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A new critical realist approach for evaluating multimethodological practice in operational research

Jane S. Christie^{a*}, John Mingers^a, Kathy Kotiadis^a, Martin Parr^{b1}

^aDepartment of Analytics, Operations and Systems, Kent Business School, University of Kent, Sibson, Parkwood Road, Canterbury, Kent, CT2 7FS, UK ^bDstl, Portsdown West, Fareham, PO17 6AD, UK

Abstract

Understanding why practitioners take the actions they do in multimethodological operational research (OR), and the effects these actions have, is fundamental for evaluating and improving practice. But it is widely recognized in OR literature and amongst practitioners that objective, comparative evaluation of complex, real-world interventions is challenging if not impossible. It is not clear how multimethodology should be evaluated. Critical realism has been advocated for exploring causation to evaluate OR practice holistically, but not fully operationalized. For our collaborative research evaluating multimethodological practice supporting strategic decision-making in non-academic settings, we therefore developed a new approach. We synthesized and operationalized empirical research and theories in OR and recent developments in critical realism and social science. In this paper, we present our theoretical framework – a new critical realist ontology of multimethodological OR practice and methodologies – and our empirical research design. We illustrate the approach with a case study of an OR analysis for a business case for government investment in a national capability. We demonstrate how we investigated the intervention context and the complex process of practitioners' choice of methods using interviews and project documents, thematic and comparative analysis, rich description, and structural and causal analysis. We explore how this new operationalization of critical realism for identifying and comparing causal mechanisms across practitioner case studies can be used: (1) to examine mechanisms leading to other actions and outcomes, including intervention success; and (2) to theorize and evaluate mixed methods research projects across disciplines, including their causal complexity and practical utility.

Keywords: Decision processes; Critical realism; Causal complexity; Multiparadigm multimethodology; OR in government

1. Introduction

In this paper, we report a new approach for evaluating multimethodological practice in operational research (OR). Multimethodology (Mingers & Brocklesby, 1997) or mixing methods (Ackermann & Howick, 2022) is the use of multiple methods or methodologies in a single intervention or research project (Christie, 2023).¹ Multimethodology is widely recognized as an essential part of the OR practitioner's role in addressing the complexity of real-world issues (Ackermann & Howick, 2022; Christie, 2025; Dyson et al., 2021; French, 2022; Härmäläinen et al., 2013; Jackson, 2019; Ranyard et al., 2022; Wright et al., 2019). We present findings from our research project evaluating multimethodological OR practice supporting strategic decision-making for or on behalf of the UK government.

In OR literature, addressing strategic issues is associated with the use of combinations of qualitative and quantitative methods (Mingers, 2001; O'Brien, 2011). Strategic issues are practical issues requiring analysis,

E-mail addresses: J.S.Christie-54@kent.ac.uk, j.mingers@kent.ac.uk, k.kotiadis@kent.ac.uk, martin.parr@guidedsystemssolutions.com

*Corresponding author

¹Present address: Guided Systems Solutions Limited, 71-75 Shelton Street, London, England, WC2H 9JQ, UK

persuasion, and judgement (Ravetz, 1971, as cited in Rosenhead & Mingers, 2001). They are conceptualized in OR as complex and as tending to be, or at least partly, wicked in nature (after Rittel & Webber, 1973; Mingers & Rosenhead, 2011). Qualitative methodologies known as problem structuring methods (PSMs) (Rosenhead, 1989, 1992, 1996) and other qualitative and participative methods, such as brainstorming (O'Brien, 2011) and SWOT analysis (Marttunen et al., 2017), are therefore seen as essential for addressing socio-political aspects of such interventions (Abdel-Malek et al., 1999; Ackermann, 2012, 2024; Christie, 2023; Dyson et al., 2021; Eden & Ackermann, 2004; Mingers & Brocklesby, 1997; Pidd, 2004; Rosenhead & Mingers, 2001).

However, in OR literature, it is not clear how the effectiveness of multimethodology should be evaluated across interventions and methods, and beyond academic practice (Brocklesby, 2023; Christie, 2023; Howick et al., 2017; Midgley et al., 2013). To date, evaluations of multimethodology in OR literature have tended to analyse particular aspects of single cases of multimethodological practice led by academic practitioners (Ackermann & Howick, 2022; Christie et al., 2022). There is a lack of in-depth, comparative analysis of practitioner case studies. These gaps are a concern for an applied, scientific discipline such as OR, in which cumulative knowledge of methods and practice is applied by practitioners to change real-world situations. In this paper, we address these gaps.

For our evaluation of multimethodological OR practice in non-academic settings, we needed a new approach for analysing and comparing the *complexity* of single cases. To generate learning across multimethodological OR practice, there is a need, first, to understand the complexity of single interventions (Brocklesby & Beall, 2018; Howick & Ackermann, 2011). Every intervention is unique and cannot be replicated (Checkland, 1981). We align our view with those of scholars who have concluded that objective evaluation of multimethodological practice is therefore challenging if not impossible (Midgley et al., 2013; White, 2006). For practical and ethical reasons in our collaborative research project, we agreed that it would not be possible to understand sufficiently the context and detail of single cases of multimethodology by reducing their complexity to sets of quantitative variables for modelling or practical experimentation (cf. Finlay, 1998; Franco et al., 2021). Instead, we needed a new systematic and systemic scientific approach for understanding and comparing multiple cases while preserving case complexity.

The central contribution of this paper is the operationalization of critical realism for evaluating multimethodological practice across OR. Our research questions were about why practitioners take the actions they do, and the effects these actions have. Therefore, we developed a new critical realist approach for investigating *causality* in multimethodological practice. Critical realism affords the possibility of examining causality (Bhaskar, 2008, 2016; Elder-Vass, 2015b; Modell, 2020; O'Mahoney et al., 2017; White, 2006, 2009, 2016; Yearworth & White, 2014). However, critical realism has not previously been fully operationalized for such empirical case study research (White, 2016). The new approach in this paper can be used to identify causal mechanisms that lead to participant actions and outcomes in multimethodological OR interventions, and to compare them across practice.

The remainder of the paper is organized as follows. In section 2, we review literature on evaluating multimethodology in OR, the suitability of critical realism for single- and multiple-case evaluation, and prior use of critical realism in OR. In sections 3 and 4, we present the new critical realist approach for evaluating multimethodological OR practice – our theoretical framework and the empirical research design. In section 5, we illustrate the approach with a case study, showing how to identify causal mechanisms. In section 6, we discuss the contributions and limitations of the research, and future research opportunities. We conclude the paper in section 7.

2. Background literature

2.1. Past evaluations of multimethodology in OR practice

To understand the complex social process of OR intervention (Keys, 1997; Midgley, 2000; Ormerod et al., 2023), it is vital to analyse and evaluate the unique complexity of single cases (Brocklesby & Beall, 2018; Howick & Ackermann, 2011; Welch et al., 2022). Yet in OR literature, there is a lack of understanding of multimethodological practice, especially in non-academic settings (Ackermann & Howick, 2022; Brocklesby, 2023; Christie, 2023, 2025; Howick et al., 2017; Midgley et al., 2013; Morgan, 2013; Wijnmalen & Curtis, 2013). Empirical evidence of the effectiveness of multimethodological OR interventions, particularly across methods, interventions and practitioners is limited (Ackermann & Howick, 2022; Hanafizadeh & Mostasharirad, 2025; Howick & Ackermann, 2011; Midgley et al., 2013). Ackermann and Howick (2022) reported an interview study of experienced mixed modellers (academic and non-academic) focusing on insights relating to modelling teams. However, Ackermann and Howick also noted that published evaluations of multimethodology have tended to be single-case analyses of OR practice led by academic researchers. Often, these evaluations involved action research investigating specific aspects of multimethodology (Christie et al., 2022; e.g., Henao & Franco, 2016; Small & Wainwright, 2018; cf. Howick et al., 2017). Recent literature reviews have tended to focus on single case studies of the use of particular methodologies in and beyond OR (e.g., Abuabara & Paucar-Caceres, 2021; Hanafizadeh & Mehrabioun, 2018; Marttunen et al., 2017; Zolfagharian et al., 2018; cf. Christie, 2023; Hanafizadeh & Mostasharirad, 2025). Surveys have revealed more of what non-academic OR practitioners do, but have lacked detail of single multimethodological projects (e.g., O'Brien, 2011; Ranyard et al., 2015). As a result, there is a lack of understanding of the complex process and the effectiveness of multimethodological practice across OR.

Moreover, there is a pressing need to find ways to compare multiple cases in order to understand underlying mechanisms and outcomes (Brocklesby & Beall, 2018; Franco et al., 2021; Luoma, 2016; Midgley et al., 2013; Yearworth & White, 2014). Howick and Ackermann (2011) concluded from their review of practical multimethodological interventions in peer-reviewed OR journals that 'there appears to be little discussion between members of the community on the generic lessons that could be identified from mixing methods in practice' (p. 503). Since then, there has been significant progress in examining how specific qualitative and quantitative methods and methodologies can be used together (Ackermann et al., 2014; Brocklesby, 2023; Christie, 2017, 2025; e.g., Ferretti, 2016; Lamé et al., 2019; Marttunen et al., 2017; Tako & Kotiadis, 2015). Some practitioners have reviewed their own approaches (e.g., Hoverstadt & Loh, 2023) and developed theory by reflecting on their practical experience across multimethodological OR interventions (Jackson, 2019, 2020, 2021, 2022a, 2022b; Midgley, 2011, 2015, 2018, 2023; Mingers, 2014, 2015; Ormerod, 2008b, 2014b). But to review insights into the complex *process* of the practice of multimethodology across OR, Ackermann and Howick (2022) returned to their (2011) literature review and Munro and Mingers' (2002) survey. Both studies, now more than twenty years' old, used thematic analysis and descriptive statistics to compare cases. Therefore, the lack of cross-case learning about the complex process and outcomes of multimethodological OR practice persists.

2.2. Critical realism and causal mechanisms

There have been calls for mechanistic accounts of why things happen in or as a result of OR interventions (Franco, 2013; Yearworth & White, 2014). Critical realism (Bhaskar, 2008, 2016; Danermark et al., 2002, 2019; Easton,

2010; Edwards et al., 2014) has been claimed as ‘the most thorough and consistent articulation of a mechanisms-based approach’ (Mingers & Standing, 2017, p. 187). It can be contrasted with positivist and interpretivist approaches along the metaphysical dimensions of ontology and epistemology (Hassan & Mingers, 2018; Mingers & Brocklesby, 1997; White, 2006, 2016; see also Appendix A in the supplementary materials). Critical realism’s realist ontology (of entities with causal powers and liabilities) provides a credible basis for scientific research in an applied discipline such as OR, in which cumulative knowledge of methods and practice is applied to change real-world situations (Mingers, 2015). With critical realism, we reject positivism’s reduction of causation to the Humean notion of constant conjunctions of events in controlled, closed systems (Mingers, 2015). Instead, real-world situations are open systems in which events (in the actual domain) are generated by multiple, interacting causal mechanisms (in the real domain of entities). At the same time, critical realism’s relativist epistemology acknowledges that empirical evidence is partial, objective reality is socially mediated, and social science is value full (Bhaskar, 2016). Against a background of calls for more use of social science in the study of OR practice (Brocklesby, 2016; Ormerod et al., 2023), critical realism therefore provides a promising, under-explored alternative to ‘determinist and voluntarist extremes’ for understanding individuals’ actions and their effects (Franco et al., 2021, p. 403).

In fact, critical realism provides a structured approach for investigating causal processes or mechanisms that explain social phenomena in terms of causal effects and outcomes (Cornelissen & Werner, 2025). In critical realism, mechanisms are ‘nothing other than the ways of acting of things’ (Bhaskar, 1975, p. 14, as cited in Wynn & Williams, 2020). These things, or entities, are material, conceptual, or social (Mingers, 2004). As we shall explore in this paper, in multimethodological OR practice, these entities will include practitioners’ knowledge and skills, reflexivity and agency; technology and models; social structures; and cultural resources, such as method guidance.

In critical realist case research (Easton, 2010), events (e.g., individuals’ actions) are reflected in observed experiences in research data (in the empirical domain). However, powers and liabilities of entities or structures, causal mechanisms, and their interactions (in the real domain), may or may not be observed or observable (Mingers & Standing, 2017; Westhorp, 2019). Critical realist analysis of research data therefore involves abduction (redescription), retroduction and retrodiction (Bhaskar, 2016; Mingers, 2014). Redescription is used to identify entities and structures in the real domain. Retroduction is used to propose underlying mechanisms. Retrodiction is used to ‘investigate what mix of causal powers [of entities and structures] interacted in what way to produce any particular event’ (Elder-Vass, 2015a, p. 81). Alternative causal explanations (Maxwell, 2004) can then be developed and refined over time using further retroduction, retrodiction, collaboration and justification. By conducting single and multiple critical realist case studies, we can therefore investigate ‘both the local and general nature of mechanisms and structures’ (Frederiksen & Kringelum, 2021, p. 31). With comparative analysis of multiple cases of multimethodological practice across OR, we can then build better understanding of underlying mechanisms and the variety of intervention outcomes (Ackroyd & Karlsson, 2014).

