



Developing shared understanding through online interdisciplinary collaboration: Reflections from a research project on better integration of health outcomes in future urban development practice

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ABSTRACT

Collaborative working has gained widespread recognition in policy and practice. However, there is less research on the process of doing collaborative research in practice than there is on the epistemological, theoretical, and methodological aspects of such work. In this paper, we address this gap by offering reflections on our practical experience of online interdisciplinary collaboration as part of a wider research project on future urban development practice. We sought to develop a shared understanding of the systems of urban development decision-making. We utilise two established frameworks of interdisciplinarity to reflect on our experience and offer practical recommendations that can help facilitate such work carried out remotely by early career researchers from diverse academic backgrounds. In so doing, our paper offers fresh insights on some of the common issues in interdisciplinary collaboration and on developing shared understanding and intellectual coherence through productive online interactions. As research is evolving to tackle complex problems that require a holistic understanding, our paper contributes to developing replicable methods for remotely conducted interdisciplinary work in the early phases of large-scale collaborative projects.

1. Introduction

Collaborative working between different fields has become a common feature of academic and practitioner research in current times (Bridle et al., 2013). Interdisciplinarity, multidisciplinary, and transdisciplinarity (terms that are frequently used to define collaborative work) occupy a key position within contemporary research frameworks, not least because such collaborations can

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provide a better understanding of complex real-world problems (Holmes et al., 2018). This growing interest in collaborative work has been fuelled by awareness among researchers and practitioners of the complexity of real-world problems that cannot be tackled from a purely disciplinary approach and that requires integration of knowledge drawn from different fields. The need for such collaborative work has further intensified due to a high demand for it among research funders, lay citizens and policymakers, who expect research to provide comprehensive answers to today's urgent problems and grand challenges of the next decades in areas such as the environment, urban planning, education, health, and renewable energy (Darbellay et al., 2014; Le Gouais et al., 2023). It is argued in the recent past that researchers working on collaborative projects need to balance 'collaboration' with 'autonomy' to extract the full benefit of such work. However, this balance between autonomy and collaboration is not static. It needs to change appropriate to task. Some team tasks require high levels of autonomy (e.g., sampling, developing inductive codes, researcher publication needs), while at different times, collaboration needs to be prioritised (e.g., setting research questions, developing deductive codes, agreeing standard procedures) (Bates et al., 2023).

We understand *interdisciplinary* research as a process that involves working on different issues within a common framework that is shared by the disciplines involved (Ramadier, 2004). We agree with Gibbons (1994) that interdisciplinary research is characterised by the development of a shared problem formulation and a common methodological framework for the investigation of different aspects of the research problem. In our view, research becomes interdisciplinary whenever the research activity involves several fields. Since there are no clear boundaries between fields, the notion of interdisciplinary therefore 'does not refer to an objective, unambiguous property of research' (Huutoniemi et al., 2010, p.82). What one perceives as a research field may constitute only part of a larger academic discipline for somebody else (Boden, 1999). We acknowledge (and submit to) this subjectivity and vagueness around interdisciplinary research. *Multidisciplinarity* is characterised by the unintegrated application of more than one disciplinary approach whereas interdisciplinary research is based on active interaction across fields (Wickson et al., 2006). In contrast to multidisciplinarity and interdisciplinarity, *transdisciplinary* research aims to enable the reciprocal connection between knowledge and action by acting as an 'arena' within which multiple stakeholders can interact with one another in the process of collaborative knowledge production (Pohl, 2008). Transdisciplinary research empowers societal transitions and requires scientists and academic researchers to collaborate with practitioners to tackle complex real-world problems with rigorous methods (Marshall et al., 2018).

A lot has been written on the nature and characteristics of collaborative research work (Lawrence, 2015; Augsburg, 2014; Wickson et al., 2006). A plethora of analytical frameworks and tools have also been proposed to evaluate the quality of such work (see Belcher et al., 2016; Wickson et al., 2006; Huutoniemi et al., 2010). Some scholars have tried to minimise the conceptual vagueness around transdisciplinarity, interdisciplinarity and multidisciplinarity (Roux et al., 2017; Holmes et al., 2018; Moirano et al., 2020) by proposing principles that can be used to distinguish these terms from each other. While enough work has been done on the epistemological, theoretical, and methodological issues around interdisciplinarity, multidisciplinarity and transdisciplinarity, limited work is available on the process of doing such collaborative work remotely from the perspective of early career researchers (ECRs). In this paper, we address this gap by offering reflections on our practical experience of doing online interdisciplinary collaboration in order to develop a shared understanding of the systems of urban development decision-making as part of a wider research project on better integration of health outcomes in future urban development practices.

By combining our reflections with two established frameworks of interdisciplinarity, we offer practical suggestions that can help facilitate interdisciplinary work carried out remotely by ECRs from diverse academic backgrounds. In so doing, our paper complements the extant literature by offering fresh insights on some of the common issues in interdisciplinary collaboration and on developing shared understanding and intellectual coherence (similar to 'collective intelligence' proposed by Woolley et al., 2010) through productive online discussions, with a view to contribute to the theoretical and empirical foundations of past and future interdisciplinary research practices. Intellectual coherence develops when shared knowledge and understanding is produced through team collaboration that would not otherwise be produced if the individuals had not worked collectively on a topic. Our reflective discussion contributes to Futures as a study field by explaining the process of developing holistic and shared understanding of a complex issue from different disciplinary perspectives (Kuosa, 2011), which is increasingly identified as important (Holmes et al., 2018). We explain in detail how we consulted and incorporated insights from various disciplines to gain a holistic and shared understanding of the complex system of urban development practice. Our study explicitly contributes to a 'probable' future (Voros, 2003) as we conducted it remotely, which arguably will be the new normal of working in the post Covid-19 time. Our paper also contributes to a 'preferable' future (Voros, 2003) in the sense that the wider project TRUUD ('Tackling the Root causes Upstream of Unhealthy Urban Development')—which our collaborative work contributed to—will help creating a future we think 'should' or 'ought to' happen (van Dorsser et al., 2018, p.80), i.e., a better urban development system which is more capable of addressing public health issues.

In the next section, we provide a brief overview of the TRUUD project for which we experimented this interdisciplinary collaborative work. In the third section, we explain the nature and scope of our online interdisciplinary work using the three dimensions of interdisciplinary research proposed by Huutoniemi et al. (2010). Thereafter, we explain the overall process of our work by drawing on Repko et al. (2006) conceptualisation of interdisciplinary research processes. We subsequently relate our key reflections to the extant literature and provide recommendations for other ECRs interested in online collaborative work. We conclude by discussing the implications of our work and by acknowledging the limitations.

