

Chapter 4

Operationalising Research: Embedded PhDs in Transdisciplinary, Action Research Projects



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Abstract This chapter explores strategies for operationalising PhD studies in the context of a large research project addressing the unrelenting problem of ill-health in the growing population of informal settlements in the Global South. We advocate that PhD training presents an opportunity to contribute to these contexts by both training a new kind of action-oriented scholar, but also by strategically deploying the enormous energies and original work generated through PhD candidates towards this critical mission. Driven by the desire to give agency and utility to PhD researchers in a much-needed domain of transdisciplinary research, the chapter chronicles the trials of a group of four PhD candidates embedded in a large health study using innovative approaches to the revitalisation of 24 informal settlement communities in the Asia-Pacific. Through a discussion between the candidates and supervisory team, the chapter uncovers three types of embedded PhD's. It articulates the challenges and opportunities of the model and reflects on the forces at play, producing practical advice for instrumentalising PhD research in the context of transdisciplinary research.

The Complex and Urgent Global Context

We find ourselves in a time of crisis. Here in Australia, Black Summer has ended with a staggering 186,000 square kilometres of bushfire ravaged land. At the peak of the bushfires, air quality dropped to hazardous levels (Tiernan and O'Mallon 2020). Meanwhile, 2020 is still set to be the hottest year on record. Then, there is COVID-19, the pandemic with more than 18 million reported cases and over 730,000 deaths (as of 11 August 2020; Dong et al. 2020). The impacts on vulnerable

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populations, while still unknown to their full extent, are horrific as the number of cases continues to rise. Informal settlements in the Global South are not only the most vulnerable communities in global society, they are also the most affected by such disasters, pandemics and climate change. Beyond these still, there is a range of other social and planetary challenges at large, worst felt by these vulnerable communities. Informal settlements provide the context and the mission for our research and action.

We write this chapter following physical isolation measures from home. But amid our numerous video conference meetings, we feel that our mission and its attendant research and research training frameworks are now more relevant and indeed urgently required. A conversation that was critical, regarding the relevance of built environment research to such global challenges as disease and homelessness, urban design and public health, the climate emergency, and systemic inequality, has now become urgent. We believe that contemporary research needs to be nimble, able to shift in response to crises. To adequately and quickly respond and contribute to these dynamic contexts, we need research that is supported by transdisciplinary¹ and cross-sectoral modes and networks to quickly and effectively respond to accelerate the cycle of translation between discovery research and on the ground implementation.

If we are seeking transformative change in these difficult contexts, we need to deploy all resources and shape engagements to contribute in tangible and direct ways to these challenges. We advocate that PhD training presents an opportunity to contribute to these contexts by both training a new kind of action-oriented scholar, but also by strategically deploying the enormous energies and original work generated through PhD candidates towards this critical mission. This approach, however, is fraught with difficulty and complexity, and we recognise the need for frameworks which guide research training and can support candidates, supervisors and the complex network of actors involved in these projects, towards more positive and productive engagements. We also need to shape these frameworks so that PhD research can contribute to the broader mission and projects at hand in direct and tangible ways. We aim here to add to the repertoire of PhD training models by articulating different types of entanglements of PhD candidates within transdisciplinary research.

Operationalising PhD Research: The Shifting Focus in Doctoral Research

There is a noticeable shift in the focus of higher education programs. In our home discipline of architecture, we see a groundswell of degrees worldwide which seek to increase the utility of research, and lessen the divide between education and practice

¹We adopt both definitions of transdisciplinary research aiming at “a more thorough integration of knowledge by focusing either (1) on transdisciplinary concepts and methods which are shared by more than one scientific discipline or (2) on the implementation of participatory processes within the research process which allow, from the beginning, deliberations with practitioners, citizens, and stakeholders about the purposes of a research project on the one side and an integration of first-hand non-scientific knowledge on the other.” (Carayannis 2013).

(Tang and Mitchell 2016; Ramirez-Lovering 2015). This has led to the development of alternative models of education and research that are increasingly “in a condition of readiness to perform some intended function” (Merriam-Webster n.d.), or rather, becoming *operationalised*.

The postgraduate education sector is experiencing this change through an increasing demand for a different type of PhD—one not only concerned with pathways to academia, but as high-level training leading to new professional opportunities in government, industry or civil society organisations. In our experience, prospective candidates increasingly seek projects and topics that address critical problems and see the PhD as a pathway to contribute to a larger mission. This change in the disposition of doctoral researchers is supported by a transition in the university sector towards impact directed education and research. High impact scholarship is often aligned to key social and environmental challenges that characterise the contemporary global context, and isolated to science, technology, engineering and mathematics (STEM) disciplines. Yet the complexity of global challenges like climate change, means that integrative, transdisciplinary and creative approaches are necessary (Brown et al. 2015). As such, in action-oriented research, we seek to break down barriers between disciplines and to enable creative dialogues between researchers, communities and government working on live projects for real-world impact. In this paradigm, “the researcher is no longer the scholar, but a developer, bureaucrat, partnered with government, communities and industry to develop new solutions. This reinforces the importance of action research and our role as academics in these big, complex urban problems” (Murray 2020). Our interest moves beyond a PhD candidate being part of a Department cohort or topical research group,² or the now common industry-partner PhD model (Department of Education 2014; Group of Eight 2013). We focus on operationalising PhD research by embedding them in transdisciplinary action-research projects.

