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## Relating Systems Thinking and Design (RSD12) Symposium | October 6–20, 2023

### **Evolving The Project Design Thinking Methodology Through Action Research**

**Gary Bell, Isabel Dunckley, Kat Lovell, and Javier Andres Calderon Tellez**

This paper introduces and presents an application of the “project design thinking” (PDT) methodology. Project management is becoming a broad discipline guided by the extended life-cycle model (i.e. front-ending, delivery, back-ending and termination). This engenders further complexities and uncertainties to be untangled, leads to new interdisciplinary developments and requires the support of broader skills for the profession.

Responding to these needs, this paper argues for the connection of design research with project management practice. Following an overview of the interdisciplinary roots of the PDT methodology, we outline the mouldable systems thinking-based process model and connect associated methods and tools. This approach is illustrated using the case of improving sustainability for a university building. The aim of this project's front-ending practice is to co-design, with identified actors, an imagined future sustainable system for the building by using Mind maps, Causal loop diagrams and Minecraft through group conversations. These visual models can support active learning and the shaping of mental models, which may inform management decision-making with respect to desirability, feasibility and viability dimensions and can lead to agreed group actions.

The development and application of the PDT process model have led to the development of a broad model for social research (based on Peter Checkland’s work). This broad model is briefly described as it is used to guide a reflective discussion of the intervention findings and evolution of the PDT methodology

and associated framework of ideas. Moreover, this work tentatively suggests an emerging shift in the role of the professional towards a facilitator of learning for untangling complexities, which initiates imagined future sustainable systems and agreed project actions in order to achieve them.

KEYWORDS: action research, co-design, design thinking, project front-ending, sustainability, systems thinking.

RSD TOPICS: Mapping & Modelling, Methods & Methodology, Cases & Practice

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## **Introduction**

Project design thinking (PDT) methodology is an approach developed for project front-ending practice. It aims to improve social situations through engaging with relevant actors. PDT attempts to identify, through active actor participation, the right sustainable, innovative solutions that are viewed as desirable, feasible and viable. Moreover, they are delivered through the appropriate project management practice. The interdisciplinary roots of the proposed methodology, connecting with project management, innovation, operational research and the systems movement, are outlined in Figure 1.

The project management discipline is continuously evolving (Davies, 2017). The symptoms and causes of unsuccessful projects (Morris, 2013; Morris & Hough, 1987) informed the inception of the "Management of Projects" paradigm (Morris, 2013; Morris, 1994). This suggests that a project (and potential innovations) is not an island (Engwall, 2003) but part of a wider system, and Morris (2011) acknowledges the increasing complexity of projects. The development of the PDT approach introduced here responds to the potential of thinking developed in the systems movement (e.g. Yeo, 1993) to address this expanding complexity in our understanding of projects, linking their development, context and performance.

Jackson (2019) asserts that systems thinking is the appropriate response to the management of complexity. Winter et al. (2006) offer some research directions for project management (e.g. from product creation to value creation, from instrumental process to a social process) to develop an understanding of connecting project context

and definition. Identifying the right sustainable innovations and the importance of value and benefits (Cooke-Davis, 2007) in organisational operations has facilitated the inception of project front-ending (Edkins et al., 2013; Morris, 2011) and back-ending (Artto et al., 2016), which are considered key meta-phases of the project life-cycle. The extension of the project life-cycle model highlights the importance of strategy, value creation, social process and innovation.

The connectivity between innovation and project management has been recognised (Brady & Hobday, 2011), and the recognition of cross-fertilisation between these disciplines is emerging (Davies et al., 2018). A further key development has been the establishment of Design thinking (Brown, 2019, 2008; Brown & Wyatt, 2010; Johansson-Skoldberg et al., 2013; Kelly & Littmann, 2005) within the Innovation discipline (Mahmoud-Jouini et al., 2016). Design thinking is connected with strategic aspects of innovation and associated with more holistic solutions to improving social situations within the context of anthropogenic climate change. Brown (2008) developed three distinctive spaces, namely, inspiration, ideation and implementation, which inform the development of innovative solutions to solving perceived problems and take a human-centred approach. Mahmoud-Jouini et al. (2016) argue for the connection of design thinking with the exploration aspect of project management and highlight potential contributions to strategy and co-creation of innovative design solutions.

The operational research (OR) discipline has contributed to both project management and design thinking. It is associated with the development of techniques (e.g. PERT) (Morris, 2013) for traditional project management practice (or technical core) (Meredith & Mantel, 2012), which is linked with the delivery phase of the life-cycle model (Figure 3). Moreover, these techniques are linked with hard OR and are an aspect of hard systems thinking. Problem Structuring Methods (links with soft OR) (Rosenhead & Mingers, 2002) (e.g. cognitive mapping (Eden, 1988) and Soft Systems Methodology (SSM) (Checkland, 1981)) have been applied to project management (Bryson et al., 2004; Winter, 2006). SSM (Checkland and Poulter, 2006) and Causal Loop Diagrams (CLD) (Senge, 1990; Sherwood, 2002) are linked with soft OR and soft systems thinking. SSM and cognitive mapping were developed through the action research strategy (Checkland, 1991; Eden & Huham, 1996; Saunders et al., 2019). It is evident that systems thinking and action research have strong connectivity with soft OR. Morris (2002) argues that soft systems

thinking approaches should be applied to project front-ending practice. Moreover, there is interest in systems thinking with design thinking and Design Research, and a need to have stronger connectivity with the Systems Movement (Checkland, 1981) is being established.

Project front-ending is connected with strategy (Morris, 2009), project strategy (Pattanakul & Shenhar, 2012), value creation (Green & Sergeeva, 2019; Norman & Ramires, 1993; Winter & Szczepanek, 2008), social process (Winter & Checkland, 2003), problem-solving and soft approaches (Bell et al, 2019), designing products and processes (Mahmoud-Jouini et al., 2016), sustainability (Morris, 2017), innovative systems solutions to improving a social situation. Moreover, project front-ending is about understanding and untangling complexities and uncertainties of the problematic (or messy) situation that needs improvement. Hence, the inception of the PDT methodology aims to contribute to project front-ending practice. This is introduced in sections 2 and 3 and presents an overview of the mouldable systemic process model and associated methods. A brief discussion of the action research strategy is presented in section 4, with an emphasis on the work of Checkland and colleagues (Checkland, 1991, 1981; Checkland & Holwell, 1998a, 1998b). This informs the development of an intellectual device which establishes the declared-in-advance theoretical framework of PDT.

Section 5 outlines an application of PDT methodology to the issue of improving the sustainability of university buildings. Minecraft was applied as a visual design thinking tool to explore various imagined future improvements. It is then connected with Causal Loop Diagrams (CLDs) in order to conceptualise an innovative sustainable future system, and key findings are outlined. This exploratory research leads to a reflective discussion (Schon, 1983) of the intervention and further evolution of the methodology (section 6). The importance of facilitation is highlighted as it encourages (active) learning (Checkland, 1985), which may shape actors' mental models (Senge, 1990), and inform management decision-making and appropriate actions. Section 7 concludes.

## **Development of PDT methodology**

PDT is an approach rooted in interdisciplinary thought (Figure 1). It is influenced by innovation (design research, design thinking and innovation management), operational research (soft and hard methods), project management (strategy, front-ending and management of projects), and systems movement (systems theory and soft and hard systems thinking). PDT is a pluralistic, human-centred approach which aims to improve a problematic situation through designing an imagined sustainable system. It is fundamentally underwritten by systems thinking and takes a multi-methods approach to problem-solving through the inception of innovative projects that can attain the agreed imagined sustainable system. Moreover, the identified innovations are realised through the appropriate project management approach.

