Article

Sustainability through Resilient Collaborative Housing Networks: A Case Study of an Australian Pop-Up Shelter

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Abstract: The UN Sustainable Development Goal "Sustainable Cities and Communities" foregrounds access to adequate, safe, and affordable housing. However, housing as a sector has faced significant sustainability challenges. Countries such as Australia face unaffordable house prices, bottlenecks in social housing supply, and escalating homelessness. To address these challenges, the sector has turned to traditional government-led interventions meant to influence supply and demand. We argue that alongside these traditional approaches, there is a need for multi-stakeholder collaboration in resilient networks that create novel niche solutions, one being pop-up shelters or dwellings established in vacant structures. This study's main aim is to identify key elements of these resilient, collaborative actor–networks. We mobilise actor–network theory concepts in a qualitative case study involving one of Australia's first pop-up shelters. Findings from semi-structured interviews suggest that resilient networks exhibit distributed leadership, the ability to selectively interrogate entrenched routines, and the ability to mobilise differentiated levels of convergence. Such resilient networks play an important role in the development of environmentally and socially sustainable housing solutions. While often ad hoc, these networks can be made systematic through the selective use of digital technologies which do not compromise the more contingent, adaptive features of networks which are critical to resilience.

Keywords: actor–network theory; adaptive reuse; collaboration; digital collaboration; pop-up shelter; resilience

1. Introduction

The Geneva UN Charter on Sustainable Housing begins with the claim that "sustainable housing has a key role in the quality of human life" [1]. However, the housing sector has persistently been linked to environmental and social sustainability challenges. In Australia, the construction, operation, and demolition of buildings generate almost 25% of the country's greenhouse gas emissions [2]. In terms of social sustainability and access, the Australian housing sector is under stress from interlocking challenges such as unaffordable housing [3], increasing homelessness [4], and bottlenecks in the allocation of social housing [5].

Many solutions to housing challenges are in the form of top-down, government-driven interventions designed to influence housing supply and demand. We argue that while there is value in such an approach, there is a need to consider other models that involve multi-stakeholder collaborations in resilient networks that create novel niche solutions. Our key research question is: *What are key elements of resilient collaborative housing networks?*

To address the research question, we conducted a qualitative case study of one of Australia's first pop-up shelters. We show how this particular pop-up shelter was a nimble niche solution that addressed persistent environmental and social sustainability challenges simultaneously. Environmental sustainability challenges were addressed because the pop-up network involved adaptive reuse of an existing structure awaiting development

approval. At the same time, social sustainability challenges were also addressed through the provision of affordable housing to vulnerable youth groups. We argue that the capacity to create such an inventive, agile solution came from the network's collaborative characteristics, which we distil from an exploratory empirical study.

The paper is structured as follows. In Section 2, we present an overview of the housing landscape, building an argument that we need to carve out more space for the role of resilient collaborative housing networks, given that they are better positioned to create novel, nimble niche solutions to housing. In Section 3, we present actor–network theory (ANT) as our analytical approach for supporting network analysis. In Section 4, we present our research methodology, which involves an exploratory qualitative case study and semi-structured interviews. In Section 5, we draw from our empirical analysis to present an emerging theoretical conceptualization of resilient collaborative networks. We end with a discussion of contributions to theory, to ANT, and to practice, while identifying directions for future work.

2. Housing Challenges in Australia

Housing in Australia is a problematic arena. From a social sustainability perspective, indicators of accessibility and affordability are troublesome. House prices in major cities have been among the least affordable in the world [3]. The 2016 census reported an increase in homelessness from the previous 2011 census, despite national-level plans to "halve homelessness by 2020" [4]. Provisions for social housing are limited [5]. Solutions to challenges often take the form of government-led interventions, implemented as levers to influence housing supply and demand. Traditional supply-side interventions include streamlining development approval, instituting reforms in planning, and increasing the stock of affordable housing [6]. In the state of New South Wales, for example, the government developer has made the commitment that for its residential projects, 5–10% of dwellings constructed will be affordable housing [7].

A range of demand-side interventions have also been mobilized. These include providing incentives for homebuyers, providing renters with greater security, or assisting people with low incomes access services related to homelessness and social housing. In 2017, the government earmarked a record-breaking Aus $1.1 billion for homeless people and for services for those in social housing [8]. Still, outcomes have been mixed. For example, allowances are being offered to first-time homebuyers, but some argue that these have been counterproductive and have exacerbated the problem of affordability by pushing up house prices in an already overheated market. Social housing has been provided by state governments and private players, but many of these dwellings have been in areas that make employment inaccessible and are lacking in community services [9].

From an environmental sustainability perspective, the sectoral trends have also been cause for concern. The city of Melbourne is expected to need more than 700,000 additional dwellings in 10 years, while Sydney is predicted to need more than 600,000 in 20 years. These projections are expected to have significant implications for greenhouse gas emissions, but to date, Australia's National Construction Code still sets requirements for energy efficiency that are minimal [2].

Housing challenges are clearly complex problems [10], thus this paper makes the argument that traditional government-driven solutions are important but inadequate in addressing such entrenched and multifaceted problems. We argue that the creation of meaningful sustainable housing solutions requires broadening the housing governance arena in four ways. First, *there is a need to move beyond the dependence on government as a central player and to foreground multi-stakeholder collaboration in addressing complex housing problems*. The government-centric approach to housing problems was once widely accepted and could be explained by the deeply entrenched, dichotomised view that the public sector's role was to provide public goods, while private firms' role was to maximise profit. This landscape has changed, with different stakeholders now becoming involved in problems that had been left to government in the past. Citizens, private companies, entrepreneurs,

and non-profit organisations are increasingly partnering to solve complex problems [11]. It is becoming more and more widely accepted that multifaceted problems, such as those confronting the housing sector, require "the collaboration of a diverse set of stakeholders operating at different levels, often in networks, from local users, to municipalities, to regional and national organizations, and also to international bodies" [12]. This is not to say that government no longer has a role; the argument being made is that there is room for a variety of collaborative arrangements, government-led or not, that could lead to innovative housing solutions, and that collaborative participation leading to a broader ecology of goals is a central component of success.

Second, *there is a need to expand the existing toolkit of interventions, to consider novel and even niche solutions*. Niche solutions tend to be overlooked, an example being the use of hidden housing stock in the form of vacant buildings. Idle assets have significant potential for adaptive reuse, that is, "[changing] the use of existing buildings for other uses than they were originally designed for" [13] (p. 14). Adaptive reuse is a strategy that has been carried out in Hong Kong, Los Angeles, New York, Cyprus, Spain, and Italy [13–15] and has been linked to environmental and social sustainability benefits. In Australia, adaptive reuse has been explored by actors who convert vacant properties into temporary dwellings for a short period, possibly because owners are awaiting development approval. These are sometimes called pop-up shelters [16]. Pop-up shelters have been used to address persistent homelessness [17] and as an emergency response to accommodation needs during the global pandemic [18]. There are, of course, other novel housing solutions beyond adaptive reuse that can also be considered: diversifying housing typologies through novel and mobilizing unexplored dwelling types, such as tiny houses and elder co-housing, and inclusionary zoning [19]. However, the focus of this study is on pop-up shelters which have begun to emerge in various forms, for example in Sydney and Melbourne [20].