Four PhDs Embedded in a Live Project

This chapter takes as a case study a group of PhDs embedded in one such project titled RISE (Revitalising Informal Settlements and their Environments), undertaken in the Monash Informal Cities Lab at Monash University. Now, almost three years into the PhD’s candidature, we see an opportunity for reflection on our experiences as supervisors and PhDs engaged in a live project.³ We have done this through a dialogical process and iterative cycles of dialogue and reflection, surfacing and exploring opportunities and challenges—a series of back and forth reflections between us—the PhD candidates and supervisory team.

We first sought reflective personal written responses from the PhDs, responding to a series of factors that the supervisory team had identified to be formative stages

²In which researchers meet and participate in events like seminars and discussion forums, or occasionally contribute to collaborative projects where their interests overlap with others.

³Live project, refer to Dodd et al. (2012) and Mitchell and Tang (2015).

in the PhD. We followed this with group discussions reflecting together on these experiences. The PhD reflections and transcribed discussions were then coded and analysed. We traced the relationship between PhD experiences and RISE project development, trying to capture how project dynamics transformed PhD projects relative to our lab mission, and the RISE project itself. We then mapped the development of PhD focus areas, structure and methodology over time against RISE, as well as competencies that emerged to enable candidates to persevere and progress effectively. In so doing, a range of enabling factors and a research ecosystem composed of a number of nested elements have emerged.

While PhD experiences were also shaped by other, more typical challenges associated with action-researchers undertaking research in a context other than their own (Scott et al. 2006), we focused closely on the PhD entanglements with the RISE project. From their reflections, we noticed trends that captured in different ways the limitations and constraints particularly in relation to the RISE method, project timelines of the PhD and project and the important separation between RISE research activities and delivery of sanitation infrastructure. In order to understand the dynamics of this entanglement, we first need to understand the RISE project.

The RISE Project and Its Methodology

Involving over 1200 households and 7000 people, RISE explores how to improve water and sanitation, by implementing a novel approach to settlement upgrading in 24 urban informal settlements in Makassar, Indonesia and Suva, Fiji (Ramirez-Lovering et al. 2018). Working alongside communities, governments, local leaders and partner institutions, RISE will implement a series of integrated water sensitive urban design (WSUD) solutions to deliver low-impact, cost-effective health and environmental improvements. The approach includes drainage, water supply and sanitation improvements, with new or renovated toilets, and connection to a decentralised treatment system of septic tanks and constructed wetlands or bio-filtration systems. Underpinned by the emerging discipline of Planetary Health, RISE's success will be measured by the health and wellbeing of residents—particularly children under five years of age—and ecological health of the surrounding environment.

RISE's focus on human health combines quantitative and qualitative approaches and is structured as a randomised control trial (RCT). Of these 24 urban informal settlement neighbourhoods, six from each country are randomly selected to receive the intervention in the first round (see Fig. 4.1). Following a period of baseline assessment monitoring health, wellbeing, policy, and environment (water, soil, temperature, floods and morphology), the project engages each community in a participatory, co-design process to develop and implement the intervention. After construction is complete, post-intervention assessment begins, continuing to monitor communities against the six non-intervention communities in each country, the control group. Through this RCT, RISE seeks to produce empirical evidence of the impact of this approach to informal settlement revitalisation on human and environmental health.

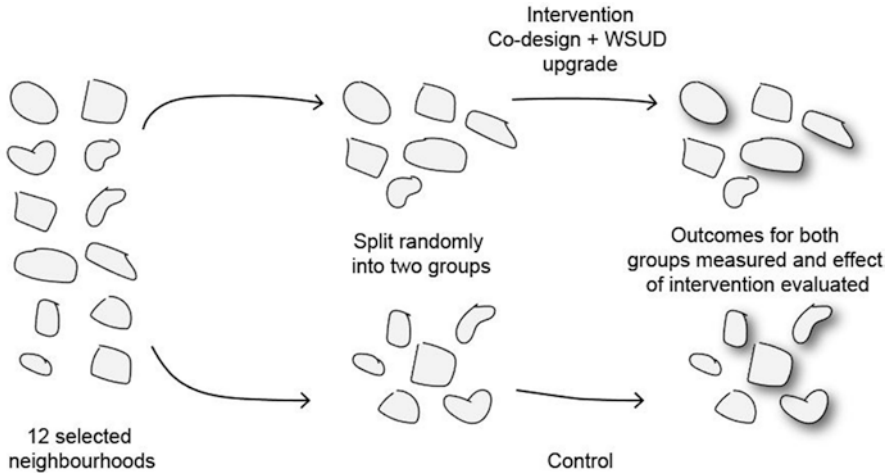


Fig. 4.1 Diagram showing the structure of the RCT and the relationship between intervention and non-intervention neighbourhoods in each country

RISE is structured into teams of interdisciplinary researchers: Design and Engagement; Ecology and Environment; Human Health; Wellbeing; Policy and scaling-up; and two country teams based in Makassar and Suva. The researchers—around 70 in total—have significant expertise in the range of fields required for project delivery, including engineering, ecology, hydrology, architecture, landscape architecture, community engagement, public health, epidemiology, statistics, economics, and IT. The country teams—approximately 30 staff in each—bring local expertise in community development, public health and environmental sciences, essential to project delivery. Not least, the project is also supported by a diverse stakeholder group, including funders,⁴ government agencies, industry partners, and the study communities.

