

Engaging with behavioural OR: On methods, actors, and praxis.

L. Alberto Franco^{a1}, Raimo P. Hämäläinen^b

^a *School of Business and Economics, Loughborough University, Leicestershire LE11 3TU, UK*

^b *Systems Analysis Laboratory, Aalto University, P.O. Box 11100, 00076 Aalto, Finland*

Abstract: In this chapter, we highlight the importance of the behavioural perspective to advance the discipline of operational research (OR). The power of this perspective lies in its ability to identify the conditions under which the impact of OR-supported processes is enhanced or hindered by behavioural factors, with a view to developing more effective OR practice. To help organise and guide the conduct of empirical studies in the sub-discipline of behavioural OR (BOR), we draw on practice theories from the social and organisational sciences to propose an integrative framework based on the three central concepts of OR *methods*, OR *actors*, and OR *praxis*. In discussing these concepts, we refer to the developing empirical BOR literature to highlight alternative analytical foci. We end the chapter by discussing the implications of the behavioural perspective for advancing the OR discipline, particularly with regards to foregrounding OR praxis in academic papers, attending to a wide diversity of OR actors, developing OR competences, and the role of theory and research methodology.

Keywords: behavioural OR, practice, impact, empirical research, theory

1. Introduction

In many other disciplines, attention to the study of behavioural issues becomes prominent when their theoretical core has reached maturity. This has happened in economics (Camerer & Lowenstein, 2003), finance (Bruce, 2010), accounting (Birnberg, Luft, & Shields, 2007), and strategic management (T. Powell, C., Lovallo, & Fox, 2011), as well as in cognate disciplines such as operations management (Bendoly, Van Wezel, & Bachrach, 2015), decision and game theory (Camerer, 2003; Von Winterfeldt & Edwards, 1986) and environmental modelling (Hämäläinen, 2015). The development of the discipline of operational research (OR) is similar and thus the current resurgence of interest in the behavioural perspective (Franco & Hämäläinen, 2016) is not surprising. We use the term ‘resurgence’ deliberately: attention to the non-mathematical and behavioural aspects of the OR profession can be traced back to past debates in the 1960s and 1970s within mainstream OR (e.g. Ackoff, 1977; Churchman, 1970; Dutton & Walton, 1964; Lawrence, 1966), and in the 1980s and 1990s within systems thinking (e.g. Senge & Sterman, 1992) and in the specialised domain of soft OR (e.g. Jackson, Keys, & Cropper, 1989). Behavioural issues received less attention in subsequent years. For example, they are hardly mentioned in the 50th anniversary issues of *Operations Research* (Wein, 2002) and the *Journal of the Operational Research Society* (Brailsford, Harper, & Shaw, 2009). However, as the OR discipline attends to the improvement of *human* problem solving and decision making in practice, a return to behavioural concerns within the discipline was in some ways foreseeable. What motivates this renewed attention to behavioural issues in OR is the recognition that developing technically correct and valid models is not enough; we also need to design model-supported interventions by taking into account behavioural factors that could enhance or hinder their effectiveness.

The latest evidence of the revival of what is now known as *behavioural OR* (Hämäläinen, Luoma, & Saarinen, 2013), or ‘BOR’ for short, can be found in the recent special issue of the *European Journal of Operational Research* that focused on BOR (Franco & Hämäläinen, 2016). In addition, high levels

¹ Corresponding author telephone +44 (0)1509 228 004; email: l.a.franco@lboro.ac.uk

of participation in BOR streams at international conferences, the creation of a BOR national interest group sponsored by the UK OR Society (<https://www.theorsociety.com/Pages/SpecialInterest/Behaviouralor.aspx>), and the launch of a BOR website portal hosted by Aalto University (bor.aalto.fi) are all a clear testimony of the closer attention that the OR community is increasingly showing to the behavioural perspective. Noticeable in this return to BOR is a commitment to *empirically* examine what people actually do within a system or when engaged in OR-supported processes. For not doing so would limit the development of relevant theories that could help advance explanations linking the key behavioural dimensions that shape the conduct of OR in practice. Such behavioural-based explanations would go beyond pure description and have a prescriptive orientation concerned with improving the use of OR in practice (Franco & Hämmäläinen, 2016), including the responsible and ethical use of OR-supported processes (Le Menestrel & Van Wassenhove, 2004, 2009; Ormerod & Ulrich, 2013).

Two main streams of work that have generated attention within BOR can be identified. The first stream has a long history within academic OR, and concentrates on the use of the OR approach to model human behaviour in complex settings. For example, there is long standing tradition of modelling behaviour in decision analysis (e.g. French, Maule, & Papamichail, 2009) and system dynamics (e.g. Sterman, 2000). The second stream investigates how behaviour affects, or is affected by OR model-supported processes in individual, group and organisational contexts. Although still relatively under researched, this stream is receiving increasing attention by both OR academics and practitioners, particularly in Europe (e.g. Ackermann & Eden, 2011; Amini, Wakolbinger, Racer, & Nejad, 2012; Brailsford & Schmidt, 2003; Franco, 2013; Hämmäläinen et al., 2013; Morton & Fasolo, 2009; Ormerod, 2014a; Rouwette, Korzilius, Vennix, & Jacobs, 2011; White, 2009). While different in focus, the two streams share the common goal of designing and deploying OR-supported interventions to improve organisational systems and operations.

Against the above background, we propose in this introductory chapter an agenda for driving the development of BOR as a legitimate sub-discipline within OR, by means of an integrative framework based on the three interdependent concepts of OR methods, OR actors and OR praxis. The framework is intended as an organising device for the conduct of empirical BOR studies, highlighting different analytical foci and points of entry into the study of behavioural issues in the practice of OR.

The chapter is structured as follows. In the next section we draw on practice theories within the social and organisational sciences to introduce the three central concepts of OR methods, OR actors and OR praxis. Next, we link these three concepts together within an integrative framework intended to organise and guide the conduct of empirical BOR studies. The framework is illustrated with exemplars from the developing BOR literature that increase or challenge our current understandings of OR practice and its impacts. We end the chapter with a discussion of the implications of the behavioural perspective for advancing the OR discipline. .

