiple stable states, multiple equilibria, any one of which is valid with respect to the state dynamics of a system, albeit not equally so from the perspective of an observer [78].	“ecosystemic epistemology to support managers in undertaking such a fundamental transformation [78]”, “It is proposed that the Anthropocene epoch represents a limit point in at least a dual sense [78]”,	“the boundaries of the focal system are extended [78]”, “social system is nested within the ecological system of the biosphere [78]”, “working within the context of systemic fluctuations [78]”, “take into account the impact on and influences of the adjoining system scales managers draw on ways of thinking and acting that are adequate in terms of scalability and reflexivity [78]”, “learning by doing” [78].		Continuous system-wide turbulence is in the core of this model [78].

Table 3. Cont.

Discover	Define	Develop	Deliver	Evolved
“elaborate strategies and actions that should comprise enterprise approaches to human influenced causes, symptoms and consequences of social strain and climate change [79]”, “supply chains generates both intended and unexpected innovation, including social-ecological innovation” [79]	“Embedding is always driven by specific strategy; available processes, partners, resources, and policies; and choice of performance metrics [79]”, “human ecology is defined as relationships between and among the enterprise, its human capital, and its supply chain with its extended social, natural, and built environments [79]”, “stakeholder relationships are competitive, cooperative, collaborative, and co-creative [79]”, “increasing maturity is associated with increasingly systematic and systemic practices [79]”, “social-ecological innovation that includes biomimetic and cradle-to-cradle approaches, big data analytics and intelligence, and supply chain proficiency [79]”.	“increasing maturity is associated with increasingly systematic and systemic practices [79]”, “social-ecological innovation that includes biomimetic and cradle-to-cradle approaches, big data analytics and intelligence, and supply chain proficiency [79]”.		Foresight information to be embedded into the strategies. This indicates circular modelling.

4.1. Four Different Strategies as a Framework

The article by [75] presents four strategies (Figure 4) as a framework on how to present change in supply chain management to create sustainability. First is to co-create change, which “involves collaborative and emergent strategies among multiple stakeholders, typically from different institutions and sectors, with varying perspectives [75] (p. 9).” This could be seen linked with the first stages of the diamond if the stakeholders are involved in analysing and creating shared understanding of the problem. The same is not presented in this manner, but more as an approach, which is common for development in the service design field [75]. Still, the authors do not agree with this approach, as they see it as somewhat inefficient in creating change and as requiring political savvy to bring about the desired shifts.

The second strategy is about supporting or pushing change. One practical example is given of global food companies and how they introduce new sustainability practices and thus support change in their channels. In this way, private or public actors may have power to make the desired change. This approach resonates with the *development* or *deliver* parts of the EDD. Still, as [75] (p. 10) point out, “On the other hand, when they do not have sufficient resources to steer change in the desired direction, actors using this strategy risk becoming irrelevant in a transition towards sustainability.”

The aim of the third strategy is to bring about change, and [75] (p. 10) present it as a “myriad of people who are directly creating alternatives”. They see that these initiatives are largely undertaken by small social enterprises or benefit corporations, which wish to change the power structures or status quo, and piloting plays a role in this in carrying out circular economy experiments. Pilots have a lot to do with the second part of the EDD model, as the aim is to explore and test new possible alternatives.

The fourth strategy aims to force change, and, according to [75] (p. 10), it means “breaking the status quo power structures through confrontation, campaigns, strikes and demonstrations.” The authors see that NGOs or civic organisations are currently more active in such strategies. Common to these organisations is that they do not engage in co-creation processes, especially if they are engaged in some form of greenwashing. Such actions could resonate with the second diamond of the EDD and more specifically with the delivery stage, as the change is or could be an outcome.

The article by [75] does not talk about or present the iterative or cyclical nature of developing a strategy or process. Additionally, the strategies do not mirror the EDD model exactly, but some elements may have similarities or perspectives that could be applied to

the EDD process. EDD is used to create strategies, and these four strategies could be one approach to applying the EDD each time, depending on what kind of change is desired.