Research Ecosystem and PhD Integration

We seek to develop an alternative model that shifts from PhD researchers embarking on isolated projects, to team-based structures integrated in live projects that contribute to a common mission—an embedded PhD model. The embedded PhD model development and successful operation relies on a range of enabling factors and a research ecosystem composed of a number of nested elements (see Fig. 4.2). This is described in the following paragraphs.

⁴The project research is supported by the Wellcome Trust, while the infrastructure implementation is supported by the Asian Development Bank (ADB), New Zealand Ministry of Foreign Affairs and Trade (MFAT) and the Government of Fiji.

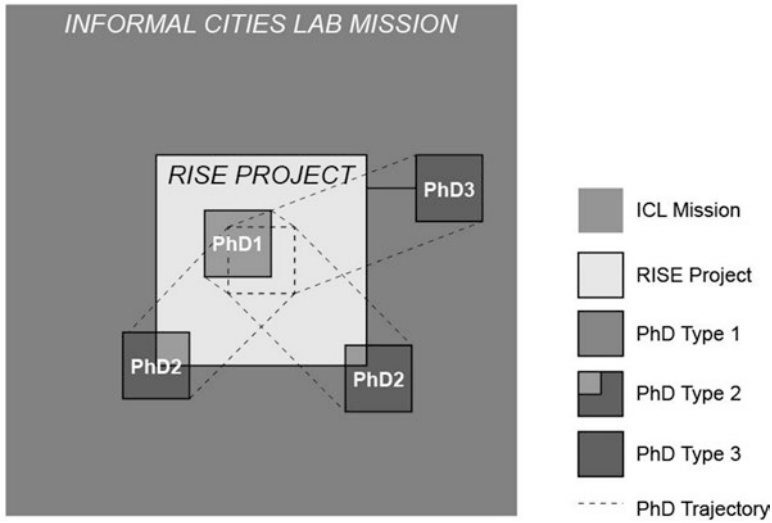


Fig. 4.2 Embedded PhD model ecosystem and different PhD typologies of integration

The Lab Mission and the Project

The Informal Cities Lab is the platform for the embedded research ecosystem. The lab is focused on the collaborative transformation of urban informal settlements in the Asia-Pacific through a transdisciplinary, community-centred approach, which in turn contributes to high-impact multi-stakeholder research projects. Conviction in this mission—its conceptual agenda and modus operandi—is central to creating an environment that is able to hold the passionate engagement required of PhD candidates undertaking the embedded PhD model. The mission provides direction for guiding the lab candidates, at a high level, through the uncertainties and dynamic environments that characterise these complex, multi-stakeholder engagements (Mazzucato 2018). Importantly, the lab also brings a network of partners and scholarship base, allowing candidates to select the ingredients that will best support their investigations. It is important that the mission is sufficiently broad to allow for different engagements but also coherent—clearly and specifically articulated to connect to varying PhD directions. As the next element in the embedded research ecosystem (see Fig. 4.1), the RISE project provides a thematic diversity to allow for different PhD directions. The project is also central in providing the research infrastructure.

The PhD Team

The establishment of a PhD cohort proved to be an essential component for the embedded model, as candidates enrolled concurrently and moved through the PhD program together. At the start of the project four competitive scholarships were advertised which described the project and PhD frameworks—team-based

engagements with a diversity of stakeholders, interdisciplinary teams and in-country governments and communities. Through broadcasting the mission, we sought to draw sympathetic candidates to RISE and its model of research training. While broad PhD subject areas were initially described, applicants were asked to identify their own specific questions to extend or complement the project aims or broader lab mission.

We were looking for a diverse PhD team and the four successful candidates were selected, among other things, based on educational backgrounds which include architecture, urban planning and social sciences, urban design, and engineering. Their motivations for joining the project ranged from disciplinary and methodological curiosities, such as the opportunity to unite professional and academic interests, or to link research from different fields, or develop and explore transdisciplinary team-based and hybrid research practices; to practical aspirations to explore real-world problems from empirical and theoretical standpoints, and to undertake impact-driven research that would enact “meaningful change” in the world. The candidature began three months after the RISE project kick-off and a few weeks after the initial community engagement activities in the Demonstration Sites⁵ in Suva and Makassar. In these early months of the RISE project, the diverse team of researchers and industry experts were still defining the research scope and implementation agenda.

Three Typologies of Integration

Reflection and analysis on the PhD experiences have revealed three distinct typologies of PhD integration within RISE: PhD type 1—embedded internal, type 2—embedded hybrid and type 3—embedded external (see Fig. 4.1). While one candidate, Daša, actively embedded her research and contributed across the range of project parameters (type 1)—methodological, structural and temporal—Erich and Mahsa focused their research contributions on specific project components, for example community-led flood monitoring or an investigation into land tenure and its impact on infrastructure upgrades (type 2). Brendan developed an aligned topic that, while using the RISE project as an embedded case study, was not directly integrated in core RISE activities. Brendan’s research, an investigation into the morphological transformation of informal settlement environments over time, is however fundamental to the overall lab mission (type 3) and contributed to RISE in its later stages.

