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A Longitudinal Exploration of Trust in Participatory Health Research – A Network Approach

Meghan Gilfoyle^{1,2}, Jon Salsberg^{1,3*}, Anne MacFarlane^{1,3}, Miriam McCarthy⁴, and Pádraig MacCarron⁵

¹Public & Patient Involvement Research Unit, School of Medicine, University of Limerick Limerick, Ireland, V94 T9PX

²Postdoctoral Fellow, Women's College Hospital Institute for Health System Solutions and Virtual Care, Toronto, ON, Canada, M5S 1B2

³Health Research Institute (HRI), University of Limerick, Limerick, Ireland, V94 T9PX

⁴Health Sciences Academy, University of Limerick and UL Hospitals Group, Limerick, Ireland, V94 F858

⁵Mathematics Applications Consortium for Science and Industry (MACSI), Department of Mathematics & Statistics, University of Limerick, Limerick, Ireland, V94 T9PX

*Correspondence:

Jon Salsberg
Jon.Salsberg@ul.ie

ABSTRACT

Background: The value of a participatory approach to the generation of evidence for health and social services from a moral, methodological and policy level continues to develop globally. Trust is a crucial mechanism in the participatory health research (PHR) process and is strongly influenced by its context. However, gaps remain in conceptualising and operationalising trust over time in PHR partnerships.

Objective: This study seeks to address such gaps, exploring the evolution of trust multidimensionally across two time points.

33 **Setting and Participants:** Participants from a PHR project called the Public and Patient
34 Involvement Ignite Network in Ireland (n=57 (T1); n=56 (T2)) were invited to complete a network
35 survey at two timepoints. The project had local and national partners.

36 **Network Measures:** We calculated several core social network measures at both timepoints
37 characterising differences between the dimensions of trust over time and between local and
38 national partners.

39 **Results:** We found subtle changes across most network measures over time and observed a slight
40 decrease in the number of connections for each trust dimension across the network, but a slight
41 increase for connections that were persistently nominated in both timepoints. We noted that some
42 networks were more similar (i.e., vulnerability and integrity) and strikingly different (integrity and
43 shared values, visions, and goals) to each other with a higher number of incoming connections for
44 national compared to local partners.

45 **Conclusion:** Our findings serve to 1) provide empirical support for using SNA to operationalise
46 trust comprehensively and multidimensionally over time in a participatory partnership, 2) offer
47 nuanced insights into the trust development process in the PPI Ignite Network over time; and 3)
48 enhance our understanding of trust in the community-based participatory research model.

49 **Strengths and Limitations of this Study:**

- 50 • This study provides longitudinal empirical support for using tools and techniques from
51 network science to clarify important conceptual and operational complexities of trust in
52 participatory health research partnerships. In doing so, we help address critical
53 ambiguities that hinder the application and evaluation of participatory health research in
54 health promotion.

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2
3 55 • Our approach to measuring trust in participatory partnerships embraces its
4
5 56 multidimensional nature, allowing us to see how trust unfolds, across all its dimensions,
6
7 57 over time.
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10 58 • By exploring trust in this way, we embraced the partnership environment, which plays an
11
12 59 important role in trust and partnership synergy and sustainability.
13
14
15 60 • This case study used a small network with two time points over a year. Considering trust
16
17 61 takes time to develop, it is possible that surveying trust at only two time points over a year
18
19 62 is restrictive.
20
21
22 63 • As trust is inherently contextual, its evolution will likely vary depending on the partnership
23
24 64 of interest.

25
26 65 **Keywords:** participatory, community-based participatory research, trust, social network analysis,
27
28 66 social networks

31 67 **Patient and Public Involvement Statement**

32
33 68 This is one sub-study that is part of a larger study in which a Research Advisory Group was involved.
34
35 69 This group comprises four research partners representing academic, service, or community
36
37 70 organisations in the PPI Ignite Network (further described in this manuscript). These partners were a
38
39 71 subset of individuals interested in this work, who were already working with co-authors JS, AM and
40
41 72 MG through a prior grant called PPI Ignite@UL. These partners provided input and approval for the
42
43 73 research objectives of this study, ensured all content in the network surveys and interview guide were
44
45 74 both accessible to participants and contextually relevant, reviewed and interpreted findings at a high-
46
47 75 level confirming from their perspective, if they agreed with the findings as a partner in the PPI Ignite
48
49 76 Network, acted as a soundboard for brainstorming ways to address any research challenges, provided
50
51 77 suggestions/feedback for ensuring dissemination materials and outputs (e.g., conference posters and
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53 78 manuscripts), and were being communicated effectively for diverse audiences. One Research

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2
3 79 Advisory Group member has been further involved in the interpretation of the results as well as
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5 80 reviewing and revising manuscript content and language, and thus, authorship of this manuscript (co-
6
7 81 author MMC). Co-author MMC was also involved in the dissemination of this work at an
8
9 82 international conference (*cf*(1))

11 83 **BACKGROUND**

14 84 The value of a participatory approach to the generation of evidence for health and social
15
16 85 services from a moral, methodological and policy level continues to develop on a global scale (2-
17
18 86 4). Participatory Health Research (PHR) can be defined as “systematic inquiry, with the
19
20 87 collaboration of those affected by the issue being studied, for the purposes of education and taking
21
22 88 action or effecting change.”(5)(pg.43) In PHR, “those affected” is intentionally broad
23
24 89 encompassing any and all individuals, community members, or groups such as patients, public,
25
26 90 health professionals, and organisational representatives. These individuals/groups can be both
27
28 91 directly or indirectly affected by a health issue.(6) With roots grounded in principles of social
29
30 92 action, justice and emancipatory philosophy, PHR has the potential to tackle complex health
31
32 93 problems and achieve more meaningful and nuanced intermediate and long-term outcomes (6-8).
33
34 94 Indeed, PHR has been gaining recognition throughout research communities as an approach that
35
36 95 serves to bridge the gap between research and practice.(6, 8, 9) Specifically, PHR helps to
37
38 96 maximise the relevancy of research and usability of its products, while simultaneously building
39
40 97 capacity and addressing issues of social justice and self-determination among end-user
41
42 98 communities.(6, 8) The central tenet of PHR is that it is a co-creation process. This means that
43
44 99 those affected by the issue under investigation or who benefit from the knowledge being produced
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46 100 are key to the knowledge production process, working as equitable partners with academics from
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48 101 idea conceptualisation to dissemination and beyond (6, 10). In this paper, we discuss PHR as an
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3 102 umbrella term for a variety of approaches (e.g., participatory action research (11), participatory
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5 103 rural appraisal (11, 12), community-based participatory research (CBPR)(13, 14)). Although these
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7
8 104 different terms may vary depending on the country of origin, discipline and research goals,(13, 15)
9
10 105 they all strive to bridge the gap between knowledge and practice by harnessing inclusivity and
11
12 106 recognising the importance of actively and meaningfully engaging those who the research serves
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14
15 107 to benefit in the research process (6).

16
17 108 One of the more widely recognised PHR approaches (6, 16), is CBPR. A CBPR conceptual
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19 109 model was developed(17) and adapted (8), which provides a concrete framework for understanding
20
21 110 how the CBPR process is influenced by contextual and process-related aspects that can affect the
22
23 111 ability to achieve both intermediate impacts (e.g. stronger partnerships) and long-term outcomes
24
25 112 (e.g. improved health, community transformation, and health equity). The intention of the model
26
27 113 is to act as a dynamic tool that evolves with research and understanding of CBPR. This includes a
28
29 114 deeper understanding of how context, partnership characteristics, and processes contribute to
30
31 115 research and intervention design, and ultimately lead to intermediate and long-term outcomes (18).
32
33 116 However, challenges in operationalising aspects of the model limit our understanding and
34
35 117 evaluation of the PHR process. For instance, Oetzel et al.(19, 20) noted that additional longitudinal
36
37 118 research is required to better understand how CBPR processes lead to outcomes and under what
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39 119 conditions, to further substantiate the mechanisms in the model (19, 20).

