

Behaviour, the theory of constraints, and the future of sustainable supply chain management

*Michel Leseure (m.leseure@chi.ac.uk)
University of Chichester Business School*

*Anthony Alexander (fm10aa@mail.wbs.ac.uk)
University of Sussex, School of Business, Management & Economics*

Abstract

The research applies Siemsen et al.'s Constraining Factor Model (CFM) to sustainable supply chain management. This involves two case studies, one in offshore wind farm development and another in heavy manufacturing. In both, there was an inability to maximise improved environmental performance. Analysis reveals the constraining factors, which CFM defines either in terms of motivation, opportunity and ability. Exogenous opportunity factors are found to constrain the focal firms and their supply chains maximising improved macro-scale environmental performance. These include regulatory, macro-economic and socio-psychological (behavioural) factors.

Introduction

In this paper, we explore the possibility that firm-level sustainability policies, including sustainable supply chain management (SSCM), struggle to perform because of constraints existing beyond the realm of the firm itself. This paper describes the theoretical context through which these constraints can be revealed and analysed, briefly covers the research methodology and data collection undertaken, and then discusses findings and theoretical implications.

Theoretical background.

Behavioural theory and SSCM

A firm's effort to become sustainable, in the presence of constraints and of ambiguity about the end state of 'true sustainability', can be described from the lenses of Cyert and March's behavioural theory of the firm. Cyert and March (1963), building on Simon (1947), critically challenged the two assumptions of the traditional theory of the firm: the idea that managers (1) use perfect knowledge to (2) maximise shareholders' wealth. They argued that under a more realistic assumption of bounded rationality, management exhibits satisficing behaviour; their challenge is to make a number of decision that result in a level of performance which is satisfactory, or 'good enough'.

In the process of making these decisions, conflict will arise within the organisation as different groups, called coalitions, take different positions based on their (bounded) perceptions. In other words, nobody is in a position to 'optimise' profits, or for that matter any other aspects of operations. Instead, Cyert and March describe management work as 'organisational searches'. Both SSCM research and SSCM practice can be re-interpreted from the lens of the behavioural theory of the firm, if the locus of analysis is extended from an

organisation to a Community of Practice (CoP) (the vertical supply chain community or the horizontal sector community or other communities). This change of locus of analysis is legitimate if one considers the claim that organisational work, learning, and innovation is better understood through communities of practice rather than organisations (Brown & Duguid, 1991).

In the absence of a clear definition of 'true sustainability' and of clear, consistent and unambiguous definitions and metrics (essential criteria for rational decision modelling, according to Keeney and Gregory, 2005), firms have no options but to search for what sustainable practices are. Hassini, Surti, and Searcy (2012), for instance, review the SSCM literature and find several hundred different definitions used, from investment in local community projects, to workplace accidents, to toxic emissions released. Such a broad range makes the problems of contests between competing frames and rival definitions problematic (Varsei, Soosay, Fahimnia, & Sarkis, 2014).

Levels of analysis in SSCM:

It is important to be clear as to whether sustainability is regarded as a property of a firm or of a supply chain. SSCM researchers are often concerned with establishing under what conditions a firm can achieve a sustainable supply chain. Instead, an alternative, and possibly more realistic perspective, is to understand the concept of sustainability as a property at a macro-scale and in aggregate. This echoes calls such as Miemczyk et al. (2012) for far greater attention to network-scales of analysis. By contrast, SSCM research that has largely inherited a dyadic perspective from SCM research, is concerned with economic performance as a firm-level attribute.

Constraining Factors:

Using the Constraining Factor Model (CFM) presented in Siemsen et al. (2008), we explore the idea that SSCM research and practices are struggling to perform because of the macro-scale context in which they take place. A common criticism is that sustainable operations management or SSCM policies concerned primarily with eco-efficiency measures, such as minor reductions in organisational carbon footprint, are insufficient to meet the demands of deep decarbonisation (CCC, 2015). This conception of improved sustainability performance as harm reduction via SSCM is an example of a local search. There is no theory stating that a local search will always fail to move a search closer to the global solution, and thus, it is not possible to conclude decisively that research into organisation-level 'local' SSCM initiatives do not have potential value. In the absence of a better search strategy, it may very well be the only way to probe and learn about how to deliver 'true, macro-scale sustainability'. A key question is: what is constraining these search efforts?