2. The project: TRUUD¹

TRUUD is a large research project that aims to map and understand the systems of urban development decision-making and co-produce and test interventions that will incorporate prevention of risk factors causing non-communicable diseases (NCDs) into the system. These ‘systems’ refer to the systems of decision-making regarding the ‘transformation of the physical form, bundle of rights, and material and symbolic value of land and buildings from one state to another, through the efforts of agents with interests and purposes’ (Healey, 1992, p.36). The research focuses on the urban development systems within the UK’s major urban areas—using Bristol and Greater Manchester as focal case studies. TRUUD is a five-year research project that started in October 2019. It involves researchers across five UK universities, two city and city region partners, and it engages with practitioner advisors and local communities. The academic disciplines include public health, urban planning and development, policy studies, corporate governance and organisation studies, law, environmental and health economics, systems engineering, and public engagement. (Table 1).

3. The nature and scope of interdisciplinary collaboration

In this section, we explain the overall nature and scope of our interdisciplinary collaborative work by drawing on the widely acknowledged ‘three dimensions of interdisciplinary research’ proposed by Huutoniemi et al. (2010): (1) the scope of interdisciplinarity, i.e., what is integrated; (2) the type of interdisciplinary interaction, i.e., how it is done; and (3) the type of goal, i.e., why interdisciplinarity takes place. We draw on these three dimensions as they offer one of the most robust conceptualisations of interdisciplinary research to date (see Holmes et al., 2018; Darbellay et al., 2014; Belcher et al., 2016).

3.1. Scope

The first step of our interdisciplinary collaborative work was to identify and agree on the most relevant concepts for understanding the systems of urban development decision-making—one of the key objectives of TRUUD. This process started with a discussion with TRUUD’s senior members who have considerable experience in leading large collaborative projects in similar areas. That initial discussion enabled us to roughly determine the boundary of urban development decision-making in England and produce a draft plan on developing a workable knowledge of the systems of urban development decision-making. We then conducted a series of scoping reviews (Xiao & Watson, 2019) to understand how public health and associated factors have been featured and conceptualised in fields related to urban development. The reviews were carried out by four of the current authors and six senior members of TRUUD project. The ‘review’ authors spent six weeks to conduct twelve reviews from their own disciplinary perspective on topics including: systems thinking, decision-making practices, representations of health in decision-making, power and influence, community assets, and the planning system.

Topics were selected based on previous experience and expertise of the authors. We agreed reviews would be no longer than 3000 words as our aim was to extract as much relevant information from each piece of literature as possible—including key methods, insights, theories, etc.—to provide a concise yet sufficient overview of what has been done (Xiao & Watson, 2019, p. 99). We strictly followed a template (Appendix 2) to ensure consistency as the reviews were later consulted by the wider TRUUD team to identify the most recurring concepts. We allowed autonomy to each ‘review’ author in terms of what search criteria, methods, and platforms they used, but we agreed that the authors would all provide sufficient information on each section of the template (Appendix 2).

The discussion with TRUUD’s senior members and scoping reviews, along with findings from the TRUUD pilot project (Black et al., 2019, 2022; Ige et al., 2019), were used to finalise the concepts that we decided to review across the scoping reviews to help us develop a shared, interdisciplinary understanding of urban development decision-making systems. Altogether, we identified ten relevant concepts: institutions; governance; networks; power; decision-making; type/use of evidence; risk management; systems thinking; value/valuation; and change management. We proceeded to review those concepts from six academic fields that we identified as most relevant for understanding urban development decision-making and that broadly represent our expertise and/or interests, namely: public administration and policy; transport planning; urban development; law, management; and commercial determinants of health.

Through the (collaborative) concept review, we managed to create a deeper and robust conceptualisation of those ten concepts from an interdisciplinary perspective, which helped the wider TRUUD team in developing a shared language and an explicit intellectual foundation for the data collection phase of the project.² Table 2 provides a summary of the methods we used in the concept review. The overall scope of our work falls in the category of ‘narrow’ interdisciplinarity (Klein, 2005) as our research fields are conceptually close to each other and represent the same broad domain of social sciences. We are labelling the scope of our work as narrow interdisciplinarity because the interactions between our six fields are less problematic in epistemological terms since the concepts, theories and/or methods are ‘relatively similar in their epistemological presuppositions’ (Huutoniemi et al., 2010, p.82). However, as reported later in the paper, we did come across epistemological difficulties throughout in terms of understanding and communicating these concepts from our respective academic fields.

¹ More information on the project is available at: <https://truud.ac.uk/>

² See the supplementary files 1–7 for an illustration of our collaboration on Miro—an online whiteboard and visual collaboration platform.

Table 1
Characteristics of the project.

TRUUD project	
Duration	5 years (2019–2024); a pilot project ('UPSTREAM') has been carried out to refine the scope and focus of the main project
Scale	England (UK)
Funding mechanism	The TRUUD Consortium has been funded by the UK Prevention Research Partnership (UKPRP), which is made up of the British Heart Foundation, Cancer Research UK, Chief Scientist Office of the Scottish Government Health and Social Care Directorates, Engineering and Physical Sciences Research Council, Economic and Social Research Council, Health and Social Care Research and Development Division (Welsh Government), Medical Research Council, National Institute for Health Research, Natural Environment Research Council, Public Health Agency (Northern Ireland), The Health Foundation and the Wellcome Trust
Main actors involved	Academic researchers (including Researchers-in-Residence) Professional partners Community members
Forums for transdisciplinary engagement/co-production platforms	Annual Workshops (4 times a year) Industry-facing workshops (3 in total) Parliamentary event targeted at key actors within government (1 in total) Masterclasses, seminars, presentations, and webinars (as and when needed)
Desired outcome	Changes to policy and practice, improved public health outcomes through population-level interventions that are large-scale, generalisable and implementable

Table 2
Developing a shared understanding of the relevant concepts for TRUUD — A summary of the methods used.