The strength of these types of novel housing solutions is that they do not have to be large-scale, top-down interventions; they can involve "small scale, diverse and niche solutions" [19]. This is not to say these solutions are easy; they require "out-of-the-box", "innovative and collaborative thinking and action" [19] (p. 183). However, they are important because they lead to increased resilience in the housing system, thus they "need to be an integral and supported part of the structural change in Australia's housing system" [19] (p. 183). This leads to the third point of our argument: that *one goal of collaborative, novel solutions is to enable resilience in the housing sector*. There is no single fixed definition for resilience, but we draw on work that defines it as "the ability of a system to respond to unforeseen events without compromise to core functions" and the ability "to survive, adapt and improve in the face of stress and change, to be able to withstand shocks, but reorganise and rebuild when necessary" [21] (pp. 2,3). A resilient housing system should be capable of dealing with a range challenges, entrenched ones or even sudden threats such as a global pandemic.

One way to be sensitised to resilience in housing is to take the perspective of the housing sector as a network. A housing network can be understood as "individuals, institutions, resources, societal norms and expectations, environmental factors, regulatory frameworks and so forth"; by extension, a resilient housing network is one that can respond to unforeseen events "through an ongoing process of feedback, reorganisation and renewal" [21] (p. 2). The fourth part of our argument, then, is that *resilient, collaborative, novel solutions emerge from resilient, collaborative networks*. The network approach we draw on is actor–network theory (ANT), an analytical approach founded on the premise that much of the world is the outcome of human and non-human actors interacting in networks [22]. We provide a more detailed discussion on ANT shortly. What is noted here is that ANT is well-suited to the study of housing, one reason being its consideration of human as well as non-human actors. ANT is also well-suited to studies involving resilience, since it assumes that all networks, even seemingly durable ones, are only contingently stable [23].

In summary, we have proposed that current models of governance in housing be rethought along four dimensions: (1) the need to build on multi-stakeholder collaboration,

which can then address (2) the need for novel and niche solutions. We have also argued for (3) the need for resilient systems, which means (4) the need to examine the housing sector as a network.

Weaving these together, our key research question emerges as: *What are key elements of resilient collaborative housing networks?* Answering this question could provide a pathway for nimble niche solutions that address environmental and social sustainability challenges in housing. This research question can be divided into five components, shown in Column 3 of Table 1 below. This approach builds on work on the development of an expanded conceptualisation of collaboration in housing construction using actor–network theory concepts [24]. This study provides a platform for extending this definition, moving from an understanding of collaboration to collaborative actor–networks to resilient collaborative actor–networks.

Table 1. Developing a conceptual definition of resilient collaborative actor–networks.

Dominant Understandings of Collaboration as Noted in [24] (p. 559)	ANT-Informed Expanded Conceptualization as Adapted from [24] (p. 572)	Directions for Exploring Resilient Collaborative Actor–Networks as Key Contribution of the Paper
Collaboration involves a monolithic, unchanging goal driven by a convenor	Departs from the view that collaboration is unitarist and emphasizes how vision and leadership can change and shift	What are the key elements of goal setting and leadership in resilient collaborative housing networks? (Section 5.1)
Collaboration is the work of humans	Highlights how both human and non-human actors can create, stabilize, unify and even destabilise collaborative networks	What are the contributions and limitations that human- and non-human actors bring to achieving resilience in collaborative housing networks? (Section 5.2)
The collaborative ideal is integration.	Interrogates the idea that collaboration has to lead conformity, and proposes instead that a looser, less cohesive notion of "coherence" can suffice	What forms, if any, do network convergence and coherence take in resilient collaborative housing networks? (Section 5.3)
Collaboration takes place in the context of an external environment that should be managed	Emphasises how networks can be layered on top of one another, and alignment between goals of layered networks strengthens collaboration	How can resilient collaborative housing networks be seen as networks dynamically aligning to other networks? (Section 5.5)
Collaboration involves structures that make collaborative arrangements stable and persistent	Interrogates the permanence of collaborative structures, emphasizing that these are always contingent	How can resilient collaborative housing networks reconcile contingency and stability? (Section 5.5)

3. Actor–Network Theory in Housing

As argued earlier, potentials for resilience in the housing sector can be identified by adapting a network approach to understanding the landscape [21,22]. The specific network approach we adopt here is actor–network theory (ANT). ANT is an analytical approach that assumes that the world is made up of heterogeneous (human and non-human) actors that are constantly exercising agency in ways that (re)create associations with one another, leading to network effects or outcomes [23,25]. Any entity "that does modify a state of affairs by making a difference" [26] (p. 71) is an actor. One of the most radical claims of ANT, then, is generalized symmetry, or the assumption that non-humans are actors because they can exercise agency. The assumption gives humans and non-humans equal ontological status, and they are thus analysed in the same way [23]. To clarify, ANT does not claim that non-humans think like humans then execute deliberate action, but it does claim that objects "authorize, allow, afford, encourage, permit, suggest, influence, block, render possible, forbid, and so on" [26] (p. 72) and therefore "material systems [can be] agents . . . or at least co-agents of intentional human action" [27] (p. 238).

Human and non-human actors are constantly working to create, recreate, or eliminate associations that make up networks. However, ANT researchers do not focus on actors as

discrete objects. Instead, ANT researchers focus on connections, associations, or interactions between actors [23]. Network outcomes are thus the effects of actors in association exercising power relative to one another, in a series of "endless attempts at ordering" [28] (p. 101). This form of "work" is the subject of much attention in ANT research, often captured under a process known in ANT as translation.

The emphasis on linkages in ANT means that entities in a network have meaning only in relation to other entities in the network. A commercial building site, for example, is only a tract of land unless it is seen in relation to the zoning controls that categorize it in a certain way. Additionally, actors' characteristics are only understood to emerge from their interactions with other entities. Researchers thus do not make *a priori* assumptions about the attributes of autonomous entities and instead "focuses on the relationships in which agents participate and how these are used to influence the shape of a network of related relationships" [29] (p. 28).

Our aim, then, is to mobilise key ANT concepts to develop the beginnings of a theoretical definition of collaborative resilient actor–networks. We develop this definition through a qualitative case study.

4. Methodology

4.1. Case Study Description

Our research involves a qualitative case study on one of Australia's first pop-up shelters. In April 2017, an Australian developer, BuildWell, had a vacant three-story hotel awaiting development approval and announced that it would make 42 affordable, fully furnished rooms available to 16- to 25-year-olds for at least twelve months. Each room would have a bathroom and a kitchenette and would be available at a nominal rental rate of AUS $180 per week. One of BuildWell's first actions was to conduct a search for an organization to operate the premises, a process that initially proved to be difficult. After a few months, the development firm obtained the services of a youth housing organisation, YouthWell.