40
41 120 Trust is frequently identified as an important component of the CBPR model, described as
42
43 121 “permeating and affecting all interactions and relationships in the partnership and as linking one
44
45 122 [domain] to another (21)(pg.14).” Trust has been underscored as a crucial mechanism (22, 23)
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47 123 essential to the PHR process that can affect the ability to achieve both intermediate impacts and
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49 124 long-term outcomes (24, 25). For example, seminal work by Jagosh et al.(23) found that the
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3 125 building and maintenance of trust was a key mechanism for supporting partnership synergy, a
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5 126 universal feature of the collaborative process necessary for building and sustaining partnerships.
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8 127 However, defining, measuring and operationalising trust in PHR is challenging given the
9
10 128 overwhelming variety of definitions associated with it (26). This reflects sentiments expressed by
11
12 129 Misztal et al.(27)(pg.117), underscoring that of Wuthnow et al.(28), describing trust as “one of the
13
14 130 most complex, multidimensional and misunderstood concepts in the social sciences (27, 28)(pg.
15
16 131 117).” As explicated by Lucero et al. (29), “although numerous CBPR scholars have discussed the
17
18 132 importance of trust and offer anecdotal suggestions, very few systematically research it (pg. 160).”
19
20 133 Influential work by Lucero et al.(25, 29, 30), has provided important advancements of trust in
21
22 134 participatory literature presenting, for the first time to our knowledge, an alternative to the binary
23
24 135 view of trust in CBPR (i.e., present or absent). As highlighted above, Lucero et al.(25, 29, 30)
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26 136 operationalised trust a typology of six categories from the lowest type being a trust deficit
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28 137 (suspicion) to the highest, called critical reflexive trust (having the ability to discuss and move on
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31 138 after a misstep). However, more work is still needed, especially exploring trust types over
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33 139 time.(25) With the recognition that trust is a dynamic, socially embedded process and extends
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36 140 beyond a simplified view as a variable, it requires a methodology that reflects this.(22)

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40 141 One approach is to view PHR partnerships as a *social network*. A social network describes
41
42 142 the relationships among people, organisations or other social actors (31). Social network analysis
43
44 143 (SNA) is a methodology for describing and measuring contextual and relational dynamics among
45
46 144 and between social actors (32). Trust is a type of relation that has been commonly explored in the
47
48 145 network literature in diverse fields (33-49), such as in health (50) and education (51). As mentioned
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50 146 by Zolin and Gibbons,(49) “for a researcher, analysis of networks that are directly or indirectly
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53 147 related to trust may yield practical and theoretical insights that are not discoverable through other
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3 148 means...(pg.189)". This is because, unlike other methods, SNA allows us to understand trust while
4
5 149 embracing its social environment(49). This is a key strength of SNA as it extends beyond the
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8 150 behaviour of the individual, embracing the social aspects of behaviour. Using SNA we can then
9
10 151 consider the interdependent nature of human data.(31, 52) Further, as trust is a type of relation, it
11
12 152 is inherently embedded in a network of relationships. This creates opportunity to explore a variety
13
14 153 of research questions about trust (49). For example, network questions can help us explore how
15
16 154 trust is developed over time (49). Indeed, viewing PHR partnerships as a social network, applying
17
18 155 SNA tools and techniques to explore trust over time, could help address the challenges that persist
19
20 156 in operationalising trust in the CBPR model, and in turn, improve our understanding and evaluation
21
22 157 of trust in the PHR process.

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26 158 Recognising this potential, Gilfoyle et al.(53) proposed a novel and interdisciplinary
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28 159 conceptual triad with trust in the centre, connecting PHR and SNA, to explore how trust can be
29
30 160 conceptualised, operationalised and measured in PHR and social networks literature. Results from
31
32 161 this scoping review(53) revealed two key findings. Firstly, it found trust to be multidimensional,
33
34 162 identifying several key trust dimensions, represented in Supplementary File 1. Secondly, it
35
36 163 underscored a lack of conceptual and operational consistency of trust, particularly in the PHR
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38 164 literature. Gilfoyle et al.(54) then empirically tested the merits of exploring trust in a PHR
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40 165 partnership, known as the national Public and Patient Involvement (PPI) Ignite Network (see
41
42 166 Setting below), comprehensively and in a multidimensional way. This revealed important nuances
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44 167 between the different dimensions of trust between partners who had national and local roles, which
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46 168 become diluted when explored in combination.

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50 169 However, authors(54) were limited in that they explored trust cross-sectionally and without
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52 170 attention to specific attributes, such as partnership characteristics (e.g., local or national partners).

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3 171 This is problematic because trust develops over time (22, 25, 30), and networks are dynamic as
4
5 172 their membership and social contexts change (55). Further, network attributes, such as the roles of
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8 173 local or national partners, can influence collaborative behaviour (31), also warranting investigation
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10 174 over time. This is especially important in PHR where the importance of trust throughout all phases
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12 175 of the research process is underscored (21, 30), especially for ensuring partnerships are effective,
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14 176 equitable and long-term.(22, 25, 56, 57) Thus, if some types of partners (e.g., those who hold
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16 177 funding [cf(18)]) are developing trust and others (e.g., local partners) are not, important goals and
17
18 178 ultimately outcomes of a partnership may be jeopardized. Addressing these limitations, this study
19
20 179 seeks to extend the findings from Gilfoyle et al.(54), better understand the evolution of trust in the
21
22 180 context of a participatory health research partnership (see setting below). This is done by exploring
23
24 181 specific features of a participatory health research network (the national PPI Ignite Network in
25
26 182 Ireland) asking:

- 30 183 1. Do the trust characteristics of the PPI Ignite Network change from T1 to T2?
- 31 184 2. Do the dimensions of trust identified differ at the local vs the national level? How did this
32 185 evolve from T1 to T2?

33 186 **METHODS**

34
35 187 This study was granted ethics approval from the University of Limerick Education and Health
36
37 188 Sciences Research Ethics Committee (#2021_03_16_EHS).

38 189 **Setting**

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41 190 In 2017, five universities across Ireland were funded as individual *PPI Ignite Teams* by the
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43 191 Irish Health Research Board (HRB) and Irish Research Council (IRC) to build capacity for public
44
45 192 and patient involvement (PPI) in health research. Building on and consolidating this work, the

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3 193 HRB and IRC then funded the *PPI Ignite Network* (March 2021-2026), “aim[ing] to provide a
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5 194 shared voice for PPI across Ireland, aiming to change the research culture, and an important
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7
8 195 contributor to improving health outcomes for the public.”
9

10 196 The PPI Ignite Network brings together academic, service and community organisations who
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12 197 co-designed the work programme and must collaborate in an efficient, synergistic and cohesive
13
14 198 manner to plan, implement and evaluate the PPI initiatives set out by the network, of which trust
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16
17 199 is key (22-25). In particular there are five key areas of work set out by the network including, 1)
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19 200 building capacity for PPI in community and academic settings, 2) develop accredited education
20
21 201 programmes for PPI, 3) enhance university policies and procedures to support PPI, 4) develop
22
23 202 quality improvement and impact; and 5) create systems for national co-ordination and functioning
24
25
26 203 (for further information on the PPI Ignite Network see: <https://ppinetwork.ie/about-us/>).
27

28 204 The PPI Ignite Network (n=57 at T1 and n=56 at T2 at time of sampling), a national PHR
29
30 205 partnership, provides a useful setting to better understand how trust evolves in a PHR partnership
31
32 206 over time. The PPI Ignite Network is comprised of seven universities called lead sites (five
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34 207 institutions involved previously as independent PPI Ignite Teams, plus two additional institutions),
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37 208 a national office, 10 national-level community partners who contribute to national-level
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39 209 governance and activities and 39 (at T1), and 38 (at T2) local-level partners who contribute to
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41 210 governance and activities at one university in the PPI Ignite Network. This administrative structure
42
43
44 211 of the PPI Ignite Network resembles that of a hub and spokes model, with the national office at
45
46 212 the center of the administrative structure, with connections to national partners as well as the seven
47
48 213 universities. The universities are then connected further to local partners. With that in mind, the
49
50 214 set-up of the PPI Ignite Network resources and decision-making pertaining to goals and objectives
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215 were distributed across the network. The PPI Ignite Network functions as a participatory
216 partnership where we explore the dimensions of trust in action for this study.

