



# Systemic Lean Intervention: Enhancing Lean with Community Operational Research



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## ABSTRACT

This paper explores how theory and methodology from Community Operational Research (Community OR) can enhance Lean initiatives. We are driven by the paucity of the literature discussing the involvement of non-obvious stakeholders, particularly local communities, in the adoption of Lean. We present a project undertaken with a food production company in the Niger Delta Region of Nigeria, where we employed a Systemic Intervention methodology to integrate theory and methods from Community OR with those from Lean. Based on this example, we argue that the inclusion of community representatives is necessary if Lean waste-reduction initiatives are to benefit both organizations and their local communities. Our only proviso is that, in the spirit of Community OR, the involvement of community representatives must be *meaningful*, so change is agreed through stakeholder engagements that respect their inputs and framings, and do not result in organizations imposing unwanted 'solutions' on communities. The paper ends with some reflections on the added value that Community OR can offer Lean practitioners.

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## 1. Introduction

Over recent decades, there has been a proliferation of approaches, both in the private and public sectors, aiming to address operational challenges and generate efficiencies through waste reduction, while creating value for customers. Amongst these, Lean thinking (hereafter shortened to 'Lean') has gained particular popularity (Womack, Jones, & Roos, 1990; Hines, Holweg, & Rich, 2004; Bhasin & Burcher, 2006; Jasti & Kodali, 2016). A common factor attributed to Lean approaches is the identification and reduction of waste, and the enhancement of operational processes, while aiming for value development (Womack et al., 1990; Womack & Jones, 2003; Jorgensen & Emmitt, 2008; Liker & Hoseus, 2008; Magenheimer, Reinhart, & Schutte, 2014). Waste is defined as non-value-adding activities in an operational process; that is, any obstacle that prevents, or introduces inefficiencies into, the unremitting flow of work processes (Liker, 2004). Non-value adding activities include 'solid' waste (e.g. unwanted inventory, materials that are discarded after manufacturing, waste resulting

from errors) and 'intangible' forms of waste (e.g. unnecessary transportation, motion inefficiencies in production and avoidable waiting time) (Metin, Erozturk, & Neyim, 2003; Pederson & Hurniche, 2011). Gustavsson, Cederberg, Sonesson, van Otterdijk, and Meybeck (2011), focusing on the food industry, classify waste depending on the point at which it is generated in the supply chain: harvesting, post-harvesting, cleaning, primary processing, transportation, distribution, storage, retail and in the homes of consumers. We would add that there are also plenty of opportunities for pre-harvest waste reduction, which was a major focus of the intervention reported in this paper.

Matete and Trois (2008) argue that *stakeholder participation* is essential to the success of Lean, and indeed they widen their boundaries beyond single organizations to talk about networks of businesses interacting in an 'industrial ecosystem' (also see Pauli, 1997; Metin et al., 2003; Kang & Schoenung, 2005; Zaman & Lehmann, 2011; Marques, Da Cruz, Simoes, Ferreira, Perriera, & De Jaeger, 2014; Zaman, 2014, 2015; Greedy, 2016). However, so far, the literature has not discussed the benefits to Lean practice from going beyond just the involvement of 'traditional' organizational stakeholders to include local communities. The traditional stakeholders of Lean initiatives include employees, customers, suppliers, external refuse management agencies (Garrido & Pasquire, 2011)

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and, in the case of the industrial ecosystem approach mentioned above, business partners. These are the stakeholders who are most 'obviously' involved in the co-production of value and waste elimination, whether this co-production is conceived as happening in 'value chains' or 'value ecosystems'. We suggest that it is actually possible to go beyond these obvious stakeholders: a wider set of community representatives can be swept into the process, with the aim of achieving an environment that is, as far as possible, waste-free – for the benefit of business organizations and their local communities.

Indeed, we argue that neglecting the involvement of local communities could limit Lean practice. This is because industries may miss new opportunities for waste reduction and value creation: local communities may bring fresh perspectives into industrial organizations and identify issues and resources that otherwise would not have been seen from a managerial perspective.

In developing countries, such as Nigeria (where our intervention was based), it has been argued that community engagement is especially important (Ibeanu, 2000; Ikelegbe, 2005a, 2005b). Ibeanu (2000) describes how multinational oil companies have neglected community engagement in Nigeria, causing hardship in the lives of people in their host communities, and this has provoked retaliatory violence and other criminal actions. This, in turn, has adversely affected the operation of the companies. Therefore, there is a clear win-win case for industrial organizations to work with local communities, so the companies can realize their goals of extracting crude oil while using Lean to reduce their waste and improve their performance (Uzochukwu & Ossai, 2016). At the same time, the local community can have their concerns about ecological damage and the destruction of non-oil-based livelihoods addressed by the companies (Ibeanu, 2000). This is where we claim that Community Operational Research ('Community OR' for short) (e.g. Jackson, 1987; Parry & Mingers, 1991; Ritchie, Taket, & Bryant, 1994; Midgley & Ochoa-Arias, 2004a; Johnson, 2012; Johnson, Midgley, & Chichirau, 2018; Midgley, Johnson, & Chichirau, 2018) can add value to Lean by providing theory and methodology for meaningful community engagement. Indeed, Community OR was born out of the desire to extend the set of 'customers' or beneficiaries of operational research beyond traditional types of private and public sector organizations (Rosenhead, 1986; Mar Molinero, 1992; Ritchie & Taket, 1994; Midgley & Ochoa-Arias, 2004b), so it is arguably a good fit for adding value to Lean, which is similarly focused more narrowly than we would like.

This paper supports our claim about the potential role for Community OR with the example of a project achieving process improvements through Lean applied to the food production industry in the Niger Delta Region of Nigeria. This project was conducted with a food production company and its local community. We developed and applied an approach called Systemic Lean Intervention (SLI) to structure, identify and address issues of waste and the development of value from both organizational stakeholders' and community perspectives. SLI integrates theory and methodology drawn from both Lean and Community OR approaches. Following Keys and Midgley (2002) and Ormerod (2014), who ask for rich descriptions of OR projects so the decision making of practitioners can be understood and lessons learned, we provide an account of the use of our SLI, explaining the methods, why they were chosen, and how they were implemented in practice. We also reflect on the added value of Community OR theory and methodology.

The structure of the paper is as follows. The next section discusses the concept of Lean in more detail, and how it can be enhanced by Community OR. Section 3 then outlines SLI. Sections 4 and 5 provide details of our application with the food production company and its local community in Nigeria. Finally, Section 6 concludes the paper with some reflections on the value that Commu-

nity OR can add to Lean practice more generally, beyond our own application.

## 2. Lean

Lean has gained popularity in both private sector manufacturing (Womack et al., 1990; Hines et al., 2004) and the public sector (especially healthcare) (Radnor, Walley, Stephens, & Bucci, 2006; Seddon, 2008; Papadopoulos, Radnor, & Merali, 2011; Radnor, Holweg, & Waring, 2012), although it is arguably under-used in food supply chains (Folinas, Aidonis, Triantafyllou, & Malindretos, 2013; Vlachos, 2015). It is a management philosophy that focuses on reconfiguring organizational processes to continually reduce and eliminate waste over time, thereby contributing to efficiency and value creation for the customer. To this end, Lean applies specialist analytical tools and techniques (Womack & Jones, 1996).

Usually Lean is understood in terms of five 'principles' (Womack & Jones, 1996; Radnor et al., 2012):

- 1 Specify 'value' from the standpoint of the customer. Value is linked to the identification of customer requirements and is not always related to the mere eradication of waste.
- 2 Identify the 'value stream' for each product/service. The value stream stretches from raw materials to customer needs. Challenge all the steps in the value stream that do not provide value but generate waste.
- 3 Make the value stream flow continuously. Eradicate waste and standardize processes, allowing them to run more smoothly.
- 4 When the continuous flow of the value stream is impossible, let the customer 'pull' (i.e., let their needs and desires drive production). This implies production upon customer demand, starting with the customer him or herself, and looking backwards through the value chain to see what has to be done to meet that demand.
- 5 Pursue continuous improvement of the value chain; that is, non-value adding activity should be removed from the value chain and the number of steps, amount of time and information needed to serve each customer should always be reducing.

Engaging with these principles allows organizations to "add value, reduce waste and continuously improve ("kaizen") in an ever-repeating process" (Radnor et al., 2012: p.365).

However, there is a paucity of empirical research in the application of Lean in food industries (Folinas et al., 2013; Vlachos, 2015), and in particular in developing countries, where scholars acknowledge that Lean initiatives face real challenges. Vlachos (2015) has highlighted the role of stakeholder participation and expertise related to the successful adoption of Lean in food supply chains, using a case study within a UK-based SME. In developing countries, and Nigeria in particular, Agunwamba (1998) attributes difficulties of implementation to a variety of issues, including unpredictable power supply outages (which can result in increased waste) and the unwillingness of many investors and credit agencies to finance waste reduction and management (also see Aibinu & Jagboro, 2002). Ekanayake and Ofori (2004) observe that levels of waste continue to rise due to a number of factors, including a rapidly growing population and the inadequacy of Government enforcement of waste reduction regulations. Indeed, the Nigerian Government has relied significantly on voluntary compliance (Linder, 1999; Sharma & Henriques, 2005; Ogbonna, Amngabara, & Ekere, 2007). There are clearly complexities in developing countries that Lean practitioners in the developed world do not have to contend with.

This is not to say that Lean practice in the developed world is free of complexity. Some writers on Lean have been criticized for describing it as a simple, linear process, where waste is identified and then eliminated, as if what constitutes waste is never

contested and reduction is straight forward (Towill & Christopher, 2002; Bhasin & Burcher, 2006; Seddon, 2008; Arlbjorn, Freytag, & Haas, 2011; Bhasin, 2011). To some extent, those seeking to reduce waste in the context of an industrial ecosystem rather than a single organization (e.g., Pauli, 1997) avoid these criticisms, as ecosystems are inherently non-linear, with organizations being viewed as having complex interdependencies. Indeed, Matete and Trois (2008) argue that the participation of relevant stakeholders is essential to success in this context. Likewise, Papadopoulos et al. (2011) emphasize the importance of stakeholders, especially those who understand how the deployment of different technologies can support waste reduction.

There are systems thinkers working at the scale of industrial ecosystems who view waste reduction in the context of moving towards a 'circular economy', where the goal is environmental sustainability and not just waste reduction for business success (e.g. Greyson, 2007; Webster, 2013; Gorissen, Vrancken, & Manshoven, 2016). This involves keeping resources in use for as long as possible, prioritising repair and reuse over recycling, and only breaking products down into recyclable parts when reuse is no longer possible. To build a sufficiently systemic understanding of circularity, harnessing both ecological and business perspectives, stakeholder engagement is essential (Gorissen et al., 2016). Turning to Lean at the scale of single organizations, we also find some explicitly systemic approaches (e.g., Ohno, 1978; Gregory, 2007; Seddon & Caulklin, 2007; Seddon, 2008; Dominici & Palumbo, 2013), and these emphasize that Lean involves the construction of operational systems, not simple linear chains of operations (Liker, 1997). They mostly acknowledge the need for stakeholder involvement too.

Nevertheless, the vast majority of the literature on Lean still focuses on a fairly narrow range of stakeholders, usually involving suppliers, employees, customers and partner organizations (Garrido & Pasquire, 2011), but leaving out other affected (or potentially affected) stakeholders who are not directly involved in the operational process (White, Pearson, & Wilson, 1999; Galloway, Rowbotham, & Azhashemi, 2000; Spithoven, 2001; Taylor & Taylor, 2009). As discussed earlier, neglected but affected stakeholders may protest and even commit crimes that can hurt businesses (Ikelegbe, 2005a). It is important for Lean practitioners to look at the wider impacts of an organization or an industrial ecosystem (Oluwaniyi, 2010).

Key stakeholders who can be affected but are not usually involved are local communities, and indeed we argue that their involvement can render new value creation opportunities visible while reducing waste. In some situations, the participation of non-traditional stakeholders can actually make the difference between the survival or demise of an organization (Daellenbach, 1994). Working with local communities is therefore important, and it is particularly useful to study the actual and potential connections between communities and the organizations embedded in and serving them. In order to address this gap in Lean practice, we introduce Community OR.

### 2.1. Lean from a Community OR perspective

We argue that the challenges of community engagement, when practicing Lean, can be overcome through the use of a Community OR approach, integrated with Lean principles and methods. While there are a number of different theoretical and methodological traditions within Community OR (see Ritchie et al., 1994, Midgley & Ochoa-Arias, 2004a, and Johnson, 2012, for some of the variety), the one that was of most relevance to our project in Nigeria, because of its strengths in conceptualizing stakeholder participation and dealing with high levels of complexity and multiple perspectives in the context of practice, was the use of sys-

tems approaches for community development (e.g., Ackoff, 1970; Jackson, 1987, 1988, 1991; Keys, 1987; Midgley, 2000, 2016a, 2016b; Gregory & Jackson, 1992a, 1992b; Gregory & Midgley, 2000; Midgley, Munlo, & Brown, 1998; Ochoa-Arias, 2004; White, 2003; Boyd, Brown, & Midgley, 2004; Midgley & Ochoa-Arias, 2004b; Waltner-Toews, Kay, Murray, & Neudoerffer, 2004; Walsh & Hostick, 2005; Midgley et al. (2007); Sommer & Mabin, 2016; Helfgott, 2018; Midgley et al., 2018).

