ASSESSING RISK DYNAMICS IN PUBLIC PRIVATE PARTNERSHIP PROJECTS

Elsa Cheung [1], Martin Loosemore and Diane Christina Chandra

[1] *University of New South Wales, Faculty of the Built Environment, Sydney, Australia*

There have been many instances of unsuccessful public private partnership (PPP) projects. Traditional reductionist approaches to risk assessment appear inadequate to manage the complex and dynamic interdependencies which exist on such complex projects. Systems dynamics methods have been used extensively outside construction to assess risk in other complex systems and theoretically show great promise in PPP projects. However, interviews with sixteen senior construction professionals with experience of PPPs, while indicating openness to new approaches, revealed significant short-comings in adopting such an approach in this context. It is concluded that if systems dynamics is to be used as a new way of assessing risk on Public Private Partnership projects, existing dependence on linear methods needs to be broken through more education about the merits of system thinking.

Keywords: risk, systems, public private partnerships.

INTRODUCTION

Definitions of PPPs vary around the world but typically refer to a procurement approach where a private sector consortium contracts to finance, design, construct and operate public infrastructure against defined public service standards (Yescombe 2007). In very simple terms, the clients buys a stream of services rather than an end-product and the consortium is paid (or abated) according to the achievement of these service standards over a concession period which can last for decades. As Howick *et al* (2009) point out, PPP projects tend to be large, complex, last over many years and involve many parties in dynamic relationships with a multitude of interdependencies and risks. This makes the assessment of risk a very challenging process which many authors have argued are undermined by traditional reductionist approaches to risk management which inherently assume that risks occur in a linear predictable fashion (Kapsali 2011, Lehtiranta 2013).

According to Koubatis and Schonberger (2005) the main problem for managers in assessing the risks in complex systems is their property of 'self-organization' – the ability of a system's connections and interdependencies to change, adapt and develop on their own without the influence of external managers. While self-organizing systems tend to be highly efficient and find a natural equilibrium, in doing so they also tend to settle at a 'critical edge' where a small change in the system can lead to catastrophic changes in the overall system. Kampmann (1999) famously illustrated this with the analogy to a pile of sand. As each grain is added, it displaces the grains of sand around it but at some point, as more grains are added, one grain will act on the

[1] m.loosemore@unsw.edu.au

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whole system and cause the pile to collapse and find a new equilibrium. According to Kampmann (1999), complex systems evolve gradually and smoothly at a steady pace to be punctuated by occasional and inevitable catastrophic changes. While they may appear under control on the surface, in reality they exist on the edge of chaos and it is impossible to predict when the sudden change in equilibrium will come. Cpmplex systems theories have been used to explain the behaviour of many self-organizing systems such as the stock market, traffic jams, epidemics, volcanoes, evolution and extinctions, forest fires and economic cycles. They have even been used to understand risks in PPP projects (Nyagwachi 2008, Masafumi 2009, Aragão and Nascimento 2010, Jang 2010, Xu *et al* 2012). However, despite demonstrating the value of this approach, we have little understanding of what the barriers in adopting system thinking may be in practice. As Koubatis and Schonberger (2005) and Helbing (2013) both point out, this involves a major 'paradigm shift' away from linear reductionist thinking about risk to a new perspective which requires risk managers to think about the dynamic interdependencies which can cause PPP projects to fail.

A SYTEMS APPROACH TO ASSESSING RISK

According to Kapsali (2011) 'systems thinking' is a holistic approach which views organisations as a series of interrelated subsystems of people, processes and technologies that cooperate towards the achievement of a common goal. Systems thinking focusses on 'relationships' rather than individual 'parts' and on the effects of cyclical relationships rather than linear cause-and-effects. The field of Systems Dynamics (SD) has developed to help us understand and model the structure and dynamics of complex systems (Sterman 2002). From a risk assessment perspective, SD enables risk managers to experiment, in a virtual world, with different risk control strategies to optimise project outcomes (Martinuzzi and Kopp 2011). Typically, the SD methodology consists of four main stages: Qualitative reflection; Computer Model Formulation and Simulation; Simulation Testing and Evaluation and; Simulation Policy and Interaction Experiments (Zagonel 2002).