BuildWell's original vision was to provide temporary dwellings for people sleeping rough on streets. However, given the limited lease period that could be offered to potential residents, the youth housing organisation director advised a recrafting of this vision. She suggested that it would be more strategic to shift the focus to residents who could be expected to transition with ease into other housing arrangements at the end of the short-term lease. This arrangement remains in place today. Under the current setup, a certain number of rooms is also allocated to clients of the Department of Family and Community Services, which provides a revenue stream that supports operations. BuildWell also partnered with a number of operators to have additional services available at the pop-up: EatWell, a non-profit organisation distributing large volumes of rescued food, was invited to partner and decided to set up a free grocery store open to the public as well as to the pop-up residents; FitWell, a clothing retailer with access to new, free "end of line" clothing, was invited to open a "store" where residents as well as the general public could obtain pieces of clothing for free, using a voucher system; and CleanWell, a mobile laundry service, was given parking privileges at the hotel, in exchange for free services for the pop-up residents on fixed days each week.

4.2. Data Gathering and Analysis

The research methodology involved a single qualitative case study, an approach which was selected because it is highly suitable for novel, emergent phenomena such as pop-ups, which are little understood [30]. Research using single case studies or a few strategically selected ones has been published in high-impact publications [31–33]. The value of single case studies has also been well-explored and justified by researchers [34,35]. Readers should also note that there are very few pop-ups in Australia [20], thus very few cases are available. Still, theory-building has been done through novel findings from a prototypical case, and this is what we seek to do here [35].

Data was gathered through interviews, document reviews, analysis of BuildWell's corporate social responsibility videos, and site visits to the pop-up shelter. One of the researchers also took part in a half-day volunteering opportunity where she assisted with operations at EatWell and at FitWell. Six interviews were conducted: two managers at BuildWell who led corporate social responsibility, the director of YouthWell, the on-site manager of the pop-up, and the state manager of EatWell. Interviews and videos were fully transcribed and analysed thematically in two rounds. First-level analysis involved identifying participant-driven thematic areas, without any reference to theory. This first round of analysis ensured we drew from the full qualitative database without closing down on the data. Second-level analysis then involved grouping themes into the five bigger clusters under the five questions in Table 1, Column 3. The use of participant-driven as well as conceptually driven themes is a strategy for strengthening the transparency of the movement from data to analysis, thus achieving rigour [36].

5. Findings

Our findings suggest that resilient collaborative actor–networks (hereafter called resilient networks for brevity) have distinct features, five of which are discussed in this exploratory study. The five Sub-Sections (Sections 5.1–5.5) below map to the sub-questions identified in Table 1. The five Sub-Sections are broken down further and are indexed (Section 5.1) to keep the discussion organised.

5.1. Resilient Leadership: Flexible Goal Definition, Distributed Leadership

One feature of resilient networks is their flexible definition of overarching goals (Section 4.1). In actor–network theory, network goals are defined through a process called problematisation. The network's prime mover frames a problem in a particular way, defines a preliminary solution, then proceeds to define other actors' roles and identities so that the network can address the problem [22]. In this case, BuildWell defined the problem as the need to utilise an idle asset. The solution was to use it to for homeless people, specifically people "sleeping rough" on the streets. Under traditional management and planning approaches, this process is often understood as top-down, unproblematic and uncontested [37]. However, an ANT approach emphasises that this process of goal setting is always subject to negotiation. BuildWell formulated a "dominant framing", but this framing was also contestable, subjected to compromise and negotiation among actors with different interests and varying degrees of power [37].

One of BuildWell's first steps was to find an organisation that would operate the pop-up shelter. After some difficulties, including efforts to reach out to well-established organisations, BuildWell partnered with YouthWell, a community youth housing organisation that had been operating for only 18 months. YouthWell's director recounted that BuildWell's vision of addressing homelessness was well-intentioned, but it needed reshaping:

> . . . *they were thinking about youth homelessness in a way that most people do that aren't involved in youth homelessness, which is that you'll be taking kids off the street. Generally, that's not how youth homelessness manifests itself. There are obviously numbers of young people that do sleep rough but there are vastly more that are going from house to house, sleeping on trains, sleeping at auntie's place on the floor one night and their mate's garage the next, having showers at the gym, that kind of thing. It's not—they haven't necessarily worn out their welcome yet. So, one, within that meeting I needed to educate [BuildWell] about how youth homelessness manifests itself.*

—Director (YouthWell)

YouthWell and BuildWell entered into discussions that reshaped the original goal for the pop-up in two ways. First, YouthWell noted the importance of managing BuildWell's reputational risk, explaining that it was important that BuildWell not be seen as the "big bad developer" when the time came to pop down and residents would have to leave. This concern for BuildWell's reputation meant that, from the beginning, the pop-up's target residents had to be individuals with a strong chance of transitioning into other more

permanent housing when the lease ended, which could take place quite abruptly when development approval was finally given. The co-director of Corporate Social Responsibility at BuildWell thus noted that a decision was made to move away from rough sleepers and to target

> *Young people who are one step away from homelessness and are kids who have been couch surfing but that have a job or they're studying or they're—so they actually pay— they probably get their allowance from the government. They have to pay for their accommodation, a very nominal amount.*

—Director, Furniture, Fittings & Equipment Procurement/Head of CSR (BuildWell)

The decision was made to target youth primarily from a nearby university. A second modification of the original goal was pursued to manage economic risk to BuildWell. The YouthWell director recalled

> *I thought that if they're going to give us this big asset I wanted to take all costs away from them. And so, the proposal that I put to them included an income stream that would be able to cover the cost of rents, insurance, utilities, you name it, plus our staffing of the building, so that we could keep people safe and well in here.*

—Director (YouthWell)

This led to YouthWell contacting the Department of Family and Community Services Community, asking if they would be willing to include the pop-up shelter in their list of accommodations for families in need of temporary housing. This arrangement provided an income stream for the pop-up, allowing the shelter to cover its own operating expenses, including staff as well as 24-h security. The Discussion Section will provide a deeper discussion on pop-ups' economic viability. What is noted here is that the vision for the pop-up evolved from a shelter for rough sleepers to a temporary hotel catering to a mix of tenants paying nominal feels.

The evolution of the vision showed that BuildWell did not impose its vision unilaterally across a network of actors. BuildWell, in effect, relinquished some of the power of leadership by allowing YouthWell to recraft the overarching network goals. We find that this relinquishment of absolute leadership to be an important feature of resilient networks. "Letting go" of a rigid agenda allowed the network to evolve in such a way that a viable niche was quickly identified and filled. This letting go was also signaled by the Managing Director of BuildWell, who basically "handed over" the running of the pop-up to the YouthWell Director, saying "It's all yours." In resilient networks, then, shared or distributed leadership appears to be a key element (Section 5.1). Power, in ANT terms, is distributed, thus every actor's agency is "...a force distributed across multiple, overlapping bodies, disseminated in degrees—rather than the capacity of a unitary subject of consciousness" [38].