Topic	Description
A. Objective of the concept reviews	Explore ten key concepts identified in the in-depth scoping reviews and TRUUD pilot project to create a deeper and more robust conceptualisation of these concepts from an interdisciplinary perspective. We have sought to develop a shared understanding and an explicit intellectual foundation for the project's interview stage. A guiding principle for us has been decision-making for healthy urban development.
B. Key questions answered in concept reviews	1. Definition: How is this concept defined within each individual discipline? 2. Contribution: What are the key conceptual insights in relation to our goals within TRUUD? 3. Theories: What are the theories that underpinned/guided the studies on this concept? 4. Implications: What are the implications for TRUUD interviews and interventions in the literature?
C. Key concepts reviewed and concept coordinators	1. Institutions (Author 6); 2. Governance (Author 2); 3. Networks (Author 5); 4. Power (Author 1); 5. Decision-making (Author 1); 6. Type/use of evidence (Author 3); 7. Risk management (Author 4); 8. Systems thinking (Author 6); 9. Value/valuation (Author 4); 10. Change management (Author 5)
D. Process for concept review	1. Each concept coordinator created a collated document for their concept. Initially they added all relevant information on the concept from each of the scoping (literature) reviews into a template. 2. We defined our six disciplinary viewpoints: public administration and policy, transport planning, urban development, law, management, and commercial determinants of health. 3. We examined two concepts per week for five weeks. At the start of each week, the relevant concept coordinator shared a document and identified key points from their analysis of the scoping reviews to help indicate the important elements for the team to consider. 4. Each member of the concept review team commented on the collated document. Where they felt that there were gaps relating to their disciplinary viewpoint, they provided additional literature review. 5. We met each week to discuss the concepts selected. We discussed the connections across the reviews, broader points of communal learning, and developed our research framework. 6. Finally, the concept coordinator provided a bullet point summary of the concept based on the template and subsequent discussion. They proposed several key questions for a discussion session with wider TRUUD team.
(continued)	
Topic	Description
E. Mapping the concept reviews	Using a visual collaboration platform Miro ³ , we developed together a conceptual map to pull together the findings across these concept reviews. The aim was to visualise the important factors of each concept and their connections to the other concepts. The maps were used in our regular discussion sessions as we sought to find gaps, unpack conceptual links, and identify research topics for forthcoming work. The completed mapping work was introduced in our discussion session with the wider TRUUD team.
F. Questions for team discussion session	During a discussion session with the wider TRUUD team, we introduced the summaries of the concepts and moved to discussing the concepts and their implications for TRUUD. We proposed the two questions below to start the discussion. Q1. How do the ten concepts relate to TRUUD? Q2. How do the ten concepts help in addressing the Work Package 1 ^a research questions: <ul style="list-style-type: none"> • 'What are the main components of the UK's urban planning and development system, how does it function, and how might health impacts be better integrated within it'? • 'What impact does new evidence on health outcomes have on the attitudes and behaviours of those with most control over the urban development process'?

^a Each work package consists of TRUUD researchers responsible for specific aspects of the project.

3.2. Type of interaction

Our interdisciplinary collaborative work was non-empirical in nature in the sense that we did not collect any primary data. Methodologically, we employed the same strategy to undertake desk research on each of the ten concepts from the six previously identified academic fields. We tried to answer the following key questions while reviewing the concepts:

Definition: How is this concept defined within each individual discipline?

- Contribution: What are the key conceptual insights in relation to our goals within TRUUD?
- Theories: What are the theories that underpinned/guided the studies on this concept?
- Implications: What are the implications for TRUUD interviews and interventions in the literature?

We then synthesised key insights on the ten concepts from each of the six academic fields to co-produce a shared understanding of urban development decision-making systems. Our ‘narrow’ interdisciplinary work thus roughly falls in the category of what [Huutoniemi et al. \(2010\)](#) call ‘theoretical or conceptual interdisciplinarity’. We synthesised (often contrasting) concepts, models, and theories from our respective research fields to develop a shared understanding of urban development decision-making systems. Most of us who participated in this interdisciplinary collaborative work were at the post-doctoral stage of our career. Being at a similar stage of career helped us in collaborating and engaging with each other more openly, which was needed to better facilitate the interdisciplinary activities we did. We considered the opportunity to work collaboratively in an early stage of TRUUD as a useful way for us to build confidence in both our own research and in developing working relationships across disciplinary boundaries ([Bridle et al., 2013](#)).

Due to the restrictions on travel and social distancing in the UK during periods of the Covid-19 pandemic, we conducted our collaborative work using online platforms. This enabled us to regularly meet, as we were all based in different parts of the country. We reviewed and commented on each other’s documents prior to our weekly meetings to discuss our findings and share our thoughts on the topics we reviewed. We used Miro—an online whiteboard and visual collaboration platform—to record our thoughts on each concept. The use of Miro boards ensured that the key areas of our discussions were visually illustrated and the interactions between our fields were graphically presented for easier understanding for the wider TRUUD team.

Table 3

The process of online interdisciplinary collaboration—based on the authors’ reflections; adapted from [Huutoniemi et al. \(2010\)](#) and [Repko et al. \(2006\)](#).

First step: Establish the nature and scope of interdisciplinary collaboration	Second step: Draw on disciplinary insights	Third step: Integrate insights from different disciplines to develop a shared understanding
Determine the scope of interdisciplinary work Key questions to answer: <ul style="list-style-type: none"> • What is being integrated and why? • What are the key areas or topics to investigate/study/review for the project? 	Identify the areas of interest/expertise in the team Key question to answer: <ul style="list-style-type: none"> • What academic fields or areas are being represented by members of the interdisciplinary team? 	Produce a single document that contains the key insights on each relevant topic/area from different fields/disciplines Key question to answer: <ul style="list-style-type: none"> • What should be the length of the document?
Determine the type of interdisciplinary interaction Key questions to answer: <ul style="list-style-type: none"> • Is the interdisciplinary collaborative work empirical or non-empirical? • What type of interaction is needed/possible (online, face-face)? • In which setting should the interaction take place (formal/informal meeting, seminar, conference)? • What tools/software/resources are needed? 	Allocation of responsibility Key questions to answer: <ul style="list-style-type: none"> • Who is doing what and why? • How often should the team meet and why (this should depend on the length of the project and on availability of time)? 	Develop a common/shared understanding of each relevant topic/area through productive and interactive discussions between the team members Key questions to answer: <ul style="list-style-type: none"> • What platform should be used to facilitate the discussion? • How to visualise and discuss the different insights on each relevant topic/area to understand the relationships between them? • How should feedback/contradictions be incorporated? • How to use that shared/common understanding of the key topics/areas to facilitate the subsequent phases of the project?
Establish/justify the reason for carrying out interdisciplinary work Key questions to answer: <ul style="list-style-type: none"> • Why is an interdisciplinary collaborative work needed? What purpose will it serve? • What benefits will it offer for the project? 	Create a standard template for everyone to write their own disciplinary insights on the key topics/areas of the project Key question to answer: <ul style="list-style-type: none"> • What is the breadth of the contribution needed from everyone? 	

3.3. Type of goal

Urban development decision-making is a complex and multi-dimensional topic that cuts across several academic disciplines (Chen et al., 2020). It involves understanding the planning system, the issues of power and influence in delivering urban development projects, the institutional intricacies, change management, and governance to name but a few (Healey and Barrett, 1990; Harding, 1994; Rydin, 2012). Addressing these cross-cutting topics from an interdisciplinary perspective was therefore pivotal to gain a shared conceptual foundation for a large-scale project like TRUUD. Our online interdisciplinary collaboration and ‘foundational’ work in the beginning of the project helped the wider TRUUD team to develop an intellectual coherence on the complex and multi-dimensional topic of urban development decision-making, which aided successful implementation of the subsequent phases (i.e., data collection, analysis, intervention design and testing) of the project (see e.g., Bates et al., 2023; Le Gouais et al., 2023).