4.2. Integrated Activity-Based Model for Sustainability Strategising

Sustainability strategies require more advanced strategic actions [76], which can be gained by incorporating planned and arising measures into strategy development processes. Existing models of SSCM, especially in terms of small enterprises, lack complexity-related flexibility and receptivity [76,82]. Hence, the article proposes that the utilisation of an integrated activity-based model can support integrating principal business targets with emerging sustainability objectives. The activity-based model further emphasises that the role of people and individual actions needs to be recognised more systematically, as “interpersonal relationships and collective agency are central in forming strategic sustainability orientation” [76]. The integrated activity-based model demonstrated how the incorporation of planned and arising measures can be implemented by individual and joint measures. As the authors emphasise, collective agency has similarities with the EDDs philosophy of participatory design.

In the model (Figure 5), the creation of strategy is performed through planned, collective, and emergent actions. In one way, these actions could be mirrored by the EDD model. At the first stage of the EDD, as in the model presented by [76], holism or making people and stakeholders take part is similar for both models. The outcomes that the model brings should be aligned with values of sustainability, and this is a good perspective for the second diamond stage. The model clearly underlines actions [76], which are predominant for the second diamond of the EDD model. The results reflect that well planned actions include both social and economic value. The aim is to shape the future through the cyclical or emergent nature of the process. The time perspective is long, and different cycles are created over a wider timeline.

4.3. Systems Perspective of Sustainability with the Systems Model

The article by [77] approaches ST based on the complex systems perspective, where sustainability is incorporated with entrepreneurship and innovation management. Sustainability in general needs to be a solid part of the organisational strategy with clear sustainable targets, and holistic system thinking is required to comprehend such a multi-layered issue as sustainability [77]. Co-creation and stakeholder collaboration is an enabler in terms of creating more sustainable innovations and business models, which reflects once again in the EDD values. Expansion to the ecosystem level of collaboration creates benefits for the organisations involved, as the efforts are supported by a broad spectrum of organisations and the positive SD also resonates at macro level [77]. Service design itself, as [77] emphasises, acknowledges the need to understand the levels of micro, meso, and macro [24,25,83]. Systems thinking is widely used in service design [82] as well, and both theories, systems thinking and wicked problems, resonate well. The linkage is clearly acknowledged: “It proposed that so called *wicked* problems that persist over time require fundamental change in structures, cultures, and practices of a societal system for the system to become sustainable [77,84].” For [77], as in service design [83], ecosystems form the basis of starting the creation process in a complex setting. The model (Figure 6) by [77] shows on the left the ecosystem that involves clients, access to capital, and knowledge institutes, which are both national and international. From this setting, knowledge is created collaboratively (first diamond) and actions are taken to create innovations for sustainability (second diamond). Collaboration, according to [77], has different levels that are micro, meso, and macro.

The empirical results emphasise that in order to improve sustainability to become more equal and fairly balanced, SC systems are required in new sustainability practices. The improvements can be made by developing supplier partnerships in SCs and enhancing the circular nature of SCs, which improves the control over SC systems [77].