There are, of course, multiple systems theories, methodologies and methods (see Midgley, 2003, for one of the largest selections from the variety of systems perspectives). 'Critical' and 'soft' systems approaches to Community OR were viewed by us as the most useful because, respectively, they place particular emphasis on questioning the boundaries of both the issues in focus and who should participate in developing improvements (e.g., going beyond conventional views of who is a stakeholder of a Lean initiative and the values that should be taken into account) and they focus attention on the inclusion of multiple perspectives (e.g., from management, shop-floor workers, regulatory agencies and host communities). Cabrera, Colosi, and Lobdell (2008), Cabrera, Cabrera, and Powers (2015) and Cabrera and Cabrera (2015) discuss the role of the concepts of boundaries and perspectives in systems thinking.

Within the literature on systems approaches for Community OR (Midgley, Munlo & Brown 1998; Midgley, 2000, 2016b; Boyd et al., 2004; Córdoba & Midgley, 2003, 2006; Foote, Gregor, Hepi, Baker, Houston, & Midgley, 2007; Midgley et al., 2007; Midgley & Pinzón, 2013; Helfgott, 2018), and also independently of it (Churchman, 1970; Ulrich, 1983; Midgley, 1992a, 1994; Yolles, 2001; Midgley & Pinzón, 2011), there is a systems theory and methodology called 'boundary critique', which emphasizes the exploration of boundary distinctions. It particularly focuses on boundaries defining participation in Community OR projects and what is of value from the different perspectives of stakeholders. It was this work that most influenced the development of SLI and our practice in Nigeria. The above authors ask OR practitioners not to take the boundaries of stakeholder engagement for granted, but to explore different possible boundaries as part of any project. Many also advocate *methodological pluralism* (e.g. Jackson, 1988, 1991; Midgley, 1992b, 2000), which is sometimes called 'multimethodology' in the OR literature (Mingers & Gill, 1997): drawing upon methods from different traditions to create new, synergistic approaches that are more than the sum of their contributory parts (Midgley, 1997a; Sommer & Mabin, 2016).

Community operational researchers working with the above ideas start with the assumption that "everything in the world is directly or indirectly connected with everything else" (Midgley, 2008, p.55; Midgley, 2011, p.8). We cannot have a comprehensive view of this interconnectedness, so setting boundaries (either implicitly or explicitly) is inevitable. However, while full comprehensiveness is impossible, we can gain greater comprehensiveness by exploring multiple possibilities for setting boundaries, considered from different perspectives, rather than taking one boundary or perspective for granted (Ulrich, 1983; Midgley, 2000). We also need to acknowledge that boundary and value judgments are linked, and values (what is important to stakeholders, associated with their purposes) strongly influence the drawing of boundaries (Churchman, 1970; Ulrich, 1983). Thus, exploring boundaries also implies exploring different possible values that may be relevant. This way of thinking can help practitioners look beyond the relatively narrow goals of 'traditional' Lean, focused solely on efficiency or productivity, and can bring into focus the wider environment and stakeholders, such as local communities and regulators, who are not directly involved with existing operational processes.

We need to emphasize that Community OR writers talk about the meaningful engagement of community groups (e.g., Midgley et al., 2018), arguing that it is important for community stakehold-



ers to have a say in the ends being pursued as well as the means of achieving these ends:

“The critical characteristic we identify as being necessary for a project to be described as Community OR is the *meaningful engagement of a community* (or communities). Now, let us first of all make clear that this does not presuppose a particular theory of community or methodology of engagement; there are numerous theories that can help us make sense of what a community is (Midgley & Ochoa-Arias, 1999) and there are even more methodologies that offer principles and methods for structuring engagement (Jackson, 1988, 1991; Midgley, 2000). However, it *does* presuppose that, for every project that someone claims is an example of Community OR, it should be possible to explain what constitutes ‘the community’. This might be residents in a geographical locale, the members of a self-help group, a sub-category of the population with particular needs or desires, an under-served or marginalized section of the population, an interest group, or even a geographically dispersed set of people interacting online. It should also be possible to say what makes the engagement meaningful rather than tokenistic or absent” (Midgley et al., 2018, pp. in press).

Community OR practitioners are strongly mindful of the need to prevent businesses and statutory agencies co-opting or manipulating voluntary organizations, community groups, marginalized stakeholders and/or vulnerable people solely for their own ends (e.g., Midgley & Milne, 1995; Ochoa-Arias, 2004). Co-option is when a community group, originally established for its own purposes, is coerced or incentivized against the will of its members to work for another organization, so its original purposes end up being distorted, marginalized or ignored (see Ochoa-Arias, 2004, for an example). Manipulation is when a statutory or business organization tells people that it is open to listening to community perspectives, but then it pursues the engagement in a way that only allows space for its own agenda and framing (Arnstein, 1969). In more sophisticated forms of manipulation, local people may be placated with ‘pseudo-dialogue’ (insincere communication), so they think they have been heard, but they later find out that the organization engaging with them was only interested in satisfying its own narrowly conceived ends. In contrast, *meaningful* community engagement involves enabling people from local communities to have a substantial input into framing both the issues to be discussed and potential actions to address them.

It is important to be clear that meaningful engagement does not mean that the OR project has to be wholly owned and controlled by the community. The issues being tackled may first be raised as a concern by the community itself or by a private or public sector organization wanting that community’s involvement (in our work in Nigeria, it was the food production company that triggered engagement via our project). Midgley et al. (2018) expand on what ‘meaningful’ means as follows:

“The more interesting question is whether any particular form of engagement can be justified as *meaningful*, and answering this usually requires a judgment in context. Whether a particular form of engagement is meaningful or not might depend on the expectations of citizens in the community, whether their representatives have the respect of the wider community and the authority to speak on their behalf, whether the agenda is set by an organization but can be influenced by community representatives, whether there is actually a need for the community to set the agenda that organizations then respond to, etc.” (pp. in press)

However, none of this implies that meaningful engagement is only about what the OR practitioner does. The engagement has to be meaningful in the context of the project, and in many situa-

tions this means client organizations and/or other stakeholders being open to engagement too. A role of the practitioner is therefore to facilitate and support this openness, addressing any constraints that clients or stakeholders might want to impose on community engagement in ways that, as far as possible, preserve its meaningfulness (see Midgley et al., 1998, and Foote et al., 2007, for examples of dealing with constraints). Certainly, the OR practitioner needs to think about his or her own meaningful engagement with communities, but also the ethics of the engagements of other parties and whether beneficial outcomes, seen from the perspectives of community members, might still be possible given the boundaries around engagement that are being set.

Given that trust is built by listening to the framings used in a local community, this has implications for how the term ‘waste’ is used in a community-engaged Lean initiative. Community representatives are likely to view waste in terms of what is thrown away (i.e., what often ends up in landfill). As discussed earlier, writers on Lean use quite technical definitions of waste that are more inclusive. It is unlikely that community members will be interested, for example, in a company’s time and motion cost savings, unless these might result in redundancies of local people. However, they may well be interested in what happens to emissions and solid forms of waste that end up in the environment that is shared by the company and community, and here technical and lay understandings of waste converge (see later in the paper for a specific example). It is important for a Lean initiative to start by listening to what community members perceive as relevant waste, and other forms of waste can be discussed subsequently, with the company exploring if they are of interest to the local community.

One final comment is worth making. In the context of integrating ideas from Lean and Community OR, it is useful to note the difference between the terms ‘value’ and ‘values’. The word ‘value’ (widely used in business, including within Lean approaches) and the term ‘values’ (as used in Community OR to indicate what matters to an individual, group or organization) have the same Latin origin. Lean talks in terms of ‘value creation’ (e.g., Womack et al., 1990; Womack & Jones, 2003; Jorgensen & Emmitt, 2008; Lindhult, Hazy, Midgley, & Chirumalla, 2015), which in business usually means the development of products and/or services that consumers or organizations are willing to pay for. We believe that this is a necessary, but not sufficient, focus in the context of Lean. To confine community engagement only to the discussion of values that are directly connected to revenue generation is overly restrictive, for several reasons. First, not all opportunities to reuse waste with the engagement of communities will be revenue generating, yet they may be socially or environmentally beneficial for all concerned, and cost-neutral or low cost for the business organizations involved. Second, if business organizations are only willing to discuss value creation that involves revenue generation, then this leaves out the potential for voluntary activity to generate value. Third, not all opportunities for innovation are obvious at first sight, and the exploration of a wide range of values can support people in generating new ideas that may be income generating in the longer term. Fourth, a restrictive view of ‘value creation’ could undermine trust if local communities interpret this as organizations imposing their own values instead of starting by listening to what matters to community members themselves. The latter is quite likely in countries like Nigeria, where some communities have had strongly negative experiences of large companies imposing their will and riding roughshod over what local people want (Ibeanu, 2000).

### 3. Systemic Lean Intervention

We argue for the combination of Lean and Community OR principles, theory and methodology to form Systemic Lean Intervention

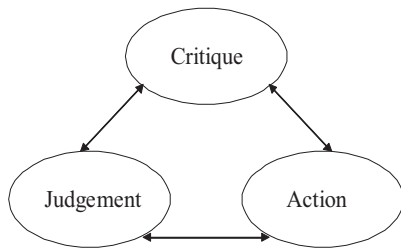


Fig. 1. Systemic intervention framework (from Midgley, 2000, p.132).

(SLI). While Lean tools can potentially help in identifying and reducing waste in an operational system, the SLI combination of Lean and Community OR pushes out the boundaries to involve affected stakeholders, and encourages learning through dialogue about different people's values, including their own. See Kurdve, Shahbazi, Wendin, Bengtsson, and Wiktorsson (2015) for further thoughts on learning in the context of Lean.

SLI is a development of Midgley's (2000, 2006, 2015) Systemic Intervention approach, which has evolved through a 30-year research programme and incorporates both boundary critique and methodological pluralism (discussed earlier). For our project in Nigeria, we used the framework of Systemic Intervention (see below), and imported methods from various sources to use from the logical perspective of this framework.

The Systemic Intervention framework (Fig. 1) is, in essence, very simple, although a lot of philosophy, theory and methodology lies behind it, which has been discussed in detail elsewhere (Midgley, 2000). There are three elements, which come into play iteratively as needed during an intervention:

- 1 *Critique*. This means critique of boundaries and values, as discussed earlier. An initial boundary critique is always necessary to explore the problematic situation (what issues, and aspects of these issues, are relevant); who could be considered a stakeholder (i.e., who is involved and affected); and what are the relationships between stakeholders. A particularly important focus is power relations, and especially processes of conflict and marginalization, which in many complex situations can become entrenched (Midgley, 1992a, 1994, 2000, 2016a, 2016b; Midgley et al., 1998; Yolles, 2001; Córdoba & Midgley, 2003, 2006; Foote et al., 2007; Midgley & Pinzón, 2011, 2013). When dealing with multi-stakeholder problematic issues, the initial assumption always has to be that there might be complexities and power relations which need to be investigated so they can be taken into account in designing an intervention; if none of these exist, then intervention may be relatively straight forward, but this should never be assumed in advance, even if the people commissioning a project assure the practitioner that there are no such issues – they may simply be blind to them, and this blindness may be part of the context that the practitioner needs to address. For example, in our work in Nigeria, we already knew about a number of complexities that have been discussed before in the literature, such as inadequate road networks, power cuts, a high crime rate, poorly organized markets, corruption and security concerns (Okoroafo & Kotabe, 1993; Ibeh, 2004; Okafor, 2007, 2008; Okonjo-Iweala & Osafo-Kwaako, 2007); and, as we explored the local context, we also became aware of the likely relevance of additional factors, such as local tribal differences, multiple languages, and an endemic lack of trust among partner organizations stemming from the complexities and uncertainties created by all of the above. We argue that some element of boundary critique is always needed up-front to prevent the Lean practitioner from assuming that the first 'story' they hear (usually from an agency paying for the project, so possibly with vested interests) is all they need to know. Also, as a

project develops, new issues may surface that had not previously been considered, so the boundary critique has to be revisited (Córdoba & Midgley, 2006). In our project in Nigeria, it was early on during the process of boundary critique that problematic interactions between the company and the local community were mentioned and, instead of dismissing this as an irrelevance, we followed up on it.

