INTER-ORGANISATIONAL COLLABORATION IN MEGAPROJECTS: A DYNAMIC MODEL OF COLLABORATIVE AND OPPORTUNISTIC BEHAVIOUR

Yingshuang Shi[1] and William Collinge

Department of Mechanical, Aerospace and Civil Engineering, University of Manchester, Sackville Street, Manchester, M1 7JR, UK

Megaprojects are one-time endeavours costing more than one billion dollars, taking many years to complete, and involving multiple stakeholders. For the development and execution of megaprojects, an unprecedented number of organisations therefore enter into inter-organisational collaboration (IOC) with commitments to sharing common goals and working together. Although there are mechanisms governing IOC by facilitating collaborative behaviour as well as restraining opportunistic behaviour, an insight into how a specific behaviour might emerge and unfold over time remains unclear. Based on System Dynamics (SD), this study presents a conceptual model to understand how collaborative and opportunistic behaviour unfolds over time and induces the dynamics of IOC. SD has shown its feasibility and appropriateness for shedding light on complex relationships between components and feedbacks. A casual loop diagram was developed through three main steps: (1) identifying key parameters related to collaborative and opportunistic behaviour on the basis of the literature; (2) analysing the cause-effect relationships between the identified parameters; (3) identifying feedback loops. The result of this study can deepen the understanding of what happens inside the black box of IOC by showing the dynamic interplay between collaborative and opportunistic behaviour.

Keywords: megaprojects; collaboration; opportunistic behaviour; system dynamics

INTRODUCTION

The last several decades have seen the rise of megaprojects globally, such as the Channel tunnel in Europe, the Three Gorges dam in China, the 'Big Dig' in the USA and Sydney Opera House in Australia, which have shaped our modern society. While megaprojects share several similarities with general projects, they are characterised with high complexity, expensive cost, specialised knowledge and massive resource which is impossible to be handled by a single organisation (Daniel and Daniel, 2019). An unprecedented number of organisations therefore enter inter-organisational collaboration (IOC) with commitments to sharing common goals and working together. IOC for megaproject implementation can take various forms such as coalition, project alliance and joint venture.

[1] yingshuang.shi@postgrad.manchester.ac.uk

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Although all forms can be effective ways to facilitate IOC development and improve megaproject performance, organisations' attitude and behaviour is not easy to be changed. For example, the failure of project alliance adoption in the Environ megaproject was reported by Van Marrewijk (2005) because the involved organisations remained behaving uncooperatively. In addition, Siemiatycki (2006) observed from a megaproject that expected benefits of public-private partnership were not achieved as the government was used to being a traditional client and showed less openness to its private partners leading to cost escalation. Without a shift in attitude and behaviour, collaboration required or stated in contracts is mere lip service and non-cooperative relationships continue to be widespread (Costa *et al.,* 2019). Thus, the behavioural aspect is a key component that should be considered in IOC.

Most of the megaproject research to date have studied IOC from the perspective of governance mechanisms (Derakhshan *et al.,* 2020; Xue *et al.,* 2017). Contractual and relational governance mechanisms are two most commonly observed types (Zheng *et al.,* 2019). Contractual governance is based on transaction cost economics and emphasises the importance of formal and legal contracts to stipulate the allocation of benefits and risks and govern inter-organisational exchanges (Lumineau *et al.,* 2011). Relational governance is based on the relational exchange theory and focuses on enhancing the relationship quality by less explicit social norms such as sharing goals (Lu et a., 2015). Both contractual and relational governance mechanisms proved useful insight about conditions motivating and facilitating collaborative behaviour as well as restraining opportunistic behaviour. However, these mechanisms do not tell how a specific behaviour might emerge and unfold over time, ignoring of which might result in governance ineffectiveness.

Behavioural aspects with a dynamic view, thus, is suggested to be essential to understanding IOC and adopting appropriate governance mechanisms. With the aid of system dynamic approach (SD), this paper presents a first step in this direction by proposing a conceptual framework, based on previous literature, of how collaborative and opportunistic behaviour unfolds over time and induces IOC dynamics. There are two reasons for justifying SD as an appropriate method. First, there are a number of elements including antecedents and consequences related to both collaborative and opportunistic behaviour and their relationships are complicated that can be positive or negative, and linear or non-linear. SD is a well-developed method for identifying complex cause-effect relationships and facilitating a better understanding with visualisation. Second, highly interdependent elements can induce behavioural changes resulting in the evolution of IOC. SD is able to open such "black box" by discovering feedback loops regarding collaborative and opportunistic behaviour and illustrating the dynamics of IOC with a holistic and systematic view.