Systems thinking attempts to tackle issues of irreducible complexity through a form of thinking based on wholes and their emergent properties (Jackson, 2019). Checkland (2012) asserts that a system can be viewed as an adaptive whole, which can evolve as its environment changes (e.g. climate change) or delivers unforeseen shocks (e.g. COVID-19) to it. The identified system may contain functional subsystems and perhaps, as a whole, be a functional part of a wider system (Checkland, 2012). Moreover, a system is an integral part of a layered structure, which makes a hierarchy of open systems. Checkland offers some conceptual systems thinking guidance “which level is that ‘system’ or ‘wider system’ is a matter of judgement made by the person making use of the concept”.

Systems thinking is an epistemology and is underpinned by two pairs of ideas, namely: emergence and hierarchy and communication and control (Checkland, 2012, 1981). These pair of ideas are derived from two different theoretical strands of thought. The first strand is connected with Biology, which examines plants and living tissue. It was recognised that in living things, there is a hierarchical structure, namely, cells, organs and the organism. This hierarchy produces boundaries which are separate from the physical world, but there can be exchanges between them (Checkland, 1981).

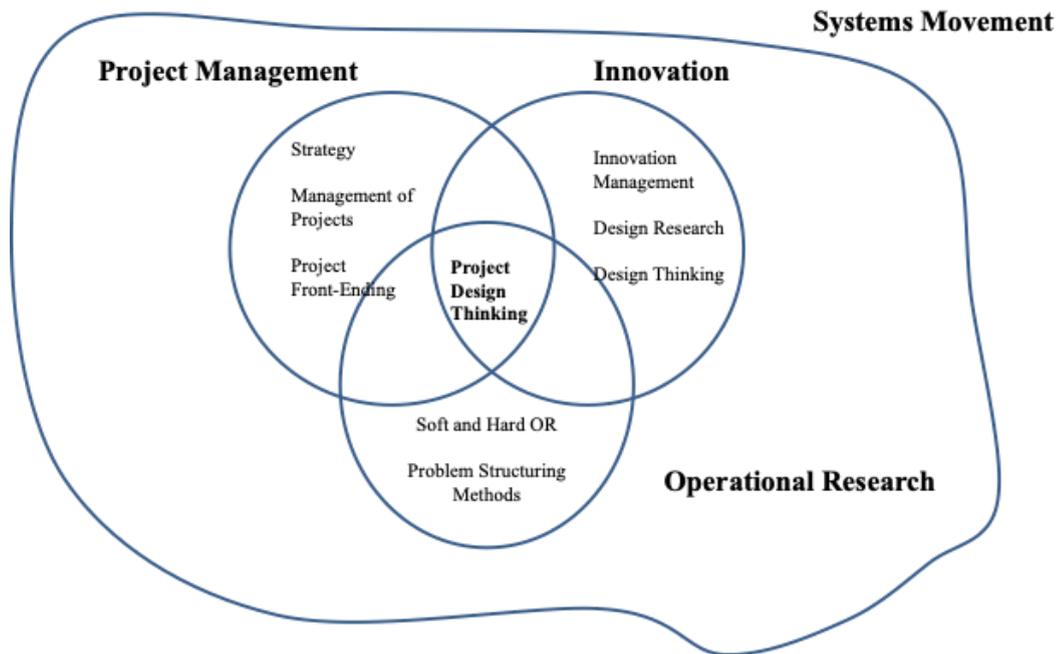


Figure 1: Interdisciplinary roots of the PDT methodology.

The notion of organised complexity is the focus of thinking in systems. Moreover, the general model of organised complexity is that there are hierarchical levels of organisation which are more complex than the one below. Checkland asserts that each level is characterised by emergent properties which do not exist at the lower level.

The second strand is derived from control theory and information and communication engineering (Checkland, 1981). A link between control mechanisms studied in natural systems and those engineered man-made systems was through cybernetics. Wiener's cybernetics work contributes to communication and control. Additionally, it recognised the importance of the process of feedback loops (i.e. positive and negative). The notion of organised complexity is the subject matter of systems, which led to the inception of the movement and is viewed as a meta-discipline. Checkland (1981) discusses the emergence of the Systems Movement, which "attempts in all areas of study to explore the consequences of holistic rather reductionist thinking" Checkland (1981). However, he suggests progress had been slow and that the use of systems ideas within specific study areas (e.g. management) could facilitate further development in both systems theory and practice.

## PDT methodology

Informed by design thinking (Brown, 2019; 2008) (Inspiration, Ideation, Implementation), Soft Systems Methodology (Checkland, 1981; Checkland & Poulter, 2006), project management (Management of Projects (Morris, 2013), PRINCE2 (OGC, 2009)), Scrum (Rubin, 2013), and Soft systems thinking (Checkland, 1981), the PDT systems-based process model (Figure 2) is fundamentally associated with the front-ending phase of the life-cycle model (Morris, 2013). It aims to support project practitioners dealing with complexity, uncertainty (Jackson, 2019; Rosenhead & Mingers, 2002) and unknown unknowns (Snowden & Boone, 2007).

The methodology utilises a mouldable systemic process model for continuous learning, understanding and adapting in order to identify and achieve the agreed sustainable system. The mouldable systemic model (Figure 3) has seven distinctive sub-systems (or functions), namely, problematic situation (current situation ( $S_0$ )), imagined sustainable system (future situation ( $S_1$ )), differences, value creation (Green & Sergeeva, 2019; Normann & Ramirez, 1993), project actions, project definition, and project plans (Table 1). Moreover, it has five distinctive causal loops for developing actor cognition and producing project definitions and plans. The offered model assists with desirability, feasibility and viability considerations. Moreover, it assists with defining project (long-term) and project management (short-term) success measures (Cooke-Davis, 2007).

*Table 1: Description of sub-systems (functional) goals and relevant methods.*

<b>Subsystem (functional goal)</b>	<b>Description</b>	<b>Methods</b>
Perceived Problematic Situation ( $S_0$ ) (addresses the who and the what)	To understand the current situation ( $S_0$ ), and this is viewed as problematic by key actors.	Fishbone, Documentary films, Lego Serious Play, Mind Maps, Rich Pictures, User Story Mapping, and Multi-Criteria Mapping.

<b>Subsystem (functional goal)</b>	<b>Description</b>	<b>Methods</b>
Imagined Sustainable System (Future Situation ( $S_1$ )) (addresses the what, the how, and the why)	To agree on an imagined situation ( $S_1$ ), and this is designed to be a sustainable system. The offered sustainable system attempts to improve the problematic situation ( $S_0$ ).	Adaptable Systems Model, CAD, CATWOE, Causal Loop Diagrams, cognitive mapping, Marvel app software, Minecraft, Purposeful Activity Models, Project Strategy Template, and Story Boards.
Differences ( $S_1 - S_0$ ) (addresses the what, the how)	To establish the differences between the problematic situation ( $S_0$ ) and the agreed imagined situation ( $S_1$ ), and this assists in highlighting potential innovative projects.	Comparison Tables.
Value Creation (addresses the why)	To explore the viability of identified project scenarios through their cost, benefit, risk and schedule, and this provides the justification for the chosen option.	Cost and Benefit Spreadsheet Modelling and Return of Investment.
Project Action (for change)	To facilitate conversations between key actors in order to establish relevant, innovative projects which are viewed as desirable, feasibility and viability.	
Project Definition (addresses the what)	Establish the definition of the projects through traditional or agile (scrum) project management approach.	Traditional Approach Project Product Descriptions, Product Descriptions, Product Breakdown Structures. Agile (Scrum) Approach User Stories, Product Backlog, Ideal Hours, and Story Points.