The three PhD typologies reflect, in various combinations, the spectrum of interplay between core project aims and more direct and connected PhD studies (type 1) to parallel and affiliate studies that may not directly integrate into core project research but deliver on important aspects, nevertheless (types 2 and 3). Each of

⁵Required by the infrastructure funders to demonstrate the scope of the intervention and the socio-technical infrastructure it comprised—largely untested in the informal settlement context—“in action”.

these PhD typologies plays an important role with diverse and parallel contributions to project and lab missions alike and is essential to a productive and resilient research ecosystem.

Reflections from the Inside

The embedded model has influenced PhD project trajectories in different ways, drawing out an exciting but often-uncomfortable interplay between the PhD's, RISE and the lab. Table 4.1 summarises the manner in which the different project elements—methodology, structure, timing, impact research, infrastructure and data—affected the three PhD typologies.

Research Methodology

Engaging in transdisciplinary research often involves complex and compound project frameworks and methodologies. These will variously affect embedded PhD structure and development. For example, while the PhD projects were not structured around the RCT approach, this context presented limitations and constraints that had profound impacts on all PhD project in different ways depending on the type. Following the RCT structure, PhD projects were initially planned to relate to the pre- and post-intervention state of communities, and the intervention design and engagement process that drove the broader team's focus. While all candidates had to be conversant in, and abide by the RCT's scientific objectives and structures, their level of alignment to the RCT structure, and the candidates' embeddedness in the research ecosystem, shaped their research in significant ways. For example, Daša, a type 1 PhD, whose research focused on participatory design workshops, found that her direct engagement in the project forced her to undertake workshops only with intervention communities and prevented additional fieldwork to be conducted in control communities to enable comparison. While close alignment was incredibly productive for her research, allowing combined data collection for her PhD with project activities, the inability to engage with control communities detracted from her research.

On the other hand, for Mahsa and Erich—type 2 PhDs, and Brendan—type 3, the nature of the research meant that they were less hampered by the RCT structure and allowed them to look across both intervention and control communities and compare different conditions. Erich's community-led flood monitoring was developed in conjunction with baseline activities across intervention and control communities and allowed him an expanded breadth of analysis. However, while these PhD

Table 4.1 Summary of the manner in which the different project elements affected the three PhD typologies

RISE project elements	PhD type 1— embedded internal (*Daša)	PhD type 2— embedded hybrid (*Erich and Mahsa)	PhD type 3— embedded external (*Brendan)
<i>Methodology</i> Compound, qualitative and quantitative methodologies of RISE allow for different alignments and engagements	Alignment to project methodology can be incredibly productive for both project and PhD but can limit scope of PhD research	More flexibility in research and activity design Still need to accommodate project activities/structure in their planning	
<i>Structure</i> RISE implementation and research objectives allow for different types of involvement and focus	Need to manage PhD’s progression alongside project, for example data analysis and research publications	Important to maintain connection to project’s specific objectives and lab mission	
<i>Timing</i> Most difficult to achieve for close alignment of PhD with the project. Project delays can significantly impact the PhD. It is important to align PhD commencement with end of project establishment	Important that the student is part of discussions relating to project timing PhD research question integral to resilience and rigor of the PhD study	Sequencing of activities is an important consideration to align to project data, milestones, and so on	Relatively detached from project timing
<i>Impact research</i> Connection of PhD to project influences the ability of the candidate to affect the work on the ground. If PhD motivation relates to action this should be discussed early on	Need to manage burden on PhD as a result of direct connection to project	PhD contribution/involvement in project limited by project elements. Data/outcomes produced in PhD may be useful for implementation further along the timeline	
<i>Infrastructure</i> Project infrastructure provides a significant and valuable enabling environment to the PhD research	Project infrastructure supported PhD fieldwork Transdisciplinary setting supported the development and enriched work		
<i>Data</i> Intellectual property and data confidentiality should be transparent and communicated early on	Need to manage burden on PhD as a result of direct connection to project	Good synchronicity with project can lead to productive contributions Poor synchronicity or limited flexibility can lead to PhD challenges	Close relationship to mission may result in unplanned productive contributions

typologies were not “internal” in the research ecosystem, they needed to accommodate the project when planning their own research. Brendan reflected that one of the most fundamental impacts on the direction of his individual research project, sited in the midst of a larger transdisciplinary research project, was the “constant back-and-forth negotiation” required to navigate the project, its research methodologies, access to research sites and data, amidst his own and other candidates’ research interests.

RISE’s large scale had multiple researchers working across the project—engaging with the same vulnerable communities—requiring negotiation of PhD scope and activities to reduce overburdening communities, meet individual requirements and team objectives. For Mahsa, these constraints extended through her project engagement, for example limiting her ability to attend community engagement sessions undertaken to co-design the infrastructure. These restrictions shaped her research approach, leading her to “consider alternative and complementary data collection activities” in order to be resilient to unpredictable project shifts and conditions.