Stage one

The first stage of qualitative reflection usually happens in a workshop of key stakeholders who are asked to describe the system under consideration, its critical resources and their dependencies. The aim of qualitative reflection is to create an aggregated model of the system. This is often done using a rich picture diagram (RPD) which is simply a pictorial multi-layered representation of the real world using symbols to represent sub-systems and their relationships within a defined system boundary (Patching 1990). This can then be synthesised into a single map of linked concepts, where relationships between main concepts are connected by linking words or linking phrases. There are precious few examples of RPDs in construction but Figure 1 shows one adapted example of a simple RPD which represents how one potential PPP risk (Force Majeure) could affect the facilities management of a major hospital is presented in Figure 2.

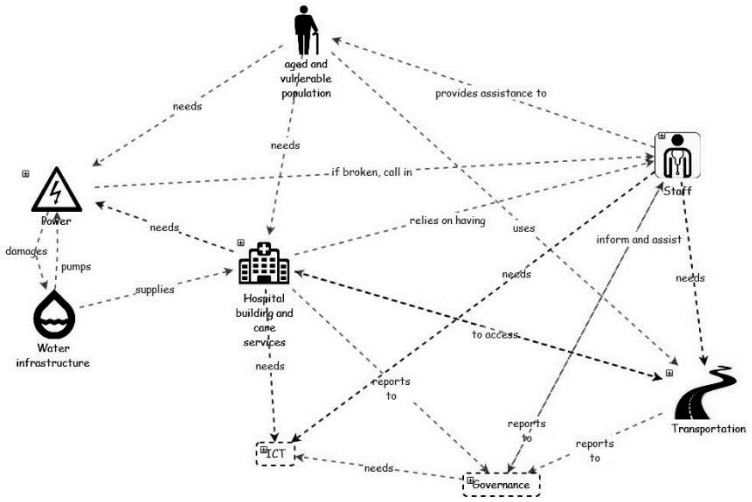

Figure 1: Rich Picture Diagram (Source: Chow et al 2012)

While used in another context by Chow *et al* (2012), Figure 1 shows how components of a hospital system (during the operational phase of a PPP project) could be affected by a force majeure risk (in this case an extreme weather event such as a heatwave). It shows how the continued delivery of hospital services is dependent on a whole range of other infrastructures and governance systems and that hospitals should not be seen or managed in isolation from these systems. Maintaining health services to defined KPIs during such an event is therefore determined by how well these interdependencies are managed.

Stage two

Following the 'Qualitative Reflection' stage, the *"Computer Model Formulation and Simulation"* stage involves converting the RPD into a dynamic map of stocks and flows (a stock and flow diagram) to show their underlying physical and feedback control structure (Sterman 2002). Figure 2 is a stock and flow diagram developed by Chow *et al* (2012) and shows the flow of patients from the community to the hospital and the top of the diagram shows the timing of the force majeure risk event, its consequences for the hospital, the effect on community infrastructure and its impact of the hospital and its impact on flows of patients and levels of care provided to the community.