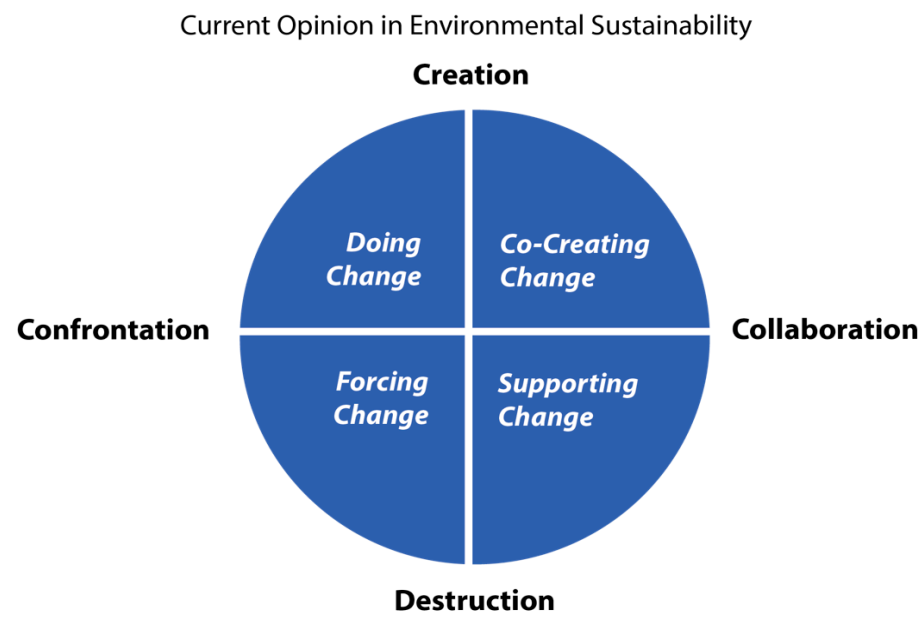


Figure 4. Change quadrants (adopted from [75], p. 9, presented in [80,81]).

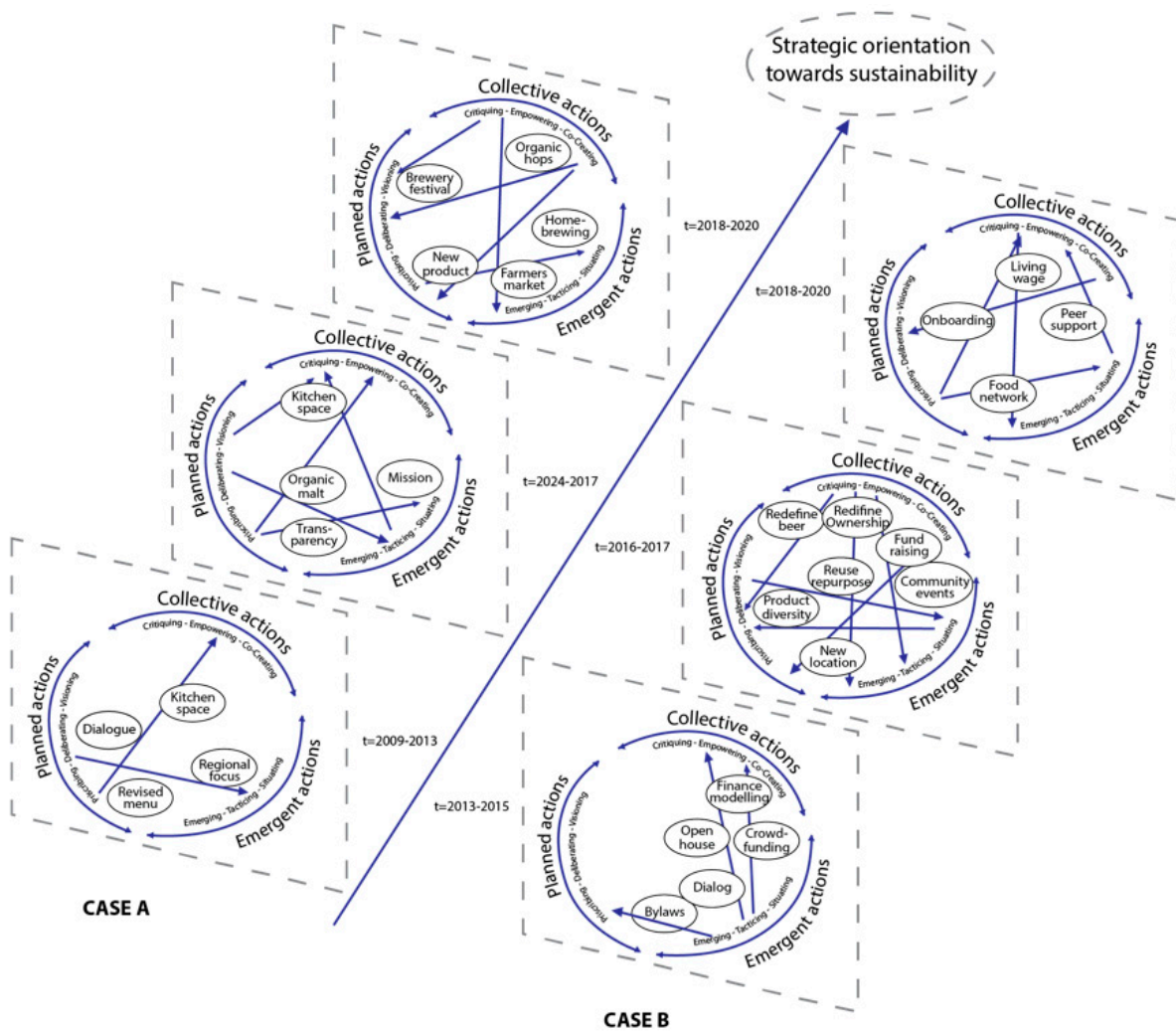


Figure 5. Integrated Activity-based Model (reproduced with permission from [76] (p. 11)).