Research Structure

Tensions Between Implementation and Discovery Research

From the outset, candidates were immersed in RISE, taking part in numerous project activities including intervention infrastructure design and development, community engagement, data collection, whole of project meetings and activities. Through this intensive immersion, candidates developed individual research agendas and projects aligned with issues identified throughout their involvement (see Fig. 4.4). The PhD projects were structured to engage in a series of investigative loops. Framed as focused studies or sub-projects, these would vary in overlap with RISE and make project contributions at key moments. As the candidates progressed, and their research became clearer and more specific, their degree of direct involvement in the project would diminish.

At the start, we wanted candidates to work closely on project implementation, namely the design of the intervention and frameworks for designing with communities. We hoped this would lead to a strong and productive connection between PhD projects and delivery. The Department’s practice-based PhD model—the “PhD by project”—supports this approach, in which, “the argument is made through both design (including analytical and observational drawings, as well as other manifestations of design) as well as discursive text” (Department of Architecture 2019). PhDs developed close knowledge of RISE through their involvement, participating in Demonstration Site design and documentation for Makassar and Suva, such as the production of drawing sets and assisting with the development of initial community consultation materials and strategies. This involvement with implementation was supported by the PhD-by-project mode, however led to unclear distinctions between

PhD and project, roles and responsibilities, which became more pronounced as time progressed. Brendan observed that “Occupying this in-between space of researcher/student/employee revealed some opportunities for research, however due to a focus on implementing and ‘actioning’ research, many gaps in the process appeared”.

The different levels of PhD integration in RISE activities shaped candidates’ research, and over time they gravitated towards different levels of integration (see Fig. 4.3). Daša (type 1) remained directly involved for the longest period, reducing only after mid-candidature; while Erich, Mahsa and Brendan (type 2 and type 3) reduced their direct involvement after confirmation, remaining connected to the project’s specific objectives and lab mission. From Brendan’s perspective, although this experience was valuable and provided insight to the project’s structure and context, “the practical realities of delivering PhD material while simultaneously documenting infrastructure designs became untenable”. It quickly became apparent that the project delivery requirements couldn’t be fulfilled by the research team alone and the work was impeding candidates from maintaining the University’s progress expectations and developing their projects.

Following confirmation (see Fig. 4.3), distance was established to protect both PhD research and the project, and at this point the different degrees of integration started to emerge. Additional delivery-focused professional staff were employed to drive the progress of the RISE project intervention, enabling the PhD candidates to focus on their research. The candidates needed to readjust expectations of their involvement in RISE, and their project’s relationship with it. Tensions remained for Daša, whose project remained closely intertwined with the project delivery, focused on community engagement and the integration of local knowledge and practices with infrastructure design. Maintaining a connection to the project while progressing the PhD was time consuming, and the separation of research and implementation teams and agendas led to a communication gap, and unclear responsibilities

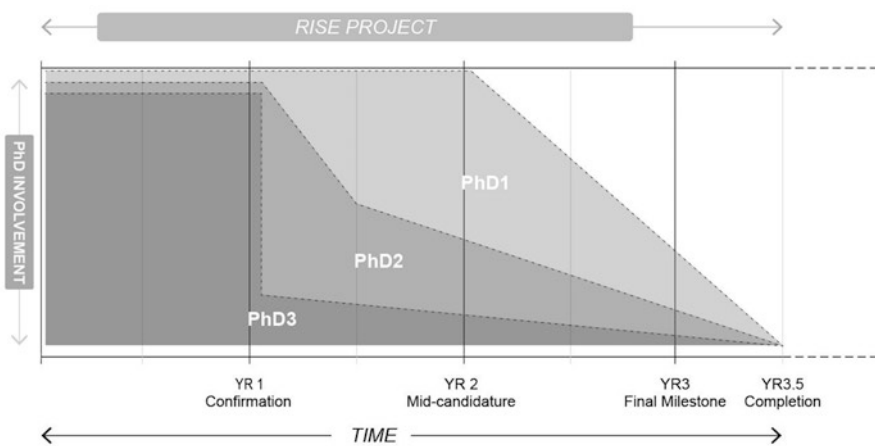


Fig. 4.3 The PhD research varied in overlap with the project and contributions over time. This was reflected across the different typologies of integration

and boundaries between the PhD project and RISE. Daša reflected that “in order to stay connected with the implementation and the real impact of RISE, I was in constant and direct contact with both research and implementation teams and looking into the design of the effective interaction with local communities”. Although she acknowledges this provided “an incredible opportunity for exploration”, on the other hand it was plagued by a complicated matrix of responsibilities and communication channels. Daša observes, “This is probably more evident because the research is embedded within the PhD-by-project and design-led research, where these boundaries are blurred”. However, it made making a productive contribution to, and engagement with, the project difficult. This has resulted in a greater separation from the project than anticipated.