In our interdisciplinary work, we had to integrate (rather than simply collaborate on) various disciplinary perspectives to develop a shared understanding of complex urban development decision-making systems. We had to work closely with each other (i.e., collaborating) in bringing in different disciplinary insights on the ten concepts we reviewed, but that ‘collaboration’ was not enough to blend everything together to develop a shared understanding. To do the latter, we had to organise ourselves into a single framework (i.e., integration) with a common goal (see Table 2). We share Pohl et al.’s (2021) view that integration requires collaboration as an open-ended learning process that consists of relations established throughout the collaboration process between (interdisciplinary) research participants and their respective ‘thought-styles and thought-collectives and more specifically pieces of knowledge, ideas, or practices from different thought-collectives as well as views of individual researchers and practitioners’ (p. 23). Our interdisciplinary work was critical in developing cognitive synergies among us through a range of expertise-sharing interactive activities (discussed in the next section).

Ultimately, our interdisciplinary interactions faced many challenges most of which—especially the non-cognitive ones such as social-organisational, social-interactional, and communicative factors of integration (Pohl et al., 2021; Jahn et al., 2012)—we overcame without any significant obstacles. We attributed this to being roughly at the same stage of our academic career, coming from social science (broadly defined) backgrounds and having a degree of openness and interest in interdisciplinary working. A substantial challenge we encountered was having insufficient time to develop our collaboration and shared understandings (Bates et al., 2023). This reflected the demands on researcher time necessary to work in interdisciplinary ways and develop collaboration, and the additional pressures we experienced in our team through remote working styles due to our geographically dispersed team and Covid-19.

4. The process of interdisciplinary collaboration

In the previous section, we explained the first step of our interdisciplinary collaborative work: establish the nature and scope of interdisciplinary collaboration (Table 3). In this section, we explain the second and third steps of our work. Following Repko et al. (2006), p.123, we divide these steps into two macro-phases: drawing on disciplinary insights and integrating insights to develop a shared understanding (Table 3). We also explain how we overcame some of the common challenges associated with interdisciplinary collaborative work in each one of these stages. We utilise Repko et al. (2006) framework as it provides an explicit formulation of the different stages of interdisciplinary research process and a detailed description of its properties (Darbellay et al., 2014). We outline the overall process of online interdisciplinary collaboration in Table 3 based on our reflective discussion in Sections 3 and 4.

4.1. Drawing on disciplinary insights

Our interdisciplinary work involved six researchers with the following areas of interest and/or expertise: public administration and policy; transport planning; urban development; law; management; and commercial determinants of health. Our priority was to bring together the ten key concepts identified in the previous stage of our research project, to create a robust conceptualisation of those concepts from a cross-disciplinary perspective. To achieve this, each one of us completed a review of each of the ten concepts, before discussing them together. This helped the wider project members to develop a shared understanding of the overlapping concepts and constituted an explicit intellectual foundation for the next stages of the research. It also helped the wider TRUUD team to identify research questions (see Appendix 1) that supported the development of interview schedules. We were fortunate that our collaborative ‘foundational’ work was very positively received and utilised by the wider project members. We describe the exercise step by step in Table 2. For ease of reference, we divide these steps into three tasks: allocation of responsibility, weekly discussions, and concept summaries.

4.1.1. Allocation of responsibility

Each researcher was responsible for one or two of the ten concepts: institutions, governance, networks, power, decision-making, type/use of evidence, risk management, systems thinking, value/valuation, and change management. The allocation was random to avoid any possible bias, i.e., the expertise/interest of the researcher did not have an impact on the concept they would be responsible for. As such, the researcher with expertise/interest in law was responsible for “use and type of evidence”; the researcher with expertise/interest in urban planning was responsible for “governance”; and so on. Each concept coordinator was responsible for: a) collating content from a previous round of scoping literature reviews in a standard format to create a concept report using the four questions

described in Section 3.2; b) sharing the document with other researchers and collating other disciplinary perspectives with relevant literature; c) chairing a one-hour discussion on the concept with other concept coordinators; and d) updating the concept report with all disciplinary insights and creating a summary to share with the wider TRUUD team.

4.1.2. Weekly discussions

To discuss each of the ten concepts, we met online for one hour on a weekly basis. Prior to those meetings, we completed a review of the concepts from our own discipline and added our comments and relevant literature to the concept reports. This preparation allowed the team, for each concept, to focus the discussion on the key theories and meanings for TRUUD, and to reflect on what they would involve for the future stages of our research.

The main challenge for us was to acclimatise to other disciplinary perspectives and theories. Indeed, most of us read for the first-time technical topics outside our area of expertise. For instance, the concepts of “network” or “decision-making” are not widely used/discussed in law. Similarly, the “complexities of financial risk” and “valuation” are rarely discussed in public health. We overcame this challenge by spending additional time each week discussing those discipline-specific topics to develop a working knowledge on them from an interdisciplinary perspective.

4.1.3. Concept summaries

The last step was to summarise the various disciplinary insights into the concept report and to write a one-page summary for each concept, with implications for TRUUD.

Integrating the different disciplinary perspectives and theories relevant to our project into a single-page document proved difficult.