- 2 *Judgment* concerning the creative design of methods to address the issues as diagnosed through the boundary critique (Midgley, 1990, 1997a, 1997b, 2000). It is important to differentiate between 'methodology' and 'methods' (Checkland, 1981; Jackson, 2000; Midgley, 2000): methodology refers to the theory that justifies the use of particular methods, and a method is a set of techniques operated in a sequence to achieve a given purpose. In the case of SLI, we drew together methodological thinking from Lean and Community OR, including the idea of methodological pluralism (e.g. Jackson, 1988, 1991; Mingers & Gill, 1997; Midgley, 2000), which encourages the use of methods from a wide variety of sources (e.g. the systems/OR literature, the natural and social sciences, and any other relevant form of practice). It might at first appear strange that a systems approach would accept the use of methods that come from more 'reductionist' scientific research traditions, which many systems thinkers have criticized (see von Bertalanffy, 1956, and Boulding, 1956, for early papers contrasting reductionist and systems science). However, it is important to be aware that 'being systemic' is about *how the researcher thinks* (Checkland, 1981) and *the way the design of an intervention is approached* (Midgley, 2000). Within the context of a systemic design, 'reductionist' and other methods that are not explicitly systemic can have appropriate uses. Sometimes methods may not currently exist to do the job required, in which case new ones can be developed (see Boyd et al., 2004, for an example). Also, as the participants' understandings of the problematic situation grow, and new issues come to the surface, different methods may become relevant, so the project can evolve. This is an idea that is discussed extensively in the action research literature (e.g., McNiff, 1988; Greenwood & Levin, 1998; Stringer, 1999; Reason & Bradbury, 2001; Bradbury, 2015), and is just as relevant to SLI practice. The overarching principle here is that the bigger the tool kit available to the practitioner, the more flexible and responsive his or her practice can be (Flood & Jackson, 1991), so we have a responsibility to enlarge our repertoire of methods over the years in response to new issues that present themselves for intervention (Midgley, 2000). In our project in Nigeria, we used a mix of methods from the traditions of Lean, qualitative social science and systems thinking (see the next section).
- 3 *Action*. The purpose of all of this is to support the participants to develop and implement recommendations for action (social and organizational change). In the context of our project in Nigeria, many of these were actions that would benefit both the food production company we were working with and their local host community.

SLI advocates for the collaborative development of improvement ideas with the affected or potentially affected stakeholders in the research process (also see Midgley, 2000; Papadopoulos et al., 2011; Ufua, 2015; Ufua, Papadopoulos, & Midgley, 2015), except in a minority of cases where coercion of some stakeholders by others prevents this. When dealing with coercion, other approaches become more useful, either as a substitute for participatory practice or to remove the coercion and make participation possible (Midgley, 1997c). SLI is also based on the work of authors who recognize that adopting a systems approach not only enables the acknowledgment and integration of participants'

purposes and values in the intervention, but also the *systemic development* of these; learning about them through engagement with modeling techniques in the context of stakeholder dialogue (e.g. Midgley, 1997b, 2000, 2011; Jackson, 2000, 2003; Midgley & Ochoa-Arias, 2004b; Córdoba & Midgley, 2006; Franco, 2006; Cronin, Midgley, & Skuba Jackson, 2014). In our project in Nigeria, these modeling techniques were qualitative, but it would be perfectly possible to use quantitative methods too if they are appropriate in context.

### 3.1. Methods

Our methods included semi-structured interviews and participant observations from the social sciences (e.g., Ritchie, Lewis, McNaughton Nicholls, & Ormston, 2014); Lean system workshops (Grove, Meredith, Macintyre, Angelis, & Neailey, 2010; Garcia, Younie, & Fornos, 2012); rich pictures, CATWOE and conceptual modeling from Soft Systems Methodology (Checkland, 1981; Wilson, 1984; Checkland & Scholes, 1990; Checkland & Poulter, 2006); and boundary diagramming from boundary critique (Midgley & Pinzón, 2011). These are discussed below.

*Semi-Structured Interviews.* Personal interviews with stakeholders were conducted at the beginning of our project as a key element of the boundary critique, to enable us to explore the issues that were of relevance to both internal stakeholders in the food production business and external ones in the supply chain, local community, government agencies, etc. This enabled some early boundary exploration. Interviewees were selected through a process recommended by Midgley and Milne (1995) for Community OR projects: an initial sample of the more 'obvious' stakeholders within the food production company (e.g., the General Manager, Assistant General Manager, several Middle Managers and a selection of front line workers in various roles) were contacted, and these people were then asked about other organizations, communities, groups and individuals they interacted with. Interviewing stopped when the same organizations were repeatedly mentioned. In addition, following Dick (1999), we specifically asked each interviewee if there was anyone who would have a different perspective on the issues he or she had discussed, and we sought them out. This is because it should never be assumed without investigation that reaching all categories of stakeholder means that all relevant perspectives have been uncovered; unless explicitly prompted to consider different perspectives, there is a tendency for interviewees to recommend other stakeholders who think like themselves. Across the whole project, 65 interviewees were involved (see Ufua, 2015, for more details of who was selected and how). Open ended trigger questions were used to keep the interviews on track while giving the respondents the opportunity to discuss matters in their own terms (Hiller & Diluzio, 2004; Gillham, 2005), and the interviews were digitally recorded. The data were then transcribed and subjected to a thematic analysis (Miles & Huberman, 1994), with quotations being coded to reflect the various waste management and other issues discussed in the interviews.

*Rich Picturing,* from Soft Systems Methodology (SSM) (Checkland & Poulter, 2006). Rich pictures are large visual representations of the problematic situation, with drawings, arrows and other symbols to portray the complexity involved (Checkland, 1981; Checkland & Scholes, 1990; Checkland & Poulter, 2006; Bell & Morse, 2013). We identified a number of themes concerning waste (and connected issues), and drew illustrations of them, adding in embellishments to show how issues were seen from different perspectives and were connected into a larger scale 'mess' (to use a term from Ackoff, 1981). We stopped short of showing issues concerning the marginalization of shop floor workers (employees complained that they were rarely listened to, even when they had good ideas to contribute, and management was largely

autocratic), as we wanted to share the picture with mixed groups of stakeholders in workshops (see later) to incorporate feedback and inform people about the 'bigger picture' they were attempting to deal with. We suspected that highlighting the marginalization of shop floor workers at an early stage in the intervention, before trust in our team had been fully won, might result in the managers closing down the project. Nevertheless, ethically, we did not want to ignore this issue: instead, we addressed it "obliquely" (Flood & Romm, 1995) by introducing it later using methods and a framing that we believed would allow the managers to hear the workers' concerns. We dealt with it towards the end of our project in a Lean system workshop, which involved discussing the value of employee participation. Also see Foote et al. (2007) for another example of a Community OR project where it was necessary to find the right framing to allow 'gatekeeper' stakeholders to open themselves to unwelcome news.

*Boundary Diagramming.* After the boundary critique interviews had been conducted and we had done a first draft rich picture, we did some boundary diagramming: see Midgley and Pinzón (2011) for the techniques we used to visually represent conflicts and processes of marginalization. Only our own team engaged in this, without the participation of stakeholders, to preserve the confidentiality of what had been disclosed about power relationships. For each issue represented in the rich picture, we asked what purposes and values were being pursued by different stakeholders, what was included within their different boundaries of concern, whether common concerns were framed differently because of these boundaries, and whether there was conflict or marginalization going on (e.g. the marginalization of shop floor workers by the management came in here, as did a conflict between the food production company and its host community). At this point we also considered, in an exploratory manner (considering several possible boundaries in relation to the rich picture), how we were going to set boundaries for the project as a whole, given the many relationships between the food production company and its environment (host community, suppliers, retail outlets, government regulators, etc.). Boundary setting not only helps to facilitate the practical conduct of an intervention; it also involves value judgments that strongly influence what improvement might come to look like in the context of that intervention (Churchman, 1970; Ulrich, 1983, 1996; Midgley, 1996, 2000; Córdoba & Midgley, 2006). In one particular team meeting, we spent a long time discussing whether it was the right thing to do (both in terms of ethics and practicality) to push out the boundaries of the project to include the local host community's concerns about waste, as well as the company's. We decided that it would not be ethically acceptable to marginalize the host community, partly because impositions by industry on local communities are already known to be damaging in Nigerian society more widely (Ibeanu, 2000; Ikelegbe, 2005a, 2005b), and partly because we could already see, based on our interviews, that there was the potential for the company and local community to collaborate in a win-win partnership to address the issues concerning them both. As boundary setting also frames what counts as improvement, we did not want to make these decisions without consultation, so after making our own judgments we tested them out with the company and its stakeholders and secured agreement on the remit of the project.

*Participant Observation:* This social science approach (Ritchie et al., 2014) was chosen to add richness to the researchers' understanding of the company, its stakeholders and their issues. Sometimes, when working alongside the participants in an intervention, relevant activities are seen and conversations heard that the researcher might not be made aware of in more formal interviews and workshops. Participation also gives researchers an opportunity to familiarize themselves with locally relevant jargon, and can help in the identification of any misunderstandings



between the researcher and others that have come about due to their different perspectives. Following the recommendation by Liamputtong and Ezzy (2005), participant observation was applied to complement the semi-structured interviews and facilitate reflection on the interpretation of the data (including building the rich picture and boundary diagrams). The first author based himself in the food production company for several months to enable this.

**CATWOE.** This is a mnemonic from SSM (Checkland, 1999; Checkland & Poulter, 2006), which can be used to explore the parameters of a possible transformation that might be considered by stakeholders for action. This exploration can ensure better mutual understanding between stakeholders (Checkland, 1981). The CATWOE letters stand for: **C**ustomers (those who could benefit from the change, or be harmed); **A**ctors (those who will need to be involved in making the change happen); **T**ransformation (a specification of the current undesirable state and the desired state that people want to see the system move to); **W**eltanschauung, or **W**orldview (the perspective from which the transformation is meaningful); **O**wners (not always in a financial sense – rather, those stakeholders who could stop the change from happening); and **E**nvironmental constraints (those things that cannot or should not be changed, which the actors have to take as given). There are no absolutely right or wrong CATWOE analyses: they are likely to be seen as more or less useful, or more or less well specified, depending on the stakeholders involved in dialogue around them (Checkland & Scholes, 1990). Following reflections on the interviews, rich picture and boundary diagrams, we identified possible transformations focused on waste minimization and reuse that the company and its stakeholders might want to pursue. A CATWOE was written up for each transformation, and then key stakeholders were consulted to see if the targets for change had been correctly identified; whether the CATWOEs needed to be modified; and which ones people saw as most useful to take forward in Lean system workshops. Importantly, discussion of the customers, actors, owners and environmental constraints helped us refine our earlier map of stakeholders (our interviewees): now we were able to narrow down to those stakeholders who really needed to be invited to workshops.

**Lean System Workshops.** Workshops were organized to model the current production processes, facilitate waste identification, identify ways of overcoming issues and map out future processes (Hines et al., 2004), all with the involvement of affected and potentially affected stakeholders defined through the boundary critique and CATWOEs. These workshops essentially took the transformations defined in the CATWOEs and went into detail about what they might involve. 24 Lean system workshops, lasting 90 minutes on average, were conducted over an 8 month period, involving different participants relevant to the transformation being examined (see Ufua, 2015, for further details). Process maps (Hines & Rich, 1997; Rother & Shook, 2003; Damelio, 2011; Gurumurthy & Kodali, 2011; Papadopoulos et al., 2011) were developed to express the flow of activities in each relevant department, and between departments and organizations, which helped the participants define the value stream, the connectivity of flow, as well as trigger recognition of the precise parts of the operational process that would need improving (e.g. waste identification, reduction and/or reuse). For each transformation, a process map was produced for the situation as it was before intervention, and another one was produced to show what the improved process should look like.

**Conceptual Modeling,** also from SSM (Checkland & Poulter, 2006). Conceptual models are visual 'maps' of the interrelated human activities needed to bring about a transformation, as specified in a CATWOE. They usually consist of a set of statements of required activities, each beginning with a verb, and all the statements are linked by arrows to show the logical dependencies between them (the linking is usually non-linear) (Checkland &

Scholes, 1990). Where possible, the set of statements is restricted to seven plus or minus two elements, because this is the number that people can keep in their short-term memories (Miller, 1956), allowing them to appreciate the conceptual model as a whole system. The utility of using this and other SSM techniques in the context of Lean has been recognized previously by Platt and Warwick (1995). In Checkland's (1981) original SSM methodology, conceptual modeling usually follows directly from the development of CATWOEs and the use of other methods to specify the transformation required. However, in our view, there is a distinct advantage to inserting Lean system workshops between the use of these two tools: while the CATWOEs get all the stakeholders on the same page in defining potential transformations, the process mapping involved in Lean system workshops draws the participants into the detail of the operational changes needed, and then the conceptual modeling can concentrate on the overall set of management actions required to bring those operational changes about. The movement is from a relatively high degree of abstraction (CATWOEs) to a much lower level (process mapping) and then back to a higher level (a 'helicopter view' conceptual model of the activities needed to bring about the changes). The agreed conceptual models were compared with the process maps and CATWOEs to check their adequacy, and were then reviewed in light of the rich picture to assess whether the participants were confident that the actions would really make a difference to the problematic situation as outlined there. Modifications were made as required.