<b>Subsystem (functional goal)</b>	<b>Description</b>	<b>Methods</b>
Project Plans (addresses the how and the who)	Establish the project plans through traditional or agile (scrum) project management approach.	Traditional Approach Work Breakdown Structure, Gantt Charts (MS Project), Critical Path Method, PRAM APM, Risk Analysis. Agile (Scrum) Approach Sprint Backlog, Spring Planning Velocity and Estimation, Ideal Hours, and Story Points.

The subsystems are viewed as purposeful, functional areas that need to address specific inputs and outputs. These outputs could be models, tables and reports that are generated by the PDT methodology.

The offered mouldable systemic model for PDT is designed to work at two different levels. The first level focuses on developing actor cognition (links with mental models) through visual and conceptual models, methods and tools. Moreover, it aims to identify the right innovation projects. The underpinning assumption is that there is an appreciation of expressed cognitive understanding through visual and conceptual models that engender learning and accommodations. This should lead to agreed purposeful actor behaviour in order to achieve the imagined sustainable future and identified goals (links with teleology (Ackoff, 1979a, 1979b)). The second level focuses on defining and planning identified projects which realise real-world innovations and attain the imagined sustainable system.

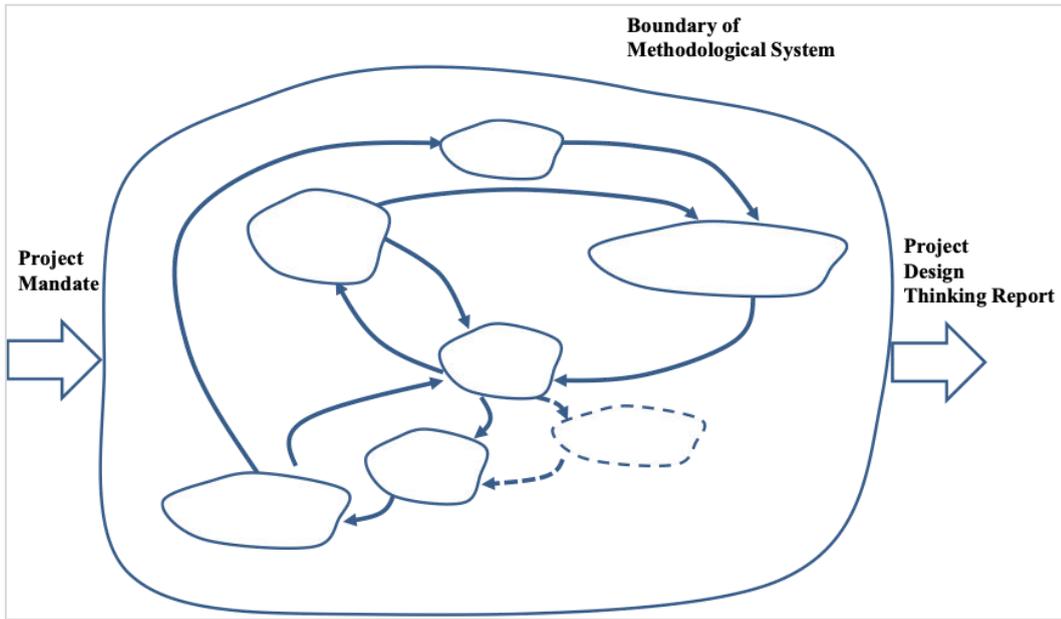


Figure 2: Adaptable PDT model.

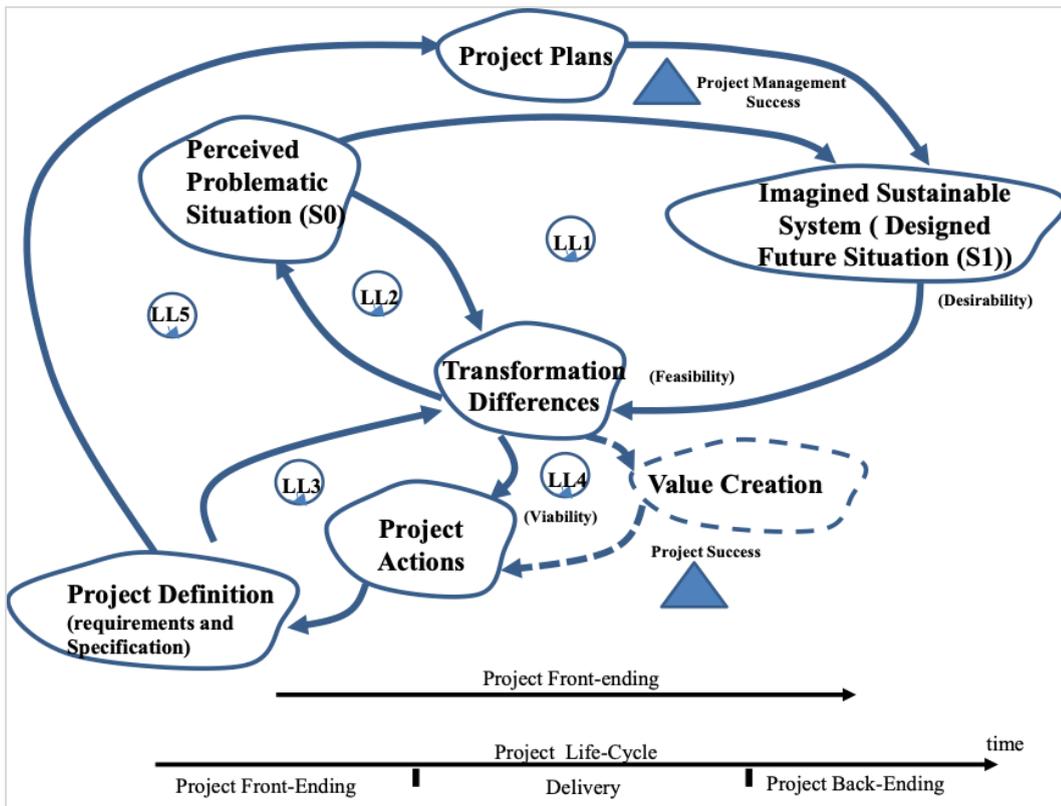


Figure 3: PDT systemic process model.

## **Action research and an intellectual device**

“What counts as facts about the social world – is continually being constructed and reconstructed in dialogue ... and in action which they take” (Checkland and Holwell, 1998a). This interpretive research perspective (Saunders et al., 2019; Burrell & Morgan, 1979) does not expect to establish unchanging social laws which sit alongside the laws of physics but requires the researcher to be involved in the problematic situation and actively explore the unfolding issues over time. To situate the continued development of the PDT systemic process model (introduced above and represented in Figure 3), this paper further develops Checkland and Holwell’s (1998a, 1998b) Intellectual Device for the structuring of action research approaches. Additionally, it incorporates connections with single and double-loop learning (Argyris, 1995).