Research Timelines

Engaging with a live project involves adapting to events and related timelines that are driven by the project’s real-world contexts. The RISE timeline was impacted by events outside the project’s control, significantly altering delivery scheduling across both countries. For example, in-country laboratory and team establishment delays meant that baseline sampling started late, causing randomisation to be delayed 12 months. Furthermore, instead of the planned synchronised randomisation in both countries, funding changes for the civil works for the Suva arm of the study caused a six-month delay in randomisation (see Fig. 4.4). These changes had knock-on effects, pushing post-construction assessment of RISE’s intervention communities

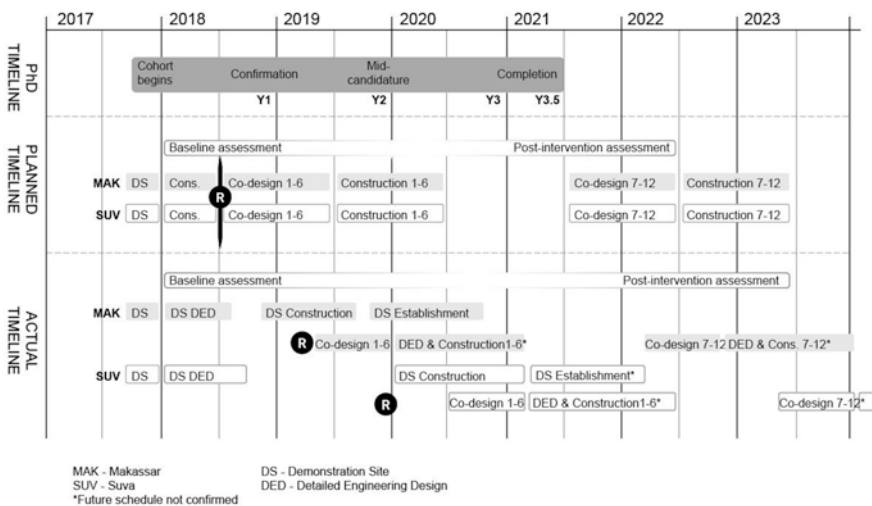


Fig. 4.4 Diagram of the PhD timeline, mapped against the planned RISE project timeline and the actual delayed timeline, as influenced by internal and external factors

outside the PhD timeline. While this did not affect the characterisation of the different PhD typologies per se, Erich and Mahsa who had originally planned to focus on Suva shifted their attention to Makassar. They were coincidentally both identified later as type 2. Preliminary fieldwork and contextual research undertaken in Suva was set aside as the candidates refocused on Makassar to maximise the overlap of the PhD with RISE. Reflecting on the shift, Mahsa observed, “While this has limited the opportunity for cross-country comparison which may help further exploration of the scalability of the RISE project, the Makassar case provided a more diverse range of land-related challenges (tenure, conflict, space), and this consequently has enriched the analysis”. It became apparent that sequencing of activities would be an important consideration, in order for the type 2—embedded hybrid candidates to remain in contact with the project and coordinate their activities to facilitate productive research contributions.

For Daša and Brendan (types 1 and 3) who planned to undertake post-occupancy studies of intervention communities, the delay meant that the first six interventions would not be delivered in time for diachronic comparison across datasets. The decoupling would also limit immediate cross-country comparison, since the countries would not experience the project synchronously, between rates of morphological change, and the impacts of participatory design activities and construction activities on communities, among other aspects. Daša’s research continued to progress alongside RISE, with her research closely tied to the project objectives, structure and outcomes. She found that the focus of her research question was contingent to the study being able to adjust to changing conditions and maintaining rigour. Contrastingly, Brendan’s research shifted here into what has been identified as a type 3—embedded external PhD, becoming more detached from the project timing, while retaining connection to the project’s specific objectives, structure and lab mission. This gave him more flexibility to define his research scope and activities.

Research Impact on Communities

The RISE project’s built intervention seeks to respond to real-world problems, such as the health and environmental challenges of inadequately serviced neighbourhoods. The project engages with participating communities through a process of co-design to identify and target significant water and sanitation gaps that can be addressed through the intervention. Engaging in RISE through an action research methodology also influenced the PhD candidates’ perspectives on RISE and development of their research.

Type 2 and 3 candidates felt that, in some instances, the project limited potential for their research to produce meaningful and useful outcomes for the project or communities as some of their research activities or aspirations were not in line with, or requisite for project implementation. Data produced by the PhD research was in some cases directly useful for project implementation. However, there is potential for the contribution or involvement of type 2 and 3 PhDs to be negatively affected

by the project itself. Since the PhD projects are ongoing it is expected that they will have promising outcomes and contributions to the project in the future.

Operating through the type 3 mode, Brendan felt that the complexity of RISE and its RCT structure prevented him from undertaking certain activities that involved communities in his research. This was in direct contradiction to his personal view, "...that in the contexts in which RISE is situated there is a great need for the collaborative generation of knowledge". This fuelled an internal conflict around "conducting research in a real-world context in which vulnerable populations provide data... [Which] directly affected and shaped my research focus, my research methods, and the theoretical framework from which I operate". The tension between research activities and lived experiences during fieldwork was observed by Erich as well. He observed that theoretical frameworks he was identifying through his literature review on water level fluctuations in informal settlements were not appropriate to these communities, even seeming "limited, misleading, or derogatory". This reinforced the importance of undertaking fieldwork and having ongoing engagement between project and PhD to support the relevance and rigour of the research.

For Daša, working through type 1—embedded internal mode, the close manner in which her research was intertwined with the project led to feelings of responsibility towards the communities, as well as challenges shifting into later research phases including data analysis and writing up. Daša, reflected that, "through my year-long fieldwork I became very close to the RISE communities. This added another layer of responsibility to my research. After my fieldwork finished, the project implementation continued. I had to distance myself from all teams and communities in order to look at the data and make conclusions that are in line with what the academic discipline demands for quality research".