It is in light of Siemsen et al. (2008) CFM model that we answer this question. This paper explains performance as the cumulative result of the ability to do something, the motivation to do so, and being provided with the opportunity to do so. Our research investigates which of these factors is a constraint as described with the CFM model as shown in equation (1):

$$Action = a_0 + a_1M + a_2O + a_3A + \theta_o(a_4 + a_5M + a_6O + a_7A) + \theta_A(a_8 + a_9M + a_{10}O + a_{11}A) + a_{12}M \times O + a_{13}M \times A + a_{14}O \times A + a_{15}M \times OxA + \varepsilon \quad (1)$$

The variables M, O, and A measure motivation, opportunity, and ability respectively. θ_o is a dummy variable taking the value of 1 if opportunity is the constraining factor (i.e. the lowest of the three factors) and 0 otherwise. θ_A is a dummy variable to indicate that ability is the constraint. If both these variables are set to 0, then motivation is the constraint.

In Siemsen et al. (2008), the application of the MOA framework is to the phenomenon of knowledge transfer between individuals in an organisation. The framework is used to determine whether some individuals have the ability but no motivation, or others have ability and motivation but no opportunity. Here, we explore the application to sustainability goals of large organisations whose actions are embedded in their CoPs. Instead of the MOA being applied at the level of an individual person, we apply it at the level of the supply chain CoP, as evidenced by a focal firm interactions with its CoP. Whilst organisational decisions are composed of the decisions of individuals, and work such as Kaplan (2008) points to contests within organisations, the concept of a dominant logic (Bettis & Prahalad, 1995; Prahalad & Bettis, 1986) can be applied here to assume a single, coherent logic, rather than contested logics. At this inter-organisational level, we seek to explore the extent to which motivation, opportunity and ability affect action to deliver a significant cut in carbon emissions.

Motivation (M) of the participants within the CoP (the focal firm and supply chain partners) is considered in terms of the strategic rationale and collective consistency for adopting sustainability. Ability (A) is considered as the capabilities of the CoP. Opportunity (O) is considered to represent individuals, resources, and factors that are exogenous to the CoP. The cases cover CoPs that are typically representative of challenging searches for sustainability

Methodology

Taking the practice-focused, empirical research method of in-depth qualitative case research, we explore two case studies of firms seeking to deliver a maximum contribution to environmental challenges. Ketokivi and Choi (2014) discuss how case research is an essential means to conduct theory elaboration, as it can consider nascent theory in tandem with the reality of business practice.

The first case, UK Wind Power Industry, is based on applied research work done in a large European Regional Development Fund project through the Interreg IVA France (Channel) England programme. This was an 18 month project involving 12 organisational partners (Leseure, 2014). Data sources include a survey of 57 global experts, interviews, and workshops. Analysis of secondary sources including conference speeches is also incorporated.

The second case, UK-based heavy manufacturer, was part of a three year ESRC funded doctoral dissertation exploring drivers and barriers to decision making via SSCM. This included 24 interviews, plus secondary source analysis conducted across a construction industry supply chain, following a large construction products manufacturer, and the CoP across their customers and suppliers and associated organisations across the relevant sectors. All organisations included in both CoPs are searching for optimum, sustainability performance. This current paper provides conceptual development based on these past case studies to inform a next stage of data collection and analysis.

Cases Studies

1: UK Wind Power Industry

Large-scale wind power is a popular solution in many countries' attempt to improve the sustainability of their electricity supply chains. Onshore wind generation, which is the cheapest to run and maintain, has been met with much social opposition. Only 1 in 6 proposed wind farms in the UK got through the consenting stage, and as of 2016, the UK Government announced that such projects will not be considered in the future. Instead, much of the focus has turned to offshore wind farms. At the time of writing of this paper, the UK boasts the largest commercial wind farm in operations in the world, the London Array, but

also the largest total commercial installed offshore wind capacity, with more planned in order to contribute to the UK's legal requirement to decarbonise the economy by 80% on 1990 levels by 2050 (CCC, 2015).

Whether or not the investment in offshore wind is truly sustainable has been a source of ongoing debates that centre on the cost of electricity and the impact of intermittence. Historically, electricity from offshore wind has been expensive, sometimes twice more than the base market. The price difference has been absorbed through a variety of subsidising mechanisms. The cost of building offshore wind farms has increased steadily in the last decade, though is anticipated to level out and then decline (Crown-Estate, 2012).