4.4. Anthropocene Approach and Resilience Thinking Framework—Adaptive Management Strategy

Adaptive management strategy are presented as follows: “a learning-through-doing approach to governance and resource management that proceeds through the exploration of multiple alternative approaches” [78]. Learning by doing is in essence the very same as in the EDD process model. Often the aim in the design process is to fail early in the prototyping stage and learn from it.

One of the ways to understand the ecosystem for [78] is not only through the human, anthropocenic worldview or paradigm, but also through the biosphere. In the design world, there has been a similar rise of thinking that there is a need to shift from the human to the environment [83]. Change in the adaptive system is the need for resilience, which means that either an individual or the system needs to recover from a turbulence or disruption. Understanding the turbulence is the first diamond; the second diamond is the actions needed to bounce back. As such this is not the model of [78], but more a perspective or framework of adaptive management strategy.

As opposed to conventional management strategies, the model of [78] emphasises the need for adaptiveness (Table 4). In terms of the SSCM, in the conventional perspective the “focus is predominantly set on seeking competitive advantage for the focal organization by controlling its suppliers, rather than seeking a shared strategic partnership serving triple bottom lines [78].” The reason for this is that the often chosen focus in business in general, and supply chain management in particular, on agreeing the three areas of the Triple Bottom Line, i.e., economic, environmental, and social, puts the focus on the now. It is therefore very difficult for any management to express a responsibility for future generations and, with that, the possibility of holistically considering the natural foundations of life, as is performed with the adaptive management strategies [85].

Table 4. Contrast between conventional and adaptive management approaches (adopted from [78] p. 8, presented in [86]).

No.	Conventional Management Strategies	Adaptive Management Strategies
1	Seek precise predictions	Uncover range of possibilities
2	Build prediction from detailed understanding	Predict from experience with aggregate responses
3	Promote scientific consensus	Embrace alternatives
4	Minimise conflict among actors	Highlight difficult trade-offs
5	Emphasise short-term objectives	Promote long-term objectives
6	Presume certainty in seeking best action	Evaluate future feedback and learning
7	Define best action from a set of obvious alternatives	Seek imaginative new options
8	Seek productive equilibrium	Expect and profit from change

4.5. SEER2 Model to Support a Pathway towards Sustainability

The remaining model traced from the SLR presents the *sustainable enterprise, excellence, resilience, and robustness model* referred to as the SEER2 model [79], which highlights the requirement for developed organisational strategies and actions that should include the understanding of human influence in SD. SC development produces results that are both intended and unexpected and potentially include social–ecological aspects.

Compared to the other models cited in this article, SEER2 (Figure 7) resonates the most with EDD. The first stage of SEER2 is strategy and governance, which aims to understand the data, and the setting of the initial stage, which is similar to the *define* stage of EDD. The second is translation and execution, which involves analysing the data (the *define* stage of EDD), from which a plan of action is then drawn (development of EDD). The final and

third part of SEER2 is called performance and refinement, which seems to correspond quite closely to the last part of the EDD, *deliver*, as both aim to bring about change.