Research Infrastructure

For many action-research PhD projects much of the first year is spent establishing research infrastructures like networks and support frameworks, to align the PhD project to a relevant real-world situation. For this PhD cohort, structural aspects of RISE established after its launch in 2017—such as international—and in-country research environments and networks—provided significant opportunities for the candidates. Although integral to the delivery of RISE, the transdisciplinary setting of partners, expert academics and practitioners provided a strong foundation for the development and enrichment of the PhD's work. For example, PhDs had the opportunity to participate in RISE's monthly interdisciplinary cross-team meetings of early career researchers and country coordinators, as well as annual workshops bringing project teams together to report and share ideas. This offered potential for collaboration and discussion on work and, in some cases, led to innovation, greater integration of the PhD project, or publications.

The candidates also took on teaching work in our Department. This included leading courses related to, and funded by the lab and its mission, such as a

month-long overseas unit engaging undergraduate students in project contexts and enabling candidates to travel during the first year of their candidature before confirmation. Their later fieldwork travel and accommodation was also covered by project funds. They found valuable support in the country offices. The local staff acted as informants, translators, mediated interactions with stakeholders from communities to institutions, NGOs and government agencies, and invited them into their homes. Brendan reflected on the value of this infrastructure, that there was this “existing network that we could use which was, is really valuable, and is continuing to be”. Erich also observed the advantage that this served in establishing and undertaking the PhD project, where relationships with communities were already established by the project.

PhDs across all typologies observed significant benefits from these project infrastructures, which provided a transdisciplinary setting of academic and practitioner experts for the development and enrichment of their work, and supported them to undertake travel to familiarise themselves with the research context.

Data

In an embedded PhD mode, it is critical that intellectual property and data confidentiality are transparent and communicated early on. Candidates across the three PhD types had different experiences relating to data collection and sharing. For Daša, her close involvement in the project delivery involved her in reporting requirements. Meanwhile, for type 2 PhDs, we observed that good synchronicity with the project could lead to productive contributions, such as a critical dataset which provided opportunities for them to contribute and collaborate with others in RISE. Through his research, Erich participated in the development and implementation of a community-based flood monitoring project. The project engaged members of the community in reporting daily changes in water levels, against gauges installed close to their home. The monitoring project produced directly beneficial data on seasonal changes to water levels in RISE neighbourhoods which could be used to understand influencing factors on community exposure during these periods, and to inform the relative levels of critical infrastructure that had particular flood tolerances.

In comparison, where PhD activities were less synchronised with the project timeline, or the PhD has very specific requirements, we observed that issues could be experienced around data availability. This would delay, or require adaptations to the PhD project, such as supplementary data collection. For example, the project documentation and reporting requirements did not always match the timelines and level of detail that type 2 candidates required and were already difficult to fulfil with the available resources. In addition, the nature of implementing the project on the ground meant that the delivery teams (based in Australia and in Makassar and Suva) needed autonomy to act and respond to on-the-ground needs as required. This fluidity affected candidates’ ability to access information “as it happened” and, for example, limited Mahsa’s ability to understand the impacts of governance and land

tenure, as they related to project implementation since “conversations, negotiations and meetings with the local and central government ...often happen spontaneously, and the meeting minutes are not well-documented or accessible promptly”.

From Brendan’s (type 3) experience, we observed unplanned productive contributions that emerged over time as a result of the close tie-in of the project topic overall. These less centrally located typologies were still able to return on project investment, giving back to the project and overall mission of the lab. For example, Brendan’s morphological studies, which included quarterly documentation of built environment changes in neighbourhoods including new builds and renovations, self-built infrastructure (such as drains) and other spatial changes within sites. This work contributed more directly to lab’s mission to better understand the built environment dynamics of informal settlements, and as a result better working within them. The work was able to be correlated with other data collected in RISE, such as information on inward and outward movements of households in communities and tied into other implementation and research work in RISE.

Candidates’ Background, Competencies and Proclivities

Through the candidates’ interplay with the forces of the live project, we observed certain competencies among the PhD candidates that allowed them to persevere and progress.

The RISE project required candidates to be flexible and adaptable in order to navigate the changing timeframes and ongoing refinement of the project scope. This was echoed through the reflections via phrases such as “negotiation and adjustment”, a need for “emergent-” or “iterative-” “development”, and “adaptability and opportunism”. While all candidates’ projects adapted and developed over time, for Erich and Mahsa (type 2 PhDs), the desire to remain relevant to the project required particular flexibility relating to the challenges they faced. Erich found negotiating the research design and frameworks with reality particularly challenging. Meanwhile, Mahsa observed that the “emergence” of the research activities and plans over time, meant that the challenges and uncertainties of the project could inform the research methods and actionable outcomes. This project experience also instigated transdisciplinary explorations and an opportunity to develop skills in “interdisciplinary understanding and communication”. For Erich relating to risk management—as an engineer conducting research on floods within a primarily architectural research group, and for Mahsa relating to urban governance and policy—as an urban designer conducting research on implementation and scaling-up. This required them to work and communicate across disciplines and with a range of project stakeholders.