2. OR methods, OR actors, OR praxis

In this section we draw upon the practice traditions within the social and organisation sciences (Feldman & Orlikowski, 2011; Jarzabkowski, Balogun, & Seidl, 2007; Nicolini, 2012; Reckwitz, 2002; Schatzki, Knorr-Cetina, & Von Savigny, 2001; Turner, 1994; Whittington, 2006), and in particular the work of Richard Whittington within strategy research (e.g. Whittington, 2003; Whittington, 2006, 2011), with a view to offering an integrative framework that highlights different analytic foci and entry points for the conduct of empirical BOR studies. Three important questions derived from practice theories are particularly relevant to the BOR perspective, and they underpin the central elements in our framework. Specifically, when examining an OR-supported process using a behavioural lens, we need to address the following questions: (1) what guides behaviour in the process; (2) whose behaviour counts in the process; and (3) how behaviour is enacted in the process. Importantly, answers to these questions can explain the impacts that are achieved (or not) from the application of OR. We turn to each of these questions below.

What guides behaviour in an OR-supported process are the *methods* used by those engaged with that process. OR methods provide the resources through which people are able to interact in order to accomplish OR-supported work. At a basic level then, methods include the range of OR techniques and tools available to support interactions in an OR-supported process. However, our conceptualisation of OR methods goes beyond techniques and tools, and also include standardised routines for building and using models, approaches to communicating with and about models, and norms and procedures for intervention design, data collection, training and teaching, and embedding OR-supported processes in organisational routines. These are important but often overlooked aspects of the methods of OR, and they too provide a source of guidance for actual problem solving and decision making interactions.

From a BOR perspective, the role or identity of those participating in an OR-supported process also matters. Here we adopt the general category of *actors* to refer to those individuals who, acting in isolation or as part of a team, design, implement, or engage with OR-supported processes. Thus OR actors do not just include mainstream OR practitioners (e.g. modellers, analysts, facilitators, consultants) who are at the centre of any OR-supported work, but also others who participate in OR-related activity either as clients, sponsors, experts or simply users. All these can be seen as OR actors whose behaviour is critical to the success or failure of OR-supported processes. Indeed, actors' behaviours matter because their effects and those of the OR methods used are intertwined in practice.

How behaviour is enacted in an OR-supported process is also important from a BOR perspective, because it pays attention to what OR actors actually 'do' with OR methods *in situ*. We adopt the term *praxis* to conceptualise this process, namely, all the various streams of actual OR activity carried out by OR actors. Although actual OR praxis involves dynamic flows of activity taking place at different organisational levels (Mitchell, 1993), behavioural aspects of OR praxis are most visible within specific 'episodes' (cf. Luhmann, 1995) of OR-related activity such as modelling sessions, meetings, presentations, and workshops of varying duration, frequency and sequence. Examining actual behaviour in OR praxis has the benefit of highlighting potential gaps between espoused or 'textbook' OR practice and what actually happens on the ground.

Answers to the above questions can provide a more holistic picture of the role and impact of behavioural-related issues in OR-supported processes. To find possible answers, we need to investigate a wider range of OR methods in context, attend to who engages with them, and closely examine how they are actually used in practice. In the next section we build on our preceding discussion to introduce an integrative framework that links the three central concepts of OR methods, OR actors and OR praxis to the context and outcomes of OR practice.

3. An integrative framework to study behaviour in OR

Figure 1 shows an integrative framework for the study of behavioural issues in OR-supported processes. The framework highlights three key interrelated concepts of OR methods, OR actors, and OR praxis (c.f. Whittington, 2006) already introduced above. Our framework also makes clear that OR methods are available for use by OR actors when they engage in OR praxis. Although shown in separate boxes, methods, actors and praxis are not discrete entities operating in a vacuum but highly intertwined within their organisational context. Thus OR methods cannot be separated from the actors who use them, and OR methods can only have material existence within OR praxis. Furthermore, the framework shows that the impact of OR methods on outcomes cannot be understood without taking into account the behaviour of OR actors, and that these will be particularly salient within given episodes of OR praxis. Finally, the framework underlines the potential feedback effects of OR outcomes on the actors and how they carry their praxis, on the OR methods themselves, as well as on the organisational context within which actors, methods and praxis are all embedded.

Our framework contrasts with that proposed recently by White (2016), which is offered as a device for thinking about behaviour across a three-dimensional typology of OR interventions. This typology is derived from alternative configurations of the (discrete) values taken by the dimensions of 'OR user' (individual/group), 'issue divergence' (high/low), and 'model use' (instrumental/symbolic). Thus

behavioural issues pertaining individual-low divergence-instrumental interventions will be different to those pertaining group-high issue divergence-symbolic interventions. Whilst useful as a heuristic device, the dimensions in White's framework would be difficult to use to guide empirical BOR studies. For example, whilst there may be instances where models are indeed used in purely instrumental or symbolic terms, model use can vary considerably across OR interventions, and it has been shown that models can in fact show both uses within the same type of intervention (e.g. Franco & Lord, 2011). The elements in our proposed framework do not represent discrete binary conceptualisations as in White's framework but, instead, allow for a range of empirical possibilities intended to facilitate the conduct of empirical BOR studies in both the field and the lab.

From a behavioural perspective, any BOR study will inevitably link all three intertwined concepts of methods, actors, and praxis to OR outcomes. Empirically, however, this can be challenging due to the complex nature of the relationship between these elements. One way to get round this issue is to choose one dominant area of empirical focus by foregrounding only one of the three central concepts, while backgrounding the others, and then examine the link between the chosen focus and OR outcomes. It is to a wider consideration of such an empirical approach that we now turn.

PLACE FIGURE 1 ABOUT HERE

3.1. Focus on OR methods

Perhaps unsurprisingly, in most OR studies the focus is on OR methods and the outcomes achieved from using them. Typically, the methods of interest are modelling techniques and models. From a BOR perspective, however, a major concern is to examine the extent to which OR methods produce *behaviour-related* outcomes such as changes in cognition (e.g. learning), attitudes, or interactions. Current empirical evidence of the methods-outcomes link is relatively strong only for some OR methods such as group model building (e.g. Rouwette, Vennix, & Van Mullekom, 2002; Schilling, Oeser, & Schaub, 2007; Scott, Cavana, & Cameron, 2016), and thus more BOR studies with this choice of focus are needed.

It is important to clarify that a focus on OR methods does not necessarily imply that the methods must capture behaviour explicitly. Hence, for example, an optimisation model that does not take into account any behavioural considerations would still be of interest from a BOR perspective, as long as the study connects the model to behaviour-related outcomes. Likewise, OR methods that capture behaviour explicitly by drawing on experience or formal theory (e.g. Brailsford, Harper, & Sykes, 2012), are not in themselves of interest to BOR unless they are linked to behaviour-related outcomes.