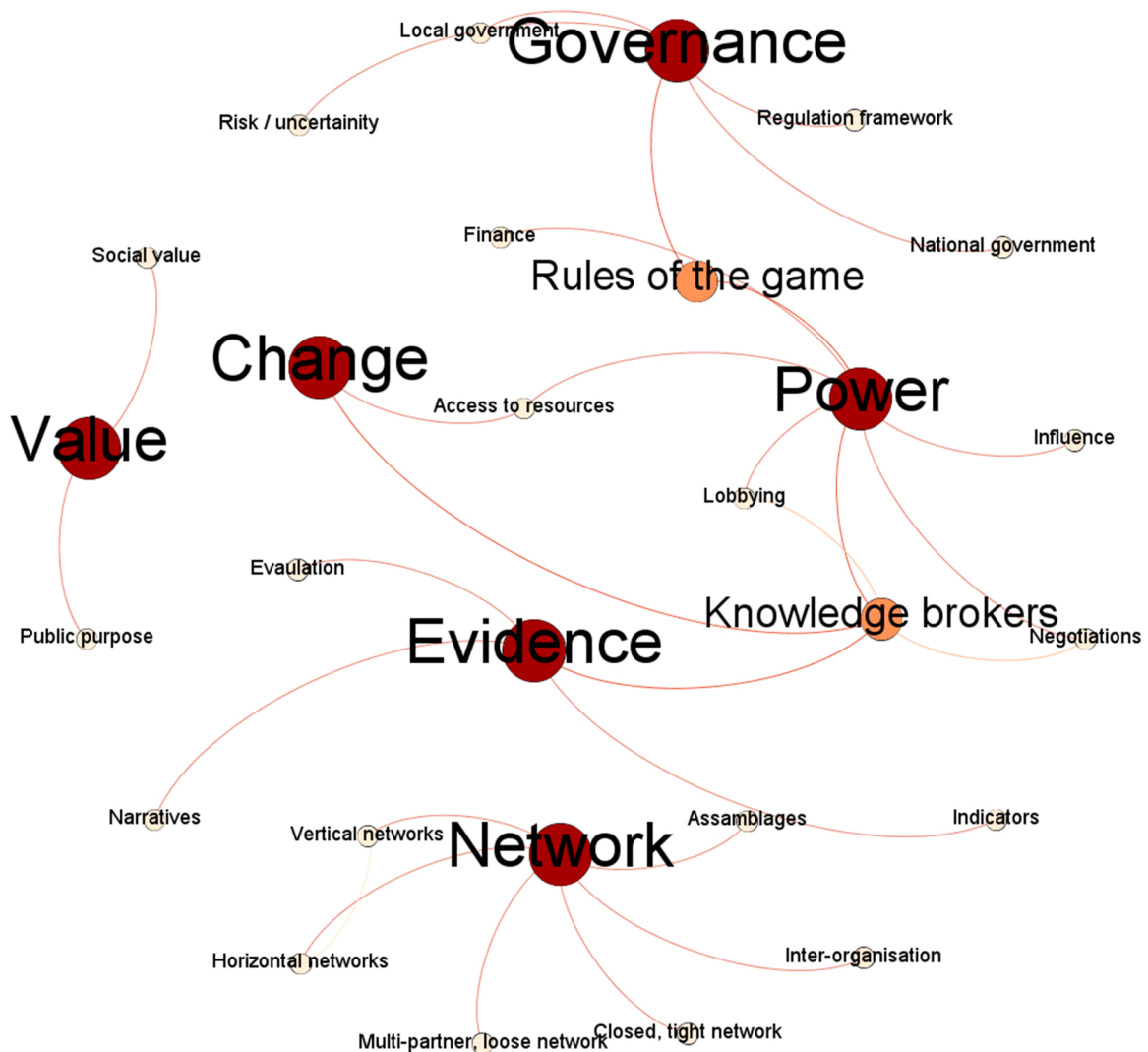


Fig. 1. : A snapshot of our interdisciplinary collaborative work on Miro showing a network graph of the overlapping concepts.

Each concept owner had to exercise some judgement to discard what was not relevant to the project, to keep what was essential, and to highlight the overlaps and/or differences in meanings. All summaries were structured as follows: 1) a short definition of the concept for TRUUD; 2) brief summaries of relevant insights and their relationship with the concept at hand; and 3) recommended areas of investigation for TRUUD.

The summaries were then shared with the wider TRUUD team for feedback. The key insights related to each concept and the feedback received from the wider TRUUD team were then integrated to produce a shared understanding—the second macro-phase of [Repko et al. \(2006\)](#) framework.

4.2. Integrating insights to produce shared understanding

In phase one, we gathered knowledge on each of the ten concepts identified as essential from six academic disciplines, namely public administration and policy; transport planning; urban development; law, management; and commercial determinants of health. The output from phase one was a one-page document per concept, summarising the various meanings, relationships with other concepts, and suggested areas of investigation for TRUUD. In phase two, we worked with the wider TRUUD team to come to a shared understanding of each concept, their relationship with one another, and what they mean for future stages of the project. This process of developing a shared understanding provided a critical foundation for identifying potential research questions for the project (see [Appendix 1](#) for details).

We introduced the ten reviews of the concepts to the wider TRUUD team in an online meeting. Each of us talked about the concept (s) we were responsible for reviewing as the concept coordinators. Each presentation lasted approximately 15 min, followed by a brief discussion. Those short presentations, in addition to the concept summaries, were instrumental in keeping the rest of the TRUUD team up to speed on the various meanings of each concept and their implications for the project.

We organised a second online meeting a week later to brainstorm on the ten concepts in an interactive manner. We again used the Miro cloud-based collaboration tool, which allowed us to work simultaneously on a whiteboard. As the concept coordinators, we drafted a diagram showing the ten concepts, their tentative relationships, and the relevant stakeholders involved. Thereafter, we worked together on the Miro board to add our own perspective to the concepts, to add relevant stakeholders, and to reflect on implications for the overall project. [Fig. 1](#) provides a snapshot of our collaborative work on Miro. Finally, we used the Miro board to write post-it notes with potential research questions and future steps for the research.³ The diagram and post-it notes that resulted from the meeting informed the design of our research questions and the key themes of the interviews (see [Appendix 1](#)). These research questions had to be collaboratively developed and agreed at the work package-level,⁴ which involved around fifteen researchers from various disciplines. This was a critical step to move the research to the next phase. However, it was a challenging task considering the different disciplinary perspectives and focuses as well as different uses of terminologies amongst the work package members. The shared understanding achieved through the interdisciplinary review of the ten concepts was a crucial element that enabled this step of establishing research questions. The concept summaries served as the basis of a systematic identification of the keywords and the specific areas of investigation needed to be taken forward. Separately, a glossary was constructed as a reference document for the project.

The interdisciplinary nature of our work inevitably generated some challenges. First, we had to recognise and accept that the method to conduct a concept-oriented literature review differed between disciplines. For instance, a review in law is typically less systematic than a review in public health where there is a greater preference for strict methods with clear protocols. This is not only due to differences in the robustness/type of methods used across disciplines, but also due to the tools that different databases offer to conduct literature reviews. Second, some concept reviews did not generate any useful insights for TRUUD in some disciplines. For example, in law, “evidence” has a precise meaning—evidence that is accepted at trial—with associated rules found in the Civil Procedure Rules, the Criminal Procedure Rules, and the Rules of the Supreme Court. However, this understanding of “evidence” was not relevant for TRUUD and was therefore not reported in the concept summary. Third, some concepts did not bear any precise meaning in some disciplines. For instance, “network” and “systems thinking” were not associated with any common understanding or theory in law. Finally, the use of a report template with four questions did not fit every concept in every discipline. In some instances, the questions had to be revised slightly to adapt to the concept and accommodate the various understandings associated with it. For example, in management, “systems thinking” is mainly applied in operations management and sustainability research. It is rarely used in other mainstream management areas such as organisation studies and human resource management. We therefore had to adapt the four questions (described in [Section 3.2](#)) slightly to suit the representation of systems thinking in the management literature.