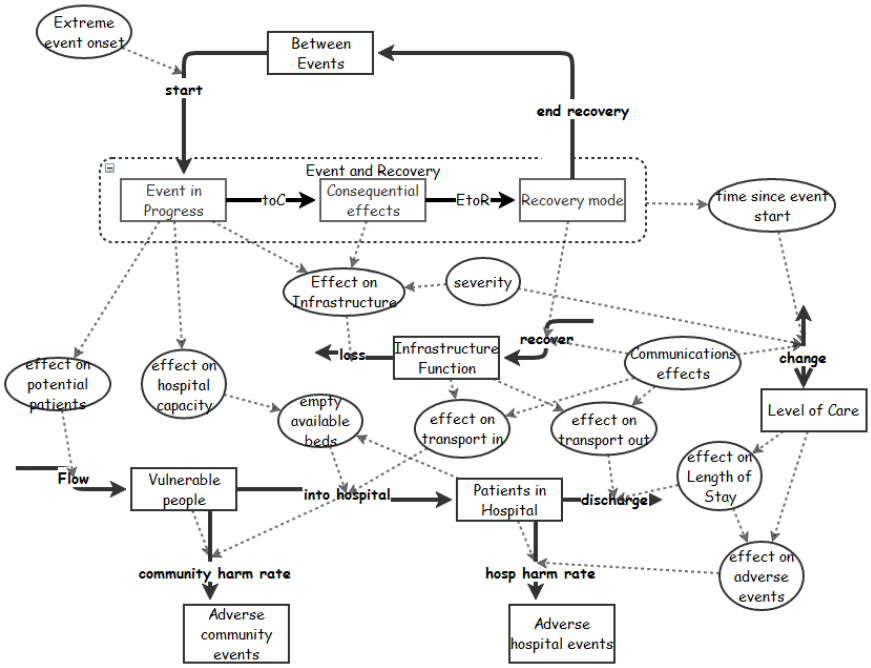

Figure 2: Stock and flow diagram created using Insight Maker (Source: Chow et al 2012)

Stage three

During the third *"Simulation and Testing"* phase the stock-and-flow model is progressively refined over multiple iterations with stakeholders to ensure any differences between the real world event patterns and the model outputs are minimised. Sterman (2002:852) describes modelling as *"... a process of communication and persuasion among modellers, clients and other affected parties. At the end of the simulation and testing process the model should accurately represent the behaviour of the system over time and allow risk managers to understand how different risk scenarios impact on the KPIs of the system being modelled."*

Stage four

In stage four of the SD process, managers conduct 'virtual intervention experiments' to explore how alternative management strategies can minimise impacts on KPIs, testing them using the SD model. The alternative policies, strategies and structures tested will rest on the imagination, experience and skill of the system stakeholders and the SD model will show which options are 'likely' to produce the best combined outcomes for the stakeholders involved.

METHODS

In order to explore the barriers to implementing a SD approach to risk assessment on PPP projects, we undertook semi-structured interviews with sixteen people, from a range of professions, who had held senior roles on major PPP projects in Australia and overseas (see Table 1 for sample structure). Each of these people had worked on several PPP projects and were identified through references from their peers as recognised experts in the PPP field.

Table 1: Sample structure

Research participants by profession	Number of research participants
Systems thinking experts	2
Project managers	1
Quantity surveyors	2
Risk management professionals	7
PPP/Infrastructure experts	4
TOTAL	**16**

Our semi structured interviews lasted for an average of one hour. We first educated our respondents about the SD approach (since this methodology is rarely used in construction). Gall et al (2003) and Turner (2010) recommend that when conducting research about past events, it is good practice to 'jog' respondent's memories of the phenomenon in question. To this end, we started our interviews by asking our respondents to reflect ion the PPP projects they had worked on and the challenges they had encountered. This process helped to reduce potential recall error. We then asked the respondents the three main research questions:

1.If a systems thinking approach were to be utilised, what would be some of the challenges involved?

2.How could systems thinking benefit the identification and management of risks in PPPs in the future?

3.What are some of the reasons why the traditional risk management approach is still used?.

The aim of the first question was to explore the main barriers that would need to be overcome in introducing a systems thinking approach into the risk management of PPP projects. The aim of the second question was to explore whether respondents saw any value in the SD approach to managing risks in PPP projects. The aim of the third question was to identify some of the reasons why SD is not widely adopted in the construction industry. In presenting the results of our analysis we present the narrative of the discussions rather than reduce the data to quantitative counts of variables via content analysis. There are two reasons for this. First, we did not seek to test the relationship between any independent and dependent variables. We simply wanted the respondents to tell us about their experiences of working in the industry on PPP projects. Second, we wanted the results to retain the full richness of insight contained in the narratives we collected from these highly experienced respondents. As Meisel (2011) notes, the power of narrative is in translating respondent accounts into data that people can comprehend. Clearly, it is not possible to recount everything that was said in this paper. So what is presented below are the main points which were issues of agreement across all respondents.

DISCUSSION OF RESULTS

Question one - If a systems thinking approach were to be utilised, what do you think would be some of the challenges involved?

Most participants believed that the SD approach was overly complex and that there would be significant cognitive challenges in shifting people to a systems thinking approach:

"Well, I think the big challenge is actually getting people to think systemically." (Resp #1).