Methods other than modelling techniques and models should also be studied in relation to OR outcomes. As discussed in the previous section, OR methods also include norms and standardised procedures for designing interventions, eliciting data, training and teaching, communicating with and about models, and even for selling or embedding OR in organisations. For example, scripts for running modelling workshops have been developed (e.g. Ackermann, Andersen, Eden, & Richardson, 2011; Hovmand et al., 2012) and their link to behavioural outcomes examined (e.g. Scott, Cavana, & Cameron, 2013; Tavella & Papadopoulos, 2015b). With respect to methods for eliciting data, there is a long tradition in decision and risk analysis of using of standard protocols to produce unbiased expert judgments of probabilities and preferences (for a recent review, see Montibeller & Von Winterfeldt, 2015). The impact of training methods using structured procedures (e.g. Carlson & Bond, 2006; Ellspermann, Evans, & Basadur, 2007) and games (Graham, Morecroft, Senge, & Sterman, 1992; Lane, 1995; Morecroft, 1988) has a long history too (e.g. Hartley et al., 1979), and is typically undertaken via experimentation (Bakken, Gould, & Kim, 1992; Capelo & Dias, 2009). By contrast, the behavioural impacts of OR teaching methods have not been the focus of empirical research, although shared experiences and reflections about different teaching methods used in the classroom

are available (e.g. Kunc, 2012; Mingers & Rosenhead, 2012; O'Brien, 2004; Pierre Brans & Macharis, 1997; Wright, Cairns, & Goodwin, 2009). Finally, the impact of approaches to communicating with and about models, selling or embedding OR are perhaps the areas that have received the least empirical attention to date, with some exceptions (e.g. Brailsford et al., 2013; Franco, Cushman, & Rosenhead, 2004; Hämmäläinen et al., 2013).

Other under researched areas with a focus on the methods-outcomes dimensions include the multiple interdependencies that OR methods can have in practice. For the effect of a particular method (e.g. a model) in practice can vary according to the presence or absence of other methods (e.g. modelling script, communication protocol). In addition, the introduction of new OR methods and their behavioural effects offers further research possibilities. For example, internet technologies are generating new methods of expert judgment elicitation (e.g. Hamalainen, Mustajoki, & Marttunen, 2010). Overall, the adoption of a methods analytic focus prompts us to investigate the wider range of OR methods actually used in practice (e.g. Ahmed & Robinson, 2013; O'Brien, 2011; Ranyard, Fildes, & Hu, 2015), how method use changes over time (e.g. Fortuin & Zijlstra, 2000) and, crucially for BOR, what the behavioural consequences of different use patterns are (e.g. Chung, Willemain, & O'Keefe, 2000; O'Keefe, 2016).

3.2. *Focus on OR actors*

Foregrounding OR actors and their impact on outcomes offers a different choice of analytical focus that makes the behavioural dimension particularly salient. Indeed, if we were to adopt a more holistic BOR perspective then we should move beyond just OR methods to include the individuals and teams that engage with them. There is a long but thin tradition of BOR studies that focus on particular types of OR actors and the outcomes of methods use. For example, there is a stream of research that examines the work of expert modellers (Tako, 2014; Tako & Robinson, 2010; Waisel, Wallace, & Willemain, 2008; Willemain, 1994, 1995), novice modellers (S. G. Powell & Willemain, 2007; Tavella & Papadopoulos, 2015b; Willemain & Powell, 2007), or both (Tavella & Papadopoulos, 2015a). Research focusing on other types of actors is also beginning to appear, such as studies of forecasting experts (Petropoulos, Fildes, & Goodwin, 2016; Syntetos, Kholidasari, & Naim, 2016), decision analysts (Papamichail, Alves, French, Yang, & Snowdon, 2007), and OR consultants providing strategy support (O'Brien, 2015).

Consequently, from a BOR perspective, claims about the link between OR methods and OR outcomes should be taken with caution if they do not account for the role and impact that the different OR actors involved can have. For OR actors may be more or less successful in their use of particular OR methods according to their level of competence and expertise (Huxham & Cropper, 1994; Keys, 2006; Ormerod, 2008, 2014b; Wright & Bolger, 1992), their cognitive style (Fasolo & Bana e Costa, 2014; Franco & Meadows, 2007; Franco, Rouwette, & Korzilius, 2016) or their preferred consulting approach (Cropper, 1990; Eden & Ackermann, 2004; Franco & Montibeller, 2010). Thus the same OR method may lead to different outcomes when deployed, used or even sponsored by a competent and experienced actor who enjoys analysis carried out in participative fashion, than by a novice actor who relies highly on intuition and prefers expert advice.

As in the case of methods, OR actors can also exhibit interdependencies that can affect outcomes. For example, the effectiveness of a modelling workshop facilitator will be contingent to who participates in the workshop: the presence or absence of a powerful and skilful actor can undercut the work of the facilitator and increase or decrease the participation of other actors, hence affecting the quality of the model. A similar argument can be made for the case of larger OR interventions. Therefore, this is an area that is worth exploring empirically, as most published accounts of OR practice tend to be positive or down play the impact of OR actors (but see Connell, 2001). An empirical focus on OR actors and their impact on outcomes also can begin to unravel the feedback effects of outcomes on actors. For example, a few BOR studies have shown enduring changes in actors' mental models (Scott et al., 2013). Other long term effects on actors can be subject to empirical examination within this focus, including effects on actors' competences, status and professional relationships.

3.3. Focus on OR praxis

At the core of the BOR perspective lies the assumption that to improve OR methods we must pay attention to *how* they are actually used by those who engage with them. As most OR practitioners will already know, the actual use of OR methods is influenced by the needs of the users and the specific contexts of use. Thus a focus on OR praxis reminds us of the complex and *situated* dynamics of method use, which must be taken into account to avoid superficial understandings of what OR actors actually do in practice, and of the critical role of these doings on generating OR outcomes. This is an area that is still relatively under explored, particularly in the field. Nevertheless, some relevant work is beginning to appear following calls to conduct fine-grained studies of the use of OR methods (e.g. Franco & Rouwette, 2011; Horlick-Jones & Rosenhead, 2007). For example, Shaw *et al* (2003) show how management teams using the same OR method within a workshop context develop knowledge about issues with different degree of complexity, which affects their ability to develop in-depth understanding about those issues. Also within a workshop context, White, Burger and Yearworth (2016) use activity theory to show how participants use mediating artefacts to wrestle with the object of a “zero carbon zone”, and demonstrate how a shared activity system is developed to accommodate contradictions between participants’ motives. On a larger scale, Ormerod (2014a) reflects on the development of the National Coal Board UK Energy model in the 1970s and 1980s, and discusses how the ‘mangled’ (Pickering, 1995) intersection of OR actors and methods affected the intervention design, deployment and outcomes.