2.3. Prior use of critical realism in OR scholarship

In OR literature, critical realism was introduced as a suitable philosophy for multimethodological OR practice (Kotiadis & Mingers, 2006; Mingers 1997a, 2000a, 2003, 2006b, 2014, 2015) and for research into OR practice (White, 2006, 2009). However, Yearworth and White (2014) concluded that, in initial academic debates,

... instead of deliberating on the pertinence or potential benefits of a deeper view on causation and causal explanation to guide enquiry into the practice of OR, the discussion has been pushed, perhaps inadvertently, into an arena of paradigmatic struggles where particular methodological and theoretical issues have displaced more general discussion on mechanisms. (p. 933)

More recently, critical realism was specifically recommended for exploring causation to evaluate OR practice holistically (White, 2016). To date, scholars have employed critical realism in research about how to use particular methods in multimethodological practice and research, for example, qualitative coding with causal loop diagrams (Yearworth & White, 2013), and more generally in the theory of multimethodology (Mingers, 1997a, 1997b, 2003, 2006b, 2008, 2014, 2017; Mingers & Brocklesby, 1997). Scholars used critical realism in proposing a problem-structuring approach to be used with other methodologies for decisions for sustainable development of large-scale infrastructure (Hector et al., 2009) and to understand philosophical assumptions of system dynamics modelling and discrete event simulation (Mingers, 2000a; Mingers & White, 2010; Rotaru et al., 2014). Critical realism was used in positioning research into frameworks for mixing system dynamics and discrete event simulation in practice (Morgan, 2013) and in positioning research into everyday problem structuring activity (Reynolds, 2021). Shaw et al. (2017, 2019) employed critical realism to theorize causal mapping of Brexit debates and narrative (that used quantitative and qualitative analysis of debates and interviews).

Scholars have also used critical realism to understand the use of problem structuring methods (PSMs) in practice while drawing on Pawson and Tilley's (1997) realist evaluation to underpin their causal analyses. Yearworth and White (2014) employed critical realism in deriving their generic constitutive definition for PSMs for identifying non-codified PSM use in engineering practice using Pawson and Tilley's (1997) context-mechanism-outcome (CMO) heuristic. In their conceptualization, PSM use is 'a process of generative causality' (p. 937; a causal mechanism, M) that links a context (C) appropriate for PSM use with 'a [unique] set of purposeful activities ... arising from the application of a putative PSM' (p. 936; the outcome, O). PSM use is a regularity of problem structuring behaviours observed consistently across interventions regardless of the specific intervention methodology. Similarly, Tully et al. (2019) conceptualized a PSM (or other intervention methodology) as a causal mechanism (M) that leads to a unique intervention outcome (O). However, Tully et al.'s research focused on another mechanism that takes a practitioner and client from problem to intervention contract. Steenmans (2017) also employed critical realism and the CMO heuristic in a complex adaptive systems (CAS) model of infrastructure planning practice, its contextual conditions (C), integration mechanisms (M), and challenges arising (O), which were addressed using PSMs. She then evaluated the impact of the PSM use (in relation to the CAS-CMO model and propositions for the impact of PSM use).

In summary, scholars have used critical realist concepts, but critical realist research into OR practice is limited (Franco et al., 2021; White, 2016; Yearworth & White, 2014). As with any research approach, some of this limited use can be put down to limitations. In relation to causation, it is acknowledged that there are practical challenges with the epistemological view of mechanisms as real but unobservable (Mingers, 2014; Shaw et al., 2019), and as interacting in complex and unpredictable ways to co-determine events (Cornelissen & Werner, 2025; White, 2016). More generally, there are ongoing debates about critical realism's assumption of judgemental rationality (Isaksen, 2024). That is, that it is possible to judge and conclude that some explanations are better than others (Mingers, 2015; cf. Midgley, 2023). In practice, judgemental rationality is reflected in corroboration of explanations of events

(including with other scholars), and justification of results in light of existing theory and empirical findings (Bhaskar, 2008). More fundamentally, there has been a general lack of methodological guidance for using critical realism in applied social research (Alderson, 2021; Fletcher, 2017; Maisuria & Banfield, 2023; Nichol et al., 2023).

In conclusion, in OR, details of how to apply critical realism to identify causal mechanisms that lead to intervention events and outcomes have not been worked out. Therefore, critical realism has not been fully operationalized for evaluating the effectiveness of multimethodology (White, 2016). Accordingly, next we present our new approach for evaluating multimethodological OR practice – the theoretical framework and empirical research design.

3. Theoretical framework

Existing theoretical frameworks for studying OR practice only partially addressed our research needs, so we developed a new framework. In this section, we show how we developed our theoretical framework by synthesizing and operationalizing scholarship on OR practice and critical realism.ⁱⁱ

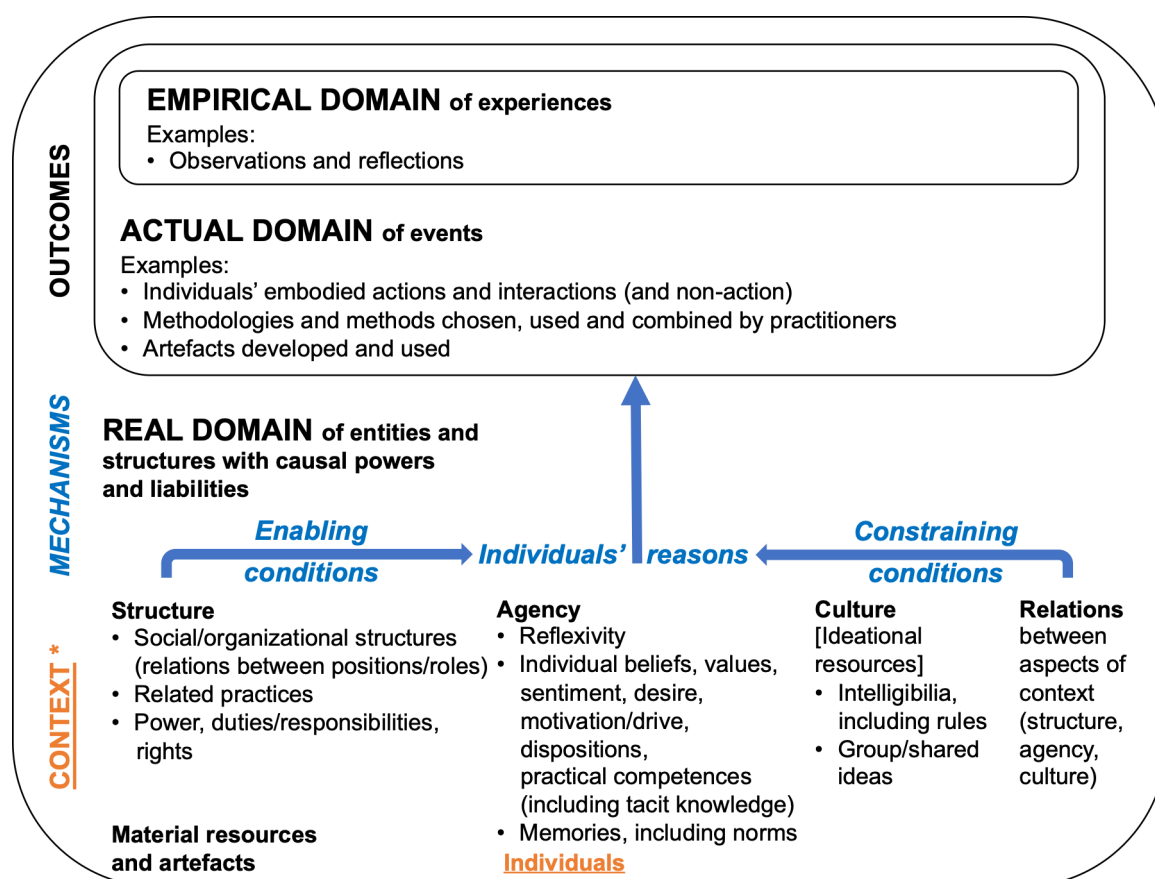
3.1. Introduction

In our research, we sought to analyse and compare single cases of multimethodological OR practice. However, because of the open, complex systems in which multimethodological OR practice occurs, in our theoretical framework we needed to focus on areas of theoretical interest (Mingers & Standing, 2017; Ormerod, 2014a). In evaluating multimethodological OR practice, we could not consider all possible influences on outcomes in one study. We needed to choose a level of analysis at which causal mechanisms were of interest (Zachariadis et al., 2013). Therefore, we defined a single OR intervention as ‘the process in which practitioners seek to understand and analyse situations, make recommendations to organizational clients about possible improvements, and support organizational action’ (Christie, 2023, p. 163). Adopting critical realism, we conceptualized an intervention as a series of events (Mingers, 2014; section 2.2 above). In our research, we then sought to identify and compare causal mechanisms that generated these events within and across cases of multimethodological OR practice.

For the overall structure of our framework (illustrated in Figure 1) we therefore combined Bhaskar’s (2008, 2016) empirical, actual and real domains (shown top to bottom in Figure 1; section 2.2 above) with Pawson and Tilly’s (1997) context-mechanism-outcome terminology (shown bottom to top on the left-hand side of Figure 1). As we aimed to identify causal mechanisms that led to intervention events and outcomes, we adopted the context-mechanism-outcome terminology from realist evaluation. However, in contrast with Yearworth and White’s (2014) framework, we did not assume a particular intervention context, nor particular outcomes, nor presuppose practitioners’ use of particular methods (PSMs). Further, in our critical realist research, we were interested in causal mechanisms that may not be observable as participant behaviours (in the empirical domain). Instead, we needed to consider the ‘context or field of operation’ (Bhaskar, 2014, p. viii) in which practitioners actually took action. Our conceptualization of multimethodological practice then needed to reflect that, in any particular context, ‘human action [in the actual domain] is influenced and co-determined by social structures, mechanisms and situations [in the real domain]’ (Bhaskar, 2016, p. 73; Danermark et al., 2019; Hinds & Dickson, 2021; Mukumbang et al., 2023). Hence, we combined critical realism’s three domains (empirical, actual, real) with the context-mechanism-outcome terminology to structure our investigation and comparison of causal mechanisms in multimethodological practice.

Thus, our theoretical framework is a new critical realist ontology of the context, mechanisms and outcomes of multimethodological OR practice. As shown at the top of Figure 1, some intervention events (in the actual domain)

may be experienced by those involved or present in the empirical domain as observations or reflections (Bhaskar, 2008, 2016; Fleetwood, 2009; Fryer, 2022). Moving down Figure 1, these experiences in the empirical domain are a subset of all events that actually occur in the actual domain. We conceptualized experiences and events as the *outcomes* of the intervention (top left of Figure 1). Moving further down Figure 1, events result from one or more causal *mechanisms* of entities and structures in the intervention *context* in the real domain. In Figure 1, causal mechanisms are illustrated with blue arrows and *italicized text*. Overall, this new ontology (illustrated in Figure 1) enables the identification of mechanisms that together provide explanation of why things happen in and as a result of a multimethodological OR intervention (Mingers & Standing, 2017; White, 2016; Yearworth & White, 2014).



* Note: Pre-existing methodologies are located across structure, agency and culture in the intervention context.

Figure 1: The theoretical framework – a new critical realist ontology of a multimethodological OR intervention

In the following subsections, we explain how we developed the new ontology of entities and structures in the real domain (below the arrows in Figure 1). Generally, in a multimethodological OR intervention there are observable entities (e.g., individuals or reports). There are also unobservable entities (e.g., ideas). Following Bhaskar (1997), we conceptualized all these as real entities with powers ‘to generate or cause a particular outcome to or with some other entity or system, within a particular context’ (Mingers, 2014, p. 72, emphasis removed). As a starting point for identifying entities and structures in the new ontology, we synthesized empirical research and theories in existing OR literature to identify three generally accepted elements of any multimethodological OR intervention (context, individuals, methodologies). In Figure 1 and its note, these are highlighted with underlined, orange text. Then, we analysed each of the three elements by combining our synthesis of OR literature with analysis using a critical realist lens (drawing especially on Archer, 1995, 1996; Bhaskar, 2016; De Souza, 2013, 2022; Fleetwood, 2005, 2021; Mingers, 2006a, 2014; Porpora, 2016). Thereby, we identified entities and structures that are

summarized in the bullet points under structure, agency, and culture in Figure 1 (i.e., the various aspects of the intervention context at the bottom of the illustration). We provide examples below. Together, these entities and structures constitute the new ontology of a multimethodological OR intervention.

3.2. The three elements of a multimethodological OR intervention

The three generally accepted, interrelated, and overlapping elements of any multimethodological OR intervention that we analysed for the new ontology are context, individuals, and methodologies. They follow from evidence of practical OR interventions from surveys (Abdel-Malek et al., 1999; Fildes & Ranyard, 1997; Fildes et al., 1999; Mingers & Taylor, 1992; Munro & Mingers, 2002, 2004; O'Brien, 2011; Ranyard et al., 2015); literature reviews (Howick & Ackermann, 2011; Keys & Midgley, 2002; Morgan, 2013); and field studies (e.g., Corbett et al., 1995; Ormerod, 1997, 2002; Overmeer et al., 1998; Willemain, 1994). We synthesized that empirical evidence with other theoretical literature on method choice and multimethodology. For the detailed review, see Christie (2025). The three elements are similar to the three notional systems that constitute the context of a multimethodological intervention in the theory of the process of multimethodology (Mingers, 1997a, 1997b, 2003, 2006b, 2014), which we develop within a critical realist framework. They are broadly consistent with the first three of the four focuses (context, purposes, methods, outcomes) in Midgley et al.'s (2013) framework for evaluating PSM use. Midgley et al. (2013) adopted purpose(s) in place of individuals, purposes being *of* individuals. They are also broadly consistent with Howick et al.'s (2017) themes for evaluating multimethodological interventions, which add modelling team (Ackermann & Howick, 2022). Next, we analyse each of the three elements by synthesizing OR and critical realist literature to identify entities and structures in the new ontology in Figure 1.

