Supporting interdisciplinary research projects via system dynamics boundary objects: An application to integrated urban water management

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Abstract

To address complex or wicked problems, we need researchers from multiple disciplines with specialised knowledge to work together in large research projects. However, while there is much interest in such interdisciplinary collaboration at the rhetoric level, its manifestations in practice are less frequent. While the system dynamics literature helps understand project collaboration and the use of boundary objects to appreciate dependencies between external stakeholder concerns, we lack understanding how system dynamics boundary objects can support interdisciplinary collaboration among a research team itself. Using an application from the area of Integrated Urban Water Management, this extended abstract demonstrates how participatory system dynamics can be used to create boundary objects for better managing interdisciplinarity in large research projects. It shows that such activities can help facilitate the communication and transfer of meaning and learning amongst diverse sub-teams and contribute to the better management of research projects. More broadly, this extended abstract also discusses the application of system dynamics in a less problem-focused context and provides a dynamic interpretation of a theory of change.

Keywords

System Dynamics, Interdisciplinary Research, Boundary Objects, Integrated Urban Water Management, Causal Loop Diagrams

1 Introduction

Scholars recognise the need for researchers from multiple disciplines to work in an interdisciplinary way when they try to solve complex or wicked problems (e.g. Klein, 2004; von Wehrden et al., 2019). Examples include matters such as equitable development, climate change, biodiversity or sustainable water management (e.g. Brugnach & Özerol, 2019). While interdisciplinary collaboration is the only way to tackle such complex challenges, it has proven to be not easy.

Interdisciplinary working remains rare rather than the norm in academia (Cairns et al., 2020). There is a trend towards specialisation and disciplinary fragmentation (Becher & Trowler, 2001; Stehr & Weingart, 2000). We observe a discrepancy between the interest in interdisciplinarity in discourse and rhetoric and its implementation in practice (Blake et al., 2013).

In this context, this study examines how participatory systems dynamics can create boundary objects for better managing the interdisciplinary nature of large research projects. It contributes to better management of research projects, facilitates communication and transfer of meaning and learning amongst diverse teams, discusses the application of system dynamics in a less problem-focused context and provides a dynamic interpretation of a theory of change.

The reminder of this extended abstract is organized as follows: after the present introduction, Section 2 discusses the system dynamics literature on project management as well as boundary objects. Section 3 describes the developed workshop process and the case study, while Section 4 outlines the workshop results. A final discussion close the extended abstract (Section 5).

2 Literature on project management and boundary objects

2.1 Project management

There exists a vast literature on the use of system dynamics modelling for project management, focused primarily on the rework cycle (e.g. Lyneis & Ford, 20072007; Sterman, 1992) or quality erosion (Black & Repenning, 2001; Sterman et al., 1997). In rare cases, system dynamics has also been used for the strategic management of complex projects (Lyneis et al., 2001). System dynamics has informed project-related work more broadly, e.g. in group engagements on modelling or with models (Andersen et al., 2007; Thompson et al., 2016). In addition, the collaboration between involved parties has been a focus, e.g. on alignment of partners (Black et al., 2006; Greer et al., 2006; Greer et al., 2009) or trust between project partners (Luna-Reyes et al., 2008). While these multiple examples show that system dynamics modelling is useful to manage complex projects, the method's use to improve interdisciplinary collaboration in research projects has not been explored.

2.2 System dynamics boundary objects

Interdisciplinary integration is at the core of the system dynamics method. Especially qualitative system dynamics models have been increasingly used to help elicit interdisciplinary relationships (Black & Andersen, 2012; Black, 2013; Hovmand, 2014; Luna-Reyes et al., 2019). Boundary objects are

> *a tangible representation of dependencies across disciplinary, organizational, social or cultural lines that all participants can modify. It can effectively advance shared understanding when participants can transform the representation to show more clearly their understanding of the dependencies among them and the implications for each participant's resources, operations and goals.* (Black & Andersen, 2012, p. 195)

While these boundary objects depict interdisciplinary dependencies, this is within a problem-focused view that maps interdependencies between different aspects of a problem.