Despite their standardisation, OR methods can be used in diverse and variable ways, and adapted to the uses to which they are put by those engaged with OR-supported processes, and this has particular effects on outcomes . This is a salient feature of the three works mentioned above, and is also evident in the recent review of mixed-methods interventions by Howick and Ackermann (2011). However, deviations from expectations of method use do not necessarily imply bad praxis. There might be cases where skilful adaptations and improvisations in the use of OR methods can take place in specific contexts (e.g. Montibeller, Franco, Lord, & Iglesias, 2009; Robinson, Worthington, Burgess, & Radnor, 2013), which may reveal potential OR method innovations. Therefore, the adoption of OR praxis as the analytic focus pays attention to the situated nature of OR method use: by examining how OR methods are enacted locally in practice, in ways that perhaps are not recognisable to the methods’ originators, BOR studies can develop theories about the role of method adaptations in generating OR outcomes.

Of course not all method adaptations or even transformations may be positive, and in this case empirical research that examines uses of methods that deviate from their standard forms can highlight areas for improvements in method use. For example, Lahtinen and Hämäläinen (2016) conducted a controlled experiment to show the emergence of path dependence in the use of the even swaps method, which they explain is the result of the accumulated effect of successive biased even swap tasks. Their findings led them to develop a strategy for carrying out the even swaps process so that the accumulation of the effects of biases is reduced.

Overall empirical studies with a focus on praxis have the potential to advance explanations of the impact of method use *in situ*. Such studies are an essential supplement to the commonly adopted approach of using post-hoc questionnaires and reflexive accounts to evaluating OR interventions

4. Implications of a behavioural perspective for OR

In this section we build on our preceding discussion to develop four broader implications of adopting the behavioural perspective for advancing the OR discipline: foregrounding OR praxis in academic papers; attending to a wide diversity of OR actors; developing OR competences; and, grounding BOR studies on relevant theories. We briefly discuss these implications next.

4.1. Foregrounding OR praxis in academic papers

The first implication is the recognition that the practice of OR will remain a ‘black box’ unless we examine how methods are actually used by OR actors. That is, a focus on OR praxis is central to progressing the BOR agenda. Mandated here, therefore, is the kind of micro-level examinations of praxis that are common in practice and decision making studies within the behavioural, social and organization sciences, and which are beginning to appear in the OR literature (e.g. Horlick-Jones & Rosenhead, 2007; Lahtinen & Hämäläinen, 2016; Velez-Castiblanco, Brocklesby, & Midgley, 2016). At issue here is to publish accounts of how OR methods are actually used by conducting empirical and close interrogations of their claimed effects in the field or the lab.

4.2. *Evaluating impact of diverse OR actors*

A second implication is the consideration of the wide variety of OR actors that participate in the practice of OR. The research agenda here concerns the study of different types of practitioners and their role and influence in the use of OR methods. Traditionally, published accounts of OR practice are written from the perspective of the OR practitioner (e.g. modellers, analyst, consultant). This focus is natural as OR practitioners are central in designing, deploying, and adapting OR methods. However, actors such as sponsors, clients, and users also play a key role in OR-supported processes and ultimately determine what OR can practically accomplish. Considering a wider range of actors will extend our understanding of OR practice beyond that provided by the OR-practitioner view. Empirical studies in the field and the lab should undertake fine-grained analyses that can illuminate how the characteristics of different types of OR actors (e.g. roles, motivations, cognitive styles, emotional states), and the dynamics in which they engage contribute to shaping outcomes of OR – supported processes.

4.3. *Developing different competences in OR*

The third implication is that effective OR praxis relies heavily OR actors’ competence to apply and engaged with OR methods. Lack of adequate skills for the deployment, use or interpretation of OR methods can profoundly affect OR outcomes, and this requires managing effectively the technical as well as the behavioural and social aspects of OR-supported processes. From a BOR perspective, how OR actors become competent in the application, use and interpretation of OR methods in praxis is a crucial research question. Here, empirical research that focuses on the teaching and training of ‘doers’ and ‘users’ of OR is highly relevant. BOR studies might thus track how OR actors learn, master or embrace different methods within the classroom or during actual praxis. Such research can help to produce empirically grounded theories of what it takes to become a competent OR actor in different settings.

4.4. *Grounding BOR studies on relevant theories*

The final implication is the need to ground empirical BOR studies in relevant theories drawn from outside the OR field. Attention to theory might seem at odds with the applied nature of the OR discipline. However, as Brocklesby (2016) notes, the practice of OR involves a complex array of dimensions that need to be better understood, and thus the use of a relevant theory can bring into view those dimensions that otherwise would remain hidden in the background, which can help generate new levels of awareness to inform OR practice. This does not imply a preference for a particular theory, nor the adoption of a specific research method to empirically test it. Thus, for example, the adoption of a theory of heuristics and biases to conduct empirical research via experimental methods (e.g. Tversky & Kahneman, 1974), a common approach that has produced many useful insights in economics, finance and operations management, would represent in our view just one possible way of studying behavioural issues in OR.

Consequently, the concern here is less with what theories or research methods are adopted than by what behavioural issue related to OR practice is examined. In this respect, our proposed framework should be seen as an organising device that could help inform empirical BOR studies grounded on a wide range of theories and research methodologies, as illustrated by the collection of works published in the 2016 special issue of the *European Journal of Operational Research* (Franco & Hämäläinen,

2016). It is worth noting that besides the use of experiments, research methods that can track behavioural factors in OR-supported processes as they arise are also needed (cf. Franco & Rouwette, 2011). In this respect the use of data generated from process-type research (e.g. Poole, 2004), both macro and micro, has the potential to offer additional valuable insights into the practice of OR from a BOR perspective.

5. Conclusions

The science of better, as the OR discipline is commonly referred to, is never just about modelling and models, but also about people. Thus *empirically-grounded* explanations of how actors use OR methods in their praxis to produce outcomes can help develop a theory effective OR practice. Such a theory can highlight the generative mechanisms that are responsible for the success or failure of OR interventions.