Argyris et al. (1982) connect the interpretive research perspective to the following components of the action research approach: a participative process between researchers and relevant actors in the problematic situation, a process of critical enquiry and learning, a focus on social practice, and a considered process of reflective learning. Checkland and Holwell (1998a, 1998b) identify a deficiency in this action approach and argue for the inclusion of a declared-in-advance epistemological framework which encapsulates what constitutes knowledge about the situation researched will be defined and expressed. Moreover, a declared-in-advanced epistemological framework allows those interested in the research and its outcomes to recover the process through which the results were obtained.

An intellectual device is offered, applied by Checkland and Holwell (1998a, 1998b) (originally constructed by Checkland (1991)) (Figure 4—the italics are the proposed enhancements), as a broad approach to establishing orthodox or alternative declared-in-advance epistemological framework. The device generates an epistemological framework that defines and expresses what constitutes knowledge of the concerned social phenomenon. The original device entails three basic parts that are applied to any piece of research. These are: Framework of ideas (F), Methodology (M) and Area of Concern (A) (Checkland and Holwell, 1998a, 1998b). In its application here, we propose two more elements, labelled Reflective Learning (RL) and Knowledge Library (KL), which close the research loop and facilitate learning through critical reflection.

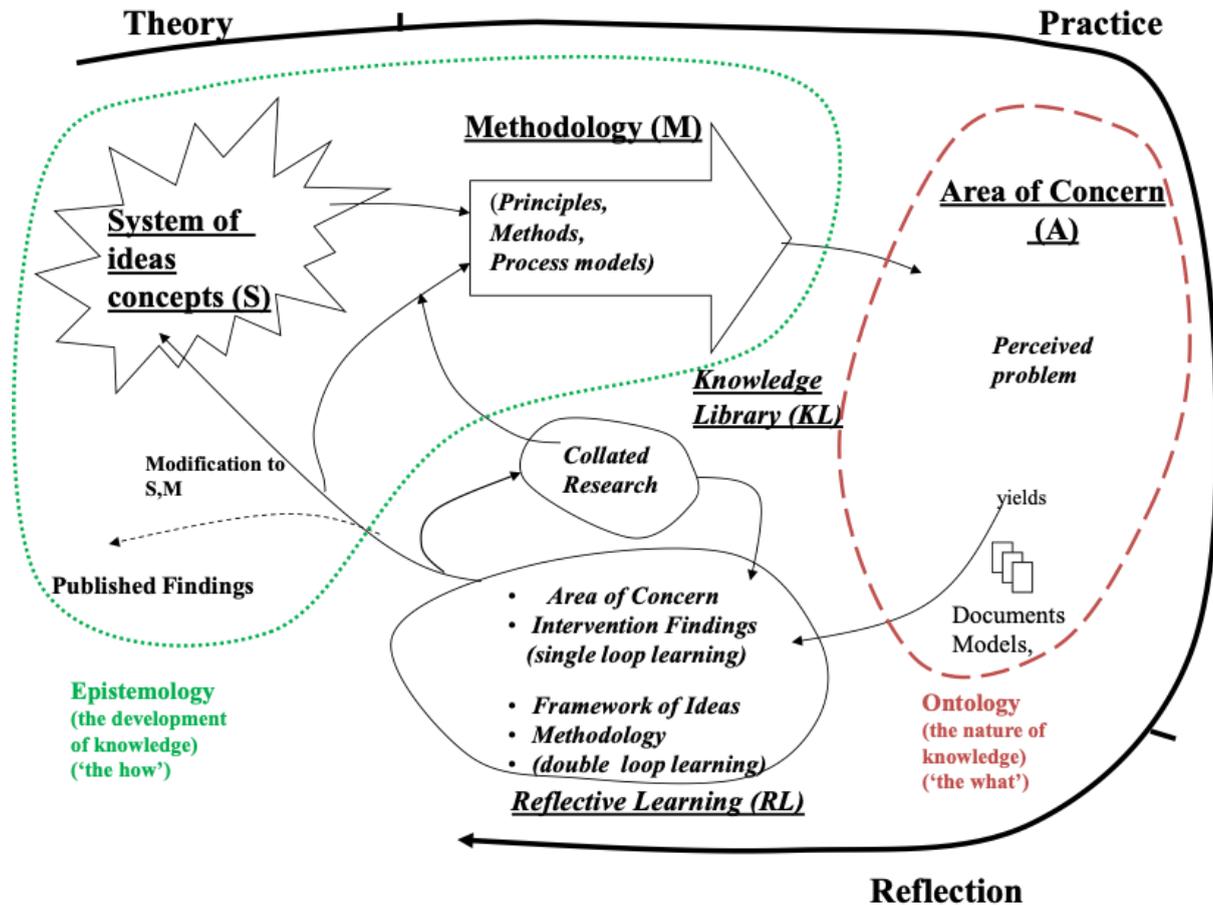


Figure 4: Key components of the intellectual device for establishing the epistemological framework (extension of the model developed by Checkland and Holwell, 1998a, 1998b).

A Framework of ideas and concepts (F) (linked with theory (Figure 4)) are used in a Methodology (M), which is applied to investigate some Area of concern (A) (or social phenomenon) (linked with practice (Figure 4)). A methodology has a set of principles associated with a group of methods used to focus on the identified purpose. Additionally, a process model is employed to structure or mould the work. Moreover, every methodology evokes distinctive roles for the modeller, e.g. facilitator or observer, and actors, e.g. active or passive, in the research process. The methodology may yield abstract models (e.g. for understanding or explaining) of the identified social phenomenon.

## PDT declared-in-advanced epistemological framework

PDT aims to design an imagined sustainable system which improves some perceived problematic situation that is experienced by various actors (A). The M is the emerging PDT methodology (shown in Figure 3), which encompasses a mouldable systemic process model, identified sub-systems, and associated methods and tools. The M and A emphasise the practice, and the purpose of the intervention is highlighted in the project mandate. Moreover, the practice of PDT attempts to address a research question, which is highlighted in the project mandate (Figure 2). F is underpinned by appreciative systems (Vickers, 1968, 1965), interactive planning (Ackoff, 1979a, 1979b), design thinking (Brown, 2019), soft systems thinking and the notion of visual and conceptual modelling from different worldviews. This leads to the development of an imagined sustainable system (captured in this process in a root definition), which is then to be realised through traditional or alternative project management practices. F is strongly linked with theory but requires more work. Figure 4 assists in the development of a declared advanced epistemological framework for the emerging PDT methodology.

## Action research and the intellectual device

Checkland (1991) developed an action research process (Figure 5) which informs the offered intellectual device.

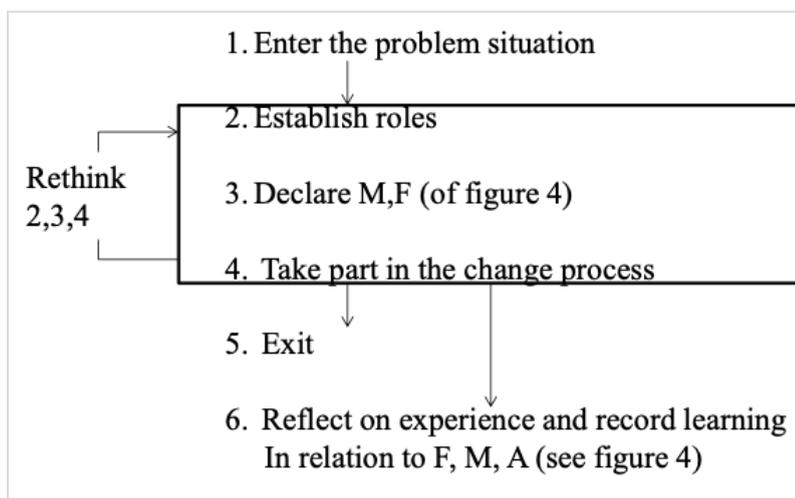


Figure 5: The process of action research (Checkland and Holwell, 1998a, 1998b).