3.3. The multimethodological OR intervention context

The first element of a multimethodological OR intervention is the intervention context (at the bottom of Figure 1). It includes the real-world situation or intervention issues (that may be) addressed, and the broader context of constant change (Howick et al., 2017) or flux (Checkland & Scholes, 1990). We conceptualized that, at the outset of a multimethodological OR intervention, real issues to be addressed, and their being seen as problematic (Mingers, 2017), are emergent from the history of the situation. As intervention proceeds, real issues, and how they are viewed, are emergent from the history of the intervention. This importance of history, as well as the interaction of aspects of the intervention context, were emphasized in Mingers' (1997b, 2006b, 2014) accounts of multimethodology (though without the detailed ontological specification needed for our empirical research). They can be found in other theoretical accounts too (e.g., see Yearworth & White, 2014, p. 937, on theories of the process of problem structuring).

In Figure 1, the intervention context includes aspects of structure, agency and culture. In fact, our new ontology of the multimethodological intervention context in Figure 1 builds on De Souza's (2013) critical realist elaboration of realist evaluation for social programmes.ⁱⁱⁱ De Souza conceptualized that, prior to the design of a new social change programme, the context comprises interrelated, 'aspects of structure, culture, agency and [their] relations' (De Souza, 2013, p. 145, after Archer, 1995, 1996). These four aspects of the pre-existing context are the conditions in which individuals take action in designing and introducing change programmes in organizational settings (De Souza, 2013, 2022). In any pre-existing context, there are 'structural and cultural mechanisms providing constraining conditions' and 'enabling conditions', and 'agent-activated mechanisms stemming from [individuals']

interactions with social structures' (De Souza, 2022, p. 83). A novel change programme, with stated aims, emerges *as a result of* these conditions or causal mechanisms. Like the pre-existing context, the programme itself will also comprise causal mechanisms, the outcomes of which can later be evaluated (Danermark et al., 2019; De Souza, 2022; Porter, 2015; Ratnayake, 2025). Hence, in our conceptualization of a multimethodological OR intervention in Figure 1, the context comprises aspects of *structure*, *agency* and *culture*, as well as *relations* between these aspects.

As shown in the bottom left of Figure 1, in multimethodological OR, there will also be pre-existing *material resources and artefacts*, including technology and physical representations of models (Franco, 2013, 2014; Lami & Todella, 2026; Ormerod, 2014a; Paroutis et al., 2015; Yearworth & White, 2014). Also in Figure 1, we illustrate with arrows our conceptualization of causal mechanisms we were interested in for evaluating multimethodological OR practice. The mechanisms include conditions that enable and constrain individuals' reasoning and actions. Accordingly, what individuals do (their actions and non-action in the actual domain) results from mechanisms of structure, agency, culture, and their relations, as follows:

... we may regard the agent's [individual's] reasons (for an action or a course of action) as a causal mechanism that triggers a particular course of action. Such a course of action may be regarded as a tendency, subject to the play of enabling and constraining ['personal, social and environmental'] conversion factors ['that account for differences between people in converting their capabilities into achievements'] ... (Bhaskar, 2016, p. 67)

Thus, our critical realist ontology of the context of a multimethodological OR intervention provided a framework for our empirical analysis of causal mechanisms that led to individuals' actions in particular interventions.

However, we still needed to identify the entities and structures within structure, agency, and culture (summarized in the bullet points under structure, agency, and culture in Figure 1). Therefore, in what follows, we first analyse structure, before moving to agency (in the next subsection on individuals). We then complete the presentation of the new theoretical framework by showing how we developed a new ontology of methodologies (being the third and final element of a multimethodological OR intervention).

Turning first to structure, we conceptualized that, generally in multimethodological OR interventions, practitioners (and other individuals) have organizational roles, and, more generally, social positions. Thus, at the bottom of Figure 1, *structure* comprises social and organizational structures that include positions or roles (with related power, duties/responsibilities, and rights) and related practices (De Souza, 2013, after Bhaskar, 1998). Following Bhaskar, social structure is relational. It does not comprise relations between persons, but relations between positions (in social structures generally) or roles (in organizations; M. I. Reed, 2009). Roles are associated with access to resources. Bhaskar's *position-practices* then link social structure and action (Mingers, 2014, p. 99). Having analysed the types of entities and structures in Figure 1 under structure, next, we analyse agency.

3.4. Individuals involved in or affected by the multimethodological OR intervention

The second element of a multimethodological OR intervention is individuals involved in or affected by the intervention (Ormerod, 2001, 2008a, 2008b, following Freeman, 1984, p. 52). It includes practitioners, and their knowledge and skills (Easton, 2010), or competences (White et al., 2020). It also includes other individuals (e.g., clients) and individuals' purposes (Midgley, 2000; Midgley et al., 2013) and expectations (Mingers, 2006b). We drew on Bhaskar's (2016) conceptualization of 'immediate, formative components of action' (cognitive, conative, affective, expressive and performative) that are 'learnt, formed, developed' and 'necessary for action' (p. 64).

Accordingly, as reflected in bullet points under *agency* in Figure 1, an individual's causal powers to act may result from their beliefs, values, sentiment, desire, motivation/drive, dispositions, and practical competences, as well as their facilities (being access to resources, which contribute to a person's transformative capacity). Opportunities to act are possibilities and circumstances (including a person's capabilities) in multiply determined contexts. Thus,

The following can be put forward as a rough formula for the formation of action:

social structural conditioning + circumstances + reflexive deliberation + values (in relation to capacities/capabilities + feasibility) = determination of the appropriate course of action (Bhaskar, 2016, p. 66)

Understanding practitioner (or other individual) action therefore requires consideration of practitioner reflexivity (also under *agency* in Figure 1). This includes practitioner reflexivity 'in relation to her [their] capacities or capabilities and the feasibility (including chances of success) of the course of action being considered' (Bhaskar, 2016, p. 64).

Finally, under *agency* in Figure 1, we include norms and, more generally, memories. This follows Fleetwood's (2021) argument that norms are 'always located in agents' [individuals'] cognitive systems ... as memories of past actions' (p. 632). We saw in the previous subsection that positions and roles are associated with individuals' practices (under *structure* in Figure 1). In organizational settings, rules and norms also underly practice in that they condition action (Fleetwood, 2021). In relation to individuals' projects or goals (Archer, 1995), rules and norms may be constraining or enabling. While we have *norms* within agency, we conceptualized the 'meaningful content' (Porpora, 2016, p. 159) of *rules* as part of Archer's (1995) 'cultural system' (p. 229). Fleetwood (2021) argues convincingly that rules are 'always located in artefacts' (p. 632). Rules are therefore under *culture* in Figure 1. We shall return to Archer's cultural system. Next, we analyse the third and final element of any multimethodological OR intervention, and show how we developed a new critical realist ontology of methodologies.

3.5. Methodologies and methods

In existing literature, there are a number of conceptualizations of OR methodologies and methods in OR practice. In multimethodology, Mingers' (1997b, 2006b) notional Intellectual Resources System 'consists of those theories, methodologies, and techniques [or methods] that could potentially be relevant to the problem situation, although not necessarily within the practitioners' current repertoire' (Mingers, 2006b, p. 218).^{iv} Midgley (2000) drew on this in systemic intervention, concluding that practitioners develop their own methodologies drawing on other practitioners' methodologies. Ormerod (2008b) distinguished between public and private methods, following Keys (1997).

In our conceptualization, OR methodologies, as ontologically real entities, come into existence through their development and use over time. A particular methodology is emergent from pre-existing knowledge, scholarship, and practice (Checkland & Scholes, 1999). Practitioners then develop knowledge and skills in pre-existing methodologies and methods, and apply them in designing interventions and in intervening. Practitioners and scholars may use methodologies in different ways, disagree over details, and develop different versions. But there are many generally recognized methodologies in OR (Gomes Júnior & Schramm, 2022; Mustafee & Katsaliaki, 2020; Petropoulos et al., 2024; Ranyard et al., 2015). Different versions and variations will be established, as in system dynamics and group model building (Vennix, 1996, 1999), or linear programming and data envelopment analysis (Sinuany-Stern, 2022).

Thus, intervention events in the actual domain in Figure 1 include practitioners' choice, use and combination of methods, and their development and use of artefacts. In practice, all methods are adapted and used in different ways by different individuals to suit particular contexts (Greene, 2015; Mingers, 2011). Empirical evidence also suggests that in multimethodological OR practice, practitioners develop their methodological approaches *through* interventions (Christie, 2025; Howick & Ackermann, 2011; Munro & Mingers, 2002). The methodological design of any multimethodological intervention is therefore a characterization of methods *as used* by practitioners (Christie, 2023) in the actual domain.

In our new ontology of methodologies (illustrated in Figure 1 and its note), we therefore distinguish between pre-existing methodologies in the intervention context (in the real domain of structures and entities), methodologies as actually used in the intervention (in the actual domain of events), and methodologies as used in past interventions (i.e., pre-existing methodologies in the context of subsequent interventions). This new ontology of methodologies thus allows consideration of their use and changing nature over time within a processual analysis that is both relational and substantive, reflecting a realist rather than 'strong process' ontology (Cloutier & Langley, 2020, p. 14; see also Midgley, 2000; Yearworth, 2024).

For example, if we are to explain how practitioners design an intervention, then we need to consider the range of methodologies they could and do or do not use, that is, pre-existing methodologies in the intervention context. These methodologies comprise aspects of culture, structure, and agency. We also need to consider other aspects of the intervention context as it changes over time. A methodology *as used* is then a socially emergent, particular configuration of components with causal powers. In turn, this particular methodology (or the methodological design of the multimethodological intervention), may be seen as real where it is used instrumentally by a practitioner and causally implicated in material, psychological and social changes. In fact, we consider an intervention an ongoing process with multiple outcomes resulting from multiple causal mechanisms. Methodologies will result from, or be implicated in, some of these multiple causal mechanisms.

For our empirical research, we then needed a systematic way to analyse the ontology of different pre-existing methodologies in the intervention context. Generally, in multimethodological OR, methodologies are conceptual intervention resources (Mingers, 1997b, 2006b, 2014) that practitioners draw on, develop and adapt (Mingers & Rosenhead, 2004; O'Brien, 2011). In critical realism, all concepts or ideas are real (Bhaskar, 1997) because of the causal effect they have on anything and everything through, '(a) material transactions with nature; (b) social interactions between people; (c) social structure; and (d) the stratification of the embodied personality' (Bhaskar, 2016, p. 53). This is Bhaskar's four-planar social being, or the four dimensions of all social activity.

As noted in Figure 1, in our new ontology of methodologies, pre-existing methodologies (in the context of a multimethodological OR intervention) are located across structure, agency and culture. In other words, their location is 'ontologically peculiar' because there are a number of different ways in which they are real (Porpora, 2016, p. 169; Fleetwood, 2005). For example, within *structure*, a practitioner's organizational role may be as expert in a methodology. Within *agency* are practitioners' memories of past use of methods. We also conceptualized methodologies as products of the minds of their creators that are independent from particular interventions or practitioners. As such they include what Archer (1996) termed 'intelligibilia', or 'meaningful content' purposively 'designed to communicate to or to otherwise influence others' (Porpora, 2016, p. 159). As intelligibilia, they are

components of Archer's (1995) cultural system. In this cultural system, there are logical relations between components, but they need interpretation and can be interpreted in different ways. Examples include descriptions of methods in practitioner discourse. Thus, intelligibilia and shared ideas are under *culture* in Figure 1.

Overall, this new ontology of methodologies facilitated our systematic, ontological, and causal analysis of methodologies as they appeared in different ways and configurations across cases of multimethodology. For example, it could facilitate analysis of the ontology and causal effects of an established version of a methodology, or a practitioner's knowledge of a methodology, or notions of appropriate methodologies for a particular context. A summary of the new ontology of methodologies, with examples, is in Appendix B in the supplementary materials.

3.6. Conclusion

In conclusion, the new critical realist ontology of a multimethodological OR intervention (illustrated in Figure 1 and its note) provides a scientific basis for empirical research for developing theory on multimethodological practice across OR. The framework is theory-informed, building on a synthesis of empirical and theoretical understanding in OR; addresses the social and material, culture and agency; facilitates development of mechanistic understanding of events and outcomes in particular interventions; and clears the way for comparing cases while preserving case complexity. It provides a systematic and systemic basis (Mingers, 2014, 2015) for understanding and evaluating the complex social process of multimethodological OR practice.

4. Empirical research design

We adopted critical realism for our empirical research design because of the structure it provides for investigating causality (Bhaskar, 2016; section 2.2 above). The aim of our research project was to evaluate multimethodology in some example projects. This would facilitate consideration with OR practitioners of whether and how alternative ways of choosing and combining methods may be beneficial (or not) in their practice (i.e., our consideration of the causal impact of multimethodology on intervention outcomes). Therefore, first, we needed to understand why practitioners chose the methods they did in the example projects. Our first research question was, *how do OR practitioners choose and combine OR methods?* Adopting critical realism (Figure 1), we looked to identify specific intervention events (methods practitioners used, and how they combined them in particular interventions). Our second research question was, *why do practitioners take these methodological approaches?* Following Figure 1, we sought to identify entities and structures and causal mechanisms that led to the events (i.e., why practitioners used and combined the particular methods).

However, due to the lack of methodological guidance for critical realist analysis of the process of multimethodological practice, we developed a new research design for our multiple case study research (Table 1). As reflected in the first two columns of Table 1, we built on general guidance for critical realist research (especially Bhaskar, 2016; Danermark et al., 2002; Easton, 2010; Mingers, 2006a, 2014; Sayer, 1992; Wynn & Williams, 2012). To understand what practitioners did in the cases, we then needed primary data from individuals involved (Yearworth & White, 2014). Following suggestions from Howick and Ackermann (2011), Morgan (2013) and Howick et al. (2017), we therefore conducted interviews and also reviewed project documents (third column, Table 1).^v Interviews are commonly used in critical realist research in generating in-depth, ontological understanding of complex social phenomena (Brönnimann, 2022; Frederiksen & Kringelum, 2021; Wynn & Williams, 2012, 2020).

More generally, in qualitative research, project documents show how practitioners work (Coffey, 2013). In this study, they provided contextual and case understanding that we compared with interview data.