We have argued elsewhere that the current concern with the behavioural aspects of OR practice represents a return to the roots of the OR profession (Franco & Hämäläinen, 2016), as evidenced by the growing number of empirical studies being published in this area. These studies represent an eclectic collection of works examining behavioural issues in OR practice from different theoretical perspectives, at different levels of analysis (individual, group, organisational), and with different research methodologies. We embrace this eclectic approach to conducting BOR studies, and in this chapter we have proposed an integrative framework to organise extant studies and also guide future research along specific analytic foci. Specifically, the framework helps define different emphases for conducting empirical BOR studies. Furthermore, the framework suggests a wider approach to OR outcomes that considers not just improved organisational performance, but also the performance of the individuals and groups involved in an actual episode of OR praxis.

The behavioural perspective in OR offers a distinctive lens that highlights the interdependencies between OR methods, OR actors and OR praxis, and how they affect, and are affected by, OR outcomes. By adopting this perspective, OR academics would be more likely to produce robust and empirically-grounded advice for improving the science of better. Ultimately, the central promise of the behavioural perspective is to enable the production of better OR methods, the conduct of improved OR praxis, and the development of increasingly competent OR actors.

References

- Ackermann, F., Andersen, D. F., Eden, C., & Richardson, G. P. (2011). ScriptsMap: A tool for designing multi-method policy-making workshops. *Omega*, 39, 427 - 434.
- Ackermann, F., & Eden, C. (2011). Negotiation in Strategy Making Teams: Group Support Systems and the Process of Cognitive Change. *Group Decision and Negotiation*, 20(3), 293-314. doi:DOI: 10.1007/s10726-008-9133-y
- Ackoff, R. (1977). Optimization + objectivity = opt out. *European Journal of Operational Research*, 1(1), 1-7.
- Ahmed, R., & Robinson, S. (2013). Modelling and simulation in business and industry: insights into the processes and practices of expert modellers. *Journal of the Operational Research Society*, 65(5), 660-672.
- Amini, M., Wakolbinger, T., Racer, M., & Nejad, M. G. (2012). Alternative supply chain production-sales policies for new product diffusion: An agent-based modeling and simulation approach. *European Journal of Operational Research*, 216(2), 301-311. doi:<http://dx.doi.org/10.1016/j.ejor.2011.07.040>
- Bakken, B., Gould, J., & Kim, D. (1992). Experimentation in learning organizations: A management flight simulator approach. *European Journal of Operational Research*, 59(1), 167-182. doi:[http://dx.doi.org/10.1016/0377-2217\(92\)90013-Y](http://dx.doi.org/10.1016/0377-2217(92)90013-Y)

- Bendoly, E., Van Wezel, W., & Bachrach, D. G. (Eds.). (2015). *The handbook of behavioral operations management: Social and psychological dynamics in production and service settings*. New York: Oxford University Press.
- Birnberg, J., G., Luft, J., & Shields, M., D. (2007). Psychology theory in management accounting research. In C. Chapman, S. & A. Hopwood, G. (Eds.), *Handbook of management accounting research* (pp. 113-135). Oxford: Elsevier.
- Brailsford, S. C., Bolt, T. B., Bucci, G., Chaussalet, T. M., Connell, N. A., Harper, P. R., . . . Taylor, M. (2013). Overcoming the barriers: A qualitative study of simulation adoption in the NHS. *Journal of the Operational Research Society*, 64(2), 157-168.
- Brailsford, S. C., Harper, P., & Shaw, D. (2009). Milestones in OR. *Journal of the Operational Research Society*, 60(S1), S1-S4. Retrieved from <http://dx.doi.org/10.1057/jors.2009.15>
- Brailsford, S. C., Harper, P. R., & Sykes, J. (2012). Incorporating human behaviour in simulation models of screening for breast cancer. *European Journal of Operational Research*, 219(3), 491-507. doi:<http://dx.doi.org/10.1016/j.ejor.2011.10.041>
- Brailsford, S. C., & Schmidt, B. (2003). Towards incorporating human behaviour in models of health care systems: An approach using discrete event simulation. *European Journal of Operational Research*, 150(1), 19-31. doi:[http://dx.doi.org/10.1016/S0377-2217\(02\)00778-6](http://dx.doi.org/10.1016/S0377-2217(02)00778-6)
- Brocklesby, J. (2016). The what, the why and the how of behavioural operational research: An invitation to potential sceptics. *European Journal of Operational Research*, 249(3), 796-805. doi:<http://dx.doi.org/10.1016/j.ejor.2015.09.034>
- Bruce, B. (Ed.) (2010). *Handbook of behavioral finance*: Edward Elgar Publishing.
- Camerer, C. F. (2003). *Behavioral game theory: Experiments in strategic interaction*: Princeton University Press.
- Camerer, C. F., & Lowenstein, G. (Eds.). (2003). *Advances in behavioral economics*: Princeton University Press.
- Capelo, C., & Dias, J. F. (2009). A system dynamics-based simulation experiment for testing mental model and performance effects of using the balanced scorecard. *System Dynamics Review*, 25(1), 1-34. doi:10.1002/sdr.413
- Carlson, K. A., & Bond, S. D. (2006). Improving Preference Assessment: Limiting the Effect of Context Through Pre-exposure to Attribute Levels. *Management Science*, 52(3), 410-421. doi:10.1287/mnsc.1050.0434
- Chung, Q., Willemain, T., & O'Keefe, R. (2000). Influence of model management systems on decision making: empirical evidence and implications. *Journal of the Operational Research Society*, 936-948.
- Churchman, C. W. (1970). Operations research as a profession. *Management Science*, 17(2), 37-53.
- Connell, N. (2001). Evaluating Soft OR: some reflections on an apparently 'unsuccessful' implementation using a Soft Systems Methodology (SSM) based approach. *Journal of Operational Research Society*, 52(1), 150-160.
- Cropper, S. (1990). Variety, formality, and style: Choosing amongst decision-support methods. In C. Eden & J. Radford (Eds.), *Tackling Strategic Problems: the role of group decision support* (pp. 92-98). London: Sage.
- Dutton, J. M., & Walton, R. E. (1964). Operational research and the behavioural sciences. *Operational Research Quarterly*, 15, 207-217.
- Eden, C., & Ackermann, F. (2004). Use of 'Soft OR' methods by clients, what do they want from them? . In M. Pidd (Ed.), *Systems modelling: theory and practice* (pp. 146-163). Chichester: Wiley.
- Ellspermann, S. J., Evans, G. W., & Basadur, M. (2007). The impact of training on the formulation of ill-structured problems. *Omega*, 35(2), 221-236. doi:<http://dx.doi.org/10.1016/j.omega.2005.05.005>
- Fasolo, B., & Bana e Costa, C. A. (2014). Tailoring value elicitation to decision makers' numeracy and fluency: Expressing value judgments in numbers or words. *Omega*, 44, 83-90. doi:<http://dx.doi.org/10.1016/j.omega.2013.09.006>
- Feldman, M. S., & Orlikowski, W. J. (2011). Theorizing practice and practicing theory. *Organization Science*, 22(5), 1240-1253.