5.2. Resilient Identities: Flexible Role Definition, Simplified Entry Passages

Law suggests that "the object [of ANT studies] is to explore and describe local processes of patterning, social orchestration, ordering and resistance. In short, the aim is to explore the process that is often called translation which generates ordering effects such as devices, agents, institutions, or organisations" [23] (p. 387). A key process for achieving this ordering is translation.

During translation, the prime mover goes beyond identifying actors as disparate players with dispersed goals and instead begins to demonstrate how the fulfilment of individual goals can only be simultaneously achieved through the formation of an alliance. The commitment to a single program is showcased as a common or "obligatory point of passage" that all actors must be funneled through. Each actor can only be enrolled in very specific terms and part of this involves interdefining themselves relative to other actors [25].

Interdefinition signals an important assumption of actor–network theory: actor identities and roles can only be meaningfully defined in terms of their relationship to other actors. BuildWell, for this ANT study, is not seen as an autonomous "developer". In this

network, for example, one way it is interdefined is relative to the idle asset. BuildWell thus emerges as both commercial developer and an altruistic community service actor offering a building for "temporary accommodation for people who need housing assistance". The empty building, in turn, is [inter]defined "temporary accommodation" relative to its target residents, while in the past it was interdefined as a commercial hotel catering to regular hotel guests.

ANT researchers argue that the process of interdefinition takes place in all networks. For resilient networks, however, it appears that the rapid negotiation of interdefined roles (Section 5.2) must take place. An example at the organisational level is YouthWell. Prior to its enrolment in the pop-up network, YouthWell was a new organisation with a different set of plans. When the possibility of joining the pop-up shelter materialised, YouthWell was willing "to drop all of its plans" to take on the pop-up shelter operation full-time. YouthWell signified its willingness to put itself through the network's obligatory points of passage, defining its role in a written proposal that was written speedily:

> So we made it our business to have a proposal in front of him three days later that said this is what we're going to do with it and luckily for us he accepted that proposal. Three months later we opened the doors.

—Director (YouthWell)

Swift role interdefinition also took place on an individual level. The current on-site manager of the pop-up shelter recalled how he had originally been hired as a community housing manager, then was told "within minutes" after the proposal was approved that he would be taking on an entirely different role as on-site manager of the pop-up shelter:

> Well, I originally applied for Housing manager job in October 2016. So then I knew that this, well, starting from day—I mean you working on something—didn't know it was to this size scale of this building—pretty much it's, like...a month later here you go, here's my baby, you need to carry the baby more.

—On Site Manager (Pop-up Shelter)

The responsiveness of key individuals and actors were decisive factors that weighed significantly in terms of which actors were enrolled, or not enrolled, in the network. Responsiveness depends in part on how easy the prime mover makes it for actors to join the networks and commit to a single network. In ANT, actors must negotiate then agree to join the network in very specific terms, going through obligatory points of passage [25]. In early stages, the managing director at BuildWell had attempted to enroll other actors

> Our managing director ... had called all these contacts to say, "Look, we've got a development site. There's actually a hotel on the site. I've thought about this. I would like to speak to someone about maybe some type of pop-up shelter." Not one person called him back.

At one point, a BuildWell representative, referred to in ANT as a spokesperson, was appointed to invite actors into the network, but this representative initiated enrolment by presenting a very complicated contract for actors to comply with. In ANT terms, highly complex obligatory points of passage were set up and many actors chose instead not to become part of the network:

> I think the way he solved the whole thing was—you know [the original spokesperson working on behalf of the managing director] overcomplicated it. It was a guy who just overcomplicated everything ... "

—Director, Furniture, Fittings & Equipment Procurement/Head of CSR (BuildWell)

> ...he's a commercial manager and he couldn't help but put every little bit of security. So no one showed a lot of interest [because he had] ... put too many rules and regulations around [the] building.

—Operations Manager (BuildWell)

The example shows how a non-human actor, in this case a contract, can exercise agency as a gatekeeper, bringing certain actors in while leaving others out. In this case, the contract became insurmountable hurdle for many initial contracts. Flexible entry points into partnership (Section 5.2) thus seem to be critical for resilient networks. Flexibility in entry points can be achieved through different strategies. Instead of tapping formal channels that identified community service actors who had established reputations, BuildWell instead began to tap people from their own networks: people they "knew personally", people they "knew from other projects", people who were "referred by the hairdressers". Even the manner of issuing invitations was informal:

> *...we don't ask people specifically. They generally say, "Look, I'm really interested. Is there anything I can do to help?" and if we feel like we need more help or there's a bit of a gap then we say, "Yeah, join the committee," and they're in. So that's kind of—I would definitely say that's been organic as well.*

> —Operations Manager (BuildWell)

Second, BuildWell moved away from tightly defined contractual requirements and instead framed the partnership question in more open-ended ways. For example, BuildWell noted that there was a huge empty Chinese restaurant on the ground floor of the hotel, so they approached a personal contract from the organisation EatWell and offered use of the facility, for very flexible terms:

> *[We said you can do] " . . . [w]hatever you want. So long as you're helping people who are in need it's all yours. So a pop-up restaurant where you're training young children or a coffee shop or—I don't know. I'm not sure what you—it's your call." [The contact] had just been to the UK and she literally jumped off her chair and she said, 'I'm going to start Australia's first free supermarket for people in need."*

> —Director, Furniture, Fittings & Equipment Procurement/Head of CSR (BuildWell)

Like YouthWell, EatWell responded quickly to the offer:

> *the decision was made to turn that into—that space into a supermarket. It was done and turned over in I think about three and a half to four months from initial concept to actually executing, so it was done very quickly. And I think this is what you find with an organisation like [EatWell], we're very agile, so if we have a great idea then we'll move pretty quickly on it and we'll get it done.*

> —Manager (EatWell)

A resilient network can thus be formed in a quick, responsive manner by actors (human and non-human) rapidly responding to the process of interdefinition, as well as by the prime mover managing obligatory points of passage in ways that lower hurdles. In the next section, we explore the role of non-humans further, this time by analysing how they can be critical to network integration.

5.3. Resilient Integration around Human and Non-Human Actors

Once actors are enrolled, the prime mover then mobilizes strategies that seek to stabilize these new identities and interests. If these strategies are successful, actors give their consent to become part of the network [39] and networks become characterized by increasing convergence. Convergence is linked factors such as to alignment (actors share space and history), coordination (actors adopt conventions prescribed by the network) and irreversibilisation which makes networks difficult to change [40]. Convergence requires that actors resolve conflicts and controversies. Controversies can take various forms, for example goal misalignment or gaps between roles and identities. When controversies are resolved, actors achieve "adhesions" as they "manage to work out a solid compromise to live together" [41] (p. 261).