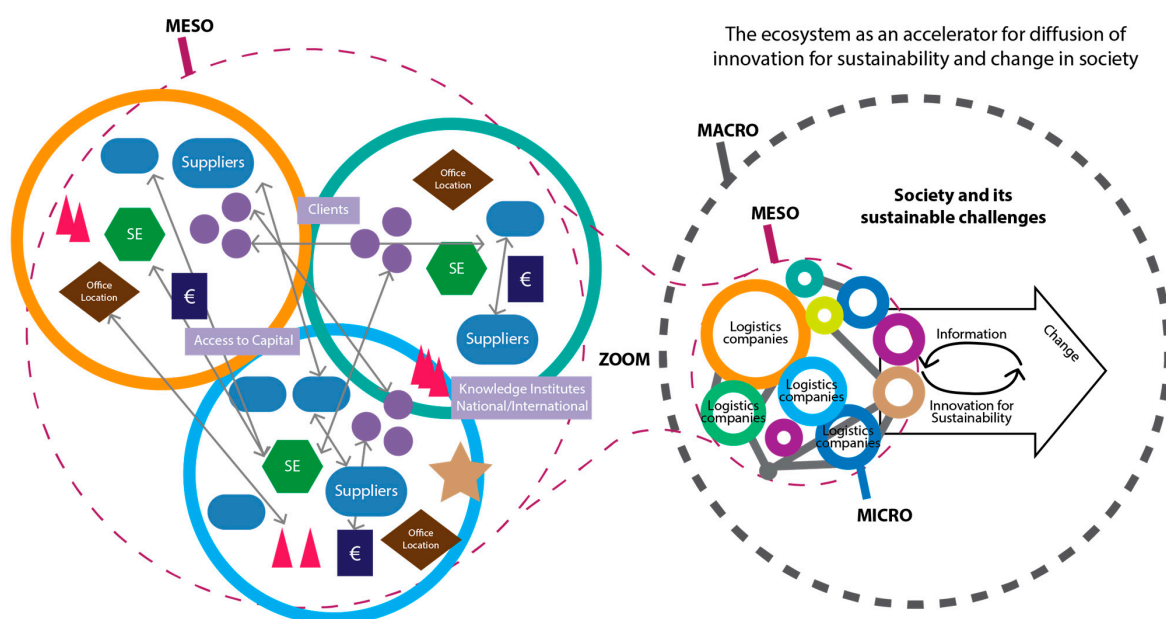


Figure 6. Ecosystem Model for Systemic Change (reproduced with permission from [77] (p. 971)).

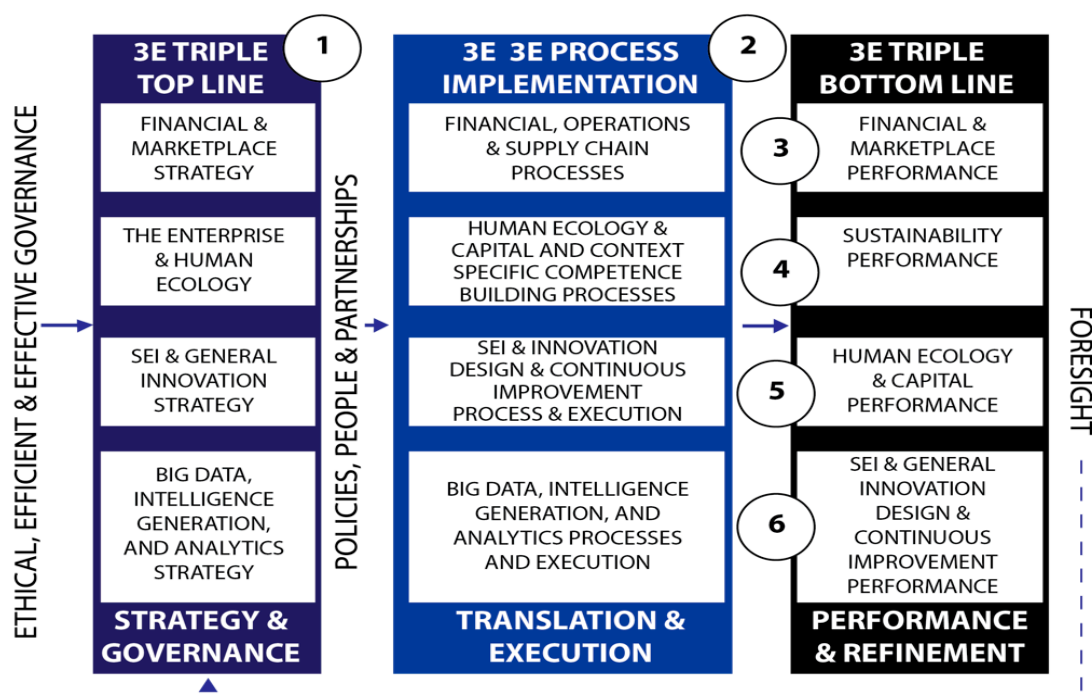


Figure 7. SEER2 model framework (reproduced with permission from [79] (p. 459)).