- Fortuin, L., & Zijlstra, M. (2000). Operational research in practice: Consultancy in industry revisited. *European Journal of Operational Research*, 120(1), 1-13.
doi:[http://dx.doi.org/10.1016/S0377-2217\(98\)00377-4](http://dx.doi.org/10.1016/S0377-2217(98)00377-4)
- Franco, L. A. (2013). Rethinking Soft OR interventions: Models as boundary objects. *European Journal of Operational Research*, 231(3), 720-733.
- Franco, L. A., Cushman, M., & Rosenhead, J. (2004). Project Review and Learning in the UK Construction Industry: Embedding a Problem Structuring Method within a partnership context. *European Journal of Operational Research*, 152(3), 586-601.
- Franco, L. A., & Hämäläinen, R. P. (2016). Behavioural operational research: Returning to the roots of the OR profession. *European Journal of Operational Research*, 249(3), 791-795.
doi:<http://dx.doi.org/10.1016/j.ejor.2015.10.034>
- Franco, L. A., & Lord, E. (2011). Understanding multi-methodology: evaluating the perceived impact of mixing methods for group budgetary decisions. *Omega*, 39, 362-372.
- Franco, L. A., & Meadows, M. (2007). Exploring new directions in problem structuring methods research: On the role of cognitive style. *Journal of the Operational Research Society*, 58(12), 1621-1629.
- Franco, L. A., & Montibeller, G. (2010). Facilitated modelling in operational research. *European Journal of Operational Research*, 205(3), 489-500.
- Franco, L. A., & Rouwette, E. A. (2011). Decision development in facilitated modelling workshops. *European Journal of Operational Research*, 212(1), 164-178.
- Franco, L. A., Rouwette, E. A., & Korzilius, H. (2016). Different paths to consensus? The impact of need for closure on model-supported group conflict management *European Journal of Operational Research*, 249(3), 878-889. doi:10.1016/j.ejor.2015.06.056
- French, S., Maule, J., & Papamichail, N. (2009). *Decision behaviour, analysis and support*: Cambridge University Press.
- Graham, A. K., Morecroft, J. D. W., Senge, P. M., & Sterman, J. D. (1992). Model-supported case studies for management education. *European Journal of Operational Research*, 59(1), 151-166. doi:[http://dx.doi.org/10.1016/0377-2217\(92\)90012-X](http://dx.doi.org/10.1016/0377-2217(92)90012-X)
- Hämäläinen, R. P. (2015). Behavioural issues in environmental modelling: The missing perspective. *Environmental Modelling & Software*, 73, 244-253.
- Hämäläinen, R. P., Luoma, J., & Saarinen, E. (2013). On the importance of behavioral operational research: The case of understanding and communicating about dynamic systems. *European Journal of Operational Research*, 228(3), 623-634.
- Hamalainen, R. P., Mustajoki, J., & Marttunen, M. (2010). Web-based decision support: Creating a culture of applying multi-criteria decision analysis and web supported participation in environmental decision making In D. Rios-Insua & S. French (Eds.), *e-Democracy: A Group Decision and Negotiation Perspective* (pp. 201-221). Dordrecht: Springer Science & Business Media B.V.
- Hartley, D. A., Johnson, P. V., Fitzsimons, A., Lovell, J., Chippendale, B., & Clayton, J. K. (1979). A case study on the development of the Home Defence training game HOT SEAT. *Journal of the Operational Research Society*, 861-871.
- Horlick-Jones, T., & Rosenhead, J. (2007). The Uses of Observation: Combining problem structuring methods and ethnography. *Journal of the Operational Research Society*, 58(5), 588-601.
- Hovmand, P. S., Andersen, D. F., Rouwette, E., Richardson, G. P., Rux, K., & Calhoun, A. (2012). Group model - building ‘scripts’ as a collaborative planning tool. *Systems Research and Behavioral Science*, 29(2), 179-193.
- Howick, S., & Ackermann, F. (2011). Mixing OR methods in practice: Past, present and future directions. *European Journal of Operational Research*, 215(3), 503-511.
- Huxham, C., & Cropper, S. (1994). From many to one—and back. An exploration of some components of facilitation. *Omega*, 22(1), 1-11.
- Jackson, M. C., Keys, P., & Cropper, S. A. (Eds.). (1989). *OR and the social sciences*. New York: Plenum Press.
- Jarzabkowski, P., Balogun, J., & Seidl, D. (2007). Strategizing: The challenges of a practice perspective. *Human Relations*, 60, 5-27.