LITERATURE REVIEW

One of the fundamental problems that IOC faces, especially in megaprojects with high levels of complexity and uncertainty, is the inherent conflict between individual interest and collective interest (Xue *et al.,* 2017). On the one hand, megaprojects as temporary endeavours gathering different organisations to work towards a common goal depend on high level of collaboration among participants whose efforts are integrated to maximise collective interests. On the other hand, organisations have inherent incentives to maximise self-interests by choosing opportunistic behaviour. Opportunistic behaviour is distinguished from other self-interest-seeking behaviour given its characteristic of 'guile' that self-interest is maximised at the expense of other

parties (Williamson, 1985). Such behaviour is observed prevailing under conditions of information asymmetry, conflicting goals between different organisations, highly uncertainty and complexity like megaprojects (Galvin *et al.,* 2021).

The extant literature has for the most part concentrated on promoting collaborative behaviour. For example, Zhang *et al.,* (2018) examined the effect of the interplay of contract functions and owners' power on contractors' collaborative behaviour. Inspired by prior research, they studied two types of collaborative behaviour: in-role and extra-role. In-role collaborative behaviour refers to mandatory responsibility explicitly described in contracts; extra-role collaborative behaviour refers to positive behaviour that has not been directly motivated by formal contracts. On the basis of Chinese construction industry, Zhang *et al.,* (2018) found that both owners' power and contractual coordination have positive effect on collaborative behaviour and contractual functions can mediate the effect of owners' power on collaboration. Similarly, Song *et al.,* (2018) also examined the effect of contractual governance on contractor's collaborative behaviour in the Chinese construction industry but focusing on contractual flexibility and risk allocation respectively, with the consideration of justice perception as a mediator. Such argument is supported in more recently by Lu *et al.,* (2020), who found that contractor's collaborative behaviour is strengthened when justice is perceived in the process of contract execution.

In addition, the opportunistic behaviour is another topic that has drawn much attention in the literature associated with its drivers and consequences. For instance, Ikuabe *et al.,* (2020) argued that project uncertainty such as unclear scope of work leads to opportunistic tendency, which has a positive effect on transactional cost. Chaudhry (2020) explained that the increase of transactional cost caused by opportunism would undermine project relationship as partners show less willingness to engage when the loss is perceived. A more comprehensive picture is shown in Lu *et al.,* (2016) and Um and Kim (2018) who suggested that high level of project uncertainty leads to opportunism, which negatively impacts project performance and project relationship. Other studies, like those focusing on collaborative behaviour, have also discussed the influence of psychological factors, such as the negative effect of justice perception on opportunistic behaviour (Feng *et al.,* 2021).

The literature on collaborative behaviour highlighted contract design and its execution process regarding the psychological aspects; while the literature on opportunistic behaviour has to a large extent discussed its drivers/inhibitors such as project uncertainty and justice perception, and consequences like transactional cost, project relationship and project performance. The extant literature shows that collaborative and opportunistic behaviour is still studied separately, indicating they are two research stream and capturing the interplay of them only implicitly. On the basis of behavioural and psychological perspectives, this paper aims to systematically tackle with the interaction between collaboration and opportunism in megaproject context.

Model Development

Steps of model development

SD, initially introduced by Forrester in 1950s (Forrester, 1961), is based on system thinking to understand internal relations between a set of parameters from a feedback view that a change in one parameter affects others which instigates modifications in the original parameter in return. In this way, an integrated pattern is provided showing how the feedback loops a system contains can lead to its dynamic behaviour over time (Bouloiz *et al.,* 2013). It has been recognised that SD modelling tools can

be classified into two main types: (1) qualitative modelling that system boundary is defined, key elements are identified, and cause-effect relationships are explained leading to a causal loop diagram (CLD); (2) quantitative modelling that elements and relationships are quantified as variables mathematic formulas leading to a stock and flow diagram (SFD) (Sales and Barbalho, 2018). As this paper presents the initial work of the three-year research achieved based on literature review, most of the information available for modelling is qualitative and descriptive. Thus, a qualitative SD modelling tool was developed and used here.