Figure 5 informs the inception of RL and KL. The fourth part, RL, induces the selection of an appropriate research strategy (Saunders et al., 2019), e.g. action research (Checkland, 1991, Hyde and Bell, 2022), which should be philosophically compatible with the identified methodology (M). Additionally, RL encourages reflection on various aspects (links with single and double-loop learning) of the intervention. Reflection (Schon, 1983) facilitates a review of the whole experience of applying the declared-in-advanced epistemological framework. The lessons learned may initiate modifications to F, M, A and RL or, in some instances, abandoning the methodology altogether. Thus, RL is considered to be the critical aspect of investigating the identified methodology and associated framework of ideas and concepts. The fifth part of the device is labelled Knowledge Library (KL). It encourages the management and collation of the completed studies and respective outputs, e.g. models and reports, which might be used for evolving F and M, and informing future studies— and this may reduce future costs.

### **Intervention findings**

The project mandate (Figure 2) informs the moulding of the systemic process model (Figure 3) through selecting relevant learning loops, sub-systems and methods and tools (see Table 1). The learning loops and sub-systems guide the intervention process and can generate various visual and conceptual models, and project definitions and plans. This intervention emphasises exploration and desirability. The project mandate is a research question—How might we improve the sustainability experience of Sussex University campus? Therefore, this intervention uses a perceived problematic situation, an imagined sustainable system, and the difference between them, which can be linked with the soft part of the methodology. Additionally, the intervention experience engenders a further reflective question—What improvements to PDT methodology can be identified?

### **Perceived problematic situation (current situation)**

This part of the intervention stresses observation, interviews and development of a Minecraft model. The observations undertaken on the Sussex campus highlight the current and potential practices of sustainability. This encouraged observing varying buildings, landscapes, and interactions. The observations undertaken were conducted in three areas of the Sussex campus. The first observed area was the Jubilee building, both internal and external, which are summarised:

Jubilee Building (observations):

- Evidence of LED lighting and motion sensor technology (internal and external)
- Multiple Recycling stations in/around the building (including general waste, mixed recycling, mixed glass, and compostable waste)
- Large glass panels on building allowing for natural light (classrooms, café, main reception/lobby)
- Building is a self-regulated, BMS system which automatically controls/adjusts temperature and regulates airflow by opening/closing windows and vents.
- Evidence of green areas, trees, and grassland but with few flowers
- Courtyard area is largely built of concrete, brick, and rock with plenty available space for student and staff use
- No evidence of solar panel technology on/around building

After completing the observations, the next stage of data collection involved the use of interviews. These were conducted with students (Figure 6) and professors (Figure 7)—who specialise in relevant fields. The use of interviews provides greater explanations and an enhanced understanding of the participants' emotions, opinions, behaviours, and experiences. Interviews were designed to be open-ended and to inspire fluid conversation. This allowed students to assist in co-producing causal loop diagrams and their worldviews to be considered when exploring with Minecraft.

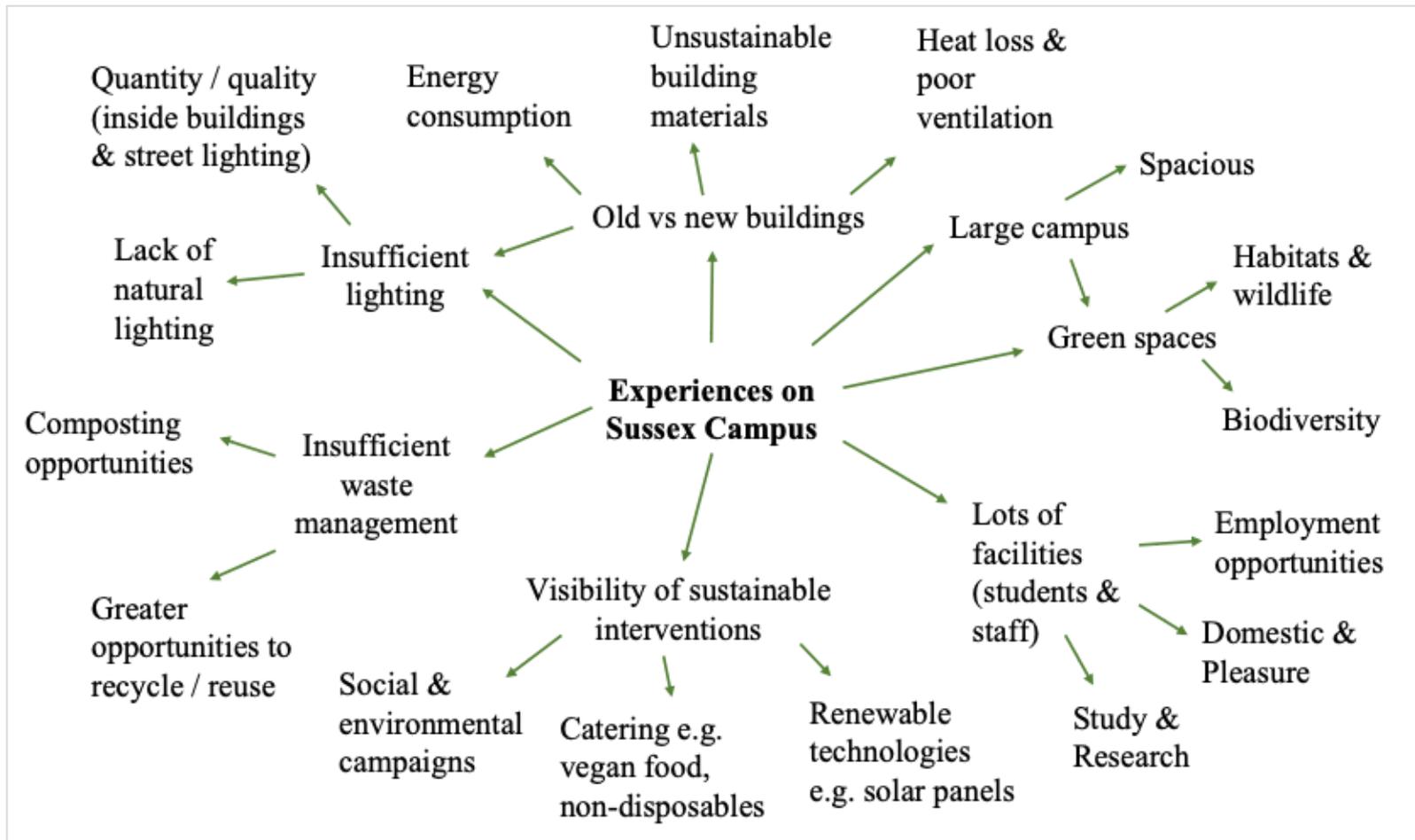


Figure 6: A mind map highlighting student experiences on Sussex Campus.



Figure 7: Mind map highlighting challenges, opportunities and recommendations for Sussex Campus in terms of sustainability (professors' perspective).