#### 4. The food production company: A live-stock farm in the Niger Delta Region of Nigeria

To preserve the anonymity of the business organization we worked with, we will use a pseudonym, calling it the Food Production Company (FPC). FPC is a live-stock farm in a rural community in the Niger Delta Region of Southern Nigeria. It is one branch of a group of companies first registered in the year 2000, although it had only moved to its present location fairly recently to facilitate expansion (the land it was previously on was too marshy to enable growth). FPC's parent company is involved with diverse industries, such as marine security, oil and gas exploration, hotels and construction. The structure of the company is presented in Fig. 2.

The establishment of the farm was informed by the diversification policy of the parent company, which was a response to the Federal Government's call for individuals and corporations to invest in the agricultural sector to address the challenge of food security, provide work for many unemployed rural youth, boost this sector of the Nigerian economy, and stem the drift of the population to urban slum living.

Early on, the farm specialized in poultry, offering products such as broilers and table eggs to customers. Later it diversified into other live-stock (see Fig. 2). It was, and still is, employing people in the local area, which is contributing to the economic development of the region.

Among FPC's external stakeholders are the local community, which mostly consists of subsistence farmers and traders. It is from this community that the majority of the FPC agricultural workers are recruited. Another stakeholder is the Environmental Health Protection Agency, which acts on behalf of the government to ensure conformity to legislation on relevant operational standards. Other external stakeholders include input material suppliers (e.g. those selling limestone, maize, sawdust and charcoal, all of which are needed for maintenance of the live-stock). The organization also has a range of wholesale and retail customers for the farm's different products.

Internal stakeholders include the senior managers, who have oversight of the farm as a whole; the middle managers and su-

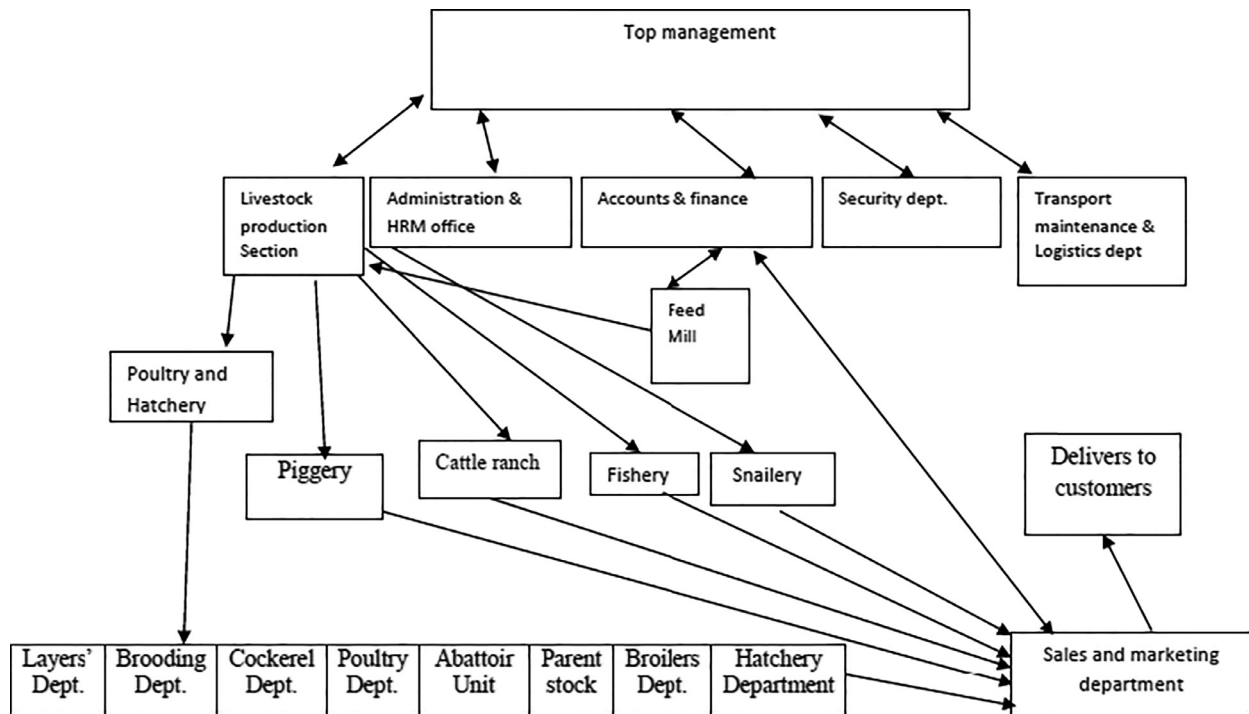


Fig. 2. Structure of FPC.

pervisors, who manage the different sections shown in Fig. 2; and the shop-floor workers.

The farm operates a ‘batch operational system’: live-stock is produced on a continuous basis, in high volume batches and with low variety in the different sections. The main sections are the Hatchery and Poultry production units; a Feed Mill; a Fishery; a Piggery; a Snailery; and a Cattle Ranch. The farm has a strong expansionary mission, focused on meeting downstream market demands, which has led to continuous diversification of products from the original broilers and eggs. When we worked with the company, the Snailery, Piggery and Cattle Ranch were new investments that were expected to take their first products to market in the near future.

## 5. An example of the application of Systemic Lean Intervention in FPC

Issues of waste minimization and the potential reuse of waste as input materials were identified right across the FPC, in every section of the business (see Ufua, 2015, for details). We engaged with the local community in relation to a number of these issues, both to understand community perspectives on them and to design solutions with their participation that could meet their needs as well as those of the company. Indeed, several of the issues were first raised by the community representatives themselves. Here, we will focus on just one such issue, and how it was addressed by FPC, facilitated by us.

### 5.1. Identifying a waste management issue of concern to the local community

Our interviews with representatives of the local community included 2 members of FPC’s Host Community Representative Committee (a liaison group set up by the company) and 3 community leaders who had already been in positions of influence before FPC had opened, so were viewed locally as independent of the company. All these interviews started with the interviewees saying that the company’s arrival in the neighborhood was really appreciated because it had introduced a quota system to guarantee a reason-

able number of jobs to local people, which had brought relief to some previously unemployed and impoverished citizens.

However, they also raised a significant waste management issue: the dumping of live-stock waste in the locality. The waste came from all parts of FPC’s operations, but especially the Poultry and Hatchery section (which was the largest part of the business), and it contained (among other things) dung, slaughterhouse effluent and animal corpses. Strong words were used to describe the dumping of waste near to communities, such as “reckless” and “a menace”. All the community interviewees described the waste as offensive, not just because of the permeating smell, but also because of the public health risk it posed (also see Jo, Yu, Sohn, & Kim, 2016, for more general thoughts about the problem of landfill waste disposal). The interviewees said that the need for economic development should not result in their health being compromised. They explained that they placed a high value on healthy living, and the issue had caused a breakdown of their relationship with FPC, which had been cordial when the company first moved there. Indeed, the members of the FPC liaison committee said that they had reached a point where negotiations were no longer productive, so they had refused to talk further about the issue until FPC met their demand for a complete cessation of dumping in neighborhoods where people’s health could be compromised.

We raised this issue with 3 senior managers, who admitted that a citizen complaint had been made to the Environmental Health Protection Agency. The complaint was upheld, and this had resulted in the imposition of a ‘sanction notice’ on the company, which meant that failure to cease dumping would result in a series of escalating penalties. However, the managers seemed to be at a loss to know what to do about this: they said they had done what they could, by ensuring that the waste was jettisoned further away, but people in the community were still complaining about the smell and health risk. Indeed, they admitted that their deteriorating relationship with their host community had resulted in them putting their plans for expansion on hold, as they were concerned that the production of even greater amounts of waste could only worsen the problem, turn more local people against them,



and trigger punitive actions by the Environmental Health Protection Agency.

In our boundary diagramming session, when our research team was reflecting on this situation (after the interviews and before we started to support the stakeholders in addressing it), we realized that there are two ways it could be interpreted using the Community OR theory of boundary critique: as a marginalization issue or as a conflict issue. The critical characteristic of marginalization is that there is no 'balance of power': the local community could protest all they like, but the company would be able to derogate them and thereby justify ignoring the issue of waste dumping because they could say it is the concern of 'unreasonable' or 'profane' people (see Midgley, 1992a, 2000, and Midgley & Pinzón, 2011, for details of the theory of marginalization). In contrast, in a conflict situation, some form of 'balance of power' is maintained, even though the conflict has become entrenched: both sides frame the focus of the conflict differently (in this case, either 'inconvenient waste as a consequence of economic productivity' or a 'health hazard as a consequence of reckless dumping'), and have leverage to continue a strategic battle (Midgley & Pinzón, 2011; Midgley, 2016a, 2016b).

It mattered whether we were dealing with marginalization or conflict, because the implications for intervention are different. As long as people are willing to engage, conflict can be addressed by participative group work, seeking to widen the boundaries and sets of values that people are using, and by employing methods that open stereotypes of the 'other side' to question (Midgley & Pinzón, 2013; Midgley, 2016a, 2016b). In contrast, with marginalization, often those on the receiving end feel disempowered, and the Community OR practitioner may need to work with them separately to provide confidential space for them to develop their perspectives on both the issues affecting them and what needs to change (e.g. Cohen & Midgley, 1994; Midgley & Milne, 1995; Midgley, 1997c; Boyd et al., 2004). Also with marginalization, it is not always the case that those working with a narrow boundary of concern, thereby marginalizing the concerns of others, are even fully aware of the implications of their viewpoints and actions, so raising awareness of the issues is often necessary (e.g. Boyd et al., 2004).

In the case of our project with FPC, even though the company had only been minimally responsive to the complaints about waste dumping from the community, we saw this as a conflict rather than a process of marginalization, for two reasons. First, the community was not without leverage: they had brought in the Environmental Health Protection Agency, and the company was seriously concerned about the implications of this. Second, the absence of a solution stemmed from uncertainty about what more could be done, not a lack of awareness on the part of FPC's management. Indeed, unlike the conflicts addressed in the 6 Community OR interventions reported in Midgley (2016a, 2016b), it had not become so entrenched that the two sides were demonizing each other, even though negotiations had broken down: all the participants said that they understood the concerns of the other side and would be willing to help identify new waste management solutions through our SLI process. Thus, there was little need for a formal conflict resolution approach (which we were ready to deploy if required), and we could work with the participants to identify technical solutions in Lean system workshops.

Note the considerable difference in our approach from a conventional Lean methodology: by starting with stakeholder interviews, we identified a waste management issue that was of concern to both the company and the local community. Had we started talking with the company employees alone, there is no guarantee that we would have learned about the involvement of the Environmental Health Protection Agency, as this was mentioned by the senior management only in response to us raising

the community concern. Most likely, a Lean methodology would have involved us in tackling the waste issues, but from the perspective of saving money and creating value within the company, not from the perspective of protecting public health. The latter was a strong moral motivator, as will become clear shortly. It also made 'improvement' look quite different than it would have done without the community involvement: arguably, any financial gain that was greater than the resources expended on our project would have been an 'improvement' from a business perspective. However, taking the community concerns into account, the 'improvements' needed to be substantial enough to make a difference to public health, as judged by the host community.

## 5.2. Designing responses

We used our CATWOE analyses to think through who should be invited to Lean system workshops (besides FPC and community representatives). The senior management of FPC agreed with our recommendation that we should invite someone from the Environmental Health Protection Agency. Deciding on participants is a boundary critique issue because it can make a big difference to the viewpoints that are accounted for in innovations (Midgley, 2016c; Midgley & Lindhult, 2017a, 2017b) and hence the acceptability or otherwise of the final results to stakeholders. In this case, knowing that any solutions would be acceptable to the Environmental Health Protection Agency was very important to FPC. However, this agency refused permission for its employees to participate in workshops, saying that it is against their policy to get close to the work of any organization they are regulating. However, they agreed to three people (the Director and Assistant Director, plus the head of the relevant regulatory department) participating in interviews. We therefore acted as a go-between, feeding the views on regulation from this agency into the Lean system workshops.

The Environmental Health Protection Agency interviewees highlighted the need for further development of value from the live-stock waste, especially the wet live-stock dung, which they suggested the farm could use to generate biogas electricity:

"There are multiple approaches to waste management, but the one we would recommend is the new approach, which is the biogas, which involves translating waste to wealth. It leaves nothing unused; converting all waste to diverse values that are of further advantages to the organization if they can implement it" (Director of the Environmental Health Protection Agency).

They reckoned that this would be economical and environmentally safe, and most importantly would give the farm a reliable electricity power supply. In our earlier interviews with FPC employees, frequent power cuts had been identified as a source of waste, such as failure of the egg incubators so whole batches of eggs and new born hatchlings sometimes died.

We ran a two-hour Lean system workshop in FPC to explore this further. The participants were middle managers, veterinarians and supervisors (all identified as 'actors' in the relevant CATWOE), and they agreed that this would be worth considering seriously alongside any other ideas that could be collaboratively developed for reducing and reusing waste. We therefore convened a further series of workshops with the departments producing live-stock waste. The relevant managers and supervisors participated, plus local people. The latter were recruited via our community interviewees, and they came in because they wanted to make a difference to the problem of waste dumping in their neighborhoods.