The model is constructed with four steps (Fig 1).

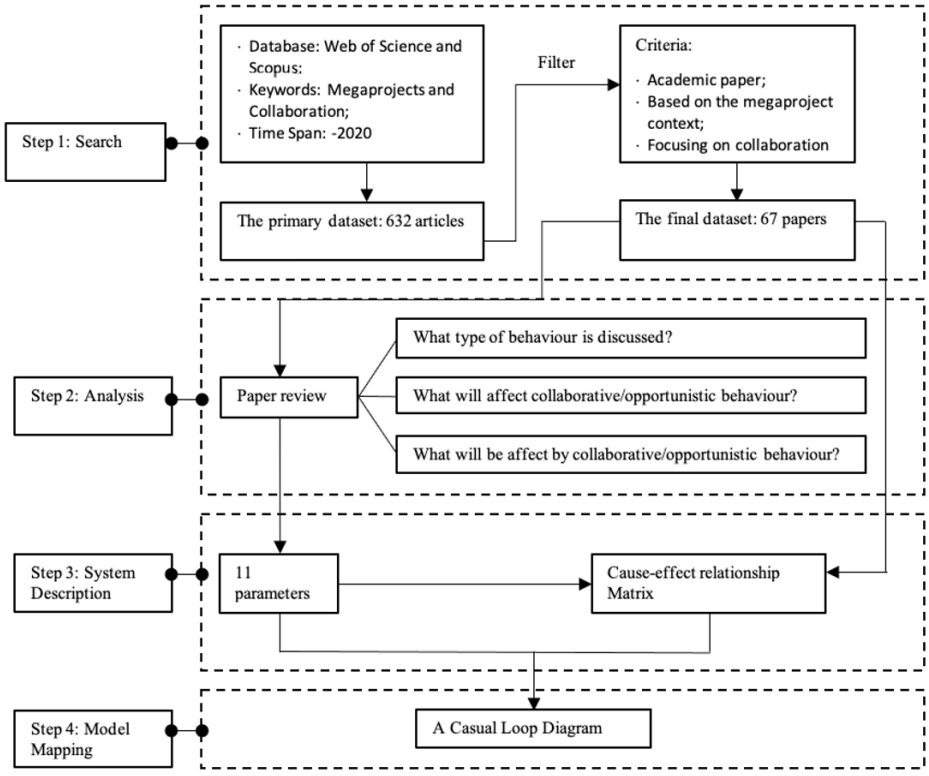

Fig 1: Steps of model development

First of all, the data used to define the system's boundary was collected. A total of 67 papers concerning collaboration in megaprojects was selected. Then, each paper was analysed to identify parameters drawing on three selection criteria. Third, the boundary of the system is determined by identified parameters and their relationships. The Decision-making trial and evaluation laboratory (DEMATEL) method adapted from Jalal and Shoar (2019) was used to identify cause-effect relationships between these parameters. In the DEMATEL method, there is an adjacency matrix in which mij denotes the direct impact of element i to element j. Experts are invited to complete this matrix by express where there is an influence from i to j. In this study, each selected paper serves as an expert and if the influence from i to j is mentioned/discussed in n papers (n=1 to 67), the corresponding cell would have a value of n, otherwise it would be 0. Afterwards, a casual loop diagram was developed and key feedback loops were identified and described.

System description

Based on the analysis of selected papers, 11 key parameters were selected defining the boundary of the system (Table 1). Following the aforementioned literature review,

collaborative and opportunistic behaviour was identified as two key parameters. Factors which can affect either collaborative or opportunistic behaviour or both involve transactional cost, profits, fairness, external pressure, dependency, non-financial capital and uncertainty. Consequences of behaviour adoption involve project performance and relationship quality. Referring to selected papers, the meaning of these parameters in this study are explained in Table 1.