For our iterative analysis of the case data (fourth column, Table 1), the first author developed a consistent yet flexible approach by cycling between the research questions, the theoretical framework (Figure 1), literature, and the data. She also built on cross-case evaluations of multimethodology in OR that used thematic analysis of intervention data (Howick et al., 2017), practitioner interviews (Ackermann & Howick, 2022), surveys (Munro & Mingers, 2002, 2004; O'Brien, 2011), and literature (Christie, 2023; Howick & Ackermann, 2011). Specifically, to identify intervention events in the actual domain (for the first research question), the first author used topic coding and memo-ing, thematic and comparative analysis, and rich description (upper row, Table 1). To identify entities and structures and causal mechanisms in the real domain (for the second research question), she used structural and causal analysis of the rich case descriptions (lower row, Table 1).

Table 1: The new empirical research design for critical realist analysis of multimethodological OR practice

ANALYSIS STAGES	RESEARCH AIMS	CASE DATA SOURCES	ITERATIVE RESEARCH ACTIVITIES	RESEARCH OUTPUTS
Description	To identify 'the object of the knowledge generated by the research ⁰ (for analysis)– the cases ¹	In this study: Interviews Project documents	In this study: Deductive and inductive topic coding of data and memo-ing Thematic and comparative analysis (within- and across-case)	In this study: Rich case descriptions comprising: • Summary case description (narrative) • Diagram of individuals' roles • Timeline • Table of methods and activities
Resolution	To identify intervention events in the actual domain ²			
Structural analysis	To identify entities and structures in the real domain ² (in the intervention context, across structure, agency and culture)	In this study: Rich case descriptions	Theoretical and explanatory interpretation and redescription of case components and aspects relevant to the particular research question ⁴ Retroduction , in which we ask, 'What generic mechanisms existed in this phenomenon ... and what do they cause to occur?' ⁵ Retrodiction , in which we ask, 'How did the combination of mechanisms interact to generate a particular outcome in this context?' ⁵	Causal explanations of events and outcomes in context • Configurations of mechanisms and the entities and structures they are emergent from⁶
Causal analysis	To identify causal mechanisms that led to the events (including individuals' reasons and enabling and constraining conditions) and relations between them ³			

⁰ Mingers (2014, p. 191) ¹Lund (2014, p. 224) ² Wynn and Williams (2012, pp. 798, 810) ³ Sayer (1992)

⁴ Danermark et al. (2019, p. 130) ⁵ Mingers and Standing (2017, p.182) ⁶ Ash (2022, p. 118)

In the remainder of this section, we explain case selection, case data (from interviews and project documents), iterative case analysis (topic coding and memo-ing, thematic and comparative analysis, rich description, and structural and causal analysis), and data access. Overall, the new research design enabled aggregation and corroboration of large amounts of purposefully sampled rich textual data (Crabtree & Miller, 1992). In the absence of co-researchers involved in detailed data analysis (Morse, 1997), it also built in multiple checks of the analysis.

4.1. Case selection

Staff at the Defence Science and Technology Laboratory (Dstl), including the fourth author of this paper, suggested current and past projects based on their interests, knowledge, and experience (Teddlie & Tashakkoki, 2009).^{vi} We

agreed that these would be projects in which OR methods were used to support strategic decision-making for or on behalf of the UK government. We aimed to select three to six cases.^{vii} These would vary along dimensions that we developed with reference to relevant literature (e.g., Howick & Ackermann, 2011; Mingers, 2000b; Van De Water et al., 2007; White, 2016).^{viii} We expected that the dimensions may be associated with variability (commonalities, differences, and patterns) in intervention contexts, processes, and outcomes across the cases (Ackroyd & Karlsson, 2014, p. 31). Comparing multiple cases would therefore provide analytical leverage and afford the possibility of formulating provisional, testable, data-driven middle-range theory developments (Easton, 2010; Eisenhardt, 1989; White, 2006). More specifically, we would ‘deepen existing theories’ of multimethodological practice by ‘qualifying ... underlying mechanisms’ (Van Burg et al., 2020, p. 10; Porpora, 2016). In the event, case selection was a process of complex and dynamic decision-making that continued during the empirical research (Plakoyiannaki & Budhwar, 2021). By design, it was not unbiased quantitative sampling of typical cases (Sim et al., 2018).^{ix} See Appendix C in the supplementary materials for further details of the case selection process.

- | |
|--|
| <ol style="list-style-type: none"> 1. Analysis for a business case for future investment in a national capability 2. Review of an approach to an organizational process to advise on its applicability to the enhancement of a national capability 3. Review of a national capability to inform its future strategy 4. Review of options for the future organizational model and governance of an organization comprising a number of national capabilities 5. Review and prioritization of options for the future technological configuration of a national capability |
|--|

Figure 2: The five cases - brief, indicative descriptions (anonymized)

The final set of five cases (Figure 2) appeared to include variation along dimensions of interest, including parties involved, methods used, and perceived levels of success. One was a current project, one was in a post-decision implementation phase, and one had led to a decision by a government minister that had been implemented. The other two projects were described as having informed subsequent decisions and/or projects. All five cases involved review of one or more national capability.^x At the outset, at least some months were available to practitioners for their work. In the event, project duration appeared to change, with practitioner interviewees tending to work on the interventions and/or wider projects for around 18 months.^{xi} The cases were described to us as quite typical. Due to restrictions arising from the sensitive and confidential nature of work in the research context (cf. Hopes et al., 2022), we could not verify this. However, as was traditional in OR (Rosenhead & Mingers, 2001) and in UK government analysis (HM Treasury, 2003, 2022), all cases involved development of decision options.

4.2. Interviews

To understand the process of choosing multiple methods (Howick & Ackermann, 2011), as well as ‘the motivation, rationale and acceptance of mixing methods’ (Morgan, 2013, p. 255), the first author conducted 50 semi-structured interviews of 40 individuals across the five cases (Table 2). Two participants each asked to bring a colleague, who was interviewed with them. In two interviews, questions covered two different cases. Interviews were face-to-face; two were by telephone. The interviewer recorded all but six interviews (when interviewees agreed) and took notes.

To identify potential interviewees, we took a snowball approach (M. S. Reed & Curzon, 2015). Interviewees were asked to recommend people and documents that could enhance our understanding of a particular case. To identify interviewees, we also reviewed project documents. We sought to reduce negative impact from retrospective sense-

making and impression management by interviewing a range of individuals, and interviewing intervention practitioners more than once over time (Eisenhardt & Graebner, 2007). As far as possible, interviewees were across Ormerod's (2001, 2008a, 2008b) categories (doers, done for, done with, done to, and done without).^{xii} Interviewees included seven practitioners (one or two per case), as well as practitioner supervisors, clients, decision makers, organizational managers, and other individuals involved in interventions (e.g., as workshop participants, interviewees, subject matter experts, or with technical, or project or programme management roles).

Table 2: Interviews and interviewees by case

	No. of Interviews	No. of interviewees	Hours of interviews (Note)	Comments on numbers and types of participants (compared with other cases)
Cases (one per row, ordered by numbers of interviewees and interviews for reasons of confidentiality)	5	2	3	Interviewees discouraged the interviewing of others about this arguably smaller-bounded case.
	8	7	7	-
	8	9	6.5	-
	11	12	10.5	Interviewees included a broader range of clients in this case. Interviews included one long interview on intervention processes relevant to other cases.
	18	12	11.5	Interviewees included a broader range of clients and more practitioners in relation to this pilot case.
Total transcribed	50	40	38.5	
Exclusion of pilot case interview	(1)	(1)	(1)	
Total analysed	49	39	37.5	

Note: Time in hours is approximate and excludes discussions before the start of the interviewer's questions (including on informed consent), and after recording was stopped (for recorded interviews).

We derived the questions in our interview guide (Appendix D in the supplementary materials) using the research questions (including the two above), our theoretical framework, and literature. Interviewees were first asked to describe their role in relation to the case. The next questions were about when the interviewee was first involved and the case timeline. Following suggestions in Howick and Ackermann (2011), practitioners were asked what influenced their choice of particular methods and not others. They were also asked about benefits and challenges of methodological approaches (expected and experienced), notions of success, and typicality of interventions. Interviews were also used to explore expectations of and commitments to other people (Mingers, 2006b), alternatives considered and rejected and not considered, and support available for using methods.

Early in interviews, practitioner interviewees were asked to draw on a blank piece of paper a timeline of the case showing key stages, activities, decisions and outcomes. We also created two handouts for practitioner interviewees (Appendices E and F in the supplementary materials). The first was an illustration of forms of multimethodology found in OR practice (Morgan, 2013; Morgan et al., 2011, 2017; cf. Christie, 2023, 2025). The interviewer briefly explained the forms and asked practitioners which resonated with them in terms of the methodological approach they took in the case. This was to prompt discussion of how practitioners used components of their methodological design together. The second handout was a grid in which practitioners were asked to write lists of individuals involved in or affected by the intervention, by category (Ormerod, 2008a). This prompted description and discussion of individuals, roles and relations. Six practitioner interviewees were interviewed more than once.

The interviewer used follow-up interviews to explore issues raised in further detail, check her understanding of case aspects, review information in documents, and ask about unclear or conflicting information. This was the form of member checking possible within the time constraints of the research. Due to the sensitive nature of the content,

the interviewer then transcribed all interviews rigorously herself (using NVivo). She took a reflexive and critical approach, actively updating her analysis for factors that may have influenced what interviewees said.

As shown in Table 2, on review of the transcript of one participant's interview about the pilot case, and having analysed all other data for that case, we decided not to use the data. It was not practical to fulfil the participant's request 'to see any responses you use to ensure accuracy', and there was very little in the transcript that was not in other case data. The very few comments not in other case data were not directly related to the research questions. This suggested that we had reached a point of saturation (Braun & Clarke, 2021), at least in understanding the case from the perspective of an individual from the same part of the same organization as this participant.

4.3. Project documents

Across the five cases, the first author obtained and reviewed over 20 project documents, including reports, memos, meeting minutes, practitioners' study plans and scoping documentation, and practitioners' own notes relating to the cases (Checkland, 1981). Study plans included descriptions of methods. Scoping documentation and project plans included milestones or deadlines for completing work. Organizational charts and distribution lists in documents facilitated identification of individuals and their roles and relations. We took an opportunistic approach to obtaining project documents, and a systematic approach to reviewing case data for other data sources. Where relevant, we also located and reviewed publicly available information. Some documents were not made available to us for confidentiality or security reasons. For further details, see Appendix C in the supplementary materials.

4.4. Topic coding of data and memo-ing

The coding approach was akin to Miller and Crabtree's (1992) template analytic style of analysis (being one of their four idealized strategies for analysing qualitative data). We used a pre-defined structure, developed it iteratively in light of case data, and took an interpretive, not statistical approach. The first author closely reviewed case data in relation to the research questions, coding data fragments to nodes and sub-nodes. She employed *in vivo* coding for capturing, for example, specific names of particular methods under the topic node 'Methods'. To balance having manageable amounts of data and remaining true to that data, coded extracts were one word to several sentences long. The first author created memos and annotations on her interpretations of research questions and data, and on node contents and overlaps, updating a research journal as she went. Overall, the coding approach facilitated organization of case data by topics, focusing of analysis and interpretation on key data extracts relevant to the research questions, and search for 'confirming/disconfirming evidence' of provisional conclusions (Crabtree & Miller, 1992). For further details of the coding of data, see Appendix C in the supplementary materials.

4.5. Thematic and comparative analysis

Thematic analysis can be adapted for use with different philosophical assumptions to develop clear, rich, nuanced understanding of complex data and to identify patterns (Braun & Clarke, 2006; Fryer, 2022; Wiltshire & Ronkainen, 2021; Xu & Zammit, 2020). In this study, a second cycle of analytical coding involved using *in vivo* coding within nodes and sub-nodes. Topic-coded data was analysed for themes, and sub-nodes were clustered and collapsed into thematic nodes. An example thematic node within the 'Why / why not this method' sub-node was 'practitioner tendency to use particular methods'. By constructing, reviewing and also re-constructing themes within topic-coded case data, the first author had to reflect on consistency between data. For example, this was helpful for the first research question as different individuals referred to methods in different ways. It was

particularly pronounced in one case where thematic analysis made clear that individuals had very different views of what the intervention should deliver. Thematic analysis also facilitated comparative analysis across cases.

4.6. Rich description of cases

In critical realist approaches to social science research, there is a need to identify ‘the object of the knowledge generated by the research’ as a first step in the analysis (Mingers, 2014, p. 191). Therefore, case descriptions are developed using research data ‘to allow the researcher to describe and explicate in detail those events believed to have actually occurred’ (Wynn & Williams, 2012, p. 797). Accordingly, we applied coded data to constructing rich, detailed case descriptions (Keys & Midgley, 2002; Stake, 2008). These included aspects of context and events and outcomes (Figure 1) to be understood for responding to the research questions. In describing cases, we sought a justifiable accommodation of underlying data across sources. Descriptions were based on subjective experiences of individuals captured through first-person accounts in interviews (in the empirical domain in Figure 1), and project documents. Therefore, we focused on establishing ‘main facts’ (Ormerod, 2014a, p. 1249), or ‘memories and interpretations’ (Langley & Abdallah, 2016, p. 137), looking for experiences that were shared across data. As our examination of cases was almost all retrospective, we considered ourselves external researchers. As Vogl et al. (2019) noted, ‘The role of the researcher is [then] to synthesize competing interpretations and present the ‘least false’ interpretation rather than ‘the truth’” (p. 620).

Each rich case description comprised: (1) a summary case description; (2) a diagram of individuals’ roles; (3) a timeline; and (4) a table of methods and activities. The diagram of roles, timeline, and table of methods supplemented (and were cross-checked to) the summary case descriptions. They provided systematically analysed data for responding to specific research questions. They also facilitated systematic comparison of cases for the identification of patterns and contrasts (Cloutier & Ravasi, 2021).