It was made clear in all these workshops that their purpose was to generate ideas for improved waste management, but that final decisions on implementation would have to be made by the senior management. From some Community OR perspectives, this might represent a compromise on the meaningful engagement of

the community representatives, making this ‘consultation’ rather than participation or a full partnership to decide the outcomes (Arnstein, 1969). However, we agree with Midgley et al. (1998) that these kinds of pragmatic compromises are often necessary, and are legitimate if the practitioner and/or key stakeholders have properly considered whether the project can still produce beneficial outcomes, as seen from community perspectives. Also, every effort has to be made to incorporate input from, and the preferred framing of, community representatives. FPC was clearly a company with an authoritarian management culture, which insisted that senior managers had the final say, and it became clear as our intervention progressed that some of the ideas for change would need very significant investments, so could not be pursued without further senior management deliberation. In our view, it is the judgment that beneficial outcomes, as seen from a community perspective, could still be obtained despite the senior management reserving the right to final decision making that made acceptance of the latter ethical.

Each time we ran a workshop with a new group of participants, we started by showing the rich picture of the problematic situation, which represented the waste issues on the farm, the impacts on the community, and the infringement of environmental health standards (among other things). This generated great interest and discussion, and it was clear that the FPC employees were really motivated by the idea that they could be helping to improve the health of the local community as well as the finances of their own company. Indeed, while we initially had difficulties convening workshops, with some managers failing to turn up (which would inevitably result in the absence of their more junior colleagues too), word of mouth about what was being discussed soon spread, and this reticence to participate evaporated. This is further evidence of the added value of a Community OR approach, complementing Lean: it was the use of the rich picture to integrate and display multiple perspectives on waste management, including community values, which generated commitment from all parties. We are not convinced that value mapping alone, which would have been the focus of a traditional Lean approach, would have generated the same enthusiasm.

One of the workshops we ran explored the biogas idea in more detail, mapping the potential value chain. There was optimism about the possibilities. However, there was also some concern that this would involve a significant financial investment, and the senior management would need to commission a feasibility study to ensure that the return on this investment would be realized. We therefore asked for a senior management meeting to be convened. The view of the Chief Accountant was pivotal in their discussions. He said that the firm currently spends nearly a million Naira (US\$3140) per month on electricity, which is a substantial part of the farm’s operational costs, and he believed that “the expenditure on this proposed project would yield so much return, especially... operational process stability”. The senior management therefore commissioned a feasibility study from a biogas consultant. This revealed that there was actually *not enough* waste to ensure a reliable electricity supply: the production of broilers, for example, would need to be doubled to generate sufficient dung. This fitted well with the company’s aspirations for expansion, and (following some market research to check that the local economy could support the extra production) the project was given the go-ahead.

During the workshops to generate other ideas, the participants acknowledged that reducing the volume of live-stock waste was a huge challenge, but they nevertheless made several suggestions on what they thought could be done by FPC to improve the situation. Some examples are provided below.

First, they suggested that some of the waste could be used to breed maggots to supplement the feed used in the Fishery. This,

they claimed, would help reduce the volume going to land fill, and reduce the cost of feeding the fish at the same time. “Maggots contain 55% protein, which can speed up the growth of fishes in the pond, and many other competitor farms that have access to these wastes have started this practice” (Hatchery manager).

Other participants cautioned that, if this suggestion is adopted, the ‘Maggotry’ should be kept at a reasonable distance from other operational sites for reasons of hygiene, and the building should be thoroughly cleaned after each batch of maggots had been produced. They also noted that there might be a risk of cross-infection from the dung and the carcasses of dead animals to the fish, which could ultimately infect the human beings eating them. As a means to mitigate this risk, the veterinarians advised that the fish should not be fed with maggots in the last 3 days before being sold, which they said would be sufficient time for any diseases to manifest themselves.

Another suggestion was to grind up the egg shells discarded by the Hatchery and use these as a food supplement for the Piggery. People were very interested in this possibility, and asked for a separate workshop to explore the ramifications of it – especially to discuss if there are any health implications for the pigs. Among the invited participants to this workshop were the Feed Mill manager and supervisors, the Hatchery manager, the Piggery manager and supervisors, and some staff from the veterinary laboratory. The Feed Mill manager and the Hatchery manager offered immediate support to the proposal, suggesting that egg shells would provide a useful source of calcium to support strong bone development in the pigs. The manager of the Piggery pointed out that it could also facilitate better “milk let down” (i.e. free flow of breast milk) for sows nursing piglets. However, other participants, especially the veterinarians, cautioned that it would require a lot of effort to purify the egg shells, especially as there are usually a few “dead in shell” chicks mixed in with them. They recommended a thorough laboratory analysis to test whether the waste could be cleaned effectively, plus a quality assurance regime to maintain cleanliness once the idea was implemented.

A very similar idea to the above was stimulated by the observation, incorporated into the rich picture, that mortality waste is sometimes unacceptably high. While some unplanned deaths of animals are inevitable on any farm, whether in the developed or developing worlds, occasionally there are larger mortality events due to the specific conditions experienced in Nigeria. An example that was given in the interviews was the failure of chicken feed to be delivered because it had to be sourced from the other side of Nigeria, and bandits had stolen the lorry and its contents en route. All the chickens on the farm died as a result, as FPC didn’t have sufficient stocks to feed them. It was suggested in one workshop that the bones from dead animals could be processed as a food supplement for the pigs, just like the egg shells.

The response of the senior management to all of these ideas was cautious approval, and they asked for research to be undertaken to make sure that no health and safety standards would be compromised by implementation.

### 5.3. Evaluation

After our intervention using SLI had concluded, we undertook an evaluation of it. We used a modified version of Midgley, Cavana, Brocklesby, Foote, Ahuriri-Driscoll, and Wood’s (2013) approach to evaluating systemic problem structuring methods. Midgley et al. (2013) recommend asking participants to fill out questionnaires straight after participating in a workshop, and then the data from these is considered in a reflective meeting with key stakeholders, examining outcomes; what can reasonably be attributed to the methods; and what has to be attributed to other factors (the context, the skills of the practitioner, etc.). Questionnaires could

not be used in FPC because most of the shop floor workers and some of the community representatives had limited literacy. We therefore conducted interviews instead (covering the same ground as the questionnaire, plus some additional questions on outcomes), and the lead author undertook his own analysis of the data (Ufua, 2015). Reflections drawing upon this analysis, and also going beyond it, are provided below.

If we look at the boundary critique conducted in this project in relation to the idea of the circular economy, discussed earlier (e.g. Greyson, 2007; Webster, 2013; Gorissen et al., 2016), we see a significant limitation. While the boundaries of our intervention were extended beyond the usual stakeholders involved in Lean to include the local community and issues impacting upon it, nobody raised concerns about global resource sustainability and the responsibilities of the company to contribute to this. This is arguably unsurprising in the context of the Niger Delta, where the primary concerns of the local community (apart from the pressing issue of public health discussed earlier) were poverty and unemployment. Perhaps people would have discussed sustainability if the Nigerian government had been actively pursuing policies and providing incentives to support industry and communities in moving towards a circular economy, but we cannot know for sure. Ulrich (1983) and Midgley and Ochoa-Arias (2004b) make an important point about boundary critique: exploring multiple boundaries can improve the inclusiveness of an analysis, but *full comprehensiveness is forever out of reach*. With sustainability being such a significant global issue, and many organizations ignoring or marginalizing questions about their ecological impacts (Midgley, 1994), this limitation of boundary critique needs to be addressed. For example, Munday (2011) suggests that, when previous research shows that particular boundaries could be relevant to a project, and participants do not refer to them, the OR practitioner has an obligation to explicitly introduce them into an analysis. There are pros and cons to this in relation to maintaining meaningful stakeholder participation: on the one hand, a trusted practitioner might stimulate new thinking; but on the other, an overly zealous one could end up imposing boundaries and alienating participants. In our view, the question of how to deal with participant 'blind spots' merits further research.

Our evaluation data showed that the interviews used as part of the SLI process were well received by the participants, one of whom mentioned that the interviews undertaken later in the project, to complement the workshops, "gave a further opportunity to the respondents to say what was in their minds" (Manager). However, several shop floor workers noted that the personal interviews did not include all the employees in FPC who would have been willing to participate. This was due to the fact that some were not able to be released from work due to the nature of their jobs, which required them to be on duty without significant time away (other than lunch and bathroom breaks). We asked whether those noting the non-inclusion of these workers thought that any significant issues or perspectives had been missed, and they all said 'no'. We suggest that this is the most important concern when judging whether the coverage was adequate. While ideally we would have been more inclusive, to facilitate wider commitment to implementation, because of time constraints (it was a nine month project), we could not have undertaken more interviews without cutting other aspects of the work, such as the value mapping or SSM workshops, and this would have been inappropriate given that we had set out to deliver a Systemic Lean *Intervention* rather than a more traditional management research project.

Our evaluation of the rich pictures suggested that, by and large, they were helpful for expressing the different aspects of the problem situation, and they stimulated a lot of interest. This was particularly the case when it came to depicting the public health issue mentioned earlier, and the early reticence of some managers and their staff to participate was overcome through informal,

out-of-workshop communications about this aspect of the rich picture. Nevertheless, two managers had a different perspective, saying that the rich pictures only duplicated the knowledge they already held, and therefore it was a waste of workshop time to discuss them. Arguably, the difference of opinion on the value of this approach comes down to whether the managers were thinking about what is useful to them personally, or whether they were considering the learning needs of other stakeholders. On reflection, we might have paid more attention to ensuring that the managers appreciated the value of sharing their knowledge.

The series of CATWOE, value mapping and conceptual modeling workshops received strongly positive evaluations by all stakeholders, as these were the places in which many of the solutions to waste management issues were proposed. However, a junior employee said he felt unable to speak openly in one of the workshops: "I would have asked this at the meeting... [except] our boss supported the idea before any other contributor to the discussion. As a subordinate to him, I did not want to sound challenging to him on his comments". The issue of power relationships affecting the quality of participation has been widely discussed in the literature (e.g. Mingers, 1980, 1984; Jackson, 1982, 1991; Midgley, 1997c; Munro, 1999; Cronin et al., 2014), and it was not altogether a surprise to us that we uncovered this instance of self-censorship: we had been made aware, very early on, of the autocratic management style in the organization and the fact that many shop floor workers did not feel listened to. We tried to address this in a workshop towards the end of the project, not through a direct challenge to the management style, but by introducing the topic of employee participation in the context of reducing waste, and facilitating a discussion of examples from the project where it had made a difference to the design of solutions. We also fed back to the senior management on these successes. While these things were received positively, we did not expect them to have a transformative effect on the organization, given entrenched habits of communication and the wider cultural context in the Niger Delta, where authoritarian management is generally taken for granted. At the end of the day, from the point of view of evaluating the success or otherwise of our workshops, we have to ask whether self-censorship significantly compromised the outcomes. Every interviewee made positive comments about the outcomes, and no other junior employees talked about self-censorship, so we conclude that the workshops were not significantly compromised.

The evaluation revealed that all of the initiatives mentioned above (plus others not discussed in this paper) were still being progressed, and the community representatives said that our project had delivered a significant breakthrough: not only would the biogas generation of electricity use up the waste that was currently being dumped in their neighborhoods, but the necessary expansion of the farm to generate sufficient waste to power the generator would create more local employment. A respondent suggested: "It [the project] harnessed the interest of FPC in developing the existing relationships between the organization and the affected stakeholders; creating a forum for debating on current issues and making participatory effort to improvements".

While the large majority of waste reuse initiatives launched as part of this project were evaluated positively, one significant aspect of our community engagement did not yield the expected outcomes. Earlier, we mentioned the problem of bandits robbing the lorries transporting chicken feed (maize) across the country to the farm. Our boundary critique had identified that there were a lot of unemployed people in the region, and we therefore generated a CATWOE looking at what it would take to support farmers in the community to grow the maize locally instead of importing it from further afield. The senior management declined to take forward this idea on the grounds that it would give too much power to the local community: the company would become reliant on a



single source of maize production, and could be forced to accept significant price rises. Rather than support the local community in this way, the senior management decided instead to modify their contracts with their remote suppliers to make them take more responsibility for the security of their deliveries. On reflection, we realize that the idea of growing the maize locally was the only one that first came from us, rather than a stakeholder. This confirms the logic of participatory practice (as opposed to expert consultancy) that permeates the literature on both Lean (e.g. Womack et al., 1990; Bowen & Youngdahl, 1998; Radnor et al., 2012) and Community OR (see, particularly, Ritchie et al., 1994, and Midgley & Ochoa-Arias, 2004a).