5. Developing shared understanding through interdisciplinary collaborative work: some suggestions

There is a growing body of literature on collaborative research, especially on Team Science ([Stokols et al., 2008](#)) and on ‘failures’ ([Fam & O’Rourke, 2021](#)). A plethora of analytical frameworks and tools have been proposed to evaluate the quality of collaborative work ([Belcher et al., 2016](#); [Wickson et al., 2006](#); [Huutoniemi et al., 2010](#)). Researchers who publish extensively on collaborative working regularly share their experiences on online blogs such as *Integration and Implementation Insights* ([i2insights, 2023](#)). Despite this growing body of literature, our understanding of the process and operational challenges of effective interdisciplinary collaboration in social sciences, especially from the perspective of ECRs doing ‘foundational’ work remotely to better inform large-scale projects, is

³ See the supplementary files 1–7.

⁴ Each work package consists of TRUUD researchers responsible for specific aspects of the project.

limited. While the literature has continued to develop, so far there does not appear to be much work that offers reflections on developing a shared understanding of complex research topics through online interdisciplinary collaboration. In this paper, we addressed this gap by sharing the methods we followed for integration and our reflections on carrying out interdisciplinary early stage 'foundational' work to better inform a wider project on future urban development practices. We shared our key reflections in a replicable manner and, based on our experiences, made recommendations to better support interdisciplinary ECR teams that are working remotely.

Open communication has been documented as a key requirement to build trust, encourage curiosity, understand different perspectives, and facilitate commitment to joint efforts (Bracken & Oughton, 2006; Lawrence, 2015; MacLeod, 2018). Such communication can be hard to achieve in an interdisciplinary team where each member applies a different disciplinary knowledge, culture, and language to problem understanding and solving. However, this difference between disciplines can also be seen as a strength that can provide a holistic understanding of the problem space. Our efforts to develop shared understanding across a team consisting of multiple social science disciplines did not attempt to eliminate the disciplinary epistemics and methods, or to ignore the historical process by which such disciplinary divisions occur in the first place. Instead, we sought to appreciate and translate disciplinary perspectives and methods to problem-solving concepts that were written and reviewed by multiple members, each contributing to our shared understanding. We therefore understand interdisciplinary 'foundational' research as a process of bringing together different disciplinary insights through active interaction among members of the interdisciplinary research team with a view to develop a shared understanding of the most relevant topics for the project. That shared understanding can subsequently be used as intellectual capital to better facilitate other aspects of the project.

In our interdisciplinary collaborative work, we were successful in collaboratively working with each other and in bringing together the different disciplinary insights on the ten most relevant concepts for our project from six academic fields that we had interest/expertise in. From the outset, we engaged in a collaborative approach to develop a shared understanding across the project team of the problem space, i.e., understanding the barriers to incorporate public health considerations into the decision-making process in the UK's complex urban development system. Like other ECRs (e.g., Bridle et al., 2013; Lau & Pasquini, 2008), we too found ourselves in an environment that was not familiar at first. However, we enjoyed a supportive environment conducive to fostering cross-disciplinary collaboration and communication from the start, as it was one of the main aims of our project (reference withdrawn for peer review). In light of our reflective discussion so far, next we offer some practical suggestions on the process of remotely carrying out 'foundational' interdisciplinary work in social sciences (Table 3) that we hope will help other ECRs interested in online collaborative working.

In our experience, early-stage interdisciplinary 'foundational' work in a project should start with a scope and boundary setting exercise to better understand the intended outcome of the project. This should then be followed with an internal assessment to understand the key skills shared by members of the interdisciplinary research team. It is important to identify and agree on the most relevant topics for the issue under investigation. This can be done, depending on the nature of the project, through review of relevant literature, interactive discussion, and brainstorming exercises between members of the interdisciplinary research team. While identifying the most relevant topics to investigate for the project, it is equally important to avoid disciplinary capture and apply interdisciplinarity from the very beginning of the project. Disciplinary capture occurs when the standards, value commitments, and methodological assumptions of one discipline in an interdisciplinary project consistently take precedence over other disciplines, thereby playing an outsized role in how the interdisciplinary research progresses (Brister, 2016). In interdisciplinary projects, some members may be tempted to push their own disciplinary perspectives onto others due to an inherent bias towards their own disciplines, i.e., believing that the perspective taken in their own discipline is better than others' disciplines. Interdisciplinary researchers should consult each other repeatedly on how to avoid such capture. In other words, the process of interdisciplinarity should be applied from the very beginning of the project to avoid potential epistemological bias and disputes going forward. This is key in our opinion in avoiding falling in the trap of 'pseudo' interdisciplinarity and yielding the full benefit of interdisciplinary collaboration. If an interdisciplinary research team makes early decisions without input from all the disciplines involved (due to disciplinary capture), then 'decisions which follow later during the research project are more likely to cascade in a pattern that conforms to the epistemological commitments of a single disciplinary framework' (Brister, 2016, p.89).

After the boundary, nature and scope of the interdisciplinary work have been agreed and set up by members of the interdisciplinary collaborative team, the focus should shift to setting a plan for bringing together the different disciplinary insights on the table. In our view, it is important to produce a standard template at this stage to guide members of the interdisciplinary team in terms of determining what information needs to be brought in from each discipline, how much breadth should be provided, what questions should be answered and why, and how much time should be spent. The template will vary from project to project depending on the nature and intensity of the interdisciplinary collaboration. Each researcher should then use the template to bring in their own disciplinary insights and provide information that will lay the foundation for the final and third stage of 'foundational' interdisciplinary collaboration, i.e., integrating disciplinary insights to develop shared understanding. Allocation of responsibility, e.g., who will cover which topic and why and who will represent which discipline, should be determined and mutually negotiated at this stage. At the same time, frequent meetings should be organised between the team members to report key findings using the standard template previously agreed.

The most crucial phase, i.e., developing a shared understanding of the key topics for the project, should begin once key insights from each of the contributing disciplines have been reported using the standard template. This shared understanding should serve as intellectual capital to better facilitate the rest of the project. To begin this crucial phase, the individual disciplinary insights should be brought together onto a single platform so that everyone can see all the key insights in one place, which is necessary to facilitate the

activities needed to develop a shared understanding. It is up to members of the interdisciplinary team to determine which platform to use to facilitate the development of a shared understanding. In our case, we used Miro to enable us to interact in real time with each other and to facilitate a productive discussion by incorporating feedback from the wider project team.