Each *summary case description* was a narrative account of what happened in a case (Porpora, 2016). In deciding what to include (Langley, 1999; Ormerod, 2014a), the first author was guided by the research questions and theoretical framework. She was also influenced by reports of practical cases in OR literature, and guidance for case writing in OR journals (especially Ormerod, 1998). Accordingly, she focused summary case descriptions on practitioners’ methods and activities (what, why, with whom, and alternatives considered), method combinations, and more and less successful aspects of methodological approaches. In effect, this was a reduction and re-telling of the coded data. Each summary case description was up to 100 pages in length. It included purposively selected quotations relating to the research questions, literature, and themes (Watts, 2013). The descriptions thus provided evidence-based overviews of how, for example, method choice (in the actual domain in Figure 1), came about. The first author used data coded to ‘Stakeholder’ (Ormerod, 2008a) categories (sub-nodes) to understand individuals involved and when they were involved (in the actual domain). For each case, the first author produced a *diagram of individuals’ roles* (in the pre-existing intervention context in Figure 1). This was akin to an organizational chart. Roles from the five case diagrams are consolidated in Figure 3 (in the subsection below on structural analysis).

Using data topic-coded to ‘Timeline’, the first author compiled an Excel database for each case. These *timelines* were lists of up to 70 key events, activities, outputs (such as reports) and outcomes (in the actual domain in Figure 1), each with start and end dates. Rows were organized chronologically and into intervention phases.^{xiii} This analysis involved corroborating statements between and across participants, interviews and documents, as well as

checking dates and other information to publicly available data. The first author also visualized the data in PowerPoint using Office Timeline. This visual mapping facilitated further data analysis and synthesis, and comparison across cases (Langley, 1999). It was a key input for the mapping of method combinations in response to the first research question (e.g., Figure 4 in the case study illustration in section 5 below). To delineate and understand further the methods, and to see how the methods related to each other, the first author also compiled a *table of methods and activities* for each case. Each row related to a single method or activity. Column headings describing the coded data recorded in each table are in the supplementary materials (Appendix H).

4.7. Data access statement

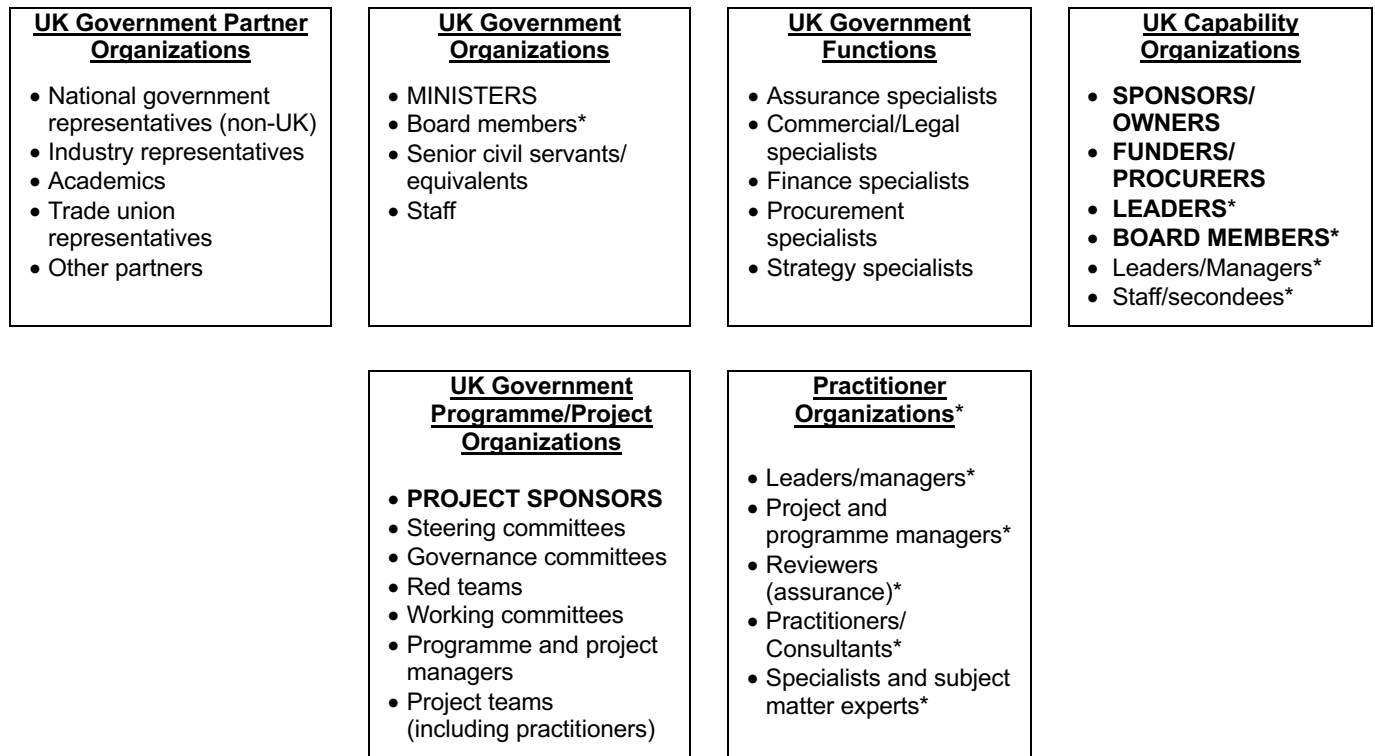
For reasons of confidentiality, and to respect our commitments to research participants (Pratt et al., 2020), we are not publishing the rich case descriptions nor all the underlying data, including interview transcripts and project documents. De-identification and anonymization of data were ongoing processes, and not fully achievable (Gummesson, 2017; The Qualitative Data Repository, n.d.). We balanced removal of identifying details with retention of sufficient detail for the long, complex cases to make sense and provide credible objects of analysis. Nor did we share the rich case descriptions with interviewees or the fourth author of this paper. Rather, the critical realist aim of our empirical research was to provide and justify provisional answers to research questions. For this, we drew on the rich case descriptions, and the further analysis and corroboration described below, as necessary.

4.8. Structural analysis

In our structural analysis, we identified entities and structures in the real domain from which mechanisms of method choice emerged (Figure 1). We did this by interpreting and redescribing case components (Table 1). This involved allocating aspects of the intervention context from each rich case description across *structure*, *agency*, *culture*, and their *relations*. For example, for *structure*, we sought to understand relations between individuals' roles (under 'Structure' in Figure 1). To illustrate the types of roles and organizations we found, Figure 3 is a consolidation of the five case diagrams of individuals' roles. Types of roles are grouped by types of organizations in which we found them. In other words, in each case we found a subset of the roles listed as bullet points in Figure 3.

Across the cases, individuals had *intervention roles*. *Intervention roles* included practitioners, clients, and decision makers, as well as quality assurers, and managers overseeing practitioners' work. Typically, practitioners worked as part of a team of individuals, each with different knowledge, skills and experience. In all cases, practitioners were tasked with delivering analysis to clients in senior civil servant or equivalent UK job grades (Clyne et al., 2023; Institute for Government, n.d.). Clients (in **bold** in Figure 3, within the capability and project organizations) were leaders, sponsors, and/or funders or procurers of the national capability/ies reviewed by practitioners. Interventions came about to provide support to strategic decisions to be made by clients and/or senior-level government boards and/or government ministers (DECISION MAKERS in Figure 3). As well as intervention roles, individuals had *employment roles*, that is, they were employees of, for example, government organizations. Evidence for the systemic and enduring nature of intervention roles came from changes in individuals allocated to particular roles over time (in case data). For our causal analysis, we could therefore assume that relations between intervention roles existed in the realist ontology (under 'Structure' in Figure 1), albeit for less time than relations between employment roles.

Delivery of OR analysis by practitioners was a ‘goal countenanced by’ practitioners (Archer, 1995, p. 198). As we shall see with examples in our case study illustration in the next section, that goal was conditioned by relations between intervention roles and relations between employment roles, as well as other aspects of structure, agency and culture. In short, we found across the cases that aspects of *agency* included practitioner reflexivity, values, beliefs, motivation, dispositions, practical competences, and norms.^{xiv} *Culture* included rules (e.g., in policy documents) and shared ideas (e.g., in practitioner discourses on past projects). Identifying these aspects of structure, agency and culture thereby facilitated ontological understanding of the intervention context (Figure 1). We then used this ontological understanding in our causal analysis to identify causal mechanisms.



LEGEND

Bold = Roles of practitioners' clients

CAPS = Roles of DECISION MAKERS

* = UK Government and/or Partner (non-UK Government) role

Figure 3: Individuals' roles across the five cases, by types of organizations

4.9. Causal analysis

In our causal analysis, we identified causal mechanisms (Figure 1) using retroduction (Table 1). As Easton (2010) states, ‘The cutting edge of this method [retroduction] is to continue to ask the question why?’ (p. 124).

Specifically, for each case, we started with individual beliefs and reasons for individuals' actions or non-action (e.g., practitioners' use of particular methods) in the rich case description (in the ‘Why’ columns of the table of methods and activities; Appendix H in the supplementary materials). We then looked to make sense of those beliefs and reasons in context (De Souza 2013, 2022, after Sayer, 1992). Accordingly, we analysed data for aspects of the intervention context ‘influencing the perceptions and actions’ of individuals (De Souza, 2013, p. 145). These implicated causal mechanisms that influenced actions, which we analysed by aspects of structure, culture and agency, and their relations (in our ongoing structural analysis). We shall provide concrete examples of this analysis in the case study illustration in the next section.

In isolating plausible explanatory causal mechanisms from data, we sought, ‘that factor which, in the circumstances that actually prevailed [in the case], “so tipped the balance of events as to produce the known outcome [e.g., in this study, the use of a particular method]”’ (De Souza, 2013, p. 145, after Bhaskar, 1998). In identifying other enabling and constraining conditions (Figure 1), we considered what *else* must have led to the existence or triggering of the mechanisms (Sayer, 1992). We also employed counterfactual reasoning because

A mechanistic explanation describes the causal process selectively. It does not aim at an exhaustive account of all details but seeks to capture the crucial elements of the process by abstracting away the irrelevant details. The relevance of entities, their properties, and their interactions is determined by their ability to make a relevant difference to the outcome of interest. If the presence of an entity or changes in its properties or activities truly does not make any difference to the effect to be explained, it can be ignored. (Hedström & Ylikoski, 2010, p. 53)

We used empirical and theoretical corroboration to evaluate plausible explanations. We presented preliminary responses to research questions in workshops and papers (including this one), inviting comments and challenge.

5. Case study illustration and findings

In this section, we illustrate the new approach (summarized in Figure 1 and Table 1) with a single case study (case 1 in Figure 2).^{xv} Specifically, we demonstrate how we used the new approach to identify causal mechanisms that led to practitioners’ use of particular methods. Our purposive selection of case 1 was a pragmatic choice. It was based on the need to illustrate the new approach in a word-limited article, which, for example, would not allow the explanation of large amounts of technical case data. It was also based on the need to deal with restrictions arising from data confidentiality and our ethical commitments to participants. To preserve some anonymity, quotations (in single quotation marks) are not attributed. To ensure representativeness, we did not select the pilot case, nor the case with two interviewees (Table 2). To illustrate the new approach in this section, we present and summarize key extracts from the rich case description (Table 1) relevant to the research questions. First, we introduce the case. Second, we present an overview of the methods practitioners used. Third, we then present findings from structural and causal analysis (Table 1). Thus, we show how we used the new approach to identify causal mechanisms.

5.1. Introduction to the case

In case 1, practitioners were tasked with providing analysis for a business case for a decision regarding future funding for a national capability, and what its organizational model should be. The decision was to be made by a senior-level government board (among the ‘BOARD MEMBERS’ in Figure 3). Other practitioners from the same practitioner organization had provided OR analysis for previous business cases relating to the existing capability. ‘A set of formal rules’ (organizational procedures) for business case approvals were prescribed in policy documents. An evidence-based appraisal of the cost-effectiveness of a set of recommended decision options was required of practitioners. This needed to focus on the needs of capability users, as well as political and practical factors. Policy documents required robust and, where possible, quantitative measures of cost-effectiveness. Assurers would then review the business case, and explain it and provide advice to the decision makers, including on the practitioners’ analysis.

The practitioners undertook background reading, initial discussions with practitioner colleagues and other individuals with intervention and capability roles (including clients and assurers – see Figure 3). Practitioners also undertook capability site visits. There were three main reasons for these activities, as follows (*with illustrative data*

in parentheses). First, practitioners sought to understand the capability, the ‘problem space’, individuals involved, and possible methodological approaches (*‘identifying the questions we need to answer’*). Second, practitioners sought to engage and build trust with individuals involved in the intervention (*‘I needed access to [capability individuals’] data, to be able to do the [...] work effectively’*). Third, practitioners sought to establish ways of working (*‘I’d never worked with [assurance] before’*). Practitioners did not use formal OR methods (*‘I didn’t use formal toolsets! I asked questions.’*). However, following this initiation stage (North Atlantic Treaty Organization, 2012), practitioners decided to use participative multi-criteria decision analysis (MCDA) as described in The Department for Communities and Local Government (DCLG, 2009, pp. 46-72). Practitioners would follow the steps in this participative MCDA methodology (DCLG, 2009, p. 50) to measure the effectiveness (or benefits) of decision options. This was because the steps would facilitate participative weighting and scoring of quantitative and non-quantitative decision dimensions for the business case.