217 A Research Advisory Group consisting of four research partners representing academic,
218 service, or community organisations in the PPI Ignite Network provided input and approval for
219 the research objectives of this study and were similarly involved with three other sub-studies. These
220 partners provided input and approval for the research objectives of this study, ensured all content in
221 the network surveys and interview guide were both accessible to participants and contextually relevant,
222 reviewed and interpreted findings at a high-level confirming from their perspective, if they agree with
223 the findings as a partner in the PPI Ignite Network, provided suggestions/feedback for ensuring
224 dissemination materials and outputs (e.g., conference posters and manuscripts) were being
225 communicated effectively for diverse audiences. One Research Advisory Group member has been
226 further involved in the interpretation of the results as well as reviewing and revising manuscript content
227 and language, and thus, authorship of this manuscript (co-author MMC).

228 **Data Collection**

229 A social network can be defined as the set of connections among people, organisations or
230 other social actors (31). This study invited all 57 (at T1) and 56 (at T2) individuals in the PPI Ignite
231 Network to complete the same network survey at two time points. The first time point (T1) was
232 near the commencement of the PPI Ignite Network in May 2021 and the second time point (T2)
233 was a year later in May 2022. This timeframe was determined based on discussions with the
234 Research Advisory Group, recognizing that the initial stages of partnership development are
235 crucial for the trust building process (58), while also ensuring sufficient time had passed to build
236 trust together. A network survey is a questionnaire used to generate names and connections among
237 individuals in a network (31). The network survey in this study was designed based on the
238 dimensions of trust identified by Gilfoyle et al.(53) and in collaboration with the Research

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239 Advisory Group to ensure the appropriateness and readability of survey questions (See
240 Supplementary File 2 for the Network Survey). The survey was administered electronically via
241 Qualtrics software (Qualtrics software, Version May 2021 to December 2022). Survey questions
242 included seven network questions that were found by Gilfoyle et al.(53), to be important
243 dimensions of trust (shown in Supplementary File 1). To generate a network, each participant was
244 asked to name up to seven organisations when answering the network survey questions (the same
245 seven organisations for each question). They were asked to consider the *individual* in the network
246 representing these organisations when responding to the network questions. This was a noteworthy
247 distinction as we were interested in exploring the *partnership* collaboration and trust, not trust for
248 the organisation.

249 The seven dimensions of trust their associated network questions were drawn from a scoping
250 review by Gilfoyle et al.(53) that sought to comprehensively identify and synthesise how trust had
251 been conceptualised and operationalised in both the PHR and social network literature, and
252 if/where convergence existed. Gilfoyle et al.(53), incorporated a thematic analysis of the extracted
253 literature, to more concretely elucidate the conceptual and operational linkages of trust across and
254 within the PHR and social network literature. The relational constructs (i.e., sub-themes from this
255 review) paralleled with discussions from the Research Advisory Group, informed the dimensions
256 of trust identified in Supplementary File 1. A later study provided empirical support to the findings
257 from the scoping review.(54)

258 259 **Analysis**

260 Individual networks for each dimension of trust were constructed from participant
261 responses to the seven trust statements asked in the network survey at both time one (T1) and time
262 two (T2). This was done by assigning a value from -1 to +1 depending on the selection of strongly

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2
3 263 disagree to strongly agree (in intervals of 0.5 for the 5-point scale) for each trust statement.
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5 264 Specifically, when a participant responded ‘agree’, a weight of 0.5 was given to the edge, while
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7 265 ‘strongly agree’ scored an edge weight of 1. A connection (i.e., link in the network) was not added
8
9 266 if participants responded with ‘neither agree nor disagree’, ‘disagree’, or ‘strongly disagree’
10
11 267 identifying only a presence of, or absence of, a trust connection. This is because, in alignment with
12
13 268 the literature on trust, we did not want to infer neutral agreement or disagreement with each
14
15 269 statement as an expression of *distrust*. Distrust is said to differ conceptually from trust (59) and
16
17 270 more specifically stated by Jones (1996) “the absence of trust is not to be equated with distrust
18
19 271 (60).”

272 *Network Measures*

273 Several network measures were used to analyse each of the seven trust dimensions at both
274 T1 and T2. Specifically, *in-degree* which is the number of incident edges a node has, i.e., the
275 number of times a node was nominated positively by another individual in the network. This helped
276 us identify the trust relationships between people in a network, i.e. who trusts whom. Meanwhile,
277 the *weighted in-degree* represents the total strength of agreement for each trust statement
278 (described further in the analysis). Thus, the *average in-degree* reported in this paper looks at the
279 mean number of received nominations across the network. This helped us identify how high trust
280 is overall in the network. Moreover, the *average in-degree* allowed us to identify if the number of
281 incoming edges received in the network as a whole (i.e., whether people agreed or strongly agreed
282 with that specific dimension of trust) changes over time.

283 *Clustering coefficient* measures the proportion of closed triads (i.e., triangles) of a network
284 (61), which allowed us to identify if a certain group is sharing trust throughout the network.
285 *Reciprocity* at the network level is measured by the proportion of reciprocated edges in the network

286 (61). A reciprocated edge occurs when the edges between two nodes point in both directions. For
287 example, if both individuals agreed or strongly disagreed with the same trust dimension between
288 them, then this increases the reciprocity. The concept of reciprocity is often seen as a critical
289 mechanism of trust (45, 56). *Freeman Centralisation about the in-degree* measures the importance
290 (centrality) of a node (62). Specifically, a higher value for one (or a small number of) individuals
291 suggests that they are in a position of power and control for that network. Comparatively, a
292 *decentralised* network implies the opposite, where the power and control were distributed across
293 many individuals. These measures allowed us to compare the structural properties of trust
294 dimensions.

295 A separate network was also constructed including only the connections that were
296 persistent in both timepoints. This allowed us to identify if the average in-degree and centralisation
297 about the in-degree changed for individuals who selected the same people at both time points (i.e.,
298 was the rate of agreement the same over time when the same individual was selected in both
299 timepoints. This enabled the comparison of how trust evolved over time for those who were
300 naming new people in T2, to those who named the same people in T2.

301 *Analysis of trust over time*

302 To compare trust networks over time, we included responses from people that participated
303 in both T1 and T2. First, we performed a two-sample Kolmogorov-Smirnov (KS) test on the degree
304 distributions. This test was deemed appropriate as it is a non-parametric test for comparing two
305 probability distributions. The KS statistic is generated by measuring the maximal difference
306 between the cumulative form of the two distributions. It reports the difference between the
307 distributions, allowing us to identify the degree to which certain trust networks differ over time.
308 Although the degree distribution informs us about the nature of connections in the networks, it

1
2
3 309 does not tell us about further details such as who is connected to whom, or how participants connect
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5 310 (e.g., do participants with a low degree connect to others with a low degree or are they more likely
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7 311 to connect to those with a high degree).

8
9
10 312 We calculated the Hamming-Ipsen-Mikhailov (HIM) distance which is a metric that
11
12 313 combines the Hamming distance (63, 64), which counts matching edges between two networks
13
14 314 (i.e., trust dimensions at T1 and T2) and the Ipsen-Mikhailov distance, a spectral distance used to
15
16 315 differentiate networks (65). Spectral distances are global measures that evaluate the difference
17
18 316 between the whole structure, though can miss differences between small sub-structures. The HIM
19
20 317 distance (66) yields a 0 if two networks are identical, or 1 if they are opposite. For example, a
21
22 318 complete graph (a network where everyone is connected to everyone else) compared to a graph
23
24 319 with no edges will have an HIM distance of 1.