It is important at this crucial phase for the researchers to avoid confirmation bias—a lack of mutually accepted evidence on the key topics that may contribute to various forms of cognitive bias, which may further inhibit the production of consensus and collaboration. Confirmation bias is the tendency to selectively privilege claims that support preconceived assumptions (Bazerman & Tenbrunsel, 2011). Overcoming these inevitable problems requires improved communication and mutual respect among the interdisciplinary team members, it also requires a compromising mindset. Drawing on our own experience, we would argue that boundaries of interdisciplinary research are under constant negotiation, far from mutual understanding or consensus, so a compromising mindset and mutual respect among team members are imperative for successful interdisciplinary collaboration. Reflecting on our own experience, we would further argue that differing understandings of, and attitudes towards, interdisciplinary research also depend very much on the diversity of researchers. It was quite apparent to us that specialisation and interest, attitudes towards the issue under research, and type of training received, all played a significant part in shaping the ways in which we positioned ourselves in respect to the interdisciplinary work we did. Like Lau & Pasquini (2008), we found that many other factors such as area of expertise and prior experience also influenced the various dimensions (e.g., contesting each other's ideas, compromising on each other's preferences, etc.) of our interdisciplinary collaboration to varying degrees.

As mentioned earlier, our interdisciplinary interactions faced many challenges most of which we overcame without any significant obstacles, due to us being roughly at the same stage of our academic career, coming from traditional academic backgrounds (PhDs), having a degree of openness and interest in interdisciplinary working, and due to the 'narrowness' of our interdisciplinary collaboration. However, we understand that undertaking collaborative research in less ideal contexts, especially for ECRs from dissimilar (academic) backgrounds working remotely in 'unsymmetrical' situations, could be far more challenging than what we reported in this paper. Working with collaborators from a broader range of disciplines, however open-minded and committed, could also be much more challenging. We assume that in such situations ECRs are likely to face more challenges with regards to disciplinary capture and confirmation bias. Problems associated with disciplinary capture and confirmation bias may exist in all collaborative research (von Wehrden et al., 2019), but the intensity of these problems and the subsequent impacts are more likely to be higher in less ideal collaborative research contexts. In our opinion, 'having a compromising mindset' and 'open to negotiation' are the most essential requirements for successful interdisciplinary collaboration in less ideal contexts. Researchers have previously reported that different forms of knowledge need to be constantly negotiated between members of the collaborative research team. They identify 'trust' and 'respect towards each other' as two most useful intangibles in the negotiation process in collaborative research (see Celliers et al., 2021; Lau & Pasquini, 2008). Members of collaborative research team may come from different backgrounds and culture which may create tensions in negotiating common activities and processes. Such difference can lead to disincentives to work across disciplinary boundaries. We argue that the greater tensions between different members of collaborative research would require intermediaries who can bridge the boundaries by minimising the competing tensions (Harries & Lyon, 2014).

We have thus far offered a reflective discussion on the process of 'foundational' interdisciplinary collaborative work carried out remotely from the perspective of ECRs. Our work is mainly situated within the 'micro' layers of the much-acknowledged Team Science Ecosystem proposed by Stokols et al. (2019). Proponents of Team Science Ecosystem (e.g., Börner et al., 2010; Read et al., 2016) argue that collaborations among researchers from different academic disciplines are embedded in a multi-layered ecosystem ranging from micro to macro scales, and from local to more remote regions. These levels include (1) individual members of teams (micro), and the teams to which they belong viewed as organisational units (micro); (2) the broader institutional contexts (e.g., universities, research centres) that support multi-team systems (meso); and (3) their community and societal milieus (e.g., policies and priorities established by national and international agencies and foundations) (macro) (Stokols et al., 2019). In this paper, we mainly reflected on how we interacted as part of a small team of ECRs (i.e., Work Package 1 of the TRUUD project), why, and the process we followed to complete the 'foundational' interdisciplinary work remotely. We further explained, again from a micro perspective, how we developed a shared understanding among the wider project members on the key areas of the TRUUD project. We did not reflect on the broader institution level (meso) and the wider societal level (macro) layers of the Team Science Ecosystem though we acknowledge that our work inevitably had many interactions with those layers. Reflecting on those interactions is beyond the scope of the current paper. Researchers interested in further expanding our reflective suggestions in this paper may address the interconnections between the micro, meso and macro layers of the Team Science Ecosystem from an ECR perspective.

Our reflective discussion in this paper makes two modest contributions to Futures as a study field. Futures as a study field examines a broad range of futures (Voros, 2003), and attempts to gain a holistic view of complex issues from different disciplinary perspectives (Kuosa, 2011). Similarly, in this paper we report on an interdisciplinary collaborative work that we carried out remotely to better inform a large-scale project on improving future urban development decision-making with regards to health outcomes. During our collaboration, we consulted and incorporated insights from various disciplines to gain a holistic and shared understanding of the complex system of urban development practice. Scholars have previously provided a rich description of the futures that research on Futures study must contribute to, namely potential, possible, plausible, probable, projected, and preferable (Voros, 2003; van Dorsser et al., 2018). Our study explicitly contributes to a 'probable' future (Voros, 2003) in the sense that it is conducted remotely, which we think will be the new normal of working in the post Covid-19 time. We reflected on our experience of collaborating remotely while maintaining the rigour and depth needed for high quality interdisciplinary work. Our paper also contributes to a 'preferable' future (Voros, 2003) in the sense that the wider project—which our collaborative work contributed to—will help creating a future we think

'should' or 'ought to' happen (van Dorsser et al., 2018, p.80), i.e., a better urban development system which is more capable of addressing public health issues. In addition, we offer our reflections in a replicable manner so that other ECRs can follow (and benefit from) the methods we applied.

6. Conclusion

We discussed and reflected on the process of 'foundational' interdisciplinary collaboration based on our own experience of remotely carrying out such work to inform a wider research project. Our interdisciplinary collaborative work was 'foundational' in nature in the sense that it provided the basis for the empirical phase of the wider research project. Our collaboration was also 'pedagogical' to the extent that we learned how to work with each other and be a constructive and productive part of a large research group—a lesson that proved its worth in the next phases of the project for the successful delivery of the project aims. We acknowledge that bringing interdisciplinarity to large-scale empirical projects that involve researchers from dissimilar academic fields such as social sciences, engineering, and medical sciences could pose additional challenges that we have not been able to explain in this paper. Other researchers discussed some of these challenges of implementing interdisciplinarity in large-scale empirical projects (see Holmes et al., 2018; Fam & O'Rourke, 2021). However, the reflective suggestions we offered in this paper would hopefully provide useful guidelines to ECRs, particularly to the ones working remotely, on how to develop shared understanding of diverse academic topics through interdisciplinary online collaboration and subsequently use that shared understanding as intellectual capital to better facilitate the overall project work and address future societal problems.

Due to Covid-19 restrictions on meeting people face-to-face, we had to conduct our entire collaborative work using online platforms. Despite not being able to interact with each other in person, we managed to complete our interdisciplinary collaborative work successfully, which begs the question whether it really does need face-to-face contact to make interdisciplinarity work. We think this is often assumed, particularly for experienced academics who have always done it that way. Whilst most Covid-19 restrictions have been lifted across the world, online or hybrid collaborations continue to play an important role in research activities. For example, many 'international' academic conferences now offer a hybrid version, enabling greener and cheaper access to knowledge especially from researchers based in the global South. Our work has shown that it is a myth that face-to-face interaction is needed in successful interdisciplinary collaboration, not least in interdisciplinary collaboration in the social sciences.