Given the requirements for business cases in policy documents, practitioners had tried to come up with a method for measuring benefits of decision options (different organizational models) objectively. However, like in other projects assessing enabling functions, this proved difficult. Practitioners considered cost-benefit analysis, but there was disagreement and some resistance from individuals. Cost-benefit analysis was not accepted. Anyway, it was challenging to connect – directly – any past project undertaken by the capability to realized financial benefits, and to differentiate decision options (i.e., organizational models) on that basis. There was some hypothetical debate about how the existing capability might have performed differently with a different organizational model.

For other business cases, numerical, physics-based computer modelling had been used to compare options using data from trials, training, operations, and/or expert judgement. However, practitioners saw the use of judgement (where objective measurement was impossible) as necessary and ‘a constraint on the process, that we couldn’t necessarily find robust quantitative analysis on option A versus option B’. In using MCDA, practitioners sought to capture capability benefits not easily quantified, to ‘get a handle on’ ‘a very complex set of potential benefits’, including ‘non-financial benefits’, and bring together qualitative and quantitative evidence in a robust way.

In choosing MCDA, practitioners drew on knowledge and experience of previous and current projects and advice from practitioner colleagues, including methodological experts. MCDA had been used to support the previous business case for the capability, including participative weighting of benefits and scoring of options, and the involvement of a range of participants. There was a lack of knowledge of apparent alternatives and a general feeling that MCDA was an ‘appropriate’ technique for this activity or purpose.

5.2. Practitioners’ methods

Using the rich case description for case 1 (Table 1), we compiled an illustration of practitioners’ methodological design. In response to the first research question (*how do OR practitioners choose and combine OR methods?*), in Figure 4, we present practitioners’ methods, activities and outputs in boxes. These are joined with arrows indicating how one led to another over time. They are categorized by Mingers and Brocklesby’s (1997) stages of a typical OR intervention (the 4As) – Appreciation, Analysis, Assessment, Action (Mingers, 2014). We see in Figure 4 that practitioners used activities and methods from the participative MCDA methodology (indicated by grey shading). We also see that, in this part of the intervention, the participative MCDA methodology provided a framework (Christie, 2023, 2025) for most of the methods in practitioners’ methodological design.^{xvi}

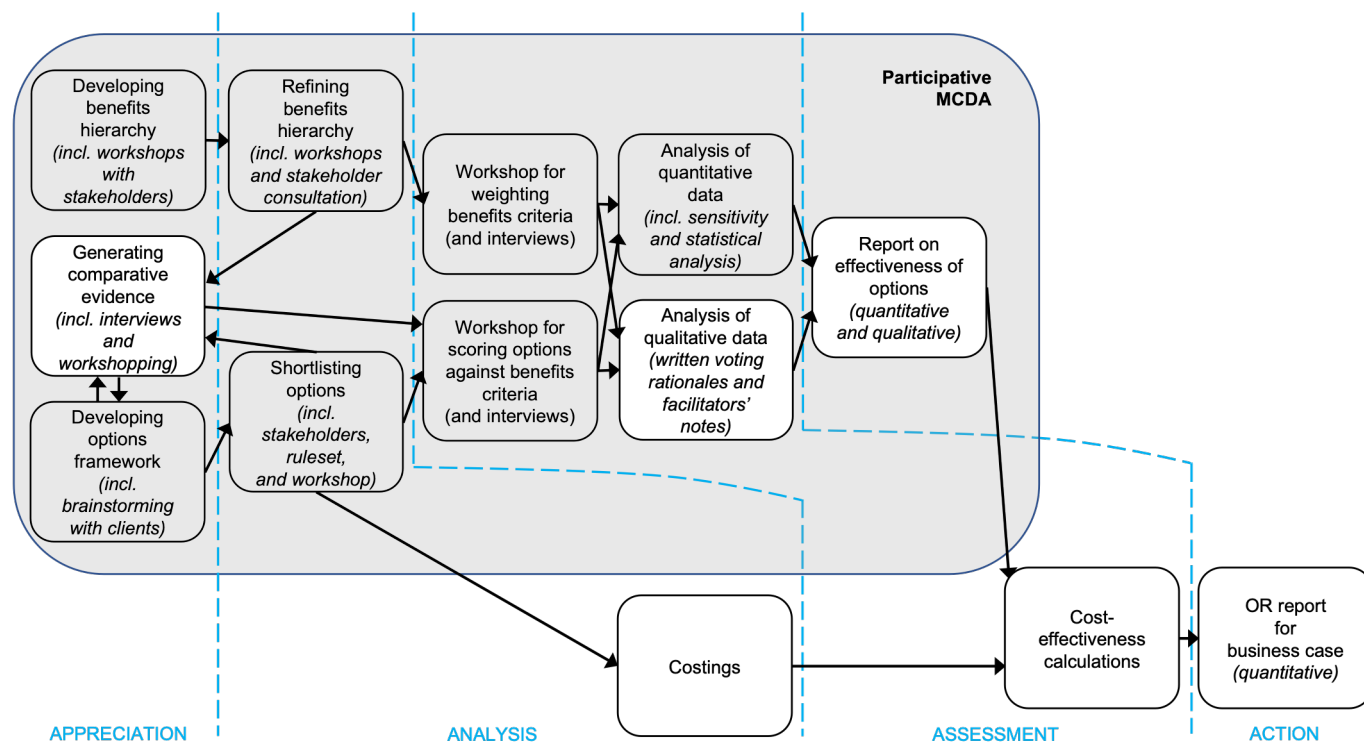


Figure 4: Illustration of methodological design (simplified) in case 1

In overview, starting at the top left of Figure 4, practitioners developed and then refined a benefits hierarchy (MCDA criteria based on capability user requirements) with selected ‘stakeholders’, including in workshops. At the bottom left of Figure 4, for generating decision options, practitioners developed a framework of (1) capability roles and (2) organizations that could take each role. They used data from previous interventions (including a version of the framework) and brainstorming with clients. The decision options generated thus represented inter-organizational models for the future capability. Moving right in Figure 4, up to five decision options were then shortlisted with selected stakeholders (and using a ruleset and workshop). Moving further right in Figure 4, the effectiveness of options was assessed by a wider selection of stakeholder representatives across two workshops (and interviews for particular stakeholders unavailable for a workshop). In one workshop, stakeholders weighted benefits criteria. In a separate workshop, a second group of stakeholder representatives scored options against the benefits criteria. For the scoring workshop, practitioners provided participants with comparative evidence of qualitative and quantitative benefits and challenges relating to other capabilities with various organizational models. They had generated this evidence earlier in interviews and by workshoping (middle left of Figure 4), the assurance team having stated that judgement alone would provide insufficient evidence for the business case.

Moving back to the right of the weighting and scoring workshops in Figure 4, practitioners used sensitivity analysis and statistical analysis to check the robustness of their MCDA modelling and calculations (in which they aggregated the quantitative weighting and scoring results). Practitioners also analysed qualitative data that they had generated in workshops and interviews (stakeholders’ written voting rationales and facilitators’ notes). Moving right again in Figure 4, practitioners presented a significant number of their qualitative findings alongside the quantitative MCDA results and diagrams in their report on the effectiveness of the options. This was to explain different stakeholders’ issues with different decision options. But it was also to back up points practitioners wanted to bring out from their analysis, and recommendations on how to address stakeholder concerns and disagreements.

In summary, the participative MCDA methods practitioners used (in the grey-shaded boxes in Figure 4) were: brainstorming, workshops, interviews, and other consultation with stakeholders for developing, refining and shortlisting decision options and benefits criteria; facilitated workshops and structured interviews for weighting benefits criteria and scoring decision options; and, statistical and sensitivity analysis. Within the participative MCDA framework, practitioners also added the following methods (illustrated within the large grey-shaded box in Figure 4): interviews and workshops for generating comparative evidence for the scoring workshops and interviews (in the unshaded box in the Appreciation stage); and, analysis of qualitative data from the weighting and scoring workshops and interviews (in the unshaded box in the Assessment stage).

In this research on multimethodology in which quantitative methods are combined with qualitative methods for dealing with socio-political issues, the additional qualitative analysis (of data generated in the weighting and scoring workshops and interviews) was of particular interest. It enabled practitioners to go beyond the recommended decision options they had found jointly with stakeholders using the participative MCDA methodology. Specifically, practitioners added recommendations for decision makers about *other* stakeholder concerns and disagreements in their report on the effectiveness of the options. We shall return to this in our structural and causal analysis.

We now move down from the participative MCDA framework in Figure 4 to complete our overview of methods. To measure the cost-effectiveness of options, practitioners combined their quantitative MCDA results with costings (costs modelling prepared by government cost consultants). In their report on the effectiveness of options, practitioners had reported more qualitative data than in other similar projects in the research context. However, this analysis was largely excluded from practitioners' final OR report (being practitioners' evidence-based appraisal of the cost-effectiveness of the set of recommended decision options for the business case). This final report focused on quantitative results and accompanying diagrams (visualization), and quantitative and qualitative risk analysis.

5.3. Structural and causal analysis

Our structural and causal analysis then led to multiple causal mechanisms resulting from aspects of the intervention context (structure, agency, culture, relations). In response to the second research question (*why do practitioners take these methodological approaches?*), our findings on why practitioners used the methods reported in the previous subsection are illustrated in Figure 5. Lines link aspects of the intervention context (from structural analysis) with the method choice mechanisms (from causal analysis). Going from left to right in Figure 5, method choice mechanisms included practitioners' aims given their roles, practitioners' tendencies, rules in policy documents, and practitioner knowledge from discourses and documents in the intervention context. Other enabling and constraining conditions (e.g., limited resources) are listed along the arrows linking the method choice mechanisms with the outcome (being practitioners' use of particular methods in their methodological design).

Let us take one of the method choice mechanisms in Figure 5 as an example – 'Practitioners' tendency to use past (not novel) methods'. Case data supported that there was a tendency amongst practitioners to choose methods used in the past. Case data also supported that the assurers, given their role as 'owner' of the approval process, had a tendency to accept and advise use of known methods. This was because intervention participants generally understood such methods. There were limited resources (time and money) for trying other, new methods in OR

projects, as well as risk aversion amongst practitioners and assurers. In Figure 5, these two conditions (limited resources and risk aversion) are along the arrow linking the method choice mechanism to the outcome at the top.

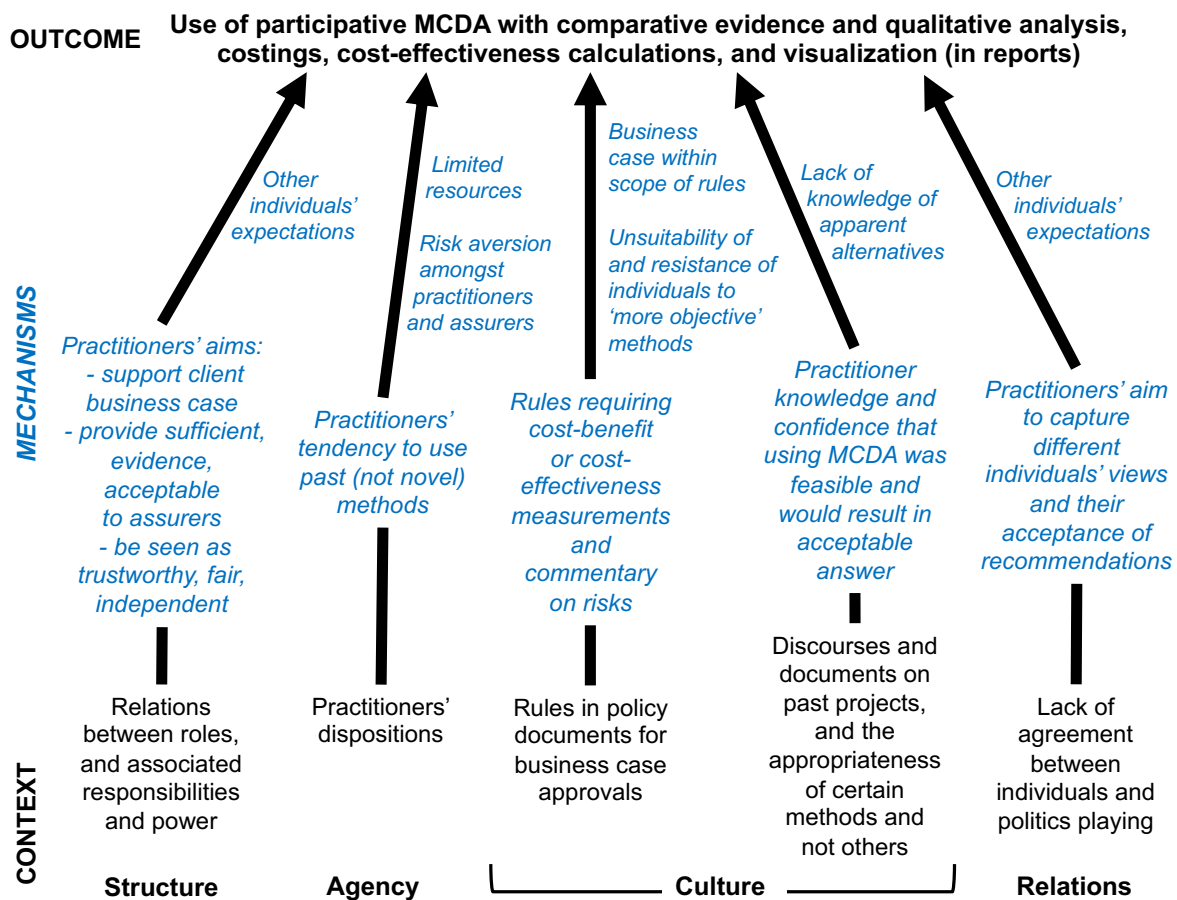


Figure 5: Mechanisms of method choice in case 1

Our structural and causal analysis of the case involved reviewing the rich case description for what methods were used for (Mingers, 2003, 2006b; Ormerod, 2005) *and* what led to their use, given what they could be used for (i.e., including, but not exhausted by, their affordances). It included consideration of which other methods could have been used to deliver similar outputs, as well as why particular methods were used in particular contexts. Taking another example, practitioners in case 1 chose MCDA because it facilitated participative weighting and scoring of quantitative and non-quantitative decision dimensions. But, as reflected in Figure 5, it was rules requiring quantitative measurement of cost-effectiveness, *and* other 'more objective' methods being unsuitable and rejected by some individuals, that led – in interaction with other mechanisms – to MCDA being chosen over other methods.