25 26 27 28 320 *Local vs National Partners*

29
30
31 321 To identify if the trust dimension networks differed between local and national partners,
32
33 322 we stratified each accordingly by type (i.e., local or national). Due to their small sample size and
34
35 323 given their role in governing the national network, we combined the national office (n=1) and lead
36
37 324 sites (n=7) with the national partners (n=10) into an overarching *national* category. We then
38
39 325 calculated the network measures described above at both T1 and T2, to identify network changes
40
41 326 over time for each local and national node.

42 43 44 327 **RESULTS**

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47 328 In T1 (May 2021), 57 individuals from the PPI Ignite Network were invited to complete
48
49 329 the network survey. Of these individuals, 43 (75%) participated. In T2 (May 2022), one
50
51 330 organisation left the network, leaving 56 individuals invited to complete the same network
52
53 331 survey. Of these 56 individuals, 33 (59%) participated. A breakdown of participation by

partnership type can be found in **Table 1** below.

Table 1: Response rate by partner type

Partnership Type	Time 1 - May 2021 (n=43)		Time 2 - May 2022 (n=33)	
	Count	Participation rate by partnership type	Count	Participation rate by partnership type
Site leads*	8	100%	7	88%
National partners*	8	80%	7	70%
Local partners	27	69%	19	50%

*Combined site leads and national partners for local vs. national analysis

Table 2 below depicts the network level measures calculated at both T1 and T2 for the seven dimensions of trust, including new collaborations. We can see that over time, the number of connections (those who agree or strongly agree with that trust dimension) and the average in-degree (i.e., the number of incoming edges received) decreases. On average, participants receive approximately one less incoming connection compared to T1. In other words, people were agreeing and strongly agreeing slightly *less* often in time two for each statement of trust compared to T1. This decrease over time is also true for the mean clustering coefficient i.e., a decline in the number of trust triangles. For example, if person A agreed with a particular trust statement in T1 about persons B and C, it is likely B and C also agreed with that trust statement about each other, creating a triangular structure of connections in the network. However, in this case, the number of trust triangles declined, meaning it is less likely that B and C shared a trust connection at time two). Further, there was also a decline in the number of reciprocal connections at time two (where the trust connection goes both ways between two individuals, e.g., person A trust person B and vice versa) throughout the network. Indeed, for in-degree

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3 348 centralisation, we note a very subtle *increase* across all trust dimensions, except for trust
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5 349 dimension 5 (shared values, visions, and goals) and trust dimension 7 (reciprocity). This means
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8 350 that over time, incoming trust connections are more concentrated on an individual/group of
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10 351 individuals. However, despite this subtle increase, overall, the networks appear decentralised at
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12 352 both time points.

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14 353 In general, the magnitude of change for each network measure varies depending on the
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16 354 trust dimension. This underscores important nuances that are distinguishable when trust is explored
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18 355 multidimensionally. For example, trust dimension 6 (power sharing and co-ownership) reported
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20 356 one of the highest total number of connections (i.e., the statement of trust that people are most
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22 357 likely to agree/strongly agree with about another individual in the network) at both time points,
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24 358 while also being the trust dimension that had the greatest decrease in the number of connections
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26 359 over time (i.e., biggest change in agreement over time compared to other trust dimensions).
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28 360 Comparatively, trust dimension 2 (integrity), has one of the fewest number of connections at both
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30 361 time points (fewest people agreeing/strongly agreeing with the integrity statement), and the
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32 362 smallest change in connections over time (i.e., relatively consistent across timepoints). For other
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34 363 network measures, like the mean clustering coefficient (i.e., average number of trusted groups),
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36 364 we observe no change from T1 to T2 for trust dimension 4 (ability), yet a relatively large reduction
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38 365 for trust dimension 5 (shared values, visions, and goals) over time.

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40 366 Network measures also reveal that some trust dimension networks are more alike. For
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42 367 example, we see that the network measures for trust dimension 1 (vulnerability) and trust
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44 368 dimension 2 (integrity), are similar to each other, as are trust dimension 5 (shared values, visions,
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46 369 and goals) and trust dimension 6 (power-sharing and co-ownership). Although dimensions 1
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48 370 (vulnerability) and 2 (integrity) are similar to each other, they are notably different from trust
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371 dimensions 5 (shared values, visions, and goals) and 6 (power-sharing and co-ownership). This
 372 finding is consistent over time.

373 **Table 2: Network-level measures over time***

Networks (n=59)	Number of Edges		Weighted In- degree Mean (std)		Clustering Coefficient Mean (std)		Weighted In- degree Centralisation		Reciprocity	
	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2
Trust Dimension 1^a (Vulnerability)	66	50	1.98 (3.00)	1.33 (2.29)	0.10 (0.20)	0.04 (0.11)	0.23	0.25	0.28	0.06
Trust Dimension 2^b (Integrity)	64	53	1.78 (2.84)	1.54 (2.55)	0.11 (0.23)	0.04 (0.11)	0.24	0.29	0.34	0.19
Trust Dimension 3^c (Reliability)	103	86	3.61 (4.40)	2.70 (4.09)	0.13 (0.20)	0.11 (0.18)	0.33	0.34	0.37	0.19
Trust Dimension 4^d (Ability)	83	59	2.65 (3.92)	1.76 (2.72)	0.06 (0.12)	0.06 (0.14)	0.26	0.27	0.29	0.24
Trust Dimension 5^e (Shared values, visions, and goals)	130	98	4.17 (5.68)	3.39 (4.80)	0.20 (0.25)	0.13 (0.21)	0.41	0.38	0.45	0.18
Trust Dimension 6^f (Power sharing and co-ownership)	126	90	3.91 (5.04)	3.09 (4.53)	0.16 (0.21)	0.10 (0.17)	0.35	0.37	0.43	0.20
Trust Dimension 7^g (Reciprocity)	102	75	2.91 (3.92)	2.26 (3.15)	0.15 (0.24)	0.11 (0.21)	0.28	0.23	0.41	0.21

374 *This table includes all connections including new collaborations at time. ^{2a}Trust Network 1
 375 question “I would discuss with [name of network member X] how I honestly feel about my work,
 376 negative feelings and frustrations”, ^bTrust Network 2 question “[name of network member X]
 377 keeps my interest in mind when making decisions”, ^cTrust Network question: “[name of network
 378 member X] is dependable. For example, they stick to their word and makes sure their actions
 379 and behaviours are consistent, ^dTrust Network 4 question: “I am comfortable asking [network
 380 member X] to take responsibility for project tasks even when I am not present to oversee what
 381 they do”, ^eTrust Network 5 question: “I feel that [network member X] shares a vision with PPI
 382 Ignite Networks vision and goals?”, ^fTrust Network 6 question: “I feel that [network member X]
 383 is open to discussion* about matters pertaining to the PPI Ignite Network”, ^gTrust Network 7
 384 question: “I feel that [network member X] trusts me”