In our case study, the non-human actor, the pop-up building, played a critical role in the achievement of convergence.

So they got an organisation that looks after youth homelessness to run the hotel and convert it, so it's suitable for youth who are homeless to be housed. A further area available for [EatWell], another area available for [FitWell] and parking at the back available for...the laundry service. So put all those services together and you have a holistic response to people who are in need. They can have accommodation, food, clothing and have their clothes washed, everything under one thing.

—Director/CEO (FitWell)

The building was the literal "shared space" where actors converged. Significant role interdefinition had taken place during the planning stage, but in the implementation stage the building also served a platform for ongoing role interdefinition with actor-occupants continuously refining interfaces. This was clearly evidenced in YouthWell's relationships with three other actors on site: EatWell, FitWell, and CleanWell. A key lesson here is that resilient networks require (Section 5.3) different levels of adhesion so that the resilient network can operate on an ongoing basis. Not every partnership has to reflect a tight coupling. This pop-up shelter case shows that if this were the case, actors would be locked into ongoing negotiations, possibly even conflicts, that could hamper efficiency.

The adhesion between YouthWell was tightest with EatWell because they occupied the same building. This adhesion was challenging for a time because of the two actors shared the hotel space but had incongruent goals:

...one example, I suppose, for us in Youth Housing, managing who comes and goes, safety is of number 1 importance, [while EatWell] has got a supermarket screaming out to everybody who walked past, come in, come in. That's like the antithesis of what we would have set up, right. But you've got to make it work.

—Director (YouthWell)

To resolve what ANT researchers refer to as a "controversy" [41], detailed negotiations had to take place around issues such as entry and exit rules, security cameras, timing of delivery, and, for a time, special hours of access to the grocery for pop-up shelter residents.

That's one of the things we spend money on, you know, when we came in is that there was CCTV but it didn't have the full coverage. So we added . . . some cameras, made sure there was—the viewing was out here in the back. We made sure there was one at reception so that the staff could be constantly seeing what's going on in the building and who's coming and going, who's coming down the side and who's coming out, you know, so that we could manage that. It was important that we didn't take those things and say, oh, well, that's it, I'm out of here, because that's—but some of them were more difficult to negotiate than others.

—Director (YouthWell)

YouthWell's relationship with FitWell also had to be negotiated, with a different outcome. FitWell was originally meant to share hotel space with YouthWell and EatWell and was allocated store space in the hotel basement. The FitWell director recounted:

[YouthWell] said they're happy for us to go downstairs to the basement. I had a look at it, and I said, I'm not bringing clients down here. I don't want people who are doing it tough, being sent to a basement. I want them to come in off the street like everybody else." The only difference between this experience here and any other retail experience is that you don't pay. But parents who come in here with their children, they get their clothes, they try things on, they complain . . . at the counter, so it looks like Mum and Dad are going to pay, so it doesn't look like a charity shop. It doesn't look like you're poor, so therefore you go down into the basement. You're poor so you're given things, not choose things. And I was very determined that we were not going to send people into an environment that I myself would not want to go into and shop . . . So we worked closely on that with [BuildWell and YouthWell] and we got to an arrangement that we were all happy with.

—Director/CEO (FitWell)

The outcome that was negotiated involved locating FitWell in a small building separate from the hotel, where the shop atmosphere that was valued by FitWell could be better achieved, without the need to manage multiple shared interfaces with YouthWell's physical space.

Finally, YouthWell's relationship with CleanWell also had to be defined. This matter was largely unproblematic. CleanWell offered its mobile laundry services from its own van and all it required was ongoing parking space, hence its operations did not merge in any way with YouthWell, apart from the need for CleanWell to allocated laundry days for pop-up residents. FitWell did mention their desire to explore the possibility of partnering more tightly with CleanWell in the future. Overall, however, CleanWell functions in an almost autonomous manner.

Our case study shows, then, that it is not necessary that all actors in networks must be fully converged. Varying degrees of convergence are possible, perhaps even helpful. Loosely coupled partnerships allow actors the space to pursue goals which might be partially divergent, and this can be expected when actors are tenuously linked in a temporary arrangement such as a pop-up.

5.4. Resilience and the Interrogation of Structured Routines

Networks stabilize into routines and may even reify over time to the point that a heterogeneous network begins to appear as a single, coherent black box, a simplification process known as punctualization [23]. When networks are black-boxed, a complex assemblage begins to be seen by others are a single actor. Scrutinising the black box takes place only when a controversy arises.

A smoothly running network can thus be left uninterrogated, to the point that it is taken for granted and its routines become difficult to change. This point is important when we consider that the pop-up shelter was formerly part of a different network. As a hotel, it was interdefined differently to another set of actors. At one point, it was a commercial hotel interdefined with the Department of Planning. The building-as-a-former-hotel had to "comply" with certain planning rules, was classified under a specific zoning classification, confined to certain terms of use and subject to certain strata regulations. For a long time, it had functioned as an actor in that network, routinely complying with regulations.

When BuildWell created the network and interdefined the building in new ways, it enrolled the building into a new network (the pop-up shelter network), but the building remained entrenched as part of the previous Department of Planning network. Put another way, it was simultaneously a building-as-pop-up-hostel and a building-as-a-former-commercial-hotel. The building was thus in a state described by actor–network researchers as multiplicity [42]. Such an arrangement can lead to tension in actors, for two reasons. First, actors may have to take on roles and identities in each network, and such roles might be contradictory. In this case study, though, it is worth noting that the shift in identities was not very significant. The physical features and even contents of the "old" original hotel were very much aligned to the physical features of the "converted" youth hostel. The original hotel rooms, for example, were simply refurbished into hostel-type accommodation. Existing beds and refrigerators that were carried over from the hotel were tagged, tested, and when suitable, simply re-used. Cheaper items such as kettles were only replaced after it was found that buying new ones would be cheaper than tagging and testing. The On-Site Manager of the pop-up shelter noted that overall, all that was needed were "just new carpet and a paint job." This refurbishment process took three months. Other key areas of the building were likewise largely retained: the hotel lobby and reception area were mostly preserved and set up as a receiving area for homeless people.

The hotel kitchen and restaurant, designed to support communal eating, was converted into an open plan grocery store with basic shelving. Some work had to be done on the restaurant area to make it usable as a grocery store:

> *It's a bit like Armageddon, you know, how those Armageddon movies—that you walk into a restaurant or everything is all set up for the day ready; it was pretty much like that.*

—On Site Manager (Pop-up Shelter)

Still, the work that had to be done in the restaurant mainly involved cleaning out the space, a task that was done through volunteers. No major work, such as structural changes, was carried out. In short, the shift from "hotel" to "hostel" was not a huge leap, making the structure an ideal candidate for adaptive reuse:

Then it was a matter of, okay, we'll fit it out and we'll be open in two weeks which we were . . . Yes, we ripped out the guts out of what was here, and we made this. So somebody came in and donated that floor at the front, somebody came in and donated the polishing of the concrete here. Somebody else repainted for us, it was just done.