Table 1: Identified parameters

Code	Elements	Explanation
P1	Collaborative behaviour	Refers to desired actions involved in the exchange activities contributing to shaping and promoting collaborative relationships. Open information exchange, joint problem-solving and flexibility are three key components of collaborative behaviour.
P2	Opportunistic behaviour	Refers to seeking interests with fraud like stealing, cheating, misleading, distorting and disguising. Opportunism can be easily induced by high asymmetry and uncertainty.
P3	Project performance	Measured with the iron triangle involving time, cost and quality.
P4	Relationship quality	Refers to the strength of connection between organisations. It can be measured by the degree of closeness, the frequency of interaction, the level of input and the consistency of goals.
P5	Transactional cost	Refers to cost associated with transaction activities. It is one of significant risks as additional cost occurs to develop and maintain inter-organisational collaboration according to transaction cost economics.
P6	Profits	Refer to short-term and financial benefits.
P7	Fairness	Refers to the equity perceived during the interaction process.
P8	External pressure	The behaviour of an organisation can be influenced by external expectations. Many of megaprojects are public infrastructure and the government is one of the key sponsors. External pressure such as political appeal and public satisfaction might strength firms' willingness to conduct collaborative behaviour.
P9	Dependency	An organisation is unable to control over the megaproject and conducts activities alone. Thus, to make decisions and get work done, an involved part needs external information and resources, and dependency is inevitable.
P10	Non-financial capital	Involves social, cultural and intellectual capital. Organisations with social capital are more likely to acquire external resources and knowledge as well as influence partners' behaviour. Cultural capital build on the firm's reputation such as credibility and capability of successfully delivering a promise. Intellectual capital involves skills, competences and knowledges ensuring firm's sustainability and competitiveness.
P11	Uncertainty	Refers to the inability to predict accurately. It consists of two types: (1) internal uncertainty, closely related to the ambiguous of partners' behaviour; (2) external uncertainty, related to the external environment with various unpredictable changes.

The cause-effect relationship between the identified parameters is shown in Table 2. The value in a cell refers to the effect of parameter a on parameter b. For example, m13=7 indicates that the positive effect of P1 (collaborative behaviour) on P3 (project performance) is mentioned 7 times. The value also indicates the link strength showing how strongly P1 is linked to P3. In addition, the negative relationship between two elements is marked with a minus symbol. For example, m23=-1 indicates that the negative effect of P2 (opportunistic behaviour) on P3 (project performance). Consequently, a total of 26 cause-effect relationship are identified based on the adapted DEMATEL method.

Table 2: Cause-effect relationship matrix of the identified parameters

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11
P1			7	5	-1				1	2	-1
P2			-1	-1	2	2					
P3	1					1					
P4	3	-1	2		-2					3	
P5	-1	1									
P6	1										
P7	1	-1									
P8	4										
P9	5										2
P10	5				-1						
P11		3			1						

A casual loop diagram

After defining the boundary of the system, a casual loop diagram visualising the interactions among parameters was developed (Fig 2). In the diagram, curved arrows represent casual relationships between these parameters. The symbol "+" represents a positive relationship which could be linear or non-linear, while the symbol "-" represents a negative relationship between the connected parameters.

As for the collaboration, for example, the reinforcement of collaborative behaviour adoption depends on factors like project performance, relationship quality, non-financial capital, transactional cost and dependency. Collaborative behaviour can generate both short-term benefits comprising low cost, short duration, high quality and more profits and long-term benefits consisting of high-quality relationship and accumulated non-financial capital. The perceived benefits encourage an organisation with more willingness to conduct collaborative behaviour. It is essential to note that positive attitude towards collaborative behaviour can be strengthened by the perceived fairness. For example, organisations have good reasons to engage in collaboration if the benefits are allocated fairly (Lu *et al.,* 2020). Also, organisations with more dependency on external resources are more prone to conduct collaborative behaviour, which in return increasing the interconnections among organisations leading to a higher level of dependency. In addition to internal motivations, incentives for collaborative behaviour in megaprojects can be external. By exposure to political and social environment, organisations are likely to behave collaboratively so as to achieve political appeal and public satisfaction.

In case of opportunistic behaviour, project uncertainty and transactional cost are observed as two key drivers (Ikuabe *et al.,* 2020). While there are inherent incentives to choose individual rationality for short-term profits and self-interest maximisation, opportunistic behaviour is encouraged when substantial resources are invested with little certainty about the value achieved. Opportunism which means that organisations pursue profits by cheating at the expense of partners' interests will cause the damage to relationship quality (Chaudhry, 2020), hinders high project performance, as well as induce additional cost and time to develop and maintain relational transactions. Meanwhile, in a less harmonious environment, few benefits related to collaboration are perceived and organisations are more likely to adopt opportunism to increase short-term interests. Moreover, the unfairness perceived during the interaction process increases the probability of opportunistic behaviour (Feng et a., 2021).