The project conditions brought forward not only “opportunistic” research endeavours but also “creative thinking and innovation” in light of working around the project’s constraints, and a need for “independence”. Brendan (type 3), aligned primarily to the mission, found that directing his research into gaps that he

identified in the project and working “externally” to RISE required a “mindset of adaptability and opportunism” while presenting benefits and opportunities. Mahsa (type 2) reflected that although project constraints affected the “duration and depth” of her research activities, these facilitated creative thinking and grounded research outcomes. In hindsight, this creativity also maintained the PhD’s ongoing relevance to the project. Meanwhile, Daša (type 1) reflected that the significant project administration undertaken by the supervisory team forced the candidates to take a proactive approach to their own development. “This was an opportunity to grow into an independent thinker, but it was also a source of insecurity and future uncertainty”.

Conclusion

As we enter into the final year of the PhD candidature, it has been useful to engage in a process of dialogical reflection between candidates and supervisors. It is evident that, while full of potential, the model of operationalising PhD research within live research projects like RISE, is fraught with difficulty and uncertainty. However, as we make strides towards new projects which engage in these difficult contexts and continue the mission of the lab, it is clear that new embedded PhDs will form an increasingly important part of the research ecosystem. There is a confluence of aspirations as a new wave of prospective PhD candidates are increasingly valuing projects that, like the lab, “promote academic opportunities with international networks and participation in research projects” (Patricio and Santos 2019).

In order for a resilient research ecosystem to thrive within the research contexts described here, we look towards bringing together a number of key ingredients to the model. A clearly articulated, mission-based research program (the lab), a multi-year, transdisciplinary impact research project and a spectrum of embedded PhDs. In our reflection of the three typologies of embedded PhD, type 1—embedded internal, type 2—embedded hybrid and type 3—embedded external, the most productive aspects of the model were the result of a set of principles which we consider to be essential ingredients for meaningful engagements.

1. *Establishing a cohort.* Moving away from the lone PhD student and, for each project engagement establishing a PhD cohort. Ideally the cohort would begin at the same time and move through the process together.
2. *Diversity of engagements.* As it is difficult to predict the course of live projects from the outset because of the many variables at play, the PhD cohort should have representation across the typological spectrum—from those that are completely intertwined with the project to those who operate towards the broader mission but are not delivering core project research. This diversity will bring resilience to the PhD cohort and to the lab.
3. *Staging.* The typological direction may only become evident over time and as the project develops and variable become clearer, candidates can transition to different pathways. Refer to Fig. 4.3, which describes this transition. In our experience

it is key for embedded PhDs to begin their studies, in their first year, closely entwined with the project. This allows for deeper engagements and a meaningful knowledge of project teams, contexts and project infrastructure. In this model, the confirmation milestone at the end of the first year marks an important moment in the model. The first year is pivotal in determining which direction the candidature will take, and which typology is best suited to the candidate's aspirations and proclivities as well as best supporting the project research ecosystem. In this example, after confirmation, PhD's types 2 and 3 veer in different degrees away from core project research towards contributing in a broader manner to the lab mission. PhD type 1 remains deeply entwined with project operations and contributing to core research up to mid-candidature at the end of year two. After this, similarly, they move away from core project research.

4. *Fieldwork*. Many PhD programs do not allow fieldwork until after the first year and the candidate has been successfully confirmed. In international development projects where PhD's are expected to make significant contributions, a meaningful understanding of the context is critical in order to ground the project in reality. Travel to the project location(s) is highly encouraged in the first year.

The articulation of this embedded research ecosystem—involving the lab research mission, the research project and the three typologies of PhD's, we hope will offer guidance to future project structures in being more deliberate and productive. Charting different PhD pathways and articulating the roles and responsibilities of multiple types of engagements may also guide prospective students and supervisors in assembling the most productive and fulfilling arrangement. This framework may also offer utility in allaying some of the concerns and fears of engaging in such a model. Being explicit about this framework from the outset provides not only choice but also direction and certainty for candidates and supervisors alike.

We have explored through this dialogue the difficulties and challenges associated with deep project integration (see Table 4.1). In type 1, the greatest level of integration requires that the PhD topic and structure align in an entwined way with the project but that it is able to sway and adapt as the project inevitably changes over time. This dynamic environment can be stressful and uncertain, requiring the PhD researcher to have a certain appetite for chaos- to be nimble, flexible and open to the uncertainties of inevitable project deviations. In type 2, the hybrid mode remains connected to the project while establishing its own research direction with contributions at key moments. Less influenced by project dynamics than the first, this typology needs to retain clear communication in order to remain synchronised. In type 3, the PhD topic and structure shift away from the project but remain aligned to the lab mission granting the greatest degree of researcher autonomy. This detachment means that the typology may have greater difficulty engaging in impactful research however this can be managed through close alignment to the lab mission.

Although the PhD types were not so much a "choice", but rather emerged as project and candidature developed, the lab mission provided a space for PhD projects to be impactful outside the project and added resilience to the research ecosystem. From our collective reflection, this is one of the core characteristics that

separates the “embedded” approach from the “traditional” approach. For prospective supervisors hoping to establish a similar operative model of PhD research, it is important that directors/managers of prospective projects are able to identify the areas where PhDs will operate and a research direction for each “type” based on the project’s unique requirements. This direction will assist future PhDs and be especially useful to supervisors in structuring and navigating transdisciplinary research ecosystems to more effectively contribute to on-the-ground, impact-driven endeavours.

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