In the remainder of this section, we demonstrate our structural and causal analysis of case 1. We present examples of how we used the rich case description to identify the method choice mechanisms in Figure 5 for two aspects of the intervention context (*structure* and *relations*). Further details and illustrative underlying data for all the method choice mechanisms in Figure 5 are in the supplementary materials (Appendix I). As illustrated in Figure 1, we conceptualized that causal mechanisms included effects of practitioners' reflexive deliberation and values (and other aspects of agency, including norms), *as well as* practitioners' social structural conditioning (Bhaskar, 2016). It was therefore not surprising that we found that the method choice mechanisms often related to more than one aspect of the context, also due to the complexity of any real-world case.

5.3.1. Structure

In our structural analysis of *structure*, we used the rich case description (Table 1) for case 1 to analyse relations between individuals' roles (Figure 1). We found that, as in the other cases, the practitioners had intervention and employment roles (as described in section 4.8 above). In addition, the practitioners, assurers and decision makers had prescribed roles in the business case approval process (as providers of analysis, and as business case assurers and approvers, respectively). In our causal analysis of case 1, we further analysed data in the 'Why' columns of the table of methods and activities (Appendix H in the supplementary materials). We found practitioners' reasons for choosing particular methods reflected their interpretations of role relations in the case, as well as effects of practitioner agency (including practitioners' reflexive deliberation, values, and norms). Case data supported that, together, these aspects of *structure* and *agency* led to specific practitioner aims regarding what they would deliver (as shown in the *structure* mechanisms on the left-hand side of Figure 5).

First, practitioners were motivated to deliver analysis in support of the *intervention clients'* business case. Second, practitioners sought to provide sufficient evidence, acceptable to the *business case assurers*. Throughout the intervention, practitioners pro-actively collaborated with clients, assurers, and others, in order to produce work that would be satisfactory. During the project, there were working group meetings with assurers in which a client was, 'brokering the discussions between the people who were responsible for generating the evidence, [...] writing the business case [...] and the [assurance] teams who were requiring a particular level a particular standard a particular approach to the solution' (client). Third, practitioners aimed to be seen as trustworthy, fair, and independent, in line with established practices of *employees of their government organization*. Accordingly, the practitioners sought to take into account a broad range of opinions. These aims also reflected practitioners' own beliefs and values.

Together with enabling conditions in the intervention context (other individuals' expectations of their work), these three aims led to practitioners' particular method choices. For example, let us take the third practitioner aim (to be seen as trustworthy, fair, and independent). This aim, conditioned by the practitioners' employer's expectations of their work, and in conjunction with other method choice mechanisms, led to, for example, practitioners' generation and analysis of qualitative workshop (and interview) data alongside their quantitative MCDA analysis (Figure 4). As is typical in MCDA (Marttunen et al., 2017, p. 2), practitioners used qualitative data to explain issues raised in relation to different decision options (in their report on the effectiveness of the options). In fact, practitioners' inclusion of qualitative analysis was viewed by other interviewees as an attempt to provide additional commentary on quantitative cost-effectiveness results relating to risks and risk mitigations, as suggested in policy documents. However, practitioners described it as an attempt to explain perspectives on 'how palatable options are to different communities', to reflect 'the richness' behind the 'fairly sterile' numerical [MCDA] scores, *and* to highlight and provide 'useful' recommendations for thinking about and addressing 'concerns' and 'issues between different communities'. Illustrative underlying data are in Figure 6.

5.3.2. Relations

Relatedly, in our structural analysis of *relations*, the rich case description supported that practitioners found a lack of agreement as to the purpose and value of the capability, and plenty of politics playing. Practitioners adopted a participative approach in workshops (and interviews), including for the weighting of benefits and the scoring of options against those benefits (Figure 4). This method choice resulted from practitioners' seeking to capture

different views on viable decision options *and* acceptance of their eventual recommendations. Illustrative data for this method choice mechanism (shown on the right-hand side of Figure 5) are in Figure 7.

Aspect of context	Agency	Structure (Relations between employment roles – practitioners and their government employer – and associated responsibilities and power)
Data	'[...] [the report on effectiveness of options] sets out a <u>whole bunch</u> of top-level [MCDA] scoring but also a massive sensitivity analysis. Looking at different perspectives. So it's not just about hard <u>numbers</u>, it's about how <u>palatable</u> options are to different communities, and what factors, where the key issues are between different communities. [...] Hard numbers kind of didn't do it. Hard numbers <u>were there</u>, but it was really the richness that sat behind that?' (practitioner) 'So I think what we sought to choose was to extract comments [on workshop participants' rationales when voting on weights and scores] which, reflected the majority position. But I think it provides, useful additional colour, beyond, a fairly sterile, it's a six or a seven. And particularly can be used to illustrate or draw out some of the reasons which led to, people voting as they have.' (practitioner)	'There was <u>such</u> resistance, within the [existing capability] delivery community that there was <u>any other way</u> apart from [the existing capability]. And that <u>nobody else could possibly</u> do this, apart from [the existing capability]. There was <u>no other</u> delivery mechanism, apart from the one that there was now. I needed some mechanism to be able to challenge that, from a fact-based position.' (practitioner) 'If, we'd have just done a straight [combination of MCDA and costings] on this, it wouldn't have given analysis that was <u>really</u> particularly <u>helpful</u>. Because actually it wouldn't have challenged <u>any</u> of the mess that was there.' (practitioner) 'the [main practitioner], was someone who was brought in, very much <u>because</u>, [they were], quite independent of that [capability] activity ongoing on.' (client)

Note: Underlining indicates vocal emphasis

Figure 6: Illustrative data for mechanism, 'Practitioners' aim to be seen as trustworthy, fair, independent'

Aspect of context	Agency	Structure (Lack of agreement amongst individuals as to the purpose and value of the capability, and plenty of politics playing)
Data	'We didn't seek consensus. It was more just trying to, make sure that the final vote represented what people were happy with, taking forward.' (practitioner)	'There were so much politics going on here. There was so <u>little</u> agreement about actually what the purpose of [the capability] <u>was</u>.' (practitioner)

Note: Underlining indicates vocal emphasis

Figure 7: Illustrative data for mechanism, 'Practitioners' aim to capture individuals' views and acceptance'

6. Discussion

The central contribution of this paper is that, for the first time as far as we are aware, we operationalized critical realism for evaluating multimethodological practice. We developed a new, plausible theoretical framework (Easton, 2010) – the critical realist ontology of a multimethodological OR intervention and methodologies summarized in Figure 1 and Appendix B in the supplementary materials. We also presented a new empirical research design for critical realist analysis of single and multiple cases of multimethodological OR practice (Table 1). Together, these provide a new approach for: (1) identifying causal mechanisms and the entities and structures in the intervention context from which they emerge; and (2) comparing cases to understand underlying mechanisms and outcomes across multimethodological interventions in OR.

In our single case study illustration of the new theoretical and empirical approach, we demonstrated how rich description and structural and causal analysis can be used to identify multiple mechanisms resulting from aspects of the context of a multimethodological OR intervention (Figure 5). These causal mechanisms together led to practitioners' use of particular methods in their methodological design (Figure 4). It is intended that our findings from this and all the other cases in Figure 2 will help Dstl review how it identifies analysis methods and consider

alternative approaches to supporting strategic decision-making (Christie, 2025). Taking a wider view, understanding why individuals take the actions they do in multimethodological OR interventions, and the effects these actions have, is fundamental for evaluating and improving practice. As we shall explore in this section, our new approach therefore clears the ground for researchers to apply critical realism to understand the operation of causation, and to provide actionable insights (Bhaskar, 2016) to improve multimethodological practice over time.

6.1. A new approach for understanding the complex process of multimethodological practice in OR

The approach presented in this paper provides a new structured and systematic way of accumulating (Brocklesby & Beall, 2018) and comparing knowledge of uniquely complex cases of multimethodological practice in OR. In proposing ways forward for evaluating OR practice there has been an understandable tendency to go to great lengths to fit within notions of replicability from the natural sciences (e.g., Midgley et al., 2013; Yearworth & White, 2014). However, this risks evaluating practice according to a limited set of values (Mingers, 2007; Pratt et al., 2020). The research in this paper instead responded to calls to complement previous experimental *and* interventionalist research into OR practice (Hämäläinen et al., 2013; White, 2016). Our new approach is complementary to the social and practice theories reviewed by Ormerod et al. (2023) in that it includes individuals' actions in interventions (in the actual domain in Figure 1) *and* interpretivist accounts thereof (in the empirical domain). By operationalizing critical realism for evaluating multimethodological practice, we have made critical realism more accessible in research (Maisuria & Banfield, 2023; Shaw et al., 2019). Moreover, we have provided a new systemic scientific approach for understanding and comparing multiple practitioner case studies while preserving case complexity.

From Ormerod et al.'s (2023) review, we might also conclude that OR lacked a compelling understanding of how to study the context of an OR intervention and its effects on individuals' actions. Ormerod et al. (2023, p. 824) concluded that researchers need to analyse the cultural, social, political and material context of the actions of intervention participants. In the case analysis in this paper, we included the interrelated and interacting causal influences of social structure, as well as cultural and material aspects, and individuals' agency and reflexive decision making (Elder-Vass, 2022), including political issues. Therefore, a key contribution of this paper is that our operationalization of critical realism enables more systematic study of all the aspects of context specified by Ormerod et al. (2023), as well as their causal effects on individuals' actions.

In terms of research methods, our empirical research design for critical realist case analysis (Table 1) can be used to derive knowledge of cases of multimethodological practice from retrospective descriptions of cases from those involved, and their reflections thereon. Whereas we used interviews and project documents, real-time observation (in the empirical domain in Figure 1) could be used to source case data. In fact, data from across research traditions could be used, including from ethnography (Franco & Greiffenhagen, 2018; Horlick-Jones & Rosenhead, 2007) and possibly autoethnography (Reynolds, 2017; Tavella, 2018). Where data is available, quantitative variance approaches could be used (Franco et al., 2021; Mingers, 2014). For recent suggestions as to methods and technologies, see Ormerod et al. (2023). The new approach in this paper can then be applied in research into multimethodological OR practice regardless of the philosophical assumptions inherent in its practice (Jackson, 2023; Ulrich, 2007) to explore causality in OR *as actually practiced* in non-academic settings.

6.2. A new approach for evaluating multimethodological practice in OR

Using our new critical realist approach for identifying causal mechanisms, future research can then investigate the causal impact of method choice, methodological design, and other aspects of multimethodological practice, on decision processes and intervention outcomes (Velez-Castiblanco et al. 2016; Hämäläinen et al., 2013). It is known that intervention success, or otherwise, does not follow directly from method choice (Ackermann & Howick, 2022; Midgley et al., 2013; Pidd, 1996). As Midgley et al. (2013) concluded, ‘inquiry focused on an intervention can look, for example, at how satisfactorily the method addressed given purposes; what aspects of the context enabled or constrained its application; and whether it gave rise to anticipated or unanticipated outcomes’ (p. 146). There is also a lack of research into the influence of different individuals (including OR practitioners) on the process of strategic decision-making where this is supported with multimethodological OR (O’Brien, 2015). In such future research, we would not ask ‘what impact did use of this method have on intervention outcomes?’. We would ask ‘how was the method or methodology (or another aspect of the practitioner approach, or another intervention aspect, e.g., another individual’s action) implicated in real causal mechanisms that led to intervention outcomes and perceptions thereof?’.

To the extent that practitioners deal with strategic decision issues that are wicked problems (see Ackermann, 2024; Camillus, 2008; Grewatsch et al., 2023; Mingers & Rosenhead, 2011), Rittel and Webber (1973) would suggest that individuals are likely to judge the same intervention outputs differently ‘to accord with their group or personal interests, their special value-sets, and their ideological predilections’ (p. 163). In OR, some individuals will be better placed to comment on outcomes, or implementation, others intervention process (Connell, 2001; Ormerod, 2008b). We therefore propose that future research evaluating multimethodology examines *perceptions of success*, including whether clients’ needs in terms of outcomes are met (Howick & Ackermann, 2011; Midgley et al., 2013), and how participants perceive intervention progress relative to individual or shared goals (Ackermann, 2024).

Thus, our new approach facilitates a move beyond previous interpretivist accounts of intervention success (Midgley et al., 2013; Ormerod et al., 2023) to unpick causal mechanisms across projects that lead to OR practitioners’ multimethodological interventions being perceived as successful. Future research can therefore investigate what makes use of multimethodology successful or otherwise (Ackermann & Howick, 2022; Howick & Ackermann, 2011) *for practitioners and other individuals involved in or affected by interventions*. It can therefore be used to respond to the need to look at ‘what works for whom and why’ (White, 2006, p. 846; Connell, 2001). Such evaluation of the extent to which practitioners are facilitating improvement of situations, and for whom, is fundamental for the successful future practice of OR as an applied discipline addressing real-world issues.

6.3. A new approach for understanding underlying causal mechanisms and causal complexity

Our empirical research was the sort of qualitative-led, intensive research that Sayer (1992) argued is required to identify causal mechanisms (Easton, 2010; White, 2016). In future research, scholars should use the new approach to examine whether particular mechanisms (e.g., practitioners’ aim to be seen as trustworthy, fair, and independent as an influence on method choice) are found generally (Wynn & Williams, 2012; Zachariadis et al., 2013) across OR practice, including across practitioners, place (including beyond the UK), and time (Rutten, 2024). This will involve structural and causal analysis of multiple cases (Pula, 2021). Researchers can also analyse mechanisms using theory from psychology and sociology (and other behavioural sciences) to check for compatibility (Hedström & Ylikoski, 2010). Extensive research should then test mechanisms at scale.