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3 385 *Kolmogorov-Smirnov (KS) test*
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5 386 After calculating the KS statistic, a non-parametric test for comparing two probability
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7 387 distributions, we do not find a statistically significant difference for the in-degree distribution
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9 388 across any of the trust dimensions from T1 to T2, implying that the two samples are drawn from
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11 389 the same in-degree distribution. This is expected, as we hope participants are naming other
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13 390 participants in the same manner at each time point, rather than, for example, choosing thoughtfully
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15 391 at T1 and randomly at T2. However, we do find that the KS statistic is larger for certain trust
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17 392 dimension networks, indicating some variation over time for some trust dimension networks
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19 393 compared to others. For example, trust dimensions 3 (reliability) and 6 (power sharing and co-
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21 394 ownership), has the largest KS statistic at 0.20, while trust dimension 2 (integrity) has the smallest
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23 395 KS statistic, 0.09. For plots see Supplementary File 3. Therefore, although changes in the KS
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25 396 statistic are subtle overall, they vary across the different trust dimensions.
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31 397 *Hamming and Ipsen-Mikhailov (HIM) distance*
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33 398 As our networks have a low density of connections, we recognize that HIM distance,
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35 399 exploring whether connections between individuals change over time, will never be close to one.
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37 400 Therefore, we are not as interested in the overall magnitude of the value, but each HIM distance
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39 401 relative to that of other trust dimensions. We see a small range in HIM distance across the
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41 402 dimensions of trust with an HIM distance ranging from 0.08 – 0.12. Specifically, we observe that
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43 403 networks for trust dimension 2 (integrity) (HIM = 0.08) are more similar from T1 to T2 compared
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45 404 to trust dimension 5 (shared values visions and goals) (HIM = 0.12). See Supplementary File 4 for
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47 405 further details.
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51 406 Indeed, both the KS statistic and HIM distance underscore greater differences across each
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53 407 dimension of trust, than within each dimension from T1 to T2.
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3 408 *Local vs National Comparison*
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5 409 Findings for the weighted mean in-degree and clustering coefficient by type of node (local
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8 410 vs national) T1 and T2, are presented in **Table 3** below. We can see a decrease in weighted mean
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10 411 in-degree (i.e., average number of incoming connections) at both time points for local and national
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12 412 nodes. However, the weighted mean in-degree is higher for national partners than the local partners
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14 413 at both time points, across all trust dimensions. This implies that individual who are national
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16 414 partners or site leads in the PPI Ignite Network, have more trust nominations, i.e., more people
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18 415 agreeing/strongly agreement with the trust statements about them, compared to local partners. We
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20 416 note the largest difference between local vs national partners for trust dimension 5 (shared values,
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22 417 visions, and goals) across both T1 and T2, while trust dimension 2 (integrity) shows the smallest
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24 418 difference between local vs national partners over both T1 and T2. Comparatively, the clustering
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26 419 coefficient does not show such consistent trends across node type, with some local partners having
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28 420 a higher clustering coefficient (i.e., trust triangles) compared to national partners at T1 but a lower
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30 421 clustering coefficient at T2 (see trust dimensions 1 (reliability), 5 (shared values, visions, and
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32 422 goals), 6 (power sharing and co-ownership), and 7 (reciprocity)).
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Table 3: Network Measures for Trust Dimensions at T1 and T2 stratified by Local vs National

Node Type

	Node Type (Local [n=27] and National [n=15])	Weighted In-degree Mean (std)		Clustering Coefficient	
		Time 1	Time 2	Time 1	Time 2
Trust Dimension 1^a (Vulnerability)	<i>Local Nodes</i>	0.55 (0.94)	0.27 (0.54)	0.11 (0.23)	0.07 (0.16)
	<i>National Nodes</i>	4.40 (4.06)	3.27 (3.11)	0.11 (0.16)	0.03 (0.05)
Trust Dimension 2^b (Integrity)	<i>Local Nodes</i>	0.59 (0.94)	0.36 (0.64)	0.11 (0.23)	0.03 (0.11)
	<i>National Nodes</i>	4.00 (3.95)	3.80 (3.37)	0.13 (0.26)	0.08 (0.13)
Trust Dimension 3^c (Reliability)	<i>Local Nodes</i>	1.50 (1.31)	0.77 (1.00)	0.16 (0.25)	0.10 (0.21)
	<i>National Nodes</i>	7.20 (5.96)	6.60 (5.17)	0.11 (0.13)	0.18 (0.16)
Trust Dimension 4^d (Ability)	<i>Local Nodes</i>	0.63 (0.87)	0.45 (0.72)	0.04 (0.11)	0.01 (0.05)
	<i>National Nodes</i>	6.20 (5.44)	4.33 (3.42)	0.09 (0.08)	0.17 (0.20)
Trust Dimension 5^e (Shared values, visions and goals)	<i>Local Nodes</i>	1.50 (1.34)	1.18 (1.53)	0.27 (0.30)	0.15 (0.27)
	<i>National Nodes</i>	9.20 (7.58)	7.93 (6.02)	0.17 (0.17)	0.17 (0.14)
Trust Dimension 6^f (Power sharing and co-ownership)	<i>Local Nodes</i>	1.63 (1.33)	1.00 (1.31)	0.20 (0.25)	0.08 (0.20)
	<i>National Nodes</i>	8.20 (6.82)	7.40 (5.69)	0.15 (0.15)	0.16 (0.14)
Trust Dimension 7^g (Reciprocity)	<i>Local Nodes</i>	1.18 (1.11)	0.81 (1.11)	0.19 (0.27)	0.12 (0.27)
	<i>National Nodes</i>	6.20 (5.29)	5.27 (3.86)	0.16 (0.25)	0.16 (0.16)

^aTrust Network 1 question “I would discuss with [name of network member X] how I honestly feel about my work, negative feelings and frustrations”, ^bTrust Network 2 question “[name of network member X] keeps my interest in mind when making decisions”, ^cTrust Network question: “[name of network member X] is dependable. For example, they stick to their word and makes sure their actions and behaviours are consistent, ^dTrust Network 4 question: “I am comfortable asking [network member X] to take responsibility for project tasks even when I am not present to oversee what they do”, ^eTrust Network 5 question: “I feel that [network member X] shares a vision with PPI Ignite Networks vision and goals?”, ^fTrust Network 6 question: “I feel that [network member X] is open to discussion* about matters pertaining to the PPI Ignite Network”, ^gTrust Network 7 question: “I feel that [network member X] trusts me”

Figure 1 illustrates the networks for these two trust dimension networks over time. We can see that the networks appear less “dense” for trust dimension 2 (integrity) over time, and denser

427 for trust dimension 5 (shared values, visions, and goals). This tells us that people's rate of
 428 agreement is different for across these trust dimensions, which is an important nuance detected
 429 when explored as distinct networks. We can also see that more nodes are disconnected from the
 430 networks in T2 compared to T1 for both dimensions of trust. However, this is more obvious for
 431 Trust Dimension 2 (integrity). This implies that the trust connection for these disconnected nodes
 432 no longer exists at T2 for that dimension of trust.

433 **Figure 1:** Networks for Trust Dimension 2 (Integrity) and 5 (Shared values, visions, and goals) at
 434 T1 and T2
 435 [insert here]

436 *Persistent Connections in T1 and T2*

437 Findings comparing network measures of persistent connections (i.e., the same person nominated
 438 in time one and T2) are outlined in Table 4¹ below. In this specific analysis, if people were
 439 collaborating with and thus nominating new individuals in T2, they were removed from this
 440 analysis. This allowed us to compare trust connections that were persistent overtime. Interestingly,
 441 the average number of weighted incoming connections across all trust dimensions increased over
 442 time. This implies that people's rate of agreement (for those they *also* almost nominated in T1)
 443 increased.

444 Table 4: Network-level measures over time*

Networks (n=59)	Weighted In-degree Mean (std)		Weighted In-degree Centralisation	
	T1	T2	T1	T2
Trust Dimension 1 ^a (Vulnerability)	0.85 (1.74)	1.02 (1.88)	0.17	0.16

¹ Non-weighted properties such as clustering coefficient and reciprocity are not included as they would not change over time as we are only including persistent connections.