At the end of the SEER2 model a line is drawn from the word *foresight* to the start of the process, which presents some form of circularity. The aim is to create a desirable future as in the EDD. The authors of [79] (p. 461) claim that the “SEER2 enables to combat select interconnected wicked sustainability challenges—especially as related to energy supply and distribution considerations.”

So, the scope of the model includes economic sustainability, i.e., the financial stability of companies, but also the consideration of social and environmental issues and challenges.

Above all, it emphasises that innovation is of great importance for companies to learn and express their responsibility towards livelihoods. This sounds quite dramatic, but it also underlines the claim to align generally positive values with corporate values and to make social responsibility profitable, so to speak [87].

5. Discussion

5.1. Sustainable Supply Chain Management Coupling with Design Thinking

The hypothesis (1a) of this paper states that ST of SCs has *wicked problem* characteristics, which was analysed in this paper by reflecting the *wickedness* of external factors tightly connected with SSCM such as climate change, sustainable development, and then proceeding to SSCM context itself. The prevalent characteristics of SSCM were reflected against the *Ten Wicked Problem Points* [20,23,30] framework and the reflections to the majority of the points were matching positively. Based on the overall analysis, we as authors claim that SSCM can be considered as a *wicked problem* and therefore the hypothesis (1a) has been generally noted to be correct.

This study uses the existing models and frameworks of ST in the SC context as a philosophy and framework to work with the EDD process model from the DTPSM perspective. Service design itself is not normally the sole authority in any given field but is proficient in holistically facilitating the co-creational process. Knowing the current perspectives and frameworks in the field of sustainable transition would be beneficial if not crucial for service designers working in the field. Three of the five models are purely presenting strategies [75–77] and fourth closely as the ecosystem [78] could be understood as the base for making a strategy.

None of the selected articles reported the use of design thinking or the EDD process model. All support co-creation in some sense—the first one even supports the idea of activism to achieve the actions needed for sustainable development. We could conclude that collaborative strategy domains in these models act as wicked problem tools normally would [23]. The EDD itself is not a strategy, but is used to make one and as performed in the last model SEER2 [79]. What the EDD model may gain from the other models presented is the value of sustainability in the context of SCM. Another interesting point from the model presented by [76] is the cyclical nature in time. Although the EDD model is cyclical and is restarted when it comes to an end it is not visualised often as in the model presented by [76]. We believe this is something that could enrich the current EDD model.

We as authors think that our first hypothesis (1b) is correct. The found frameworks or models are mainly presenting strategies and perspectives on how the work from the wicked problem perspective should be performed in the field of sustainable supply chain management; therefore, using DTPSMs such as the *Evolved Double Diamond* design (EDD) process model can potentially provide novel and more structures to the framework and models. Still, the SEER2 is very close and coupling these two models could bring some interesting insights to the field. Thus, we recommend more future research on them. Our second (2) hypothesis on the contrary was evidently wrong in the way that we assumed how the models would not cover the four areas of the EDD model. Our systematic literature review found models that all pretty much could be understood with the two diamonds, although cannot be mirrored one to one.

5.2. Future Implications Coupling Design Thinking with SSCM Research

With strong and inevitable drivers pushing for SSCM, new approaches are necessary from organisations and cross-disciplinary research domains to better comprehend and govern this highly complex subject. Even though the research literature on SSCM models and frameworks has been quickly expanding to meet this demand, coupling with DTPSM, which is also a rapidly emerging research field, has yet to be widely implemented. Introducing ST towards SSCM clearly as a *wicked problem* type of challenge and combined exploitation of DTPSM such as a contextualised EDD process model aligned with existing research frameworks. Enrichment potential in this context can be implemented in forms

of providing more structure, clarity, and improving holistic stakeholder engagements processes.