The second controversy is that wind farms produce electricity in response to the variability of the weather, not the variability of consumer demand. When there is less wind there is less electricity produced. Large-scale hydro-electric power is used in the UK to match peak demand (early evening) but there is little potential for future expansion of this to meet the variability of output from wind farms. Instead, the use of multiple small scale fossil fuel generators in the form of 'diesel farms' or 'virtual powerplants' (where large scale electricity users are paid to 'power down' at crucial moments of supply variability) are the leading solutions for the near term future.

Existing offshore wind farms cannot be described as being built to replace fossil fuels power plants though but to operate in parallel with them. Regulations in the electricity sector giving 'grid priority' for wind mean that when output is high - when it is windy - the output of traditional fossil sources is reduced accordingly. The current practice is thus to use an expensive source of energy that reduces the utilisation of the cheap source, and therefore increases the cost of the cheap sources. Price comparisons of renewables such as wind and solar, versus coal or gas, that only compare the cost at the power plant level and do not take into account the cost profile at the level of the whole electricity system are therefore misleading.

In this case study, the CoP are organisations interacting with energy firms involved in this energy transition. It is an extremely dispersed community due to the complexity of the underlying design problem, the variety of participating organisations, but also the number of specialist disciplines that are involved. Key stakeholders are UK Central Government Ministries (currently the Department of Business, Energy and Industrial Strategy), a number of government-affiliated networks and bodies promoting and stimulating the sector (such as the Renewable Catapult), the National Grid, the energy regulator OFGEM, and large scale technology providers. These interact with a multitude of smaller stakeholders: research centres, universities, local government, and businesses, plus a range of campaigning organisations. Organisationally speaking, this community of practice is vibrant with exchange with large conferences and trade fairs (e.g. the All Energy Conference) taking place nearly every month of the year.

Considering the buzz that is readily observed in all of these events, the intensity and duration of strategic debates (Burgelman & Grove, 1996) that takes place between the stakeholders, the number of responses to public consultations, the quantity of competing bids for research funds, it is easy to conclude that the motivation of this community is high and therefore very unlikely to be the constraining factor. Ability is a different story. The amount of intellectual capital forming this community is impressive, yet its ability to transcend specialisation is a question mark. It is interesting to note that the main ability challenge is a challenge of co-ordination and integration, i.e. typical operations management challenges.

Different stakeholders are trying to direct searches in a vast number of directions. Examples of search directions cover the full electricity supply chain from generation to consumption: lowering technology costs, the development of floating wind turbines, alternatives technologies such as tidal and wave power, the development of the European

super-grid, energy storage, smart dynamic grids, and smart consumption. The ability to innovate and propose solutions in each of these directions is very high and coalitions do exist.

For example, some in the wind coalition seem to consider wave energy as an expensive and unproven concept, especially given the harsh environment of the ocean, particularly during storms. They also often view floating wind as an unlikely technology, much to the dismay of the floating wind coalition. Although there are some obvious synergies between some of these search directions (e.g. between lowering the cost of offshore wind and energy storage), the synergies can only be achieved through co-ordinated actions. For example, smart homes coupled with dynamic demand market incentives to encourage consumers to increase consumption at the right time (e.g. a washing machine offering a discount to take advantage of wind energy surplus - essentially an update of the overnight Economy 7 tariff that the UK ran in the 1980s) could reduce the problem of intermittence. Neither technology has any value if the transmission grid is not flexible enough to allow these dynamic adjustments to supply and demand. This challenge can be equated with a sales and operations planning (SOP) problem; but the current design of the UK transmission system and market mechanisms prevent any form of SOP.

Opportunity is an unusual dimension to consider in operations management research, and amounts to investigating how exogenous factors, such as consumer behaviour, and more generally society's behaviour, affect performance. This omission is counter-intuitive as processes of social acceptance shape supply chain networks, influence location decisions, and define the underlying values from which supply chain design principles are formulated. As mentioned above, 6 out of 10 onshore wind farms have historically been rejected. Even though wind farms were preferred by policy makers as they were thought to avoid social opposition, an analysis of UK planning data shows that the rate of acceptance of UK offshore wind farms is only 50%. This is surprising as opinion polls consistently suggest that up to 77% of the UK public is in favour of renewable energy. This discrepancy is well known as the social gap, and is described and analysed in detail along with its constituent NIMBY (not in my back yard) effect by Bell et al. (2005). Here, the current consenting process is described using the following sequence: experts (from the CoP) determine where a wind farm could be built; developers announce the decision to build. This typically raises concerns from local residents and developers are left to defend their decisions.