The reflective discussion we offered in this paper is more accessible for ECRs who are often recruited as part of large-scale collaborative projects and are asked to carry out initial review work from different disciplinary perspectives. Our work will hopefully help such researchers in facilitating early stage 'foundational' work in large-scale collaborative projects, especially when such work is carried out remotely. We also demonstrated how to develop a shared understanding of complex topics in the early stages of a large-scale project and use that shared understanding as intellectual capital in the latter stages.

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Declaration of Competing Interest

None.

Data availability

Data will be made available on request.

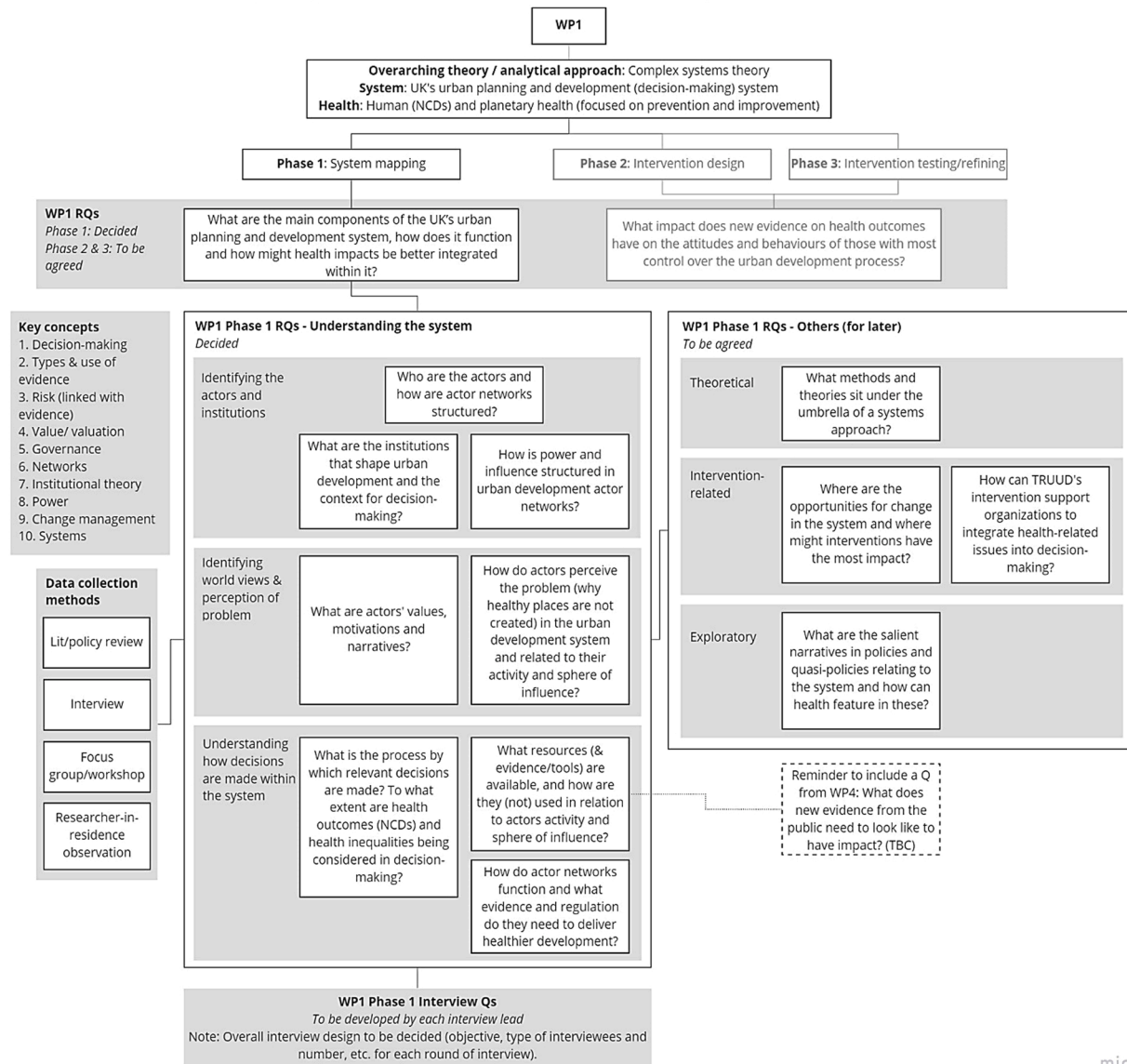
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Appendix 1. Identification of key research questions for TRUUD based on our interdisciplinary collaborative work

WP1 Phase 1 RQs in a Hierarchy, as of 11Mar2021

Note: This diagram organises the themes and overarching RQs compiled from various WP1 activities (including concept reviews) under the WP1 RQs, following the "actor, game, and network (AGN) analysis." While not illustrated, many of these questions link with one another and link to other work packages too. In general, the whole of 'Phase 1: System mapping' feeds into 'Phase 2: Intervention design'. This diagram focuses on WP1 Phase 1 (hence other phases are coloured grey and are to be revisited at a later date).



miro

*RQ = Research Questions; WP = Work Package (each WP consists of TRUUD researchers responsible for specific aspects of the project).

Appendix 2. Template followed in the scoping reviews for TRUUD work package 1

Author/s:

Topic:

Total word count:

1. **Introduction:** Scope and purpose of the review; State any intentional exclusions (what the review will not cover); Outline the structure of the review **100 words**.

2. **Literature:** Description of the body of literature investigated including any/all of theory, discipline, schools of thoughts, etc. **200 words**.

3. **Questions:** The questions you are hoping to answer by examining the literature **100 words**.

4. **Process/methods used:** Search terms used; Databases used for searching relevant literature; Rationale for using those databases; Statistics (number of articles derived, number of relevant articles, etc.); Methods followed to sort out relevant articles (scanning abstracts, checking the context or scope of the papers derived, publication year, etc.). **200 words – can be bullets**.

5. Main section: Report the key insights (decide on what approach to use, e.g., chronological, thematic) **1500–2000 words.**

6. Conclusion: A summary of the key findings—similarities/dissimilarities between the reviewed works, identify gaps, possibly justify a particular research agenda (supported by the findings of the review) **300–400 words.**

References No word limit.

Appendix B. Supporting information

Supplementary data associated with this article can be found in the online version at [doi:10.1016/j.futures.2023.103176](https://doi.org/10.1016/j.futures.2023.103176).

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