*Figure 8: Screenshots of the Jubilee Building (current situation).*

For the sustainable projects suggested, Minecraft can highlight the ideas, recommendations and potential projects that were discussed during the interviews and identified through observations and secondary research. Moreover, Minecraft can be used to demonstrate the transition from the current situation to the imagined situation. Minecraft software provides a creative, collaborative, and interactive tool that students or student groups could use to co-create realms that symbolise the various projects.

The use of Minecraft (Figure 8) presents an opportunity for visualising projects at inception and adapting them throughout the conceptualisation process. It can be used as a tool to engage students and professors in the university's progress.

### **Imagined sustainable system (designed future situation)**

This part of the intervention process explores an imagined sustainable future system, which is co-created with students and professors. Mind Maps, Minecraft and CLDs were utilised, with an emphasis upon visual thinking and conversations with key actors associated with the situation. The student mind map (Figure 9) for a sustainable campus includes wilding, whereby improved aesthetics and energy are derived from natural sources, including renewable energy in the form of solar panels, of which are

accompanied to all compatible buildings and spaces. Moreover, students recognise it must transition to 100% sustainability, with sustainable buildings and construction, university-owned and operated sustainable energy systems, and zero carbon footprint.

The professors' mind map for an imagined sustainable Sussex campus (Figure 10) includes the scope for expanding renewable energy (solar, electricity, heat), enhancing biodiversity through wilding and supporting habitats for species to thrive, student involvement and reduced consumerism, both in the consciousness of impacts and the principles of recycling. However, one of the other elements discussed refers to the invisible aspects, that is, the difference in community, leadership and governance, ethos and values, and social aspects, including equality, care, and cooperation.

The mind map informed the Minecraft model (Figure 11), which highlights the changes from the original model (Figure 9), with the application of interventions that have been taken forward from the results of the research. Noticeable changes include the Jubilee building rooftop, Jubilee lecture hall, and the surrounding green spaces. The possibility of a solar-powered water feature in the Jubilee courtyard was also added. Some of the benefits of this intervention for campus users include the natural aesthetics, support of mental health and relaxation, and the increase in campus biodiversity by attracting insects, birds, and other species. As discussed, the model also showcases the imagined installation of several rooftop solar panels on the Jubilee building. This would generate a significant proportion of energy for the Jubilee building, with any excess being a benefit for the rest of the campus.

After reviewing the data collected during interviews, observations, and development of the Minecraft model, a CLD was co-created with some students. Additionally, the PQR formula (see Table 2) and CATWOE (see Table 3) (Checkland and Poulter, 2006) were used to produce a *root definition* (a concept from Checkland) that describes the imagined future system (Table 4).

PQR Formula		
Purpose	What (P)	<ul style="list-style-type: none"> <li>• Increase the use of solar power through panel technologies;</li> <li>• Increase energy generation;</li> <li>• Increase energy capture.</li> </ul>
Transformation Process	How (Q)	<ul style="list-style-type: none"> <li>• Several solar panels on the Jubilee rooftop;</li> <li>• Energy capture and transfer;</li> <li>• Divert sustainable energy into Jubilee (and elsewhere on campus)</li> <li>• Set up maintenance team.</li> </ul>
Output	Why (R)	<ul style="list-style-type: none"> <li>• Meet university goals to becoming a green campus;</li> <li>• Meet goals in sustainability strategy;</li> <li>• Increase energy efficiency on campus;</li> <li>• Increase sustainability, energy security, self-sufficient;</li> </ul>

Table 2: PQR formula describing imagined sustainable system (designed future situation).

C	(Customer) Sussex Students, Staff, and Faculty (additional benefit to other visitors)
A	(Actors) Sussex University, Sussex faculty, Contractors
T	(Transformation Process) Generating renewable energy through solar panels
W	(Worldview) Sustainability, security, stewardship, staff and students
O	(Owner) Sussex University
E	(Environment) Climate Change, University Strategy, Energy Cost, Social Values, Society Needs

Table 3: Root Definition of imagined sustainable system (designed future situation).

University of Sussex-owned and implemented solar panel technology to enhance sustainability and increase energy efficiency on campus.

Table 4: Root Definition for imagined sustainable system.

This assisted in the development of the CLD (Figure 12), which highlights the potential for several sustainable projects on campus, as demonstrated in the observations and as discussed during the interviews. This provided an enhanced understanding and replicability of student worldviews, thus increasing the element of realism and the applicability of the model.

By using these models and tables, we can structure discussions that question the reality of the situation, as well as the systemic desirability and cultural feasibility of the suggested or implemented actions for improvement—supported by real worldviews and experiences of the problematic situation.

## Differences

This part of the intervention process explores transformation differences, which can lead to the identification of potential projects. Table 5 highlights the significant aspects associated with the current situation that seek improvement and the associated changes with the imagined situation. Moreover, it identifies the evident differences between the two situations and the potential impact of investing in a solution for the problematic situation.

<b>Transformation Difference Table</b>		
Current Situation (S0)	Imagined Future Situation (S1)	Differences (S1-S0)
Unsustainable energy use	sustainable energy use	Transition to sustainable energy; renewable energy sources
Low energy security	High energy security	Campus can capture, generate, and store its own energy; reduce reliance on national energy systems
Unstable campus	Increase campus sustainability	Campus incorporates changes; greater effort to support SDGs and university sustainability strategy

<b>Transformation Difference Table</b>		
Low visibility of sustainable projects and interventions	Demonstration of sustainable intervention and commitment to sustainable projects	Greater demonstration of commitment to sustainability; greater awareness and understanding of interventions
Low student and staff satisfaction	High student and staff satisfaction	Greater student/staff experience on campus; sustainability aesthetics; increase enrolment
Limited student/ staff awareness	Increased student/ staff awareness	Improved attitudes and behaviour towards sustainable technologies; increase marketing (e.g. word of mouth).

*Table 5: Transformation difference table (informed by SSM, Checkland and Poutler, 2006)*