## 6. Final Reflections

This paper has discussed how to achieve waste minimization and value development from the perspectives of both the 'usual' stakeholders of a company and its local community. In our example of working with FPC in Nigeria, the 'traditional' boundaries of a Lean initiative were pushed out, and this was achieved through a synergistic combination of Lean and Community OR, brought together in a new Systemic Lean Intervention (SLI) approach. The tradition of Community OR of most relevance to this is the use of systems approaches, and particularly the theory and practice of boundary critique (Ulrich, 1983; Midgley, 1992a, 1994, 2000, 2016a, 2016b; Yolles, 2001; Midgley et al., 1998, 2007; Boyd et al., 2004; Córdoba & Midgley, 2003, 2006; Foote et al., 2007; Midgley & Pinzón, 2011, 2013; Helfgott, 2018). Below, we offer some final reflections on the added value of Community OR generally, and SLI in particular, compared with more 'conventional' Lean approaches.

First and most obviously, the added value of Community OR is that it focuses attention on local communities. Every business and public sector organization is embedded in a host community and also has responsibilities to wider society. In our project with FPC, we demonstrated how working with community representatives transformed how waste management was seen: instead of viewing it as just a business issue (concerned with reducing costs and ensuring regulatory compliance), the FPC employees realized that there was a public health issue at stake, and this strongly motivated them to redouble their efforts to find ways to reuse their waste. Essentially, our intervention provided opportunities for the *systemic co-creation* (Midgley, 2016c) of innovations between the company and its community.

The principle here is that bringing multiple perspectives into Lean (and other) innovation processes can generate new synergies (Easterling, 2016). However, practitioners who are not used to engaging with communities might ask themselves how they can ensure that this sort of activity is genuinely synergistic and does not end up engaging people in workshops that turn out to be fruitless. Two answers come from the Community OR literature. First, *ask a sample of people in the community who might be expected to have different perspectives* if there are issues that the organization needs to address. If they say 'no', then further community engagement is probably not going to be particularly useful, other than for the on-going maintenance of relationships. The theory of boundary critique essentially advocates *probing* the environment of the organization to see what kind of approach might be most appropriate (Midgley, 2000). Probing is a relatively cost-effective way of testing whether a full investment in community engagement is required. The second Community OR answer to ensuring that engagement is fruitful is to draw upon the panoply of systems/OR methodologies and methods that exist for structuring dialogue and engaging people in participatory modeling (Ritchie et al., 1994; Midgley & Ochoa-Arias, 2004a). A particularly relevant collection of methodologies has been assembled by Rosenhead and Mingers (2001).

Linked with the above mention of 'probing', Community OR offers some systems theory and methodology to conceptualize *exploring the boundaries* of stakeholder engagement, plus the issues of relevance to any given Lean initiative, instead of taking these boundaries for granted. While the logic of stakeholder engagement is now well established (Mitchell, Agle, & Wood, 1997; Ackermann & Eden, 2011), there is still a tendency for private and public sector organizations to conceptualize their stakeholders as only those people and organizations who are obviously involved in their activities (e.g., employees, suppliers, customers, business partners and refuse management agencies in the case of a typical Lean initiative). The issue here is that those who are *affected but not involved* are equally important (Ulrich, 1983), for two reasons. The first is ethical: most people regard it as unacceptable for a business to externalize its costs on communities and ecosystems, especially when this threatens public or environmental health, as it did in our project with FPC. The second reason why affected stakeholders are important is about enlightened self-interest: the externalization of costs can result in regulatory action or even community reprisals, which can damage the organization concerned (Ibeanu, 2000), so it is preferable to anticipate potential problems and deal with them before they escalate into conflicts.

Another benefit that can be imported from Community OR relates to the conceptualization of conflict and marginalization processes (Midgley, 1992a, 1994, 2000, 2016a, 2016b; Midgley et al., 1998; Yolles, 2001; Foote et al., 2007; Midgley & Pinzón, 2011, 2013). Many of these authors have explored the practical implications for intervention of identifying conflict, marginalization and other types of power relationship, and we suggest that it is naive to think that Lean initiatives will always be unaffected by these things. The Community OR literature can provide guidance on how to include marginalized groups (e.g., Boyd et al., 2004) and turn destructive conflicts into synergistic collaborations (e.g., Midgley, 2016a, 2016b). In the case of our project with FPC, the conflict had not become so entrenched that it required formal resolution, and a combination of community engagement and the normal kinds of process mapping techniques usually associated with Lean (Hines & Rich, 1997; Rother & Shook, 2003; Damelio, 2011; Gurumurthy & Kodali, 2011; Papadopoulos et al., 2011) were sufficient to support the identification of synergistic solutions to the waste dumping problem.

The penultimate form of added value that comes from Community OR, and could be useful to Lean practitioners, is the theory and practice of methodological pluralism (e.g. Jackson, 1991; Mingers & Gill, 1997; Midgley, 2000). In SLI, this is expressed as the creative design of methods, potentially drawing upon methods from any tradition, but in the case of our project in Nigeria it was methods from systems thinking, Lean and the social sciences. It is not just that the bigger your tool kit is, the more flexible your practice can be (although this is clearly true) (Flood & Jackson, 1991); it is also that mixing methods from different traditions enables the synergistic combination of different types of insight (Midgley, 1992b, 2016d). Although many forms of Lean practice discuss the value of collaboration (e.g. Womack et al., 1990; Bowen & Youngdahl, 1998; Radnor et al., 2012), usually the focus is on (as far as possible) obtaining an objective or consensus view on value chains and production processes. There may be disagreements between stakeholders, but then the emphasis is placed on resolving these to create the best possible process model. In contrast, authors working in Community OR place a great deal of emphasis on the creation of *better mutual understanding* between stakeholders with different values and perspectives, rather than trying to resolve them (Ritchie et al., 1994; Midgley & Ochoa-Arias, 2004a; Johnson, 2012). Indeed, modeling is often focused on the *representation of subjective and inter-subjective viewpoints* on problem situations and potential actions to address them (also see the various contribu-

tions in the volume edited by Rosenhead & Mingers, 2001). The synergies that can come from bringing together these two types of modeling are significant: methods from Community OR (and indeed the wider practice of OR and systems thinking) can support people in framing the waste (and other) issues that need addressing, taking account of multiple viewpoints in the identification of both problems and possible solutions, and then Lean methods can be brought on stream to model the details of what different solutions could involve. This was precisely the rationale in our own SLI project. Hence, we argue that our study provides food for thought for practitioners who not only want to extend their boundaries of stakeholder engagement to include local communities, but who also want to increase the flexibility and responsiveness of their practice by bringing together methods from diverse traditions so that they can address a wider range of purposes than more conventional approaches to Lean can achieve on their own.

We look forward to continuing research on this extension of Lean practice using the theory, methodology and methods from Community OR.

## References

- Ackermann, F., & Eden, C. (2011). Strategic management of stakeholders: Theory and practice. *Long Range Planning*, 44, 179–196. doi:10.1016/j.lrp.2010.08.001.
- Ackoff, R. L. (1970). A black ghetto's research on a university. *Operations Research*, 18, 761–771. doi:10.1287/opre.18.5.761.
- Ackoff, R. L. (1981). *Creating the corporate future*. New York: Wiley.
- Agunwamba, J. C. (1998). Solid waste management in Nigeria: Problems and Issues. *Environmental Management*, 22(6), 849–856. doi:10.1007/s002679900152.
- Aibinu, A. A., & Jagboro, G. O. (2002). The effects of construction delays on project delivery in Nigerian construction industry. *International Journal of Project Management*, 20, 593–599. doi:10.1016/S0263-7863(02)00028-5.
- Arlbjorn, J. S., Freytag, P. V., & Haas, H. (2011). Service supply chain management: A survey of Lean application in the municipal sector. *International Journal of Physical Distribution and Logistics Management*, 41(3), 277–295. doi:10.1108/0960003111123796.
- Arnstein, S. R. (1969). A ladder of citizen participation. *Journal of the American Planning Association*, 35(4), 216–224. doi:10.1080/01944366908977225.
- Bell, S., & Morse, S. (2013). Rich pictures: A means to explore the 'sustainable mind'? *Sustainable Development*, 21(1), 30–47. doi:10.1002/sd.497.
- Bertalanffy, L. von (1956). General system theory. *General Systems*, 1, 1–10.
- Bhasin, S. (2011). Performance of organisations treating Lean as an ideology. *Business Process Management Journal*, 17(6), 986–1011. doi:10.1108/14637151111182729.
- Bhasin, S., & Burcher, P. (2006). Lean viewed as a philosophy. *International Journal of Manufacturing Technology Management*, 17(1), 56–72. doi:10.1108/17410380610639506.
- Boulding, K. E. (1956). General systems theory—The skeleton of science. *Management Science*, 2, 197–208. doi:10.1287/mnsc.2.3.197.
- Bowen, D. E., & Youngdahl, W. E. (1998). "Lean" service: In defense of a production-line approach. *International Journal of Service Industry Management*, 9(3), 207–225. doi:10.1108/09564239810223510.
- Boyd, A., Brown, M., & Midgley, G. (2004). Systemic intervention for community OR: Developing services with young people (under 16) living on the streets. In G. Midgley, & A. E. Ochoa-Arias (Eds.), *Community operational research: OR and systems thinking for community development*. New York: Kluwer/Plenum.
- Bradbury, H. (Ed.). (2015). *The Sage handbook of action research* (3rd edition). London: Sage.
- Cabrera, D., & Cabrera, L. (2015). *Systems thinking made simple: New hope for solving wicked problems*. Ithaca NY: Odyssean Press.
- Cabrera, D., Cabrera, L., & Powers, E. (2015). A unified theory of systems thinking with psychosocial applications. *Systems Research and Behavioral Science*, 32(5), 534–545. doi:10.1002/sres.2351.
- Cabrera, D., Colosi, L., & Lobdell, C. (2008). Systems thinking. *Evaluation and Program Planning*, 31(3), 299–310. doi:10.1016/j.evalprogplan.2007.12.001.
- Checkland, P. (1981). *Systems thinking, systems practice*. Chichester: Wiley.
- Checkland, P. (1999). Systems thinking. In W. Currie, & R. Galliers (Eds.), *Rethinking management information systems*. Oxford: Oxford University Press.
- Checkland, P., & Poulter, J. (2006). *Learning for Action: A short definitive account of soft systems methodology, and its use for practitioners, teachers and students*. Chichester: Wiley.
- Checkland, P., & Scholes, J. (1990). *Soft systems methodology in action*. Chichester: Wiley.
- Churchman, C. W. (1970). Operations research as a profession. *Management Science*, 17, B37–B53.
- Cohen, C., & Midgley, G. (1994). *The North Humberston diversion from custody project for mentally disordered offenders: Research report*. Hull: Centre for Systems Studies.
- Córdoba, J. R., & Midgley, G. (2003). Addressing organisational and societal concerns: An application of critical systems thinking to information systems planning in Colombia. In J. Cano (Ed.), *Critical reflections on information systems: A systemic approach*. Hershey: Idea Group.
- Córdoba, J. R., & Midgley, G. (2006). Broadening the boundaries: An application of critical systems thinking to IS planning in Colombia. *Journal of the Operational Research Society*, 57, 1064–1080. doi:10.1057/palgrave.jors.2602081.
- Cronin, K., Midgley, G., & Skuba Jackson, L. (2014). Issues mapping: A problem structuring method for addressing science and technology conflicts. *European Journal of Operational Research*, 233, 145–158. doi:10.1016/j.ejor.2013.08.012.
- Daellenbach, H. (1994). *Systems and decision making*. New York: Wiley.
- Damelio, R. (2011). *The basics of process mapping* (2nd edition). New York: Productivity Press.
- Dick, B. (1999). *Rigour without numbers: The potential of dialectical processes as qualitative research tools* (2nd edition). Chappel Hill QLD: Interchange.
- Dominici, G., & Palumbo, F. (2013). Decoding the Japanese Lean production system according to a viable system perspective. *Systemic Practice and Action Research*, 26, 153–171. doi:10.1007/s11213-012-9242-z.
- Easterling, D. (2016). Five steps for managing diversity to create synergy. *Integration and Implementation Insights*. <https://i2insights.org/2016/05/19/managing-diversity/>. [accessed on 15th August 2016].
- Ekanayake, L. L., & Ofori, G. (2004). Building a waste assessment score: Design-based tool. *Building and Environment*, 39, 851–861. doi:10.1016/j.buildenv.2004.01.007.
- Flood, R. L., & Jackson, M. C. (1991). *Creative problem solving: Total systems intervention*. Chichester: Wiley.
- Flood, R. L., & Romm, N. R. A. (1995). Enhancing the process of choice in TSI, and improving chances of tackling coercion. *Systems Practice*, 8, 377–408. doi:10.1007/BF02253393.
- Folinas, D., Aidonis, D., Triantafyllou, D., & Malindretos, G. (2013). Exploring the greening of the food supply chain with Lean thinking techniques. *Procedia Technology*, 8, 416–424. doi:10.1016/j.protcy.2013.11.054.
- Foote, J. L., Gregor, J. E., Hepi, M. C., Baker, V. E., Houston, D. J., & Midgley, G. (2007). Systemic problem structuring applied to community involvement in water conservation. *Journal of the Operational Research Society*, 58, 645–654. doi:10.1057/palgrave.jors.2602248.
- Franco, L. A. (2006). Forms of conversation and problem structuring methods: A conceptual development. *Journal of the Operational Research Society*, 57, 813–821. doi:10.1057/palgrave.jors.2602169.
- Galloway, L., Rowbotham, F., & Azhashemi, M. (2000). *Operations management in context*. Oxford: Butterworth-Heinemann.
- Garcia, P., Younie, D., & Fornos, J. (2012). Implementation of lean transactional at Tenneco Europe, applications in finance. *SAE Technical Paper 2012-01-0517*. doi:10.4271/2012-01-0517.
- Garrido, J. S., & Pasquire, C. (2011). Value theory in Lean construction. *Journal of Financial Management of Property and Construction*, 16(1), 8–18. doi:10.1108/1366438111116043.
- Gillham, B. (2005). *Research interviewing: The range of techniques*. Maidenhead: Open University Press.
- Gorissen, L., Vrancken, K., & Manshoven, S. (2016). Transition thinking and business model innovation – towards a transformative business model and new role for the reuse centers of Limburg, Belgium. *Sustainability*, 8, 112. doi:10.3390/su8020112.
- Greedy, D. (2016). Landfilling and landfill mining. *Waste Management and Research*, 34(1), 1–2. doi:10.1177/0734242X15617878.
- Greenwood, D. J., & Levin, M. (1998). *Introduction to action research: Social research for social change*. London: Sage.
- Gregory, A. J. (2007). Target setting, lean systems and viable systems: A systems perspective on control and performance measurement. *Journal of the Operational Research Society*, 58(11), 1503–1517. doi:10.1057/palgrave.jors.2602319.
- Gregory, A. J., & Jackson, M. C. (1992a). Evaluating organizations: A systems and contingency approach. *Systems Practice*, 5, 37–60. doi:10.1007/BF01060046.
- Gregory, A. J., & Jackson, M. C. (1992b). Evaluation methodologies: A system for use. *Journal of the Operational Research Society*, 43, 19–28. doi:10.1057/jors.1992.3.
- Gregory, W., & Midgley, G. (2000). Planning for disaster: Developing a multi-agency counselling service. *Journal of the Operational Research Society*, 51, 278–290. doi:10.1057/palgrave.jors.2600912.
- Greyson, J. (2007). An economic instrument for zero waste, economic growth and sustainability. *Journal of Cleaner Production*, 15(13–14), 1382–1390. doi:10.1016/j.jclepro.2006.07.019.
- Grove, A. L., Meredith, J. O., Macintyre, M., Angelis, J., & Neailey, K. (2010). UK health visiting: Challenges faced during lean implementation. *Leadership in Health Services*, 23(3), 204–218. doi:10.1108/17511871011061037.
- Gurumurthy, A., & Kodali, R. (2011). Design of lean manufacturing systems using value stream mapping with simulation: A case study. *Journal of Manufacturing Technology Management*, 22(4), 444–473. doi:10.1108/1741038111126409.
- Gustavsson, J., Cederberg, C., Sonesson, U., van Otterdijk, R., & Meybeck, A. (2011). *Global food losses and food waste: Extent, Causes and Prevention*. Rome: Food and Agriculture Organization of the United Nations.
- Helgott, A. (2018). Resilience, systems thinking and development: Towards an operational framework for systemic resilience with applications for community operational research. *European Journal of Operational Research*, in press.
- Hiller, H. H., & Diluzio, L. (2004). The interview and the research interview: Analyzing a neglected dimension in research. *The Canadian Review of Sociology and Anthropology*, 41(1), 1–21. doi:10.1111/j.1755-618X.2004.tb02167.x.
- Hines, P., Holweg, M., & Rich, N. (2004). Learning to evolve: A review of contemporary lean thinking. *International Journal of Operations and Production Management*, 24(10), 994–1011. doi:10.1108/01443570410558049.