"I think it could benefit by simplifying it for a lot of people. If it's simpler, then people will adopt it." (Resp #8) …

Notably, it was argued that the adoption of a systems approach would threaten established power structures on projects and challenge path dependencies by requiring people to communicate in new ways:

"…the challenge is how do you bridge those different interests in the process over time …. It's also communication. Not just from the initial design intent through to operation but back the other way as well, from the operational functional need back to those who are conceiving and designing. (Resp #6)

In contrast to the free, integrated thinking which a systems approach allows, our respondents expressed some discomfort and insecurity with the lack of standardised guidance and education around the systems approach compared to established methods of managing risk.

"If there's some sort of background of information, guidance, what needs to be done, standards. What we're doing is based on the ISO 31000 and that standard, that's world documented. (Resp #13).

"Part of the problem is that it's not taught in schools and it's not taught in schools. Firstly, the teachers don't know it themselves and …… it's very rarely taught in any universities. It's not embedded in anyone's psyche. We just don't think that way. (Resp #1)

Some respondents also pointed to the legal implications of moving to a systems perspective and defended current approaches which allowed them to offload risk. This suggests that current ways of thinking about risk are largely dicated by the way they are distributed in traditional construction contracts.

"One of the benefits of the current more narrow approach is more rigid allocation of risk and that means that one party is usually then accountable for a loss in the event that that risk arises. One of the challenges for adopting a slightly broader approach is to then say ..Well, haven't you actually then blurred who's actually responsible for that risk and shouldn't you actually be trying to hold parties accountable for the specific roles etc. that they've actually taken on?" (Resp #2).

Question two - How do you think a systems thinking approach could benefit the identification and management of risks in PPPs in the future?

Despite the many barriers above most saw the SD approach as offering potential to facilitate a more collaborativeand holistic understanding of risks on PPP projects.

"..what you're describing in terms of a system based approach to risk assessment, I think would be crucial to looking at projects holistically. Too often our industry looks at things in a fragmented approach. So you end up with a disconnect with what the vision was through to the concept, to the design, to the construction, to the operation. …, all this fragmentation creates inter-phases and that's where the risk is more likely to occur. So yes, you need a more system based approach" (Resp #6).

Our respondents provide numerous examples of problematic PPP projects which might have benefited from a SD approach.

"The best example where systems thinking wasn't applied was on the Cross City Tunnel. The tunnel basically runs from east to west across the city. They put a toll on it with forecast traffic projections which were wrong. And then everybody started using what they call "rat runs" just to avoid it and go through the backstreets of Kings Cross and so started blocking the streets. That could have been foreseen if someone had used a systems thinking approach and looked at it holistically on what's going to happen if you put a toll on this road and what alternatives they had. And in fact it ended up costing the head of the RTA his job so it had big political ramifications." (Resp #2)

Question three - What do you think are some of the reasons why the traditional risk management approach is still used?

The majority of the research participants believed that the main reasons why the traditional risk management approach is its simplicity. Importantly, it is also supported by an international standard.

"I think people can understand it. It's structured, it's straight to the point and you can do it. …. People who know a project can do that relatively easily. And it's quite logical – you identify the risk, you work out what can I do to mitigate that risk. The tables are all there, you plug the numbers into an excel spreadsheet and it works it all out for you."

Our respondents also indicated that traditional linear methods give people certainty over allocation of risks and responsibilities and therefore greater accountability, whereas an SD approach might confuse this.

"The risk management approach deals with risk items separately and therefore seems to be more accountable and measurable. In a management point of view, one would like to see a straight forward result of his/her adopted strategy, rather than to see a mixture of impacts that becomes so remote to one's direct effort." (Resp #7).

Finally, it was clear that most people felt comfortable with the linear thinking required by the traditional approach.

"It's pretty much idiot proof. People understand that matrix of low, medium, high and extreme. The way it's presented and coloured. I think that it's very transparent. …. It allows people to schedule what the problems are. I'm a person that likes lists. Even when I come in during the day, I'll have a list of what to do and prioritise them. And once you put in the likelihood of all the risk issues, it lists them in order of the problems. So in doing that it kind of gives people an attack list. The risk actually becomes actionable. So it allows people to do things about risks rather than just accept them for what they are." (Resp #11)