We cannot assess the extent to which authors use system dynamics boundary objects to manage the interdisciplinary more deeply within their research projects and teams, but reporting of such efforts is missing. Therefore, our study will innovate by reporting on the use of a CLD to support interdisciplinarity *within* a research project. This project is located in the integrated urban water management area.

3 Method

Our case study is part of the CAMELLIA project, that aims to improve Community Water Management for a Liveable London (https://www.camelliawater.org/). It addresses pressure from climate change and growth, e.g. with regards to green and blue infrastructure, combined with a diversity of interest (Daniell, 2012; Pluchinotta et al., 2018; The UK Water Partnership, 2015; OECD, 2015). It includes a disciplinary diverse team of about 25 academics and researchers from water-related engineering, planning, organisational and participatory research.

Our workshop was intend to develop a boundary object, i.e. a CLD of the project that could serve better interdisciplinary integration. In this specific task, we focused on interdisciplinary collaboration, i.e. between the diverse disciplines involved in the CAMELLIA project, and did not include the project's non-research partners and stakeholders, which would have meant transdisciplinary collaboration. Seven work package related sub-groups of two to three people each completed the following five different tasks/sessions over a seven-hour workshop:

i. 'Hopes and Fears' to establish joint expectations for the CLD and project;
ii. Sub-groups' 'Core Variables Elicitation' to identify the sub-groups' key variables;
iii. 'Variables Voting/Ranking' to select a starting point for modelling;
iv. Two sessions of 'Creating Causal Loop Diagram'; and lastly
v. A 'People, Methods, Tools and Models' activity to elicit joint activities and dependencies between sub-groups.

The facilitation team consisted of three people: one author who acted as facilitator only, one author who acted as facilitator and helped the modeller and a modeller who added variables, links and loop indicators as the facilitators had suggested after discussion with the participants. Facilitators also participated in the Hopes and Fears, Core Variables Elicitation and the People, Methods, Tools and Models activities because the idea was to include the entire CAMELLIA team. Yet, they came last when they participated.

In the workshop we worked live in Vensim® Software (by Ventana Systems). After the workshop, we slightly re-arranged variables and made slight modifications with two non-attending team members, and then asked the entire group for consent again. Later, we simplified the CLD from about 30 to 17 variables for better communicability and are in the process of obtaining full group consent about this again.

4 Short summary of results

The resulting initial CLD with about 30 variables summarises and connects the team members' core variables and areas of work. The People, Methods, Tools and Models activity helped us go into detail and see connections between very specific tasks and models as well as work packages

in the project. We found overlaps, linkages and, interestingly, also gaps in expertise and project coverage.

A further analysis of feedback loops within the CLD identified a number of particularly reinforcing mechanisms. It became apparent that many of these mechanisms are analysed and designed by many different work packages and thus disciplinary foci within the team. They indicate across which very explicit boundaries interdisciplinary collaboration within the team is required.

5 Discussion and conclusions

This extended abstract presented the development of a CLD as boundary object to support interdisciplinary collaboration within a research project. It responds to calls for better interdisciplinary collaboration in water management research as well as in research projects that tackle complex challenges more generally. Furthermore:

- This extended abstract is complementary to existing system dynamics research in the area of project management by supporting the interdisciplinary aspects of a project rather than having a focus on time, cost and quality.
- Our approach contradicts traditional system dynamics practice by a CLD developed without a clear time dimension and with just a loose problem definition. A similar approach was followed by one of the authors (Zimmermann & Curran, 2020). Yet, this novel approach seems promising for the identification of overlaps and collaboration needs.
- The People, Methods, Tools and Models activity proved to be promising to help span across boundaries.
- The developed model and boundary object describes a feedback-focused theory of change of how our research activities are expected to create change.
- In the area of integrated water management this extended abstract provided a novel angle by not focusing on water aspects per se but interdisciplinarity and project management instead.

Limitations to our extended abstract include that we reported about the early phase of using a boundary object for managing interdisciplinarity. The usefulness of boundary objects depends on the level of engagement with them (Sapsed & Salter, 2004), but we cannot yet report on long-term effects. We thus recommend more research in this promising area.

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