- Hines, P., & Rich, N. (1997). The seven value stream mapping tools. *International Journal of Operations and Production Management*, 17(1), 46–64. doi:10.1108/01443579710157989.
- Ibeanu, O. (2000). Oiling the friction: Environmental conflict management in the Niger Delta. *Environmental Change and Security Project Report*, 6(6), 19–32.
- Ibeh, K. I. N. (2004). Furthering export participation in less performing developing countries: The effects of entrepreneurial orientation and managerial capacity factors. *International Journal of Social Economics*, 31(1), 94–110. doi:10.1108/03068290410515448.
- Ikelegbe, A. (2005a). The economy of conflict in the oil rich Niger Delta Region of Nigeria. *Nordic Journal of African Studies*, 14(2), 208–234.
- Ikelegbe, A. (2005b). Engendering civil society: Oil, women groups and resource conflicts in the Niger Delta Region of Nigeria. *Journal of Modern African Studies*, 43(2), 241–270. doi:10.1017/S0022278X05000820.
- Jackson, M. C. (1982). The nature of soft systems thinking: The work of Churchman, Ackoff and Checkland. *Journal of Applied Systems Analysis*, 9, 17–29.
- Jackson, M. C. (1987). Community operational research: Purposes, theory and practice. *Dragon*, 2(2), 47–73.
- Jackson, M. C. (1988). Some methodologies for community operational research. *Journal of the Operational Research Society*, 39(8), 715–724. doi:10.1057/jors.1988.126.
- Jackson, M. C. (1991). *Systems methodologies for the management sciences*. New York: Plenum.
- Jackson, M. C. (2000). *Systems approaches to management*. New York: Kluwer/Plenum.
- Jackson, M. C. (2003). *Systems thinking: Creative holism for managers*. Chichester: Wiley.
- Jasti, N. V. K., & Kodali, R. (2016). Validity and reliability of lean enterprise frameworks in Indian manufacturing industry. In Proceedings of the institution of mechanical engineers, Part B: Journal of engineering manufacture: 230 (pp. 354–363).
- Jo, Y., Yu, I., Sohn, S., & Kim, D. (2016). Waste management in the age of alternative energy. *International Journal of Environmental Science and Development*, 7(1), 80. doi:10.7763/IJESD.2016.V7.745.
- Johnson, M. P. (2012). *Community-based operations research: Decision modeling for local impact and diverse populations*. New York: Springer.
- Johnson, M. P., Midgley, G., & Chichirau, G. (2018). Emerging trends and new frontiers in community operational research. *European Journal of Operational Research*, in press. doi:10.1016/j.ejor.2017.11.032.
- Jorgensen, B., & Emmitt, S. (2008). Lost in transition: The transfer of lean manufacturing to construction. *Engineering, Construction and Architectural Management*, 15(4), 383–398. doi:10.1108/09699980810886874.
- Kang, H., & Schoenung, J. M. (2005). Electronic waste recycling: A review of US infrastructure and technology options. *Resources, Conservation and Recycling*, 45, 368–400. doi:10.1016/j.resconrec.2005.06.001.
- Keys, P. (1987). Management and management support in community service agencies. *Dragon*, 2(2), 19–45.
- Keys, P., & Midgley, G. (2002). The process of OR. *Journal of the Operational Research Society*, 53, 123–125. doi:10.1057/palgrave.jors.2601313.
- Kurdve, M., Shahbazi, S., Wendin, M., Bengtsson, C., & Wiktorsson, M. (2015). Waste flow mapping to improve sustainability of waste management: A case study approach. *Journal of Cleaner Production*, 98, 304–315. doi:10.1016/j.jclepro.2014.06.076.
- Liamputtong, P., & Ezzy, D. (2005). *Qualitative research methods*. Oxford: Oxford University Press.
- Liker, J. K. (Ed.). (1997). *Becoming Lean: Inside stories of US manufacturers*. Portland OR: Productivity Press.
- Liker, J. K. (2004). *The Toyota way*. New York: McGraw-Hill.
- Liker, J. K., & Hoseus, M. (2008). *Toyota culture: The heart and soul of the Toyota way*. New York: Mc Graw Hill.
- Linder, S. H. (1999). Coming to terms with the public-private partnership: A grammar of multiple meanings. *American Behavioral Scientist*, 43(1), 35–51. doi:10.1177/00027649921955146.
- Lindhult, E., Hazy, J. K., Midgley, G., & Chirumalla, K. (2015). Value driven innovation in industrial companies: A complexity approach. In Proceedings of the XXVI ISPIM conference – Shaping the frontiers of innovation management 14–17 June 2015.
- Magenheimer, K., Reinhart, G., & Schutte, C. S. (2014). Lean management in indirect business areas: Modeling, analysis, and evaluation of waste. *Production Engineering*, 8(1–2), 143–152. doi:10.1007/s11740-013-0497-8.
- Mar Molinaro, C. (1992). Operational research: From war to community. *Socio-Economic Planning Sciences*, 26, 203–212. doi:10.1016/0038-0121(92)90011-S.
- Marques, R. C., Da Cruz, N. F., Simoes, P., Ferreira, S. F., Perriera, M. C., & De Jaeger, S. (2014). Economic viability of packaging waste recycling systems: A comparison between Belgium and Portugal. *Resources, Conservation and Recycling*, 85, 22–23. doi:10.1016/j.resconrec.2013.12.015.
- Matete, N., & Trois, C. (2008). Towards zero waste in emerging countries: A South African experience. *Waste Management*, 28, 1480–1492. doi:10.1016/j.wasman.2007.06.006.
- McNiff, J. (1988). *Action research: Principles and practice*. New York: Routledge.
- Metin, E., Erozturk, A., & Neyim, C. (2003). Solid waste management and review of recovery and recycling operations in Turkey. *Waste Management*, 23, 425–432. doi:10.1016/S0956-053X(03)00070-9.
- Midgley, G. (1990). Creative methodology design. *Systemist*, 12, 108–113.
- Midgley, G. (1992a). The sacred and profane in critical systems thinking. *Systems Practice*, 5(1), 5–16. doi:10.1007/BF01060044.
- Midgley, G. (1992b). Pluralism and the legitimization of systems science. *Systems Practice*, 5(2), 147–172. doi:10.1007/BF01059938.
- Midgley, G. (1994). Ecology and the poverty of humanism: A critical systems perspective. *Systems Research*, 11, 67–76.
- Midgley, G. (1996). What is this thing called critical systems thinking? In R. L. Flood, & N. R. A. Romm (Eds.), *Critical systems thinking: Current research and practice*. New York: Plenum.
- Midgley, G. (1997a). Developing the methodology of TSI: From the oblique use of methods to creative design. *Systems Practice*, 10, 305–319. doi:10.1007/BF02557900.
- Midgley, G. (1997b). Mixing methods: Developing systemic intervention. In J. Mingers, & A. Gill (Eds.), *Multimethodology: The theory and practice of combining management science methodologies*. Chichester: Wiley.
- Midgley, G. (1997c). Dealing with coercion: Critical systems heuristics and beyond. *Systems Practice*, 10, 37–57. doi:10.1007/BF02557850.
- Midgley, G. (2000). *Systemic intervention: Philosophy, methodology, and practice*. New York: Kluwer/Plenum.
- Midgley, G. (2003). *Systems thinking: Volumes I-IV*. London: Sage.
- Midgley, G. (2006). Systemic intervention for public health. *American Journal of Public Health*, 96, 466–472. doi:10.2105/AJPH.2005.067660.
- Midgley, G. (2008). Systems thinking, complexity and the philosophy of science. *Emergence: Complexity and Organization*, 10(4), 55–73.
- Midgley, G. (2011). Theoretical pluralism in systemic action research. *Systemic Practice and Action Research*, 24, 1–15. doi:10.1007/s11213-010-9176-2.
- Midgley, G. (2015). Systemic intervention. In H. Bradbury (Ed.), *The Sage handbook of action research* (3rd edition). London: Sage.
- Midgley, G. (2016a). Moving beyond value conflicts: Systemic problem structuring in action. In Proceedings of the Keynote Papers and Extended Abstracts from the OR58 Conference 6–8 September 2016.
- Midgley, G. (2016b). *Moving beyond value conflicts: Systemic problem structuring in action*. Hull University Business School Research Memorandum #96.
- Midgley, G. (2016c). Co-creation without systems thinking can be dangerous. *Integration and Implementation Insights*. <https://i2insights.org/2016/07/07/co-creation-and-systems-thinking/>. [accessed on 15th August 2016].
- Midgley, G. (2016d). Four domains of complexity. *Emergence: Complexity and Organization*, 18(2), 137–150.
- Midgley, G., Ahuriri-Driscoll, A., Baker, V., Foote, J., Hepi, M., Taimona, H., Rogers-Koroheke, M., Gregor, J., Gregory, W., Lange, M., Veth, J., Winstanley, A., & Wood, D. (2007). Practitioner identity in systemic intervention: Reflections on the promotion of environmental health through Māori community development. *Systems Research and Behavioral Science*, 24, 233–247. doi:10.1002/sres.827.
- Midgley, G., Cavana, R. Y., Brocklesby, J., Foote, J., Ahuriri-Driscoll, A., & Wood, D. (2013). Towards a new framework for evaluating systemic problem structuring methods. *European Journal of Operational Research*, 229, 143–154. doi:10.1016/j.ejor.2013.01.047.
- Midgley, G., Johnson, M. P., & Chichirau, G. (2018). What is community operational research? *European Journal of Operational Research*, in press. doi:10.1016/j.ejor.2017.08.014.
- Midgley, G., & Lindhult, E. (2017a). *What is systemic innovation?* Hull University Business School Research Memorandum #99.
- Midgley, G., & Lindhult, E. (2017b). What is systemic innovation? *Systems Research and Behavioral Science*, under review.
- Midgley, G., & Milne, A. (1995). Creating employment opportunities for people with mental health problems: A feasibility study for new initiatives. *Journal of the Operational Research Society*, 46, 35–42. doi:10.1057/jors.1995.4.
- Midgley, G., Munlo, I., & Brown, M. (1998). The theory and practice of boundary critique: Developing housing services for older people. *Journal of the Operational Research Society*, 49, 467–478. doi:10.1057/palgrave.jors.2600531.
- Midgley, G., & Ochoa-Arias, A. E. (1999). Visions of community for community OR. *Omega*, 27, 259–274. doi:10.1016/S0305-0483(98)00044-9.
- Midgley, G., & Ochoa-Arias, A. E. (Eds.). (2004a). *Community operational research: OR and systems thinking for community development*. New York: Kluwer/Plenum.
- Midgley, G., & Ochoa-Arias, A. E. (2004b). An introduction to community operational research. In G. Midgley, & A. E. Ochoa-Arias (Eds.), *Community Operational research: OR and systems thinking for community development*. New York: Kluwer/Plenum.
- Midgley, G., & Pinzón, L. (2011). The implications of boundary critique for conflict prevention. *Journal of the Operational Research Society*, 62, 1543–1554. doi:10.1057/jors.2010.76.
- Midgley, G., & Pinzón, L. (2013). Systemic mediation: Moral reasoning and boundaries of concern. *Systems Research and Behavioral Science*, 30, 607–632. doi:10.1002/sres.2228.
- Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook*. London: Sage.
- Miller, G. A. (1956). The magical number seven, plus or minus two: Some limits on our capacity for processing information. *Psychological Review*, 63(2), 81–97. doi:10.1037/h0043158.
- Mingers, J. C. (1980). Towards an appropriate social theory for applied systems thinking: Critical theory and soft systems methodology. *Journal of Applied Systems Analysis*, 7, 41–50.
- Mingers, J. C. (1984). Subjectivism and soft systems methodology—A critique. *Journal of Applied Systems Analysis*, 11, 85–103.
- Mingers, J. C., & Gill, A. (1997). *Multimethodology: The theory and practice of combining management science methodologies*. Chichester: Wiley.