- Keys, P. (2006). On becoming expert in the use of problem structuring methods. *Journal of the Operational Research Society*, 57, 822-829.
- Kunc, M. (2012). Teaching strategic thinking using system dynamics: lessons from a strategic development course. *System Dynamics Review*, 28(1), 28-45. doi:10.1002/sdr.471
- Lahtinen, T. J., & Hämäläinen, R. P. (2016). Path dependence and biases in the Even Swaps decision analysis method. *European Journal of Operational Research*, 249(3), 890-898. doi:<http://dx.doi.org/10.1016/j.ejor.2015.09.056>
- Lane, D. C. (1995). On a resurgence of management simulations and games. *Journal of the Operational Research Society*, 604-625.
- Lawrence, J. E. (Ed.) (1966). *Operational research and the social sciences*. London: Tavistock Publications.
- Le Menestrel, M., & Van Wassenhove, L. N. (2004). Ethics outside, within, or beyond OR models? *European Journal of Operational Research*, 153(2), 477-484. doi:[http://dx.doi.org/10.1016/S0377-2217\(03\)00168-1](http://dx.doi.org/10.1016/S0377-2217(03)00168-1)
- Le Menestrel, M., & Van Wassenhove, L. N. (2009). Ethics in Operations Research and Management Sciences: A never-ending effort to combine rigor and passion. *Omega*, 37(6), 1039-1043. doi:<http://dx.doi.org/10.1016/j.omega.2008.12.009>
- Luhmann, N. (1995). *Social Systems*. Stanford, CA: Stanford University Press.
- Mingers, J., & Rosenhead, J. (2012). Introduction to the Special Issue: Teaching Soft O.R., Problem Structuring Methods, and Multimethodology. *INFORMS Transactions on Education*, 12(1), 1-3.
- Mitchell, G. (1993). *The Practice of Operational Research*. Chichester: Wiley.
- Montibeller, G., Franco, L. A., Lord, E., & Iglesias, A. (2009). Structuring resource allocation decisions: A framework for building multi-criteria portfolio models with area-grouped projects. *European Journal of Operational Research*, 199(3), 846-856. doi:10.1016/j.ejor.2009.01.054
- Montibeller, G., & Von Winterfeldt, D. (2015). Cognitive and motivational biases in decision and risk analysis. *Risk Analysis*, 35(7), 1230-1251. doi:10.1111/risa.12360
- Morecroft, J. D. (1988). System dynamics and microworlds for policymakers. *European Journal of Operational Research*, 35(3), 301-320.
- Morton, A., & Fasolo, B. (2009). Behavioural Decision Theory for Multi-Criteria Decision Analysis: a guided tour *Journal of the Operational Research Society*, 60(2), 268-275.
- Nicolini, D. (2012). *Practice theory, work and organization: An introduction*. Oxford: Oxford University Press.
- O'Brien, F. A. (2004). Scenario Planning: Lessons for practice from teaching and learning *European Journal of Operational Research*, 154(3), 709-722.
- O'Brien, F. A. (2011). Supporting the strategic process: A survey of UK OR/MS practitioners. *Journal of the Operational Research Society*, 62(5), 900-920.
- O'Brien, F. A. (2015). On the roles of OR/MS practitioners in supporting strategy. *Journal of the Operational Research Society*, 66(2), 202-218.
- O'Keefe, R. M. (2016). Experimental behavioural research in operational research: What we know and what we might come to know. *European Journal of Operational Research*, 249(3), 899-907. doi:10.1016/j.ejor.2015.09.027
- Ormerod, R. J. (2008). The transformation competence perspective. *Journal of the Operational Research Society*, 59(11), 1435-1448.
- Ormerod, R. J. (2014a). The mangle of OR practice: Towards more informative case studies of 'technical' projects. *Journal of the Operational Research Society*, 65(8), 1245-1260.
- Ormerod, R. J. (2014b). OR competences: the demands of problem structuring methods. *EURO Journal on Decision Processes*, 2(3-4), 313-340.
- Ormerod, R. J., & Ulrich, W. (2013). Operational research and ethics: A literature review. *European Journal of Operational Research*, 228(2), 291-307. doi:<http://dx.doi.org/10.1016/j.ejor.2012.11.048>
- Papamichail, K. N., Alves, G., French, S., Yang, J. B., & Snowdon, R. (2007). Facilitation practices in decision workshops. *Journal of the Operational Research Society*, 58(5), 614-632.

- Petropoulos, F., Fildes, R., & Goodwin, P. (2016). Do 'big losses' in judgmental adjustments to statistical forecasts affect experts' behaviour? *European Journal of Operational Research*, 249(3), 842-852. doi:<http://dx.doi.org/10.1016/j.ejor.2015.06.002>
- Pickering, A. (1995). *The mangle of practice: Time, agency, and science*: University of Chicago Press.
- Pierre Brans, J., & Macharis, C. (1997). Play theatre a new way to teach O.R. *European Journal of Operational Research*, 99(2), 241-247. doi:[http://dx.doi.org/10.1016/S0377-2217\(96\)00339-6](http://dx.doi.org/10.1016/S0377-2217(96)00339-6)
- Poole, M. S. (2004). Generalization in process theories of communication. *Communication Methods and Measures*, 1(3), 181-190.
- Powell, S. G., & Willemain, T. R. (2007). How novices formulate models. Part I: qualitative insights and implications for teaching. *Journal of the Operational Research Society*, 58(8), 983-995.
- Powell, T., C., Lovallo, D., & Fox, C., R. (2011). Behavioral strategy. *Strategic Management Journal*, 32, 1369-1386.
- Ranyard, J. C., Fildes, R., & Hu, T.-I. (2015). Reassessing the scope of OR practice: The Influences of Problem Structuring Methods and the Analytics Movement. *European Journal of Operational Research*, 245(1), 1-13. doi:<http://dx.doi.org/10.1016/j.ejor.2015.01.058>
- Reckwitz, A. (2002). Towards a theory of social practices: A development in cultural theorizing. *European Journal of Social Theory*, 5(2), 243-263.
- Robinson, S., Worthington, C., Burgess, N., & Radnor, Z. J. (2013). Facilitated modelling with discrete-event simulation : Reality or myth? *European Journal of Operational Research*, 234(1), 231-240.
- Rouwette, E. A. J. A., Korzilius, H., Vennix, J. A. M., & Jacobs, E. (2011). Modeling as persuasion: The impact of group model building on attitudes and behavior. *System Dynamics Review*, 27(1), 1-21. doi:10.1002/sdr.441
- Rouwette, E. A. J. A., Vennix, J. A. M., & Van Mullekom, T. (2002). Group model building effectiveness. A review of assessment studies. *System Dynamics Review*, 18(1), 5-45.
- Schatzki, T. R., Knorr-Cetina, K., & Von Savigny, E. (Eds.). (2001). *The practice turn in contemporary theory*. London: Routledge.
- Schilling, M. S., Oeser, N., & Schaub, C. (2007). How effective are decision analyses? Assessing decision process and group alignment effects. *Decision Analysis*, 4(4), 227-242.
- Scott, R. J., Cavana, R. Y., & Cameron, D. (2013). Evaluating immediate and long - term impacts of qualitative group model building workshops on participants' mental models. *System Dynamics Review*, 29(4), 216-236.
- Scott, R. J., Cavana, R. Y., & Cameron, D. (2016). Recent evidence on the effectiveness of group model building. *European Journal of Operational Research*, 249(3), 908-918. doi:<http://dx.doi.org/10.1016/j.ejor.2015.06.078>
- Senge, P. M., & Sterman, J. D. (1992). Systems thinking and organizational learning: Acting locally and thinking globally in the organization of the future. *European Journal of Operational Research*, 59(1), 137-150.
- Shaw, D., Ackermann, F., & Eden, C. (2003). Approaches to sharing knowledge in group problem structuring. *Journal of the Operational Research Society*, 54(9), 936-948.
- Sterman, J. D. (2000). *Business dynamics: Systems thinking and modeling for a complex world*. Boston, MA: Irwin McGraw-Hill.
- Syntetos, A. A., Kholidasari, I., & Naim, M. M. (2016). The effects of integrating management judgement into OUT levels: In or out of context? *European Journal of Operational Research*, 249(3), 853-863. doi:<http://dx.doi.org/10.1016/j.ejor.2015.07.021>
- Tako, A. A. (2014). Exploring the model development process in discrete-event simulation: insights from six expert modellers. *Journal of the Operational Research Society*, 66(5), 747-760.
- Tako, A. A., & Robinson, S. (2010). Model development in Discrete-Event Simulation and System Dynamics: An empirical study of expert modellers. *European Journal of Operational Research*, 207(2), 784-794.
- Tavella, E., & Papadopoulos, T. (2015a). Expert and novice facilitated modelling: A case of a Viable System Model workshop in a local food network. *Journal of the Operational Research Society*, 66, 247-264.