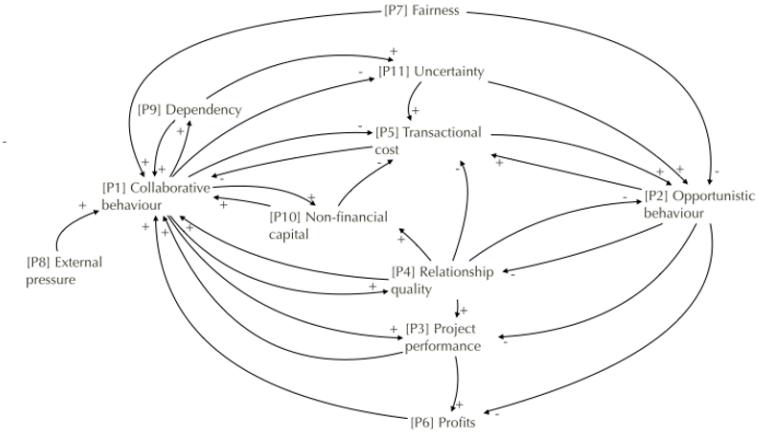

Fig 2: The casual loop diagram

The interplay between collaborative and opportunistic behaviour is observed as one important aspect involving several complex and overlapping feedback loops. When collaborative behaviour is adopted, transactional cost is prone to decrease resulting in low motivation for opportunistic behaviour. With depressed opportunism, negative impacts om project performance and relationship quality are mitigated, which induces more positive attitude and confidence towards collaborative behaviour. However, transactional cost is not simply related to collaborative behaviour. It also has positive relationship with project uncertainty. In other words, the effect of collaborative behaviour on transactional cost decrease might be weakened if project uncertainty is high. In addition to such reinforcing loop example, there are balancing loops involving collaborative and opportunistic behaviour. For instance, dependency strengthened by collaboration indicates that decision making and actions of an organisation rely more on partners, which increase risks of behavioural and internal uncertainties. When there are higher uncertainties perceived, an organisation is prone to choose opportunistic behaviour to assure short-term benefits while this results in higher transactional cost, which in return dis-encourages collaborative behaviour and an organisation might be more independent. This then restarts the loop leading to a balance between collaborative and opportunistic behaviour.

CONCLUSIONS

This paper explored psychological and behavioural perspectives of IOC in megaproject context. In particular, the SD approach was adopted structuring the literature review process and offering an in-depth investigation of how collaborative and opportunistic behaviour develops over time and induces the dynamics of collaboration between participated organisations. By reviewing the extant literature, 11 key parameters and cause-effect relationships between them were identified and a casual loop diagram was proposed. The findings partly support prior research by showing that collaborative behaviour can be motivated by additional profits, fairness perceived and external requirements, project and relationship performances; while factors such as lack of fairness, uncertainty, increased transactional cost and poor relationship quality are more likely to result in opportunistic behaviour. Also, balancing feedback loops involving both collaborative and opportunistic behaviour show that there are equilibriums not only inhibiting very close collaborative relationship but also preventing high levels of opportunisms.

This paper offers two contributions. First, most of the megaproject research to date have studied IOC from the perspective of governance mechanisms regarding choosing appropriate approaches to foster collaboration and restrain opportunism. This study contributes by investigating psychological and behavioural aspects of IOC to understand why and how collaboration and opportunism can emerge and decrease. Second, the existing literature captures the interplay between collaborative and opportunistic behaviour only implicitly. This paper provides a conceptual model for a systematic understanding of the dynamic interaction.

Despite the contributions, there are some methodological limitations. First, dynamic parameters and cause-effect chains are based on existing studies. Thus, testing the validation of proposed model and its accuracy in reflecting the real world should be further explored. Second, a casual loop diagram is established to describe the interplay between collaborative and opportunistic behaviour. To facilitate a better understanding, quantifying elements and their relationships so as to run the computer-based simulation should be further explored. Third, the scope of this study only focused on the psychological and behavioural aspects. Future work should consider the interaction between behaviour and governance mechanisms so as to select appropriate mechanisms for a specific IOC state.

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