Trust Dimension 2^b (Integrity)	0.83 (1.89)	1.09 (2.10)	0.17	0.18
Trust Dimension 3^c (Reliability)	1.57 (2.64)	1.89 (3.01)	0.22	0.24
Trust Dimension 4^d (Ability)	1.09 (2.04)	1.37 (2.34)	0.21	0.20
Trust Dimension 5^e (Shared values, visions, and goals)	2.02 (3.02)	2.37 (3.60)	0.23	0.29
Trust Dimension 6^f (Power sharing and co-ownership)	1.98 (3.00)	2.30 (3.59)	0.23	0.30
Trust Dimension 7^g (Reciprocity)	1.26 (2.29)	1.67 (2.65)	0.18	0.19

445 **This table explores connections that were persistent over time (i.e., excludes new collaborations*
 446 *in T2). ^aTrust Network 1 question “I would discuss with [name of network member X] how I*
 447 *honestly feel about my work, negative feelings and frustrations”, ^bTrust Network 2 question*
 448 *“[name of network member X] keeps my interest in mind when making decisions”, ^cTrust*
 449 *Network question: “[name of network member X] is dependable. For example, they stick to their*
 450 *word and makes sure their actions and behaviours are consistent, ^dTrust Network 4 question: “I*
 451 *am comfortable asking [network member X] to take responsibility for project tasks even when I*
 452 *am not present to oversee what they do”, ^eTrust Network 5 question: “I feel that [network*
 453 *member X] shares a vision with PPI Ignite Networks vision and goals?”, ^fTrust Network 6*
 454 *question: “I feel that [network member X] is open to discussion* about matters pertaining to the*
 455 *PPI Ignite Network”, ^gTrust Network 7 question: “I feel that [network member X] trusts me”*

456 In summary, findings highlighted:

- 457 • An SNA approach identified subtle changes over time in when exploring trust
 458 multidimensionally in the PPI Ignite Network. On average there was a slight decrease in
 459 trust connections for each dimension of trust from T1 to T2 on a global level. However, trust
 460 connections that were persistent over time, increased across all dimensions of trust.
- 461 • More distinct differences are present when stratifying trust across the dimensions by
 462 partnership type (i.e., local or national partner), where national partners and site leads in the

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3 463 PPI Ignite Network, have more trust nominations, i.e., more people agreeing/strongly
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5 464 agreement with the trust statements about them, compared to local partners.
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8 465 • These findings suggest an edit to the current conceptual view of trust as illustrated in
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10 466 Supplementary File 1, replacing it with a more dynamic, multidimensional representation of
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12 467 trust depicted in Supplementary File 5.
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14 468 **DISCUSSION**

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17 469 This study extends the work by Gilfoyle et al., (53, 54) by comparing the dimensions of
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19 470 trust over time, by local or national partnership type, and more broadly, by contributing to the
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21 471 conceptual and operational gaps surrounding trust in participatory research partnerships (53, 54).
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23 472 By analysing the different dimensions of trust as separate networks, we can identify where they
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25 473 change over time. We provide empirical support for a comprehensive and multidimensional
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27 474 exploration of trust as it evolved in the PPI Ignite Network, detecting subtle changes across most
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29 475 network measures over time. We could see a general decrease in the number of connections for
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31 476 each dimension of trust over time across the PPI Ignite Network. However, trust connections that
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33 477 were persistent over time, increased across all dimensions of trust. This suggests that when
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35 478 partnerships were maintained from T1 to T2, trust increased. Comparatively, across the PPI Ignite
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37 479 Network trust decrease slightly, likely due to new formed collaborations, where trust had yet to be
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39 480 established/sustained. This is persistent with the literature which suggests trust must be built and
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41 481 sustained over time, and new collaborations/change in personnel can impact its development and
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43 482 maintenance (22, 67).
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49 483 We also found that some networks were more similar (i.e., vulnerability and integrity) and
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51 484 others strikingly different (integrity and shared values, visions, and goals) to each other, with a
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53 485 higher number of incoming connections for national partners compared to local partners. These
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3 486 findings provide important contributions to the literature, namely providing empirical support for
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5 487 using SNA to operationalise trust in a comprehensive and multidimensional over time in a PHR
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7 488 partnership. This is key as PHR advocates for contextually derived and driven knowledge
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9 489 production, to suit the needs of the communities (8, 68) and is underscored in the CBPR conceptual
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11 490 model (18). Therefore, operational techniques must also consider the context of the partnership so
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13 491 that partners can both understand and evaluate if the goals of the partnership are being met and if
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15 492 they are on a trajectory of success. This can be a limitation of more traditional quantitative
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17 493 analytical approaches, creating challenges for measuring context across partnerships (69). This is
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19 494 a key strength of SNA tools and techniques, which embrace the individual and system-level
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21 495 perspective, when exploring complex social-relational processes, like trust, while considering the
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23 496 social context and how it influences individuals within it (70).

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28 497 Using SNA also provided us with “insight into the relationships, positions, structure and
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30 498 strength of a network (71)(pg.4)” across two time points. We could see where trust relations did
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32 499 or did not exist in the PPI Ignite Network over time through the network maps *and* understand the
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34 500 implications of individual positions and the network structure as whole. For example, central actors
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36 501 are thought to have more prestige, visibility and influence in a network, and are often viewed as
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38 502 opinion leaders that are key to the diffusion of ideas and behaviour (31). This has important
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40 503 implications for the trust development process, highlighting areas for structural intervention (i.e.,
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42 504 strategic actions that or remove links between nodes (72)). Specifically, findings could help
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44 505 partners capitalise on strong connections and address areas of weakness to ensure trust is built and
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46 506 maintained over time. Indeed, understanding the trust development process is a current gap in the
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48 507 PHR literature, where "the majority of trust and community-based participatory research literature
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50 508 conceptualised trust as an outcome and acknowledges that research on trust development is lacking
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3 509 (29)(pg.62).” An enhanced understanding of the trust development process could in turn dictate
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5 510 where (often limited) time and resources are spent to improve trust in partnerships, and ultimately
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7 511 partnership functioning. For example, considering the finding that local partners were less central
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9 512 compared to national partners (i.e., had fewer incoming nominations across each dimension of
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11 513 trust), we could recommend immediate interventions, like creating opportunity for local partners
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13 514 to lead on work. However, if partnership capacity is an issue, interventions such as the
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15 515 (re)distribution of resources and support to local partners would be needed. Indeed, we could use
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17 516 SNA to both operationalise and then evaluate trust comprehensively and consistently over time.
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19 517 For instance, the network maps provide a visual representation of each trust dimension for the PPI
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21 518 Ignite Network over a 1-year timepoint, which could be used mode for evaluating the trust
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23 519 development process. For instance, findings could be presented and discussed with members of
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25 520 the PPI Ignite Network to ensure they, a) adequately reflect their experience of trust in the PPI
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27 521 Ignite Network, and b) to better understand why trust may have evolved as it did over the course
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29 522 of 1 year. As trust is key to achieving successful outcomes in a partnership (23, 73), this would be
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31 523 especially important for networks like the PPI Ignite Network who have committed to working
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33 524 together over the course of 5 years.
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40 525 *Limitations*

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42 526 Although embracing context is important, readers should consider this when interpreting
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44 527 and/or applying findings to their own research. This case study used a small network with two time
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46 528 points over a year. Considering trust takes time to develop, it is possible that surveying trust at
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48 529 only two time points over a year is restrictive. Further, as trust is inherently contextual, its
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50 530 evolution will likely vary depending on the partnership of interest.
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54 531 *Future Research*

532 Areas of future work could include exploring whether trust conceptualised and
533 operationalised in the PPI Ignite Network led to better partnership outcomes. Also, we could
534 identify additional network features that might be influential for trust in PHR, such as asymmetry
535 in relationships. In addition, future research could explore whether certain trust dimensions (i.e.,
536 of the 7 dimensions) are more relevant or pertinent to specific aspects of the CBPR model. We
537 also hope to explore the trust development process across other PHR partnerships, to compare
538 findings across multiple study contexts.