- Tavella, E., & Papadopoulos, T. (2015b). Novice facilitators and the use of scripts for managing facilitated modelling workshops. *Journal of the Operational Research Society*. doi:10.1057/jors.2015.7
- Turner, S. (1994). *The social theory of practices*. Cambridge: Polity Press.
- Tversky, A., & Kahneman, D. (1974). Judgment under uncertainty. Heuristics and biases. *Science*, 185, 1124-1131.
- Velez-Castiblanco, J., Brocklesby, J., & Midgley, G. (2016). Boundary games: How teams of OR practitioners explore the boundaries of intervention. *European Journal of Operational Research*, 249(3), 968-982. doi:<http://dx.doi.org/10.1016/j.ejor.2015.08.006>
- Von Winterfeldt, D., & Edwards, W. (1986). *Decision analysis and behavioral research* Cambridge: Cambridge University Press.
- Waisel, L., Wallace, W., & Willemain, T. (2008). Visualization and model formulation: an analysis of the sketches of expert modellers. *Journal of the Operational Research Society*, 59(3), 353-361.
- Wein, L. M. (2002). Introduction to the 50th Anniversary Issue of Operations Research. *Operations Research*, 50(1), iii-iii. doi:doi:10.1287/opre.50.1.0.17795
- White, L. (2009). Understanding Problem Structuring Methods Interventions. *European Journal of Operational Research*, 99(3), 823-833.
- White, L. (2016). Behavioural operational research: Towards a framework for understanding behaviour in OR interventions. *European Journal of Operational Research*, 249(3), 827-841. doi:<http://dx.doi.org/10.1016/j.ejor.2015.07.032>
- White, L., Burger, K., & Yearworth, M. (2016). Understanding behaviour in problem structuring methods interventions with activity theory. *European Journal of Operational Research*, 249(3), 983-1004. doi:<http://dx.doi.org/10.1016/j.ejor.2015.07.044>
- Whittington, R. (2003). The work of strategizing and organizing: For a practice perspective. *Strategic Organization*, 1(1), 117-125. doi:10.1177/147612700311006
- Whittington, R. (2006). Completing the practice turn in strategy research. *Organization Studies*, 27, 613-634.
- Whittington, R. (2011). The practice turn in organization research: Towards a disciplined transdisciplinarity. *Accounting, Organizations and Society*, 36, 183-186.
- Willemain, T. R. (1994). Insights on Modeling from a Dozen Experts. *Operations Research*, 42(2), 213-222.
- Willemain, T. R. (1995). Model formulation: What experts think about and when. *Operations Research*, 43(6), 916-932.
- Willemain, T. R., & Powell, S. G. (2007). How novices formulate models. Part II: A quantitative description of behaviour. *Journal of the Operational Research Society*, 58(10), 1271-1283.
- Wright, G., & Bolger, F. (1992). *Expertise and decision support*: Springer Science & Business Media.
- Wright, G., Cairns, G., & Goodwin, P. (2009). Teaching scenario planning: Lessons from practice in academe and business. *European Journal of Operational Research*, 194(1), 323-335.

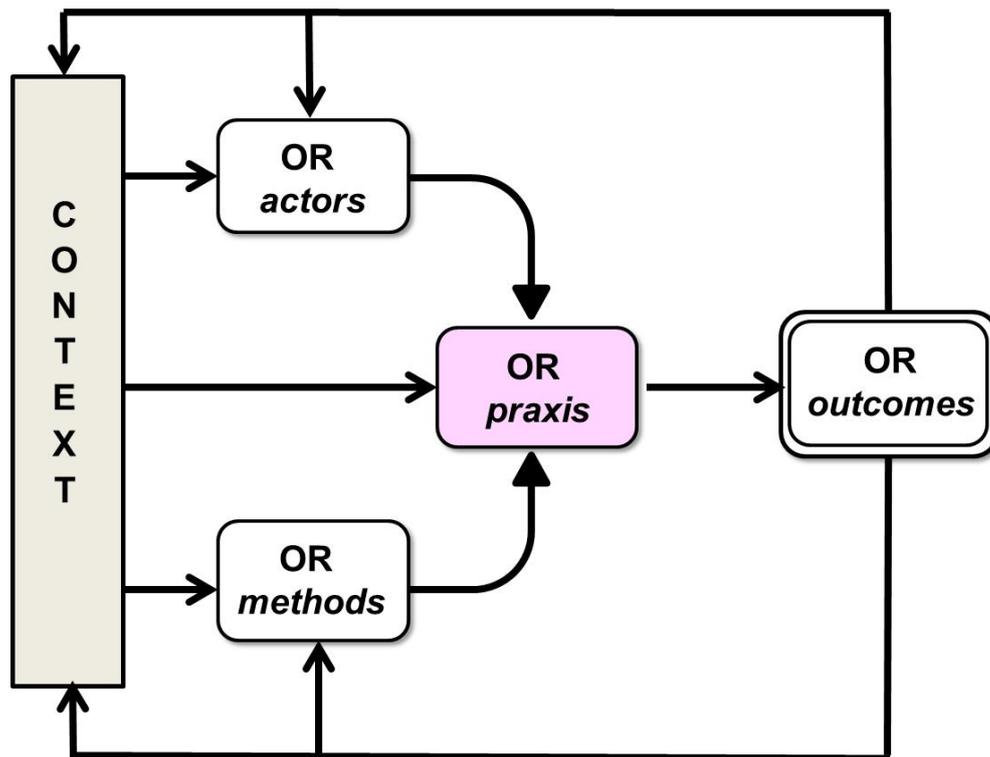


Figure 1: An integrative framework for the study of behaviour in OR