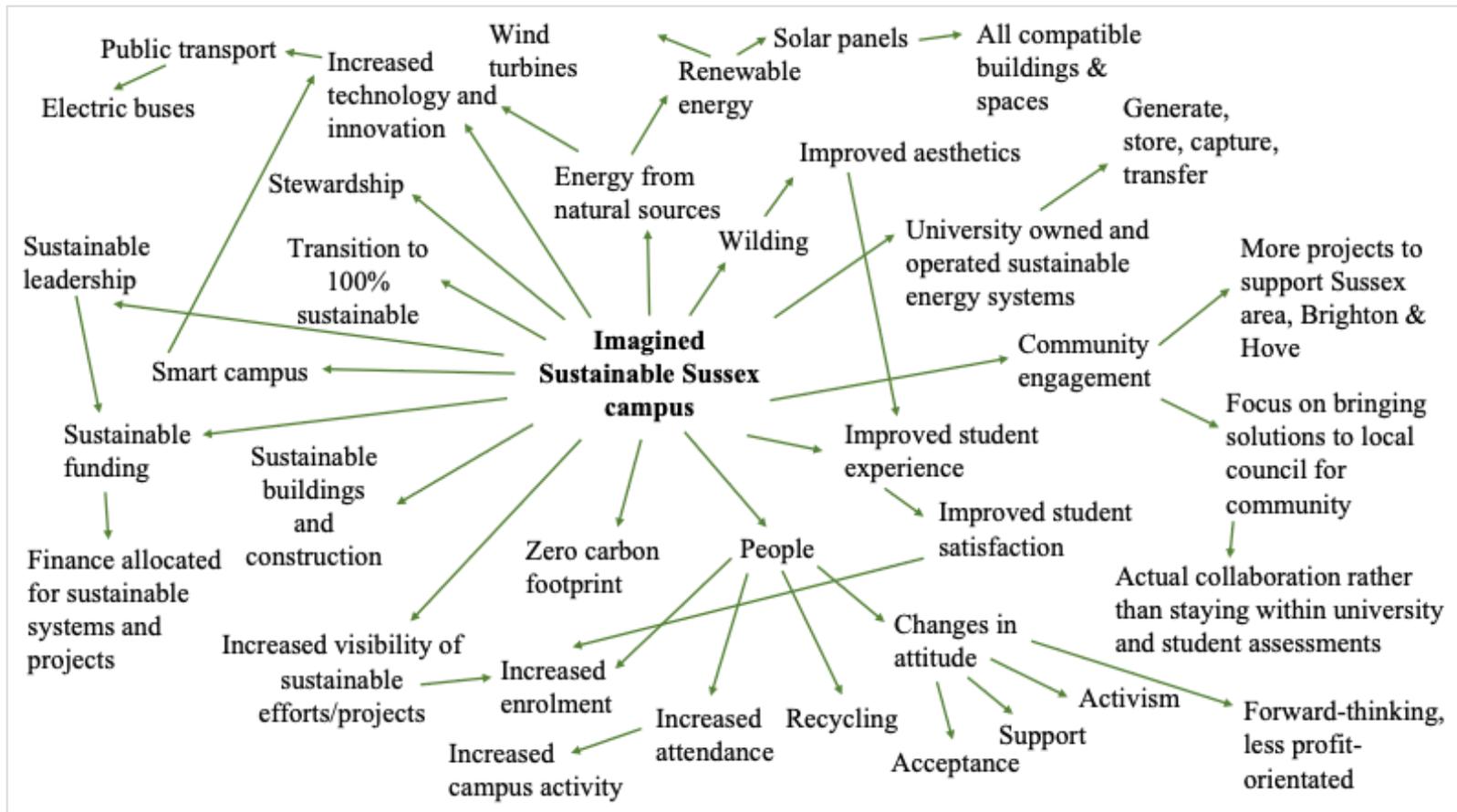


Figure 9: A mind map of imagined sustainable Sussex Campus (student perspective).

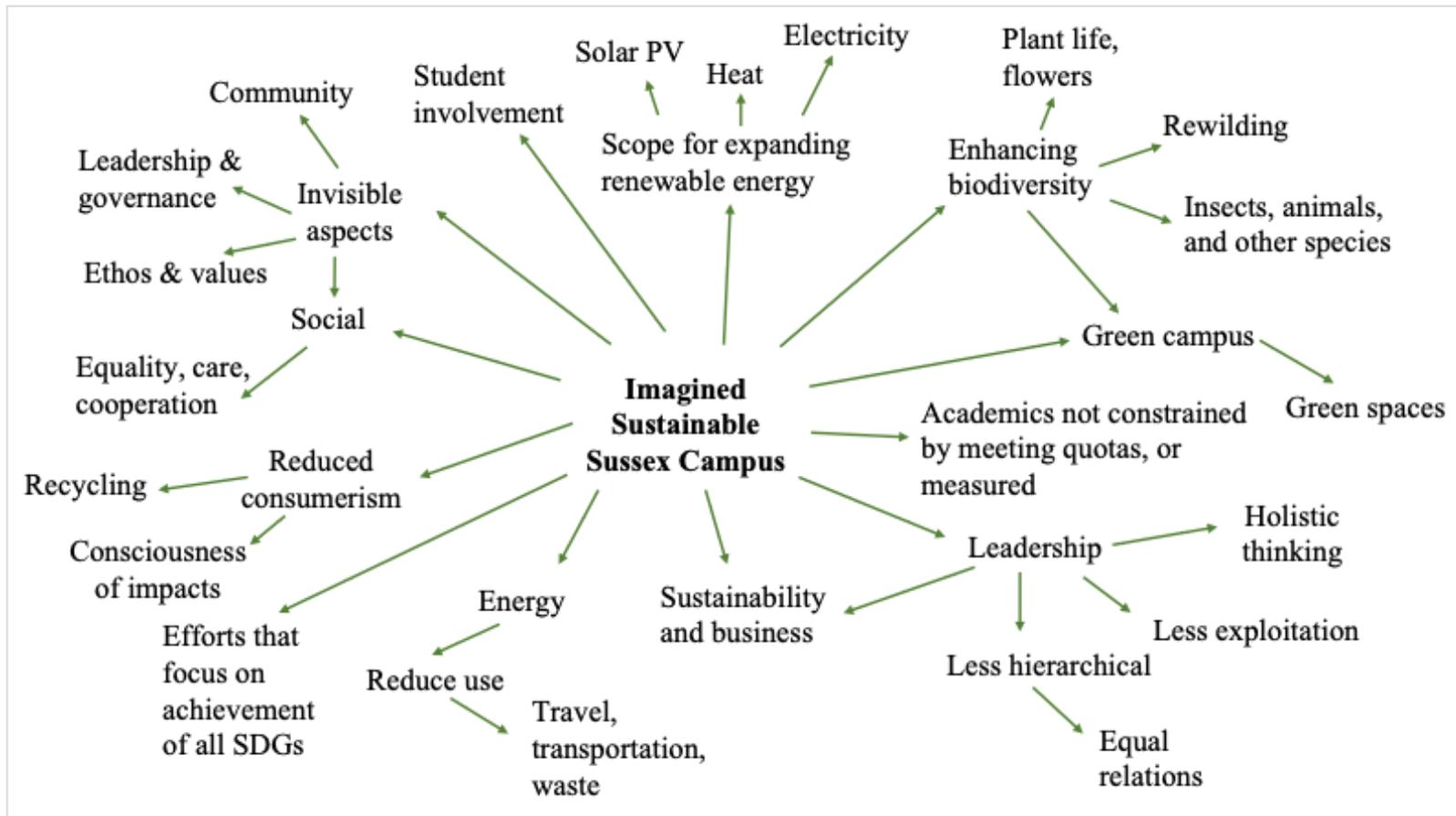
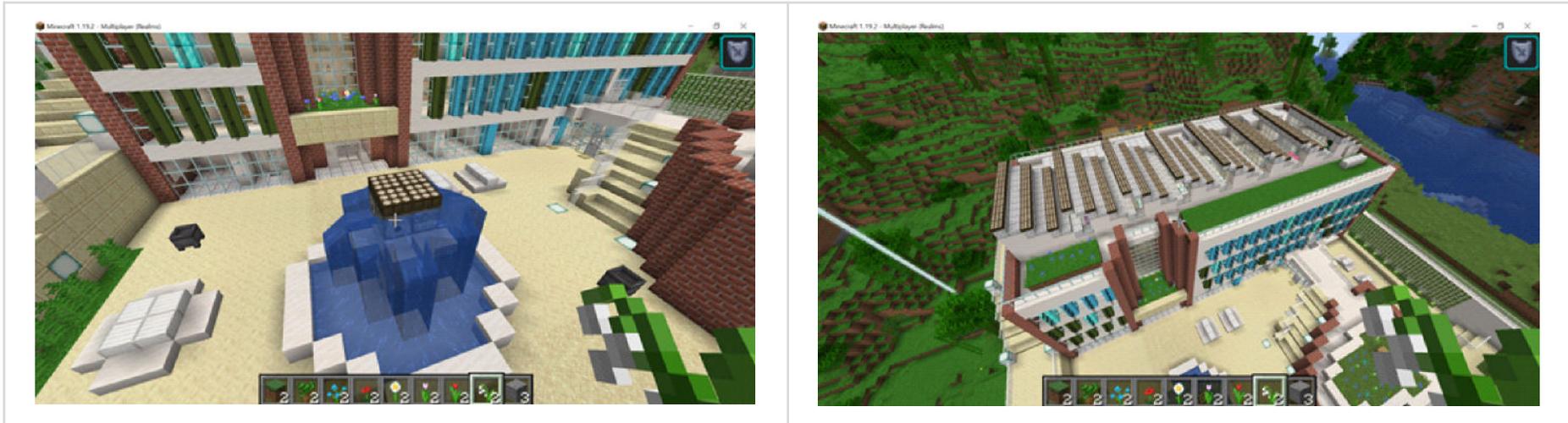


Figure 10: A mind map of imagined sustainable Sussex Campus (professor perspective).