539 CONCLUSION

540 This study utilises a novel and interdisciplinary lens, drawing from both the social network
541 and PHR literature, to further clarify important conceptual and operational complexities of trust.
542 In doing so, we were able to extend findings of Gilfoyle et al.(53, 54), analysing trust consistently
543 and comprehensively *over time* in a real-world partnership, the PPI Ignite Network. Findings
544 provide empirical support for employing SNA to explore the evolution of trust as a
545 multidimensional concept in PHR partnerships over time. Future research could consider exploring
546 trust over a longer period of time, to better understand the evolution of trust in their context.

547 AUTHOR CONTRIBUTIONS

548 All authors have made substantive intellectual contributions to the development of this study. MG
549 conceptualized and led the study, drafted, and edited the final manuscript. PMC analysed the data
550 and contributed to the study design, data analysis and interpretation, writing, and editing of the
551 manuscript. JS secured funding, contributed to the study conceptualisation, data analysis and
552 interpretation, and contributed to the writing and editing of the final manuscript. AMF contributed
553 to the study conceptualisation, writing, and editing of the final manuscript. MMC contributed to
554 study conceptualisation, interpretation of results, reviewed and approved manuscript.

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564 565 COMPETING INTERESTS

566 None declared.

567 DATA AVAILABILITY STATEMENT

568 The data that support the findings of this study are available from the corresponding author, JS,
569 upon reasonable request.

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27 756 **List of Figures (1):**

28
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30 757 **Figure 1:** Networks for Trust Dimension 2 (Integrity) and 5 (Shared values, visions, and goals)
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32 758 at T1 and T2
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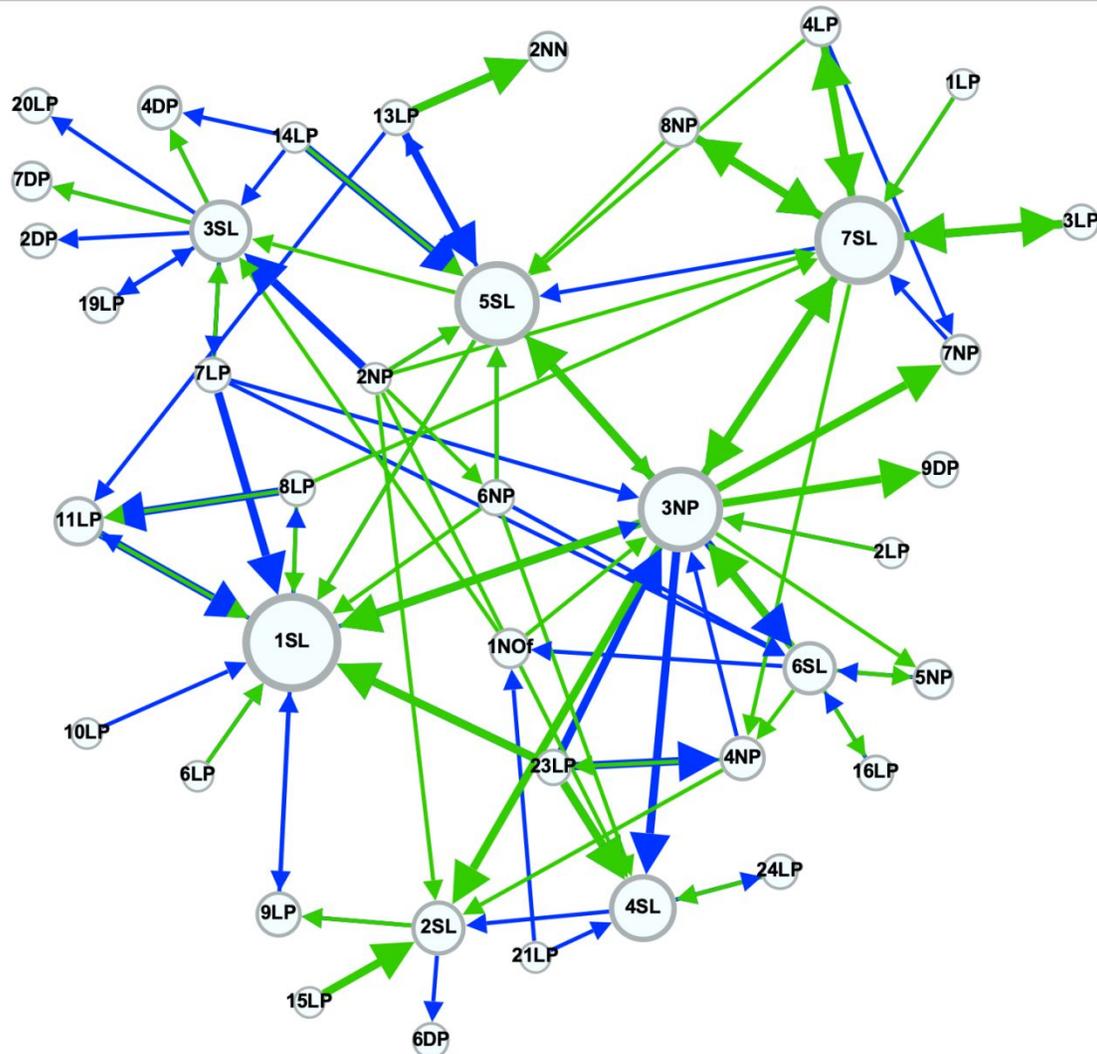
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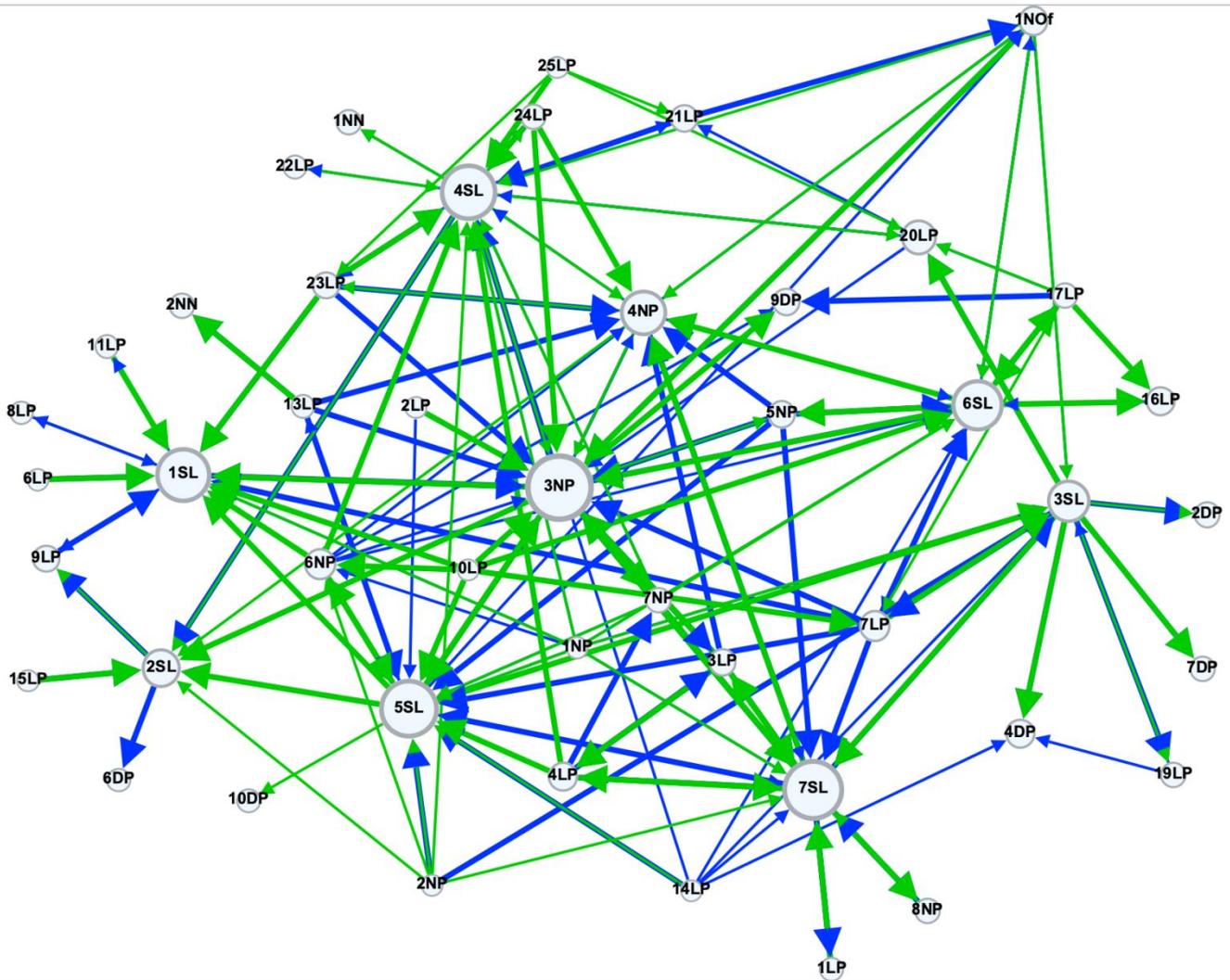
Figure 1: Networks for Trust Dimension 2 (Integrity) and 5 (Shared values, visions, and goals) at T1 and T2