—Director/CEO (FitWell)

That said, adaptive reuse of structures sometimes raises other challenges, one being the need for users making sacrifices to accommodate less-than-ideal situations:

That's one of the key parts because often the buildings we're going into, if they are set aside for [Development Approval], they're obviously in some state of disrepair because they've been left idle for a while or nobody's really looked after them towards the end of their life span because they know they're going to get knocked down, and we've been in many buildings like that, where it's going to get knocked down next year, why would we bother repairing that there, why would we bother spending money on it when we know it's going to be knocked down, not knowing that we might take it over. So the market we're in at the moment is definitely not perfect, it's got leaks in the roof and the plumbing doesn't work often and the cool room that's in the back there often needs repair; it's a pretty run-down spot.

—Manager (EatWell)

Multiplicity, or embeddedness in multiple networks, also raises other challenges apart from potentially conflicting identities. Actors that are part of two or more different networks might be subject to contradictory *rules and routines* shaping each network. To allow the building-as-pop-up to function meaningfully as an actor in the new network, some of the planning rules and regulations that the building was previously enmeshed in had to be interrogated. As we will show, resilient networks must strategically interrogate (Section 5.4) and selectively reconfigure (Section 5.4) the routines of black-boxed networks.

BuildWell and YouthWell, for example, undertook the task of exploring what could, and could not, be changed in terms of the building's relationship with the Department of Planning. They did not automatically assume that the building would continue to be subjected to the original hotel restrictions (thus they interrogated the black box). At the same time, they were selective about which aspects of the relationship they could alter and which aspects they had to accept and work around.

Two aspects of the Planning/hotel interdefinition could not be radically changed in the new network. First, the building had previously been classified by Planning as a serviced apartment, a classification that would later prove to have advantages, thus YouthWell opted to continue working within this category:

So this is registered as a serviced apartment building. If it had been registered as a hotel we probably couldn't have done student accommodation. We could have done temporary accommodation; we couldn't have done student accommodation. And given . . . we only had 12 months . . . we wouldn't have had time to overdo the planning changes plus the costs of doing that, the legal advice, this, that and the other. So certainly we were very lucky that the use was serviced apartment building or serviced apartments, so there is no maximum level of stay in a serviced apartment, so that meant we could have people living here. Whereas, if it was a hotel it's 30 days or something, so we wouldn't have been able to do that without changes or hoping nobody noticed, which is not a very fun place to be.

—Director (YouthWell)

That the hotel was interdefined as a service apartment relative to Planning allowed the hotel to "take on" the role it sought to fulfill: provide temporary accommodations

for students and for families in need. This form of interdefinition, however, did have some disadvantages:

> *So we did have to change some things, I mean, the temporary accommodation, you know, serviced apartments are supposed to be serviced. We're supposed to be in there cleaning those rooms and changing the beds and doing all those things. It's a part of a serviced apartment. If you're not servicing it it's not a serviced apartment, it's a hotel. So things like that we had to build into the service delivery. That adds a layer of cost for us that wasn't really necessary. But it was our way of saying, well, yep, we're just going to work within what we've got here, and we endeavour to do our best to work within what we had. If had been an office building or a hotel, as I say, it would have been much more to do.*
>
> —Director (YouthWell)

A second aspect of interdefinition had to do with council fees. The building was positioned between BuildWell as a structure owned by a commercial developer and YouthWell as a building operated by a non-profit. As a not-for-profit pop-up, it sought exemption from certain council fees, but ended up still having to pay them because its owner was a commercial developer:

> *. . . we have an exemption from paying them but because we're not the owner of the building, we're the operator of the building; the exemption applies to the owner, not the operator. So from a planning perspective having that changed would be very useful and make this much more sustainable.*
>
> —Director (YouthWell)

BuildWell had been more than willing to pay these, but YouthWell has taken on this responsibility and has asked BuildWell to invoice these charges as they came in.

> *So in terms of the council rates, those council rates are being charged to BuildWell and then we ask them to send us invoices and we reimburse them in regards [sic] to that. In a perfect world though that money would remain with us as an NGO . . . [so] there's going to be less to put towards long term housing because of these costs when we're actually exempt from paying them.*
>
> —Director (YouthWell)

From an ANT perspective, the building thus continues to operate according to some of the rules of a previously established network. BuildWell and YouthWell have made judicious choices to work within some of these. However, they have also picked battles as specific arenas for change, pinpointing areas of "controversy" [41] that could change the way entrenched and limiting networks are run:

> *So yes, we've been working and have provided papers and had meetings with New South Wales Planning to try and get them to work with us and other developers to look at temporary rezoning of commercial, industrial sites that will allow developers to do things like the [this] project where it benefits the community in some way while a site is sitting empty for possibly years and years when we've got people sleeping on the streets or couch surfing or not having anywhere to go . . . So we are trying to work with government to change zoning. So that's one area so that then we can look at potentially doing certain aspects of the [pop-up], if not the whole [pop-up], at some of our sites if it's appropriate and there's a long enough lead time in terms of the DA.*
>
> —Director (YouthWell)

5.5. Resilience, Expansion and Contingent Stability

The previous section shows that networks can stabilise and even reify over time to the point that a heterogeneous network begins to appear as a single, coherent black box [23]. However, ANT researchers are clear that convergence and black boxes, while appearing persistent, are always contingently achieved [25].

In ANT, therefore, the potential for network destabilization is always present. Every attempt to create a new network is an attempt to create order as human and non-human

entities engage in processes involving negotiation and struggle towards network goals. The process is fraught with conflict. While networks can reach the point where they seem to be stable, " . . . the actor–network should not . . . be confused with a network linking in some predictable fashion elements that are perfectly well defined and stable, for the entities it is composed of, whether natural or social, could at any moment redefine their identity and mutual relationship" [43] (p. 93). ANT researchers thus study networks bearing in mind that they are simultaneously provisional and stable [37]. In our case study, there was strong evidence for this, specifically when actors made it clear that they planned for the pop-up while simultaneously planning for the pop-down.