*Figure 11: Jubilee building (future situation) with solar panels and solar-powered water feature.*



## Reflective discussions

A reflective causal loop was created to demonstrate the factors in the use of the gaming platform, Minecraft, for the purpose of this work and, indeed, future research (Figure 13). This model was co-created with students and highlights the benefits of using Minecraft for a variety of purposes. This includes the ability to demonstrate the potential of projects, the provision of a landscape for creativity, and the interactive nature of the software, which allows students and professors alike to collaborate on potential projects at the same time. The use of Minecraft is also beneficial in terms of PDT, that is, assisting in the front-end of project management and conceptualisation. Minecraft also enables refinements and the notion of continuous improvement as realms can be adapted by the user(s). This improves the way in which projects are initiated, which in turn potentially increases the success rate of projects.

It is believed that the use of the soft part of PDT encourages active learning and shaping actor mental models. Through probing, some of the intervention findings were unexpected (e.g. street lighting and democracy), which has connectivity with unknown unknowns (Snowden & Boone, 2007) and complexity. Moreover, this leads to the view that facilitation is a critical professional skill for project front-ending practice.

Finally, the epistemological framework (see for PDT) is used to reflect upon the methodology (M) (i.e. mouldable systemic process model, subsystems and methods) and the area of concern (A), which focuses on intervention practice. Rigorous reflections of F,M,A are central to action research and linked with double-loop learning (Argyris et al. 1982). This paper highlights the role of *researcher in front-end practice*.

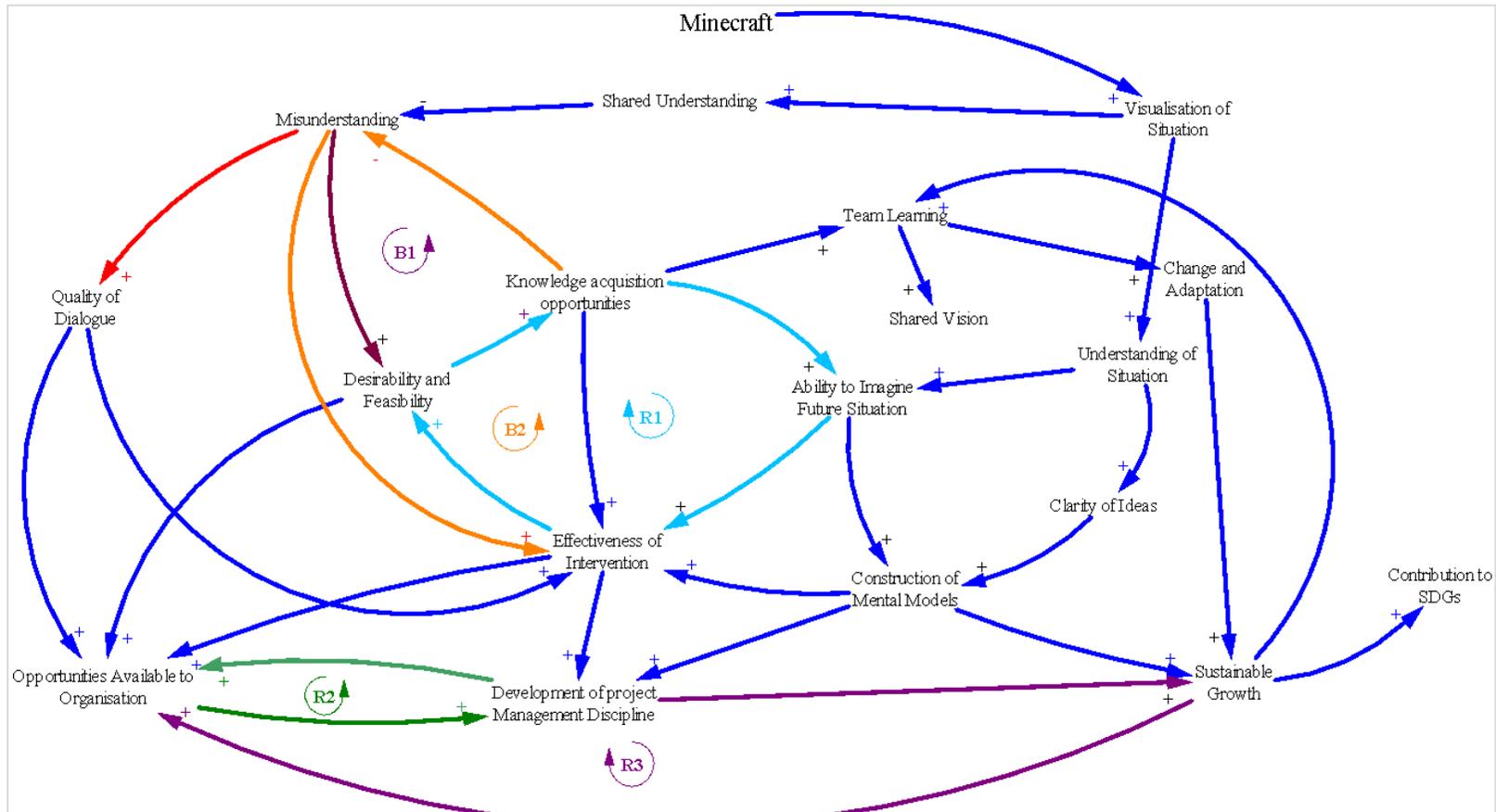


Figure 13: CLD explanation of Minecraft learning potential.

## Conclusions

The PDT developed and applied here provides the basis for connecting systems understanding and design thinking into an understanding of project front-ending. PDT is a pluralistic, human-centred approach which aims to improve a perceived problematic situation through designing an imagined sustainable system. The PDT process model is combined with action research approaches by extending Checkland and Holwell's (1998a, 1998b) work. This provides an approach to, systematically and reflectively, address processes of front-ending in projects.

The application of the PDT approach to the problem of sustainability in university buildings has illustrated the frameworks developed and presented an example using Mind Maps, Minecraft and CLDs. This application emphasises visual thinking and features the co-development of an Imagined Sustainable Future situation with important actors.

This first illustration of the PDT approach would benefit from extension and application across projects and settings. For the further development of both the PDT process model and its position within an action research approach, a programme of connected project case studies is suggested to structure further learning and illustration of the reflective learning and knowledge library elements.

The development and application of the PDT approach further emphasises the extending of professional roles for those working with projects. This approach highlights the skills of facilitation for learning for untangling complexities that could be a beneficial addition to the skillsets of project professionals.

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