For example, Navitus Bay, a project larger than the existing London Array wind farm, was rejected for fears that its landscape impact would negatively affect the local tourism industry. There is ample academic evidence that such negative impacts have never been experienced and that wind farms can even have a positive impact on tourism. The South Coast location of Navitus Bay is important as it avoided most of the distribution constraints discussed above, given the proximity of the proposed wind farms to large industrial and residential areas. Besides impact on tourism, opposition reasons included rather extravagant claims that the wind farm would increase carbon emissions and the public concluded that the wind farm would be best located elsewhere (in regions actually subject to distribution and utilisation constraints).

UK Government policy had focused more on the issue of ability, through technology and R&D support, and encouraging the associated manufacturing industry, i.e. turbine and associated component production, than in addressing social acceptability. While such manufacturing jobs are indeed desirable for an economy, it could be argued that like other forms of local content requirements, it can increase technology cost and therefore exacerbate the issue of public resistance.

Although the UK currently hosts the largest offshore wind farm in the world, the actual installed capacity, when compared with UK demand and overall capacity, means that such assets are a local search, a mere first step, towards a genuinely sustainable energy system. At

this stage of our research, it is difficult to conclude with certainty whether ability or opportunity is the constraint to continuing and intensifying this search. The fact that the constraint cannot be identified is in fact an opportunity problem since policy makers are in the same position as manufacturing managers before the theory of constraint (Goldratt & Cox, 1984). In other words they are in a position where they have to invest to resolve a number of issues, without knowing what the real bottleneck to improvement is.

It is tempting to lean on the side of opportunity as the constraining factor. Social opposition is common across a range of large scale infrastructure projects, from airport expansion to new high speed rail lines. These are informed somewhat by the legal, socio-cultural and geographical particulars of the UK, which can be thought of as exogenous to the community of practice.

2: UK Construction products supply chain

The UK construction sector is relevant for addressing carbon emissions given the high volumes concrete and steel, and the way that buildings consume energy as result of their design. This case examines the supply chain and operational impacts by looking at the construction project for a particular new building designed to a high standard of 'eco-design'. The supply chain from the client who commissioned the building, the architects who designed it, the contractors hired to build it, a large construction materials supplier, and their suppliers, particularly from the energy sector. As with previous discussion, taking a singular focus on the carbon footprint of the building in isolation is similar to that of the carbon footprint of a firm in isolation. Instead, the footprint of the whole supply chain is explored, and in particular the relative carbon footprint of construction materials going into the building.

Construction projects involve a very large range of materials from a wide variety of suppliers, depending on the design specifications. A major manufacturer of construction products was subject to detailed investigation across a wide range of staff, plus customers and supplier meetings regarding SSCM policy and two internal working group sessions on SSCM were also attended. Having identified that the largest aspect of the manufacturer's environmental impact was that associated with their electricity supply, interviews were then conducted with their energy supplier, with triangulation and juxtaposition provided by an alternative large customer.

At the time of the data collection, a change in electricity supply contracts was underway, and a contested area for definitions of sustainability was seen in the first supplier's use of nuclear electricity as a source of low-carbon power. While this difference was accepted by the alternative large customer (a rail network company), it was not addressed by the construction products manufacturer due to regulatory and economic barriers. As such, the opportunity to establish a carbon-free manufacturing process was effectively prevented by regulatory barriers. The status of nuclear power as a source of carbon-free power has become a controversial point as a result of the wind, solar and biomass industries aligning with environmental campaign organisations that were first established as anti-nuclear organisations. The evidence base for the link between the role of nuclear power and the relative carbon performance of an economy is shown in the OECD data on relative emissions intensity (gCO₂/kWh) per country.

This exogenous regulatory and sociological context is clear from investigation into the energy sector supply chain. Whilst the supply of nuclear fuel enables the provision of large volumes of carbon-free electricity around the world, particularly in France, where the manufacturer has some operations, the contested nature of this definition of sustainability make this a highly salient issue for behavioural and rational decision making around SSCM. Institutional drivers including the coercive legislative context and normative factors around

public understanding, provide external constraints to their doing so that centre on external influence on decision making and bounded rationality.