By operationalizing critical realism for identifying causal mechanisms in multimethodological OR practice, we also showed *how* OR intervention is causally complex (Yearworth & White, 2014). Intervention events and outcomes in Figure 5 resulted from the combination of multiple mechanisms (Gerrits & Verweij, 2013; Ragin, 1987), with each mechanism operating contingently (Danermark et al., 2019; Porpora, 2016).

To investigate further the causal complexity of multimethodological practice in OR, a critical realist approach to configurational analysis could be used. This could build on Henfridsson and Bygstad's (2013) use of a survey of digital infrastructure evolution to identify equifinality (multiple different configurations of mechanisms leading to the same outcome) and multifinality (other configurations leading to other outcomes). However, in future research, set-analytic configurational approaches, such as qualitative comparative analysis (QCA) (Furnari et al., 2021; Ragin, 1987), may be useful. QCA can be used to compare sets of configurations of conditions and outcomes across cases (using necessity and sufficiency analysis) to identify patterns that give clues as to possible causal relationships (White, 2018). These patterns can then be analysed using a critical realist approach, especially abduction and retroduction, to identify causal mechanisms (Runde, 2020; Rutten, 2024).

But in future studies, QCA could instead be used to compare mechanisms (Pula, 2021) identified using the new approach in this paper, *and* to compare events (including practitioner actions) and outcomes. Further, mechanisms, events and outcomes could be compared across both practical cases *and* theories of multimethodology. This could facilitate further cross-case understanding of multimethodological practice as part of wider, multimethod approaches (Gerrits & Pagliarin, 2021; Gerrits & Verweij, 2016), building on the empirical methodology developed in this research.

6.4. A new approach for theorizing and evaluating mixed methods research across disciplines

In future, our new approach can also be used for theorizing and evaluating mixed methods research in and across other disciplines. Specifically, the new critical realist ontology of multimethodological practice and methodologies (Figure 1; section 3.5 above) and the empirical research design (Table 1) can be adapted and used to identify and compare underlying causal mechanisms, events, and outcomes across mixed methods research projects. As already discussed in relation to OR, this new approach can therefore be used to evaluate the practical utility (Dahler-Larsen, 2023) and to understand the causal complexity (Poth, 2018) of any mixed methods research project.

Moreover, our theoretical framework provides a systematic and systemic scientific basis for an alternative to ecological, interactive, and other realist approaches to the theory of the complexity of designing a mixed methods research project (e.g., Maxwell, 2022a, 2022b; Nastasi et al., 2010; Plano Clark & Ivankova, 2015; Schoonenboom et al., 2018; Stoecker & Avila, 2021). For example, in mixed methods research literature, the role of individuals involved in or affected by research as an influence on research design has recently started to be recognized explicitly (Poth, 2018). The new approach in this paper can be used to structure theorizing and empirical research about the causal influences of these and other aspects of the research context on the complex process of method choice though structure, culture, and agency (in the intervention context in Figure 1).

6.5. Limitations

As with other theory-based realist approaches to identifying mechanisms and evaluating the outcomes of complex interventions (Greenhalgh et al., 2025), a potential disadvantage of the new approach is that the first author found it time-consuming. This was exacerbated by needs to understand a plethora of context-specific jargon, transcribe the

interviews herself, and analyse cases without artificial intelligence. This was a first attempt. Nonetheless, it could be argued that the case study did not go far enough in identifying causal mechanisms and reporting their interaction in a narrative way (contrary to Porpora, 2016). Further research, building on the new approach, could therefore model the interaction of mechanisms, and changes in the intervention context, over time. Such research could build on Franco et al.'s (2021) proposal to use OR modelling to understand the process of OR, and Mingers' (2006a) proposals for combining quantitative modelling (e.g., simulation or system dynamics) with qualitative analysis.

Theoretical underpinning for changes in the intervention context could come from Archer's (1995, 1996) theory of the morphogenesis of structure, culture and agency, which builds on Bhaskar's transformational model of social activity (TMSA). In morphogenesis, 'configurations of components' of 'structure, culture, agency and relations' are transformed, reproduced, or remain the same over time (De Souza, 2013, p. 148). Archer (1995) was interested in explaining population-level change and actions of groups or 'large sections of the population' (p. 216). However, she claimed that morphogenesis provided a framework for *any* social situation, 'whether that be a detailed examination of local strategic practice or the unfolding of relationships between organizations at a societal level' (Mutch, 2020, p. 8).

Future research building on the new approach in this paper with morphogenesis could therefore help practitioners understand, in the context of particular interventions, for example, the influence on method choice of issues such as path dependence (Hämäläinen & Lahtinen, 2016; Lahtinen et al., 2017) and distributed working (Ackermann, 2024), as well as participant engagement with OR models over time (Ackermann, 2024). There is also 'double morphogenesis, where agential powers are elaborated in the process of socio-cultural transformation' (Archer, 1995, p. 185). Then, 'triple morphogenesis' of actors in social positions and roles (Archer, 1995, p. 274) provides a way of conceptualizing changes in social identities of individuals. Future research underpinned by morphogenesis could therefore also examine changes in participants' knowledge and skills (competences) and social identities (Ormerod, 1997; 2008b; 2014b) as OR intervention proceeds.

Like Ackermann and Howick (2022), we focused on individuals' reports of interventions (in interview data), albeit that we included a much wider group of individuals, and examined documents. In future research, access to real-time interventions could permit enhanced researcher attention to embodied and collective behaviour (Ackermann & Howick, 2022; Henao & Franco, 2016; White, 2016; White et al., 2016) and their effects in interventions, as well as 'model affordances provided by diverse means whether via a model or via the social' (White, 2016, p. 837). In future action research, scholars can employ our new approach to analyse causal effects of their involvement on events and outcomes (Midgley et al., 2013) by including themselves in the structural and causal analysis (cf. Gherardi, 2025; Whittington, 2026). Our ontological analysis can also be broadened to include non-humans, including 'animals, plants and other aspects of the environment and ecosphere' (Stephens et al., 2019, p. 4), and agentic artificial intelligence (Burger & White, 2026; White, 2026).

7. Conclusion

In this paper, we introduced our research project evaluating multimethodological OR practice and explained our decision to develop a new critical realist approach to investigate causality. We reviewed literature on past evaluations of multimethodology and use of critical realism in OR. We concluded that we needed to operationalize critical realism by developing an ontology of a generic multimethodological OR intervention. This would enable us

to identify and compare causal mechanisms across practitioner case studies. Accordingly, we re-conceptualized multimethodological OR practice, synthesizing existing literature on OR interventions and their elements (context, individuals, methodologies), and conceptualizing causal mechanisms that lead to participant actions and outcomes. We presented our new, critical realist empirical research design for single and multiple case study research. We illustrated our new theoretical and empirical approach with a single case, demonstrating how we identified causal mechanisms of practitioner method choice using rich description, and structural and causal analysis. We discussed our development and employment of the new approach, reviewing the contributions of this paper, limitations of the research, and future research opportunities within and beyond OR. We described our research, methods and results in this paper and elsewhere (Christie, 2017, 2023, 2025; Christie et al., 2022) in the interests of transparency (Van Burg et al., 2020), trustworthiness (Foster-Collins, 2020) and credibility (Nowell et al., 2017). We balanced those needs with needs for confidentiality and anonymity (or at least de-identification of individuals), and practicalities of time-constrained research and word-limited publications. As part of our critical realist approach to justification and corroboration, further critique is invited. In summary, this paper provides theoretical grounding and methodological guidance for future scholarship on the context, process and outcomes of multimethodological practice across OR, and of mixed methods research projects generally. It can be used to support and inform future practice.

Notes

ⁱ Mingers and Brocklesby (1997) termed the special case of multimethodology in which practitioners integrate methods from different paradigms (across so-called hard/quantitative, soft/qualitative, and critical systems OR), ‘multiparadigm multimethodology’. As Christie (2023, 2025) discussed in more detail, this brings multimethodology close to definitions of mixed methods research that require the integration of qualitative and quantitative aspects of research (see Hitchcock & Onwuegbuzie, 2022; Onwuegbuzie & Hitchcock, 2022).

ⁱⁱ As far as possible, we derived the theoretical framework using scholarship on multimethodological practice. Some of this scholarship will also be relevant to single-method interventions. In fact, we expect that much of the framework will be relevant to any OR intervention. However, single-method interventions were outside the scope of the research reported in this paper. We would expect single-method interventions to be relatively unusual in practice addressing complex, real-world issues (Christie, 2025).

ⁱⁱⁱ A social programme is a set of activities designed to encourage a set of changes or outcomes (Danermark et al., 2019, p. 207).

^{iv} In the theory of multimethodology, a methodology is ‘not the study of methods, nor the approach taken in a particular study ... but ‘a structured set of guidelines or activities to assist people in undertaking research or intervention ... within a particular paradigm’ ... (Mingers & Brocklesby, 1997, p. 490)’ (Christie, 2025, p. 27). A single methodology can be decomposed ‘into methodological stages, ... methods [or techniques], and tools [such as checklists]. Practitioners may then use the detached elements in other methodologies, or new frameworks’ (Christie, 2023, p. 167).

^v In the event, we were not given access to observe interventions in real time, hence our use of interviews and documents. This is a recognized challenge for research into OR practice in non-academic settings (Dyson, 2022; Ormerod, 1998; Ranyard et al., 2022).

^{vi} Dstl is a UK government executive agency (see UK Government, n.d.).

^{vii} Much guidance is available in research literature on numbers of cases but claims to a ‘golden number’ have been criticized in the context of qualitative and mixed research (Eisenhardt, 2021, p. 153). The aim in this research project was to make contributions to theory and practice, and our view was that these might not be reliant on the number of cases or extent of data, except that trying to do too much would mean never finishing! Rather, academic and practical contributions required quality in interpretation of data, and responses to research questions. In the end, the choice of number of cases was a pragmatic decision, based on what would be adequate for responding to the research questions, and acceptable for this type of research and its gatekeepers and reviewers (Braun & Clarke, 2021).

^{viii} For the proposed dimensions, a list of the principles we agreed for selecting cases for the research, and an illustration of the format of the purposive case longlist we used in selecting cases, see Christie (2025, p. 114).

^{ix} For practical and philosophical reasons in our research project, we did not intend that the multiple case study research data would constitute a statistically representative sample from which we could generalize to a wider population of practitioners’ strategic decision support work (cf. Yin, 2014), though some cases were described to us as typical of practice in the research context (that supported strategic decision-making for or on behalf of government). Instead, with the critical realist assumption of open systems (Bhaskar, 2008), we assumed a separation of causality and generality (Porpora, 2016, p. 209), and sought transfactual generalization to more plausible and nuanced, evidence-based descriptions and explanations of multimethodological OR practice than found in previous research (section 2.1 above). For a report of our multiple case study findings, see Christie (2025).

^x In the context of organizational strategy, a capability is defined as, ‘the combination of processes, tools, skills and behaviors, and organization that delivers a specified outcome’ (PwC, n.d.). National capabilities include UK Government organizations and groups (see UK Government, n.d., for examples) and parts and subsets thereof.

^{xi} Further, at least three of the five cases involved practitioners re-working previous interventions, which led to a need for us to understand – to at least some extent – years of practitioners’ work.

^{xii} Ormerod’s (2001, 2008a, 2008b) categories indicate individuals’ roles in relation to intervention activities, with the aim of being comprehensive. Like Ormerod, regrettably, we did not approach individuals in the done without category, due to lack of time.

^{xiii} We sought to understand practitioners' work across all intervention phases, as captured in the rich case descriptions. To keep the research manageable (Lund, 2014), for responding to the research questions we focused on one phase per case. Each selected phase started with practitioners being tasked with providing analysis and ended with practitioners delivering their findings to clients in the form of a report.

^{xiv} As the sample of practitioners was small, and there were confidentiality issues, we did not analyse personal interviewee characteristics (e.g., social and personal history) in our ontological analysis of agency.

^{xv} For a report of our findings in relation to all five cases in Figure 2, see Christie (2025).

^{xvi} Practitioners explained that their methodological approach was that they sought to answer, 'the questions we need to answer, to satisfy those who are judging' using 'the appropriate toolsets to do that, that are already available', and only looking to 'develop [...] a totally new method if there isn't something there that which adequately delivers it safely'. Separately, in response to the first interview handout showing Morgan et al.'s (2017) forms of multimethodology (Appendix E in the supplementary materials), practitioners described their overall methodological design – across all intervention phases – as 'towards the integration' (Christie, 2025). That is, close to synthesizing methods within a new, larger framework (after Bennett, 1985, and Mingers & Brocklesby's, 1997, 'multiparadigm multimethodology').

Acknowledgements: This work was supported by the Economic and Social Research Council grant number 1636934 and Dstl. The content of the paper was cleared by Dstl for publication. We thank everyone in UK Government and beyond who facilitated and participated in this research for their time, and for sharing their experiences. We thank Nick Harris (Dstl) for his assistance with presentation and publication of the results. We thank three anonymous reviewers for their encouragement and recommendations. We obtained ethical approval from the University of Kent Faculty of Social Sciences Research Ethics Advisory Group for Human Participants. For the purpose of open access, the authors have applied a Creative Commons Attribution (CC BY) licence to any Author Accepted Manuscript version arising.

Declaration of interests: M. Parr was formerly employed by Dstl, and is currently owner, director, and employee of Guided Systems Solutions Ltd., a consultancy that undertakes some of its work for the UK government.

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