We believe that service design as a perspective and as facilitation could work well in the SSCM context, as it does not represent itself in the process but rather the end-user, and here thus the variety of actors involved. Future versions of this paper could continue to develop further and contextualise a novel EDD process model for this specific purpose. The wider exploitation and revealing the future potential areas and its varieties of coupling design thinking with SSCM research would require further cross-disciplinary research efforts. A recently published empirical study in regard to ST towards the circular economy concept [88] emphasised that the utilisation of design thinking and the contextualised Double Diamond model can benefit sustainability-related transition processes by improving the holistic understanding, stakeholder engagement [89], and therefore positively affecting the quality and stakeholder acceptance of the decisions [90]. Based on [91] thinking has already demonstrated its perceived usefulness in many industries, but it is highlighted in empirical studies (e.g., [92]) that implementing design thinking practices requires strong commitment, support, and fluent communication from the management as any radical change process.

6. Conclusions

In the SLR of previous research on ST in SCs, it was noted that co-creation and stakeholder collaboration are some of the key supportive elements in existing frameworks and models. In this respect, DTPSM potentially provides an improvement in structure formation and new approaches to tackle this highly complex issue. In addition, the *wicked* nature of the issue would require expansion of the mindset from closed-form solutions towards continuously evolving ideology. Therefore, it can be argued that in this context there are only the best possible more or less temporary solutions available, which have no exact stopping rule or a specific end stage. In other words, it can be summarised that it is basically impossible to find a clear solution, but understanding and involving the evolving character of SSCM can improve the conceptualisation of the models and frameworks, which is performed in close collaboration with facilitators from the design thinking domain.

Existing models cannot be purely mirrored with the EDD process model one on one, although they have many similarities and aspects that could be reflected in the four stages. Still, it is important to recognise and work in such a way that the theme involved will have the same stages as the EDD process model. Having a group working, for example, on the *discovery* stage and others on *deliver* would be detrimental, tearing apart, and prejudicial for the joint process, unless it has not been agreed upon by everyone. There are many examples of this in politics ending up in the tabloids. It is good to bear in mind that working with sustainable development is very political. New reports or information not known during an EDD process may be stimulants that a team would change their current stage to a previous one, for example, this year's reports on climate change and the rise of the sea levels. We think that the iterative nature in this context of making development in sustainable transition in supply chain management is vital. We need constant looping of the data and new research being performed in the field. For example, the new report on climate change forces us to rethink our future strategies and ways of coping.

The frameworks and models found through the literature review are all from the context of SSCM. We did not specify any specific industry sector at this stage, but gave some suggestions in the text. We see that the Double Diamond design model is suitable in the light of the research to be used in the context of SSCM. The model was created both for designers and non-designers to tackle challenges. As the challenges are the focus of the model itself, it does not specify where or what field the challenge is. We call for case studies to apply the Double Diamond model in the context of SSCM, also using and coupling the frameworks and models found. Many of the models would enrich the Double Diamond process model in the context of SSCM.

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Appendix A

SYSTEMATIC LITERATURE REVIEW PROTOCOL	
Aim	The aim is to identify, extract, and align relevant elements from existing models to create a novel model by using the Double Diamond approach
Question	How can sustainability transition (ST) alignment with supply chain management (SCM) be modelled as a wicked problem? Secondly, how do the current methods or frameworks mirror or discuss with the EDD process model?
Objective	The objective is to search for existing articles that combine ST, SCM, and WP and preferably provide models or frameworks to combine these elements. The starting point of this research is that there is an expected research gap in that area, which will be identified during the research. The literature findings are analysed and collected to formulate a novel Double Diamond model that combines all three items: ST, SCM, and WP.
Protocol	The whole process of making the literature review (as the aims, questions, selection of articles . . .) was made in meetings among the authors and with a peer-review way of seeking best practices.
Search strategy	Once the aim, scope, and objective of the research were agreed, then it was defined that the systemic literature review utilises a search string: “framework” OR “model” AND “wicked” AND “supply chain management” AND “sustainability transition”. The search engines were selected to be Google Scholar and Scopus.
Process of selecting articles	The literature search was conducted at the journal portals Scholar and Scopus with the aforementioned search string. It was then assured that there are no duplicate article results and the article list was finalised. There was no specific timeline set and it became obvious that the vast majority of the articles were not older than five years, indicating that the specific research topic is very recent. Only scientific articles were included.
Inclusion and exclusion criteria	Despite this, the search string was generated so that the results were expected to result in articles that would contain all four elements such as framework/model, sustainability transition, wicked and supply chain management. It was noted that very seldom the articles incorporated all these elements together. On the contrary, in the majority of the articles the elements were used separately or only mentioned in the keywords selection. Each of the articles were briefly reviewed and the ones that clearly did not match the research criteria of this study were excluded. The selected articles that continued in the SLR process were reviewed in more detail. Some of the excluded articles were very topical in the context of this study, but we needed to put aside most as they did not provide a specific model or framework. As the main aim of this SLR was to gain and compare existing models/frameworks against the Evolved Double Diamond process model, it was therefore necessary to have comparable data, which could have been gained only through models and frameworks.