As engineering-focussed firms operating in highly regulated industries, the established dominant logic predominantly rules-based, but they are influenced by the values of the communities where they operate. For the contractor, this includes, for instance, SSCM policies for local hiring, imposed by politicians seeking to address local unemployment, or sustainability officers engaging in local traffic issues around construction sites. For the manufacturer, it includes the challenges of competing in global markets where product specifications are tightly defined by international standards, yet labour standards (such as for health & safety in the workplace) are very different. Such difference produce cost-disadvantages. In UK construction, the sustainability element in the supply chain is more or less completely regulated via aspects of the UK building regulations and industry codes such as BREEAM and BES6001, which have been in force for more than ten years.

Directors included in the study are aware of the gap between the level at which these interventions force performance via technical specifications, and the resulting net benefit in terms of macro environmental impact. In other words of the disconnect between local searches and global searches. Many of the firms included in the CoP have made sustainability a strategic priority, so with top level buy-in and a strong internal structure of working groups seeking to drive sustainable & responsible business issues. There are also wider sector-level initiatives aimed at reducing the carbon footprint of the industry as a whole, and strong interest from customers for a wide range of sustainability indicators, including specific SSCM procurement policies. However, whilst the BREEAM code contributes to the driving of SSCM back up the supply chain from the customer end, it is a weak catalyst for addressing the carbon footprint. Large industrial firms in the study, have long been subject to carbon disclosure and management via the European Union Emissions Trading Scheme (EU-ETS) and the Carbon Emissions Management And Reduction Standard (CEMARS /ISO14065). The BES 6001 Responsible Sourcing standard and BS8903, Sustainable Procurement Standard are also used. Life-cycle analysis (LCA) and Environmental Product Declarations (EPDs) are also adopted, ahead of anticipated legislation (such as the EU Labelling of Construction Products Directive).

However, all of these are primarily taken as external auditing issues related to the metrics of supplier selection decisions rather than as a driver for local operational improvement or substantial decarbonisation of the manufacturing supply chain. Industrial facilities such as arc furnaces have a very high demand for electricity. Decentralised renewable energy systems, including onsite wind turbines, were examined but found to be inadequate in scale and prohibitive in cost. In addition, the firm had no core competency in running such systems or desire to acquire it. Reducing the size of the energy demand through efficiency measures was undertaken, and is an example of alignment between an economic gain for the firm and a sustainability gain for society. But despite incremental progress, full decarbonisation is problematic. Substituting 100% of the energy supply to a zero-carbon tariff, dubbed a green tariff from wind, solar or biomass, or a blue tariff from nuclear, encountered significant economic and legislative barriers. As local searches for optimum sustainability, such efficiency measures provide local advantages but the contribution to global solutions to date is minor.

Exogenous barriers to advancing the sustainability of the supply chain via decarbonisation therefore involve behavioural sense-making between the CoPs. Divides exist between the buyer and supplier perspectives, and supplier and rival supplier perspectives (where there is conflict over sense-giving as to what the criteria for specification of a product should be), and conflict over the internal and external application of specifications such as LCA. While conducting an LCA as an external auditing exercise serves as a snapshot, like an annual

report responding to an external demand, it does not (yet) act as a driver for significant reduction of the environmental footprint. In addition to these drivers, the manufacturer has an internal goal for cutting carbon, which is aligned with the economic benefit of cost-cutting. However, going beyond these eco-efficiency projects as a means to reduce energy demand, the substitution of energy supply to carbon-free sources is prevented by a high degree of complexity in the regulatory context, which is an instance of bounded rationality as well as providing economic disincentives. Initiatives such as Renewables Obligation Certificates required to verify an electricity supply as carbon-free either cannot be used as they have already been sold by the generator via off-set schemes (OFGEM, 2015), or are subject to higher costs due to exceptions to nominal carbon taxes granted by the Government to assist the competitiveness of the manufacturing base (such policies are also present in, for instance, Germany). The legislative structures around energy generation in the UK are thus central to how firms can account for their energy consumption in carbon or carbon-free terms.