Based on our findings, resilient networks are formed on the assumption that any stability they achieve is contingent. We saw three strategies to accommodate this in the pop-up case study. First, early planning of the exit strategy was carried out (Section 5.5). Put another way, the "pop-down" was planned even as the pop-up was being conceptualized. YouthWell planned its entire model on the idea of a well-managed pop-down that would mean no harm to BuildWell, to residents, or to themselves. At the core of this strategy was the decision to target residents whose needs were not complex and who would have housing options beyond their stay at the pop-up shelter. The director of YouthWell noted

> *we've taken the risk to their reputation so seriously from the moment they put it on our plate it's built into the design, it's built into the allocation strategy, it's built into the risk manager's plan, it's built into the exit plan, you know, it—we never forget that we cannot do that to them. We have to ensure an orderly exit. And that's not just for BuildWell's benefit, I mean, obviously that's for our benefit, it's for the young people's benefit.*

—Director (YouthWell)

Second, the uncertainty of pop-down was tempered through agreed-upon yearly timeframes (Section 5.5). BuildWell as "landlord" has given YouthWell, EatWell, and CleanWell one-year leases. The one-year time frame is not long-term, but it does give actors enough notice about when they will be expected to pop-down:

> *Well, they've been very good because they've given us extensions of one year at a time. So it was originally a one year, and then we got another year and then we got another year. So, they're giving us plenty of notice, they're fantastic to work with. But it's a good question you ask because if we were in a situation where we were going to be [00:14:30] in a month's time, you're out, that would not be suitable for us, because it's not just us but it's all the charities that we work with who are used to sending their clients here that then would have to reconsider their work model.*

—Director (YouthWell)

The tenants have found ways to work within this planning window. For example, capital expenditure decisions are made knowing that they could be vacating the premises in a year's time, when development approval for the site has been approved. At present, however, this approval has not been received and the pop-up shelter has been running for more than three years.

A final point has to do with replicating the effort. In ANT, stability is often understood to lead to expansion, which can be achieved through inscribing network programs of actions into devices that in effect extend the reach of a network: texts, oral messages, technological artifacts such as machines, and social artifacts such as institutions. Put another way, translations originally performed in the network are thus captured in inscripts, which then "become [the networks'] support, their more or less faithful executive" [22]. In the case of the pop-up, expansion would mean the creation of similar pop-ups in other spaces. "Expansion", however, may not be a suitable term given that pop-ups by nature are transient and do not exist long enough to expand significantly. What could take place is the (re)creation of a new pop-up. In some ways, the new pop-up would be very different, with a new site, different partners, possibly different clientele. However, recreation could be facilitated by the development and mobilisation of a low cost, highly collaborative business

model (Section 5.5), which can be enacted in swift yet customisable ways. The YouthWell director spoke briefly about having key elements of the model already in place:

> . . . *that kind of modelling is pretty quick and easy. I mean, you know, we know what staffing costs, we know what security costs, we know—whereas before I had to go and find all that out, you know, what does it cost to have someone awake all night long? I don't know . . . Now I do, because I've been paying it for two years. So once you've done something once it's quicker and easier . . .*
> —Director (YouthWell)

6. Discussion: Digital Tools for Systematisation

The aim of this study was to address the question *What are key elements of resilient collaborative housing networks?* We have addressed the research question posed by identifying the elements of resilient collaborative networks, which are summarised in Table 2, Column 2.

Table 2. Elements of resilient collaborative actor–networks.

Research Sub-Questions	Findings for an Extended Conceptualization of Resilient Collaborative Networks
What are the key elements of goal setting and leadership in resilient collaborative housing networks? (Section 5.1)	Flexible goal definition (Section 5.1) Distributed leadership (Section 5.1)
What are the contributions and limitations that human- and non-human actors bring to achieving resilience in collaborative housing networks? (Section 5.2)	Human actors: Rapid negotiation of inter-defined roles (Section 5.2) Non-human actors: Flexible entry points into partnership (Section 5.2)
What forms, if any, do network convergence and coherence take in resilient collaborative housing networks? (Section 5.3)	Convergence through different levels of adhesion, with non-humans setting the stage for shared space (Section 5.3)
How can resilient collaborative housing networks be seen as networks dynamically aligning to other networks? (Section 5.4)	Strategic interrogation of black-boxed routines (Section 5.4) Selective reconfiguration of black-boxed routines (Section 5.4)
How can resilient collaborative housing networks reconcile contingency and stability? (Section 5.5)	Early planning of exit strategy (Section 5.5) Annual time frames to temper uncertainty (Section 5.5) Development and mobilisation of a low cost, highly collaborative business model (Section 5.5)

The value of such networks is that they are capable of novel collaborative arrangements that give rise to novel housing solutions capable of addressing persistent environmental and social sustainability challenges. In our empirical study, we showed how one such network was created as an assemblage of "strange bedfellows": a commercial developer, youth housing organization, food distributor, clothing distributor, and free mobile laundry service provider. These actors formed relationships with other non-human actors, including an empty hotel, zoning regulations, and building elements such as entrances and exits. These human and non-human actors "assembled" into a network where the outcome was a pop-up shelter. As a solution, this shelter addressed a key social sustainability target of adequate, safe, and affordable housing under Sustainable Development Goal # 11 Sustainable Cities and Communities [44]. Importantly, it simultaneously addressed an ongoing environmental concern. By mobilising the strategy of adaptive reuse of an existing building, the pop-up network addressed the goal that housing be "planned, constructed in used in a way that minimizes environmental impact and promotes environmental sustainability" [1] (p. 11).

An important question that arises from studies such as this is whether there is enough evidence to conclude that pop-ups are economically viable. Our stance is that broad questions on economic viability are most effectively addressed using evidence from a broader base of data, possibly through statistical studies or multiple case studies, so clearly it is beyond the scope of this single case study to address this issue fully. Still, there are three points we can make on this matter. First, we have made an analysis of one of the first pop-up shelters in Australia, and this is an important contribution. It helps establish

grounding for more studies that will eventually build up a repository of lessons, including lessons on economic feasibility. Second, we have still made an important contribution by showing how, in this instance, pop-up shelters can be economically feasible, in this case by setting up the facility to house families and thus earning a regular income stream from the government. While some might claim that the findings from an individual case might be an anomaly and therefore cannot be generalisable, we draw from Flyvbjerg [35] to point out the opposite. The case we present can be valuable as an example of Popper's "black swan" case: we have debunked any notion that pop-ups are "never feasible", and we have provided a foundation that can "stimulate further investigations and theory building" [35] (p. 228). Third, business professionals that have driven the few pop-ups in Australia have presented well-informed qualitative judgments that pop-ups are economically viable. The director at BuildWell heading CSR was one of our key interviewees. She holds a key procurement role and acknowledges that BuildWell operates primarily as a commercial developer. However, despite her role and her firm being driven by business imperatives, she has argued that running the pop-up has not been an economic burden and that similar initiatives can be undertaken by others:

> *...our whole [project] has been managed and set up in-house with all our divisions and for very low cost, minimal effort and huge collaboration. So we're really doing things right. Now we need to actually talk about it to other people so they start doing the same thing.*

—Director, Furniture, Fittings & Equipment Procurement/Head of CSR (BuildWell)

Professionals outside of the pop-up network, but with extensive experience in the residential construction sector, have already theorized about how the benefits of pop-up shelters outweigh their costs. Robert Pradolin, former general manager of the multinational developer Frasers Property, has been advocating for the use of empty buildings in Australia for housing purposes and has been quoted as saying:

> *If I was running government as a business I would consider the costs in the long term of not housing people through the impact on civil issues around hospitals, police and courts etc . . . and you can actually build a very strong economic case that if you don't provide housing for people who need it, both from an affordable housing perspective such as key workers and for those who just can't afford it . . . then it is going to cost the economy in the long run a lot of money.* [45]

Pop-up initiatives have been gaining traction, albeit slowly, in Australia and overseas. Apart from this case study, other Australian examples include a building owned by a Sydney faith-based organization, awaiting demolition and temporarily converted into a transitional home for older women; a former Melbourne aged care facility awaiting master planning, also converted into a home for older women and transportable homes built on government-owned parcels of land in Melbourne's west, designed to be leased for ten years after which the land will be taken back for road widening and the homes relocated. These examples were discussed in earlier work describing networks that were characterized as robust due to resilience, stability, or mobility [20]. More recently, Australian pop-up accommodations have been reported in parking facilities in Brisbane [46], while in Western Australia, advocates have pushed for conversion of aged care homes, vacant buildings, and unused church and government land into affordable and social housing [47]. Pop-up shelters have sprung up in other countries as well: in Missouri, USA, a vacant 98-bed osteopathic hospital has been converted into a 62-bed shelter [48] while in Massachusetts, USA, pop-up cabins have been erected to replace tent communities [49]. Pop-up efforts have also been reported in Spain and Italy [19].

If pop-ups are indeed a viable solution to housing challenges, then pop-ups should eventually move beyond sporadic, ad hoc efforts. The fact that pop-ups are meant to be resilient should not be misinterpreted to mean that they should always be unsystematic, improvised arrangements. Every pop-up shelter does not have to be treated as a new case being rebuilt from the ground up. On a broader scale, the same thing can be said about adaptive reuse. Studies and initiatives on the adaptive use of buildings in Australia have

already been carried out [50,51], and measures can be taken so that efforts, individually and collectively, can become more coordinated. Pop-up and adaptive use initiatives in Australia can benefit from increased systematisation.

Systematisation may take different forms. When systematization involves routinization, then it can be argued that systematization will involve the support of digital technologies. We are careful to point out here that we are arguing for the targeted use of use of digital tools across the different stages of network development, not the uncritical implementation of these tools across all phases in an uncritical manner.

As the findings show, many of the strengths of resilient actor–network rest on organic and adaptable strategies and processes. Leadership should be flexible (Table 2, Section 5.1) and should be allowed to shift (Section 5.2). Roles should be allowed to evolve and adapt (Section 5.2). In cases such as the one presented, routines have a role, but are still selectively deployed, even interrogated (Section 5.4) and reconfigured (Section 5.5). Not everything is routinised and stabilized.

The move away from wholescale routinisation in resilient housing networks has an important implication. It is widely accepted that digital technologies are often mobilized to support routine and stability [52]. However, empirical findings show that routine and stability are not what pop-up solutions are about. In implementing novel housing solutions such as pop-ups, the use of stabilizing technologies must be implemented in a careful and strategic manner. In an industry that is poised to take on the innovations associated with 4R [53], it is important to note that there still times that selective, careful use of digital technologies can be more effective.

We do not advocate the use of technologies to routinise leadership, role definition, enrolment of actors, and large sets of pop-up/adaptive reuse processes. These could compromise the resilience and adaptability of pop-ups. However, routinization, digitisation, and the technologies of 4R can still be effectively implemented, particularly on a macro level that transcends single pop-ups. Two examples are given here. First, systematisation might mean that aggregated information and knowledge about pop-ups and adaptive reuse cases is built up over time, so that learnings and more formal knowledge resources from past cases can be carried over into new projects. This was done in one study [54] which envisioned the development of a database for adaptive reuse projects, a "progressive digital library" where architects and students can upload information about the old building and its previous uses, the new building and its current uses, and the process of transformation. Information can take many forms: historical facts, interventions undertaken, outcomes of formal analyses of the structure, etc. The database thus helps ensure that future efforts of adaptive reuse are informed by rich descriptions of precedents.

A second strategy for systematisation, also involving digital tools, could be in the form of digital maps or precinct information models. Maps and models can be used to identify vacant properties and can become a basis for finding potential locations for pop-up shelters or more possibilities for adaptive reuse, especially if information is detailed and updated in a timely manner. The organisation Housing All Australians, which champions pop-up shelters in Australia, has claimed "We believe there are 1000′s of suitable unused empty buildings across Australia that can be repurposed for short term use as crisis or transitional shelter, without cost to the owner" [16]. Digital maps and models can provide visualisation capabilities that can show which buildings are vacant at a given point in time. More sophisticated, dynamic precinct information models can incorporate a time component and allow vacancies to be visualised in ebbs and flows over a given period, a capability that can support planning.

We come full circle in our discussion to suggest that government might play a key role, but it does not always have to be a centralized leadership role. It could in some cases be a facilitative role, one that shapes the systematization of broad-based collaborative efforts. Government might also perhaps provide the digital platforms for these initiatives. However, we theorise that to keep these networks resilient, government would function as a collaborative partner working alongside other actors.

7. Conclusions

In addressing the research question, we have made three contributions. First, we have made a theoretical contribution. Earlier work involved the development of an expanded conceptualisation of collaboration for construction using actor–network theory [24]. In this study, we built on this work to develop a definition of resilient collaborative actor–networks, by outlining key features. This definition brings together three bodies of work: literature on resilience, network theory, and collaboration. Of course, a key limitation can be raised in relation to the methodology involving a single case study. Our response is that future work can develop this definition further, through the study of other pop-up shelters, or through the examination of other nimble, resilient housing solutions. That said, we emphasise that that the choice of this case study is not a weakness, but a strength. Pop-ups are nascent in Australia and very limited information is available [20]. The research thus provides important learnings about a phenomenon that is emergent and little-understood.

A second contribution is that the research identifies possibilities for enriching actor–network theory. Actor–network proponents have argued about the contingent stability of actor–networks, and this idea has been difficult to observe in the built environment [23,25]. There are difficulties in understanding durable buildings as precarious actor–networks, yet researchers have argued that every structure should be perceived as a "building-on-the-move" that shifts with ongoing developments: "a zoning limit, a new fabric, a change in the financing scheme, a citizen's protest" [55] (p. 110). Pop-up shelters capture this contingent stability. Section 5.3 has provided concrete ways that show how "contingency" and "stability" can be reconciled in the pop-up's operations. This finding has important implications for researchers and practitioners seeking to understand and manage the Industry 4.0 wave, which some say is sweeping through construction sectors. Stabilising technologies do not always have to be implemented in a wholescale manner. There are solutions that require more targeted and selective use of routinising technologies so that the adaptability and resilience of networks are not compromised.

A third contribution is for practitioners. The study provides a set of concrete strategies (Table 2, Column 2) that will be useful for future actors seeking to establish other pop-up shelters or, more broadly, seeking to implement nimble, responsive housing solutions. The case study provides rich descriptions of "portable principles" [34] that can be transferred to different contexts.

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