SYSTEMATIC LITERATURE REVIEW PROTOCOL	
Process of extraction of relevant information	<p>An Excel table was created with columns extracting basic knowledge of the publications: Author/Year/Institution, Faculty, etc./Country/Name of the article/Journal/Keywords. In terms of extracting and incorporating data of existing models/frameworks to the Double Diamond process model, we decided to follow Nessler's (2018) framework, which offers a clear division of which sub-elements should be included in each sector of the Double Diamond model. The Double Diamond process model was divided as follows: the Discover section includes general cluster topics and it is considered as a starting point; the Define section includes insights, themes, and opportunity areas; the Develop section includes ideation and evaluation; and the Deliver section includes more in-depth implementation, building, testing, iteration, and possible solutions. For these four columns, the texts were copy-pasted from the original articles. ITERATIVE. Here, the text was an analysis of the models and frameworks between the author A and B.</p> <p>CYCLE 1: The context of the articles was briefly reviewed and reflected against the search string elements and how these were incorporated. The results were extracted to an Excel sheet. The articles that were clearly out of the scope of this study were excluded. The potential articles were included for further review, where it was checked more in-depth how the research results of the nominated articles would match the given criteria. We used only the word "wicked" and not "wicked problem" or "wicked issue" because there are many variations of how it is used and we wished to find all of them. Another important focus was the "sustainability transition", and we made a conscious choice of adding "transition" and not having "sustainability" alone. We wanted to know specifically how the ST is being handled today in the realm of wicked problems and what are the current models or frameworks applied to it. Due to the rapidly evolving nature of the issue and its rather recent relevance among research literature, we decided to focus on peer-reviewed journal and conference publications.</p> <p>CYCLE 2. The selected articles that contained all four elements were analysed on the basis of the Evolved Double Diamond model. The findings from the existing models and frameworks were categorised based on the sectoral division between Discover, Define, Develop, and Deliver stages, and in this context we utilised Nessler's (2018) categorisation for improved comparison.</p>
Results and data synthesis	The results found are provided in a separate table.
Discussion	Discussion is realised in the form of an article.
References	<p>Protocol made according to: Hammick, Marilyn, Timothy Dornan, and Yvonne Steinert. "Conducting a best evidence systematic review. Part 1: From idea to data coding. BEME Guide No. 13." Medical teacher 32, no. 1 (2010): 3–15. Double Diamond categorisation reflections with: Nessler, D. (2018). How to solve problems applying a Design Thinking, UX, HCD or any Creative Process from scratch V2. Retrieved from https://uxdesign.cc/how-to-solve-problems-applying-a-uxdesign-designthinking-hcd-or-any-design-processfrom-scratch-v2-aa16e2dd550b (accessed on 1 September 2021).</p>

Appendix B

Scholar/Scopus DATE: Reference (APA)

- Scholar 28 August 2021: Dentoni, D., Waddell, S., & Waddock, S. (2017). Pathways of transformation in global food and agricultural systems: implications from a large systems change theory perspective. *Current opinion in environmental sustainability*, 29, 8–13.
- Scholar 9 October 2021: Monique de Ritter, 2015. "Mission Driven Enterprises in Ecosystems as Drivers for Sustainable System Change," *Managing Intellectual Capital and Innovation for Sustainable and Inclusive Society: Managing Intellectual Capital and Innovation; Proceedings of the MakeLearn and TIIM Joint International Conference 2*, ToKnowPress
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