CONCLUSION

The aim of this paper is to explore the current barriers in adopting a systems thinking approach to managing risk in PPP projects. Our results indicate that despite the proven benefits of this approach in theory, the practical implementation of these ideas in reality is likely to be problematic. Most professionals are unfamiliar with the systems thinking process, have not been taught to think in this way and feel comfortable with traditional methods which provide a standardised, simple and well-established approach. This is despite a realisation that risks on PPP projects are highly complex

and that many projects fail due to unanticipated risk arising from complex interdependencies which were not detected. Our findings focus and further the important work of Stewart (1995), McLucas (2003), Kapsali (2011) and Lehtiranta (2013) who question the efficacy of linear risk management thinking and present a practical reality-check to the work Nyagwachi (2008), Masafumi (2009), Aragão and Nascimento (2010), Jang (2010) and Xu *et al* (2012) who have conceptually demonstrated the potential value of a systems thinking to overcome this problem in PPP projects. By better understanding the barriers which have to be overcome in implementing such an approach we are now in a better position to understand and explore the cognitive and behavioural barriers to implementing a new approach to risk assessment on PPP projects.

REFERENCES

Aragao, J J G and Nascimento N J (2010) Modelling public private partnerships, In proceedings of *"System Dynamics Society Annual Conference"*, University at Albany, Albany, USA, 1180 – 1196.

Chow, V W, Loosemore, M and McDonnell, G 2012. Modelling the impact of extreme weather events on hospital facilities management using a system dynamics approach. Association of Researchers in Construction Management (ARCOM): *"28th Annual Conference"*, Edinburgh, United Kingdom, 3-5 September 2012,1157-1167.

Helbing, D (2013) Globally networked risks and how to respond, *"Nature"*, 2 May, **497**, 51-59, doi:101038/nature/12047.

Jang G (2010) *"The bids-evaluation decision model development and application for PPP transport projects: a project risk modelling framework"*, unpublished Doctor of Philosophy Thesis Submitted to Department of Mechanical Engineering In partial fulfillment of the requirements For the Degree of Doctor of Philosophy Colorado State University, Fort Collins, Colorado.

Kampmann, B (1999) *"Self-organized criticality, emergence, catastrophe theory and linguistic theory: four preliminary studies with special emphasis on the concept of meaning"*, Institut for Litteratur, Kultur og Medier, Syddansk Universitet, Odense Universitet, , Denmark.

Kapsali, M. (2011) 'Systems thinking in innovation project management: A match that works' *"International Journal of Project Management"*, **29**(4), 396-407.

Koubatis, A. and Schönberger, J.Y. (2005) 'Risk management of complex critical systems' *"International Journal of Critical Infrastructures"*, **1**(2/3), 195-215.

Lehtiranta, L (2013) Collaborative risk management processes: a constructive case study, *"The Engineering Project Organization Journal"*, **3**(4), 198-212.

Meisel Z F and Karlawish J (2011) Narrative vs Evidence-Based Medicine--And, Not Or, *"Journal of the American Medical Association"*, **306**(18): 2022-2023.

Martinuzzi A, and Kopp U (2010) Experience with systems constellations in theory-based evaluation - a new tool to support actor-centred Evaluation, Full paper (abstract No: 10EES-0841) for the *"9th International European Evaluation Conference"* in Prague, October 6-8.

Masafumi, H (2009) *"Public-private partnerships in space projects : an analysis of stakeholder dynamics"*, Thesis submitted in partial fuillfillment for Degree of Masters of Science, Technology and Policy at Massachusetts Institute of Technology. Engineering Systems Division.; Massachusetts Institute of Technology. Technology and Policy Program.

Nyagwachi J N (2008) *"South African Public Private Partnership (PPP) projects"*, Thesis submitted in partial fulfilment of degree of Philosophiae in construction management at Nelson Mandela Metropolitan University, South Africa.

Sterman, J.D. (2002) *"Business dynamics: Systems thinking and modelling for a complex world"*, McGraw Hill, USA.

Xu Y *et al* (2012), System Dynamics (SD) -based concession pricing model for PPP highway projects, *"International Journal of Project Management"*, **30**(2), 240-251.

Yescombe, E. R. (2007) *"Public-Private Partnership: Principles of policy and finance"*, Butterworth-Heinemann, Oxford, UK.

Zagonel A A (2002) Model conceptualization in group model building, Zagonel, Aldo. Model Conceptualization in Group Model Building: Tension between Representing Reality and Negotiating a Social Order. In Proceedings of the *"International System Dynamics Conference"*, Palermo July 2002, 341-356.