In addition, international competitors are one of the most powerful external influences. The competitive advantage these competitors have, based on their lower price, is fundamentally shaped by the actions of government as a stakeholder. Government influences the firm, and the whole sector, via the differences in cost base imposed by Western standards of business. These are absent in emerging economies, particularly in heavy manufacturing such as, say, steel, where lower labour costs and lower environmental and health & safety standards, along with different currency valuations, have an enormous impact on relative competitiveness. This macro-economic context is thus highly influential on SSCM and its related decision making. The competitive pressure is also exacerbated by the UK government forcing key customers of the manufacturer, such as water utilities, to deliver a reduction in bills to consumers. This is due to political reasons as domestic water bills were argued to be too high. The impact is then that the utilities are forced to bid for work with cost as the pre-eminent criteria in supplier selection. While environmental and social performance criteria may be included in supplier selection processes, they are never weighted more highly than price. Even technical performance, longevity of product, post-sales service levels or other additional criteria cannot outweigh cost.

A further instance is the difference in energy policies in different countries, and the relative difference this has on the concentrations of CO₂ associated with manufacturing. As the operations and supply chain director describes,

"At the moment, our electricity usage in all our carbon footprint is based on UK government average, which is based on the current mix of renewable versus all the other forms of generation. If you compare that with France, which we can readily do because we've got open access to the information there - which have a lot less. Why? Because they've got a far greater proportion in nuclear generation in France than we have in the UK. So, their electricity generation from a carbon footprint point of view is a lot more favourable. So maybe in 15 years time when there's two more nuclear power stations on stream, and more wind turbines dotted around the place, it will improve a little bit. "

The emergent concept of stakeholders is thus complemented by the relative carbon intensity of different countries national grids. The exogenous factor for achieving a more sustainable supply chain for manufacturing is thus the nature of the electricity grid, with France and the UK providing clear contrasts. If carbon were to be weighted more highly than cost in supplier selection decisions then it follows that French manufacturing would become more competitive than UK manufacturing, assuming all other things being equal.

In summary, the motivation of parties in the CoP is strong with many having made sustainability an explicit strategic priority for their business.. Ultimately, opportunity is

revealed as the primary constraint as it is external factors to the CoP that have the biggest effect, largely the nature of the regulatory and macro-economic context, with some influence from social acceptability (such as around the tangential issue of the cost of water supply).

Discussion and conclusions:

Our case studies confirm that the CFM version of the MOA model provides a useful analytical lens through which a supply chain, conceptualised as a CoP seeking more sustainable approaches, is constrained in its search for macro-scale sustainability. We show that opportunity, i.e. factors exogenous to the CoP, can often be the constraining factor. This conclusion is consistent with that of Shevchenko et al. (2016) that "*external stakeholders have yet to create the conditions that would compel firms to become truly sustainable*" (p. 911). However, Shevchenko et al. (2016) focus on analysing a firm's behaviour and develop a mathematical model explaining why some firms would delay their investments for becoming truly sustainable (an M-constraint). This is consistent with various studies that address the resistance of firms to adopting sustainability as a strategic priority (e.g. Bowen (2014). Shevchenko et al. (2016) explain this delay by the fact that external pressures from stakeholders (Freeman, 1984; Freeman et al., 2010) are not enough to replace current offsetting practices by efforts to design new and truly sustainable solutions. Our framework instead consider less calculative firms that are genuinely seeking sustainability but face constraints, i.e. our focal firms are *being delayed* rather *delaying investment*.

There are two specific contribution of the SCFM model:

1. To define the constraints that can delay macro-scale sustainability as potentially being any of the three factors (M, O, and A) and to conceptualise these constraints as dynamic variables, potential changing as the search for sustainability progresses.
2. To reconceptualise the ownership of supply chain design decisions. Whereas a management science and operations management approach would ask the question: "what is the best possible (optimal) sustainable supply chain design?", our framework asks the question: which coalitions are in a position to shape supply chain design and how good are their searches for true (macro-scale) sustainability? This shifts the question of supply chain design from a micro-scale (firm-level) to a macro-level of analysis (the CoP and its exogenous coalitions). Similarly with Shevchenko et al. (2016), this also stresses the need for managing stakeholder's expectations. However, we argue that this goes beyond a corporate stakeholder management issue and also involves CoP governance/co-ordination.

While the current paper primarily seeks to make a contribution in the form of a conceptual framework, the empirical foundations and theorising remain in development and will be enhanced further via additional future research.

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