- Mitchell, R. K., Agle, B. R., & Wood, D. J. (1997). Toward a theory of stakeholder identification and salience: Defining the principle of who and what really counts. *Academy of Management Review*, 22(4), 853–886. doi:10.5465/AMR.1997.9711022105.
- Munday, P. G. (2011). Resilience for disasters: A theoretical assessment of four paradigms and boundaries. *MRes dissertation*. Hull: University of Hull.
- Munro, I. (1999). Man-machine systems: People and technology in OR. *Systemic Practice and Action Research*, 12, 513–532. doi:10.1023/A:1022469607464.
- Ochoa-Arias, A. E. (2004). An interpretive systemic exploration of community action in Venezuela. In G. Midgley, & A. E. Ochoa-Arias (Eds.), *Community operational research: OR and systems thinking for community development*. New York: Kluwer/Plenum.
- Ogbonna, D. N., Amngabara, G. T., & Ekere, T. O. (2007). Urban solid waste generation in Port Harcourt metropolis and its implications for waste management. *Management of Environmental Quality: An International Journal*, 18(1), 71–88. doi:10.1108/14777830710717730.
- Ohno, T. (1978). *The Toyota production system: Beyond large-scale production*. Portland OR: Productivity Press.
- Okafor, E. E. (2007). Globalisation, casualisation and capitalist business ethics: A critical overview of situation in the oil and gas sector in Nigeria. *Journal of Social Science*, 15(2), 169–179.
- Okafor, E. E. (2008). Development crisis of power supply and implications for industrial sector in Nigeria. *Journal of Tribes and Tribals*, 6(2), 83–92. doi:10.1080/0972639X.2008.11886580.
- Okonjo-Iweala, N., & Osafo-Kwaako, P. (2007). *Nigeria's economic reforms: Progress and challenges*. Washington DC: The Brookings Institution.
- Okoroafo, S. C., & Kotabe, M. (1993). The IMF structural adjustment program and its impacts on firm performance: A case of foreign and domestic firms in Nigeria. *Management International Review*, 33(2), 139–156. www.jstor.org/stable/40228148
- Oluwaniyi, O. O. (2010). Oil and youth militancy in Nigeria's Niger Delta Region. *Journal of Asian and African Studies*, 45(3), 309–325. doi:10.1177/0021909610367767.
- Ormerod, R. J. (2014). The mangle of OR practice: Towards more informative case studies of 'technical' projects. *Journal of the Operational Research Society*, 65(8), 1245–1260. doi:10.1057/jors.2013.78.
- Papadopoulos, T., Radnor, Z., & Merali, Y. (2011). The role of actor associations in understanding the implementation of lean thinking in healthcare. *International Journal of Operations and Production Management*, 31(2), 167–191. doi:10.1108/01443571111104755.
- Parry, R., & Mingers, J. (1991). Community operational research: Its context and its future. *Omega*, 19(6), 577–586. doi:10.1016/0305-0483(91)90008-H.
- Pauli, G. (1997). Zero emissions: The ultimate goal of cleaner production. *Journal of Cleaner Production*, 5(1–2), 109–113. doi:10.1016/S0959-6526(97)00013-9.
- Pederson, E. R. G., & Huniche, M. (2011). Negotiating lean: The fluidity and solidarity of new management technologies in the Danish public sector. *International Journal of Productivity and Performance Management*, 60(6), 550–566. doi:10.1108/17410401111150742.
- Platt, A., & Warwick, S. (1995). Review of soft systems methodology. *Industrial Management and Data Systems*, 95(4), 19–21. doi:10.1108/02635579510086698.
- Radnor, Z. J., Holweg, M., & Waring, J. (2012). Lean in healthcare: The unfulfilled promise. *Social Science and Medicine*, 74, 364–371. doi:10.1016/j.socscimed.2011.02.011.
- Radnor, Z., Walley, P., Stephens, A., & Bucci, G. (2006). *Evaluation of the lean approach to business management and its use in the public sector*. Edinburgh: Office of the Chief Researcher, Scottish Executive.
- Reason, P., & Bradbury, H. (Eds.). (2001). *Handbook of action research: Participative inquiry and practice*. London: Sage.
- Ritchie, C., & Taket, A. (1994). Operational research and community operational research: Some background. In C. Ritchie, A. Taket, & J. Bryant (Eds.), *Community works: 26 case studies showing community operational research in action*. Sheffield: Pavic Press.
- Ritchie, C., Taket, A., & Bryant, J. (Eds.). (1994). *Community works: 26 case studies showing community operational research in action*. Sheffield: Pavic Press.
- Ritchie, J., Lewis, J., McNaughton Nicholls, C., & Ormston, R. (2014). *Qualitative research practice: A guide for social science students and researchers* (2nd edition). London: Sage.
- Rosenhead, J. (1986). Custom and practice. *Journal of the Operational Research Society*, 37(4), 335–343. doi:10.1057/jors.1986.61.
- Rosenhead, J., & Mingers, J. (2001). *Rational Analysis for a problematic world revisited: Problem structuring methods for complexity, uncertainty and conflict* (2nd edition). Chichester: Wiley.
- Rother, M., & Shook, J. (2003). *Learning to see: Value stream mapping to add value and eliminate Muda* (2nd edition). Cambridge MA: Lean Enterprise Institute.
- Seddon, J. (2008). *Systems thinking in the public sector: The failure of the reform regime and a manifesto for a better way*. Axminster: Triarchy Press.
- Seddon, J., & Caulkin, S. (2007). Systems thinking, lean production and action learning. *Action Learning: Research and Practice*, 4(1), 9–24. doi:10.1080/14767330701231438.
- Sharma, S., & Henriques, I. (2005). Stakeholder influence on sustainability in the Canadian forest products industry. *Strategic Management Journal*, 26, 159–180. doi:10.1002/smj.439.
- Sommer, K. A., & Mabin, V. J. (2016). Insights into the eldercare conundrum through complementary lenses of Boardman's SSM and TOC's evaporating cloud. *European Journal of Operational Research*, 248, 286–300. doi:10.1016/j.ejor.2015.06.033.
- Spithoven, A. H. S. G. M. (2001). Lean production and disability. *International Journal of Social Economics*, 28(9), 725–741. doi:10.1108/EUM0000000005690.
- Stringer, E. T. (1999). *Action research* (2nd edition). London: Sage.
- Taylor, A., & Taylor, M. (2009). Operations management research: Contemporary themes, trends and potential future directions. *International Journal of Operations and Production Management*, 29(12), 1316–1340. doi:10.1108/01443570911006018.
- Towill, D., & Christopher, M. (2002). The supply chain strategy conundrum: To be lean or agile or to be lean and agile? *International Journal of Logistics Research and Applications*, 5(3), 299–309.
- Ufua, D. E. (2015). *Enhancing lean interventions through the use of systems thinking in the food production industry: A case in the Niger Delta Region, Nigeria*. Ph.D. thesis. Hull: University of Hull.
- Ufua, D. E., Papadopoulos, T., & Midgley, G. (2015). *Enhancing lean interventions through the use of systems thinking in the food production industry: A case in the Niger Delta Region of Nigeria*. In *Proceedings of the 58th Annual conference of the international society of the systems sciences (ISSS)*, Washington DC, USA August 2014.
- Ulrich, W. (1983). *Critical Heuristics of social planning: A new approach to practical philosophy*. Berne: Haupt.
- Ulrich, W. (1996). *A primer to critical systems heuristics for action researchers*. Hull: Centre for Systems Studies.
- Uzochukwu, C. U., & Ossai, I. F. (2016). Lean production: A frontier for improving performance of oil and gas companies in Nigeria. *Pyrex Journal of Business and Finance Management Research*, 2(5), 35–41.
- Vlachos, I. (2015). Applying lean thinking in the food supply chains: A case study. *Production Planning & Control*, 26(16), 1351–1367. doi:10.1080/09537287.2015.1049238.
- Walsh, M., & Hostick, T. (2005). Improving health care through community OR. *Journal of the Operational Research Society*, 56(2), 193–201. doi:10.1057/palgrave.jors.2601896.
- Waltner-Toews, D., Kay, J., Murray, T. P., & Neudoerffer, C. (2004). Adaptive methodology for ecosystem sustainability and health (AMESH): An introduction. In G. Midgley, & A. E. Ochoa-Arias (Eds.), *Community operational research: OR and Systems thinking for community development*. New York: Kluwer/Plenum.
- Webster, K. (2013). What might we say about a circular economy? Some temptations to avoid if possible. *World Futures*, 69(7–8), 542–554. doi:10.1080/02604027.2013.835977.
- White, L. (2003). The role of systems research and operational research in community involvement: A case study of a health action zone. *Systems Research and Behavioral Science*, 20(2), 133–145. doi:10.1002/sres.537.
- White, R. E., Pearson, J. N., & Wilson, J. R. (1999). JIT manufacturing: A survey of implementation in small and large US manufacturers. *Management Science*, 45(1), 1–15. doi:10.1287/mnsc.45.1.1.
- Wilson, B. (1984). *Systems: Concepts, methodologies, and applications*. Chichester: Wiley.
- Womack, P. J., Jones, D. T., & Roos, D. (1990). *The machine that changed the world*. Toronto: Collier MacMillan Canada Inc.
- Womack, J. P., & Jones, D. T. (1996). *Lean thinking: Banish waste and create wealth in your corporation*. London: Touchstone books.
- Womack, J. P., & Jones, D. T. (2003). *Lean thinking: Banish waste and create wealth in your corporation* (2nd edition). London: Simon and Schuster.
- Yolles, M. (2001). Viable boundary critique. *Journal of the Operational Research Society*, 52(1), 35–47. doi:10.1057/palgrave.jors.2600069.
- Zaman, A. U. (2014). Identification of key assessment indicators of the zero waste management systems. *Ecological Indicators*, 36, 682–693. doi:10.1016/j.ecolind.2013.09.024.
- Zaman, A. U. (2015). A comprehensive review of the development of zero waste management: Lessons learned and guidelines. *Journal of Cleaner Production*, 91, 21–25. doi:10.1016/j.jclepro.2014.12.013.
- Zaman, A. U., & Lehmann, S. (2011). Urban growth and waste management optimization towards 'Zero waste city'. *City, Culture and Society*, 2, 177–187. doi:10.1016/j.ccs.2011.11.007.