Trust Dimension 2 - Integrity



Note: Blue arrows indicate T1 connections. Green arrows indicate T2 connections. The size of the node pertains to the number of incoming nominations for that individual. A larger node has more people 'agreeing' or 'strongly agreeing' with that statement of trust about them. NP = National Partner; LP = Local Partner; SL = Site Lead; DP = nominated but did not participate in network survey; NN = nominated but not in the PPI Ignite Network.

Trust Dimension 5 – Shared Values, Visions and Goals



Note: Blue arrows indicate T1 connections. Green arrows indicate T2 connections. The size of the node pertains to the number of incoming nominations for that individual. A larger node has more people ‘agreeing’ or ‘strongly agreeing’ with that statement of trust about them. NP = National Partner; LP = Local Partner; SL = Site Lead; DP = nominated but did not participate in network survey; NN = nominated but not in the PPI Ignite Network.

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Supplementary File 1: A Multidimensional View of Trust



Supplementary File 1 description: The figure displays the 7 dimensions of trust as identified in the scoping review by Gilfoyle et al.(1) The network survey in this study was designed based on these dimensions, with a collaboration question acting as the *name generator* (2) for the network survey.

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(Time 1) Network Survey and Framing Questions - PPI Network

Start of Block: Information sheet and consent form

Information Sheet **Before continuing, please review the information sheet for volunteers by clicking the link below:**

LINK: [removed for peer review]

[consent form removed for peer review]

Consent By clicking 'Yes' below, I am providing my consent to participate as indicated above OR click 'No' below, if you choose not to participate at this time.

- Yes, I consent to participate (1)**
- No, I choose not to participate at this time (2)**

End of Block: Information sheet and consent form

Start of Block: Network Questions Part 1



Question 1

Thank you for taking part in this study!

You have read the study information letter and have signed an informed consent form, so you understand the purpose of the study and the use to which its findings will be put.

Individuals and institutions will be anonymised in all wider reporting of results.

This questionnaire should take approximately 15 minutes to complete.

Section 1: Network Questions

Level of Collaboration

For the following questions we are asking you to name organisations you are collaborating with on the PPI Ignite Network. When choosing an organisation, think about the specific individuals that represent the organisation in the network. *For example, if you were collaborating with [example name].*

Once you start typing an organisation's **full** name, an auto fill drop-down box will appear. Select the organisation you want. If needed, click here for a full list of network organisations.

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Question 1:

- a. Enter up to 7 organisations that you collaborate with on the PPI Ignite Network.**
- b. Beside each of the selected organisations, rank your intensity of collaboration.**

For peer review only

(Please refer to Table A to guide your ranking)

Table A

Level	Definition	(0) No
interaction	No interaction, not aware of individual in this organisation	
	(1) Networking	I am aware of the
	individual(s), but we have loosely defined roles, little communication, and all decisions made independently	
	(2) Cooperation	
	We provide information to each other, have somewhat defined roles, formal communication, but all decisions are made independently	
	(3) Coordination	We share information and resources, have defined
	roles, frequent communication, some shared decision making	
	(4) Coalition	We share ideas and resources, have frequent and
	prioritised communication, and have a vote in each other's decision making	
	(5) Collaboration	We belong to one system,
	our frequent communication is characterized by mutual trust, consensus is reached on all decisions	

	0 No Interaction (1)	1 Networking (2)	2 Cooperation (3)	3 Coordination (4)	4 Coalition (5)	5 Collaboration (6)
Type organization 1 here: (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Type organization 2 here: (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Type organization 3 here: (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Type organization 4 here: (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Type organization 5 here: (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Type organization 6 here: (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Type organization 7 here: (7)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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End of Block: Network Questions Part 1

Start of Block: Network Questions Part 2

Statement 1 **Relational questions about 7 PPI Ignite Network Members** For each of the organisation names (up to 7) you listed in Question 1, please answer the following:

Question 2: On a scale from (1) strongly disagree to (5) strongly agree, please rate the extent to which you agree with the following 7 statements:

**Note: statement 6 has additional descriptions to help guide your selection*

	1 Strongly Disagree (1)	2 Disagree (2)	3 Neither agree nor disagree (3)	4 Agree (4)	5 Strongly agree (5)
\${Question 1/ChoiceTextEntryValue/1} (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
\${Question 1/ChoiceTextEntryValue/2} (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
\${Question 1/ChoiceTextEntryValue/3} (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
\${Question 1/ChoiceTextEntryValue/4} (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
\${Question 1/ChoiceTextEntryValue/5} (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
\${Question 1/ChoiceTextEntryValue/6} (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
\${Question 1/ChoiceTextEntryValue/7} (7)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Statement 5 .

	1 Strongly Disagree (1)	2 Disagree (2)	3 Neither agree nor disagree (3)	4 Agree (4)	5 Strongly agree (5)
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1/ChoiceTextEntryValue/7 (7)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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Statement 6 .

	1 Strongly Disagree (1)	2 Disagree (2)	3 Neither agree nor disagree (3)	4 Agree (4)	5 Strongly agree (5)
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1/ChoiceTextEntryValue/4 (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
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1/ChoiceTextEntryValue/7 (7)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Statement 7 .

	1 Strongly Disagree (1)	2 Disagree (2)	3 Neither agree nor disagree (3)	4 Agree (4)	5 Strongly agree (5)
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\${Question 1/ChoiceTextEntryValue/1} (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
\${Question 1/ChoiceTextEntryValue/2} (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
\${Question 1/ChoiceTextEntryValue/3} (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
\${Question 1/ChoiceTextEntryValue/4} (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
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\${Question 1/ChoiceTextEntryValue/6} (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
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Statement 8 .

	1 Strongly Disagree (1)	2 Disagree (2)	3 Neither agree nor disagree (3)	4 Agree (4)	5 Strongly agree (5)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60					
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1/ChoiceTextEntryValue/2 (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
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1/ChoiceTextEntryValue/4 (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
1/ChoiceTextEntryValue/5 (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
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1/ChoiceTextEntryValue/7 (7)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Statement 9 .

	1 Strongly Disagree (1)	2 Disagree (2)	3 Neither agree nor disagree (3)	4 Agree (4)	5 Strongly agree (5)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60					
1/ChoiceTextEntryValue/1 (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
1/ChoiceTextEntryValue/2 (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
1/ChoiceTextEntryValue/3 (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
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1/ChoiceTextEntryValue/7 (7)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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Statement 10

	1 Strongly Disagree (1)	2 Disagree (2)	3 Neither agree nor disagree (3)	4 Agree (4)	5 Strongly agree (5)
1 1/ChoiceTextEntryValue/1 (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2 1/ChoiceTextEntryValue/2 (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3 1/ChoiceTextEntryValue/3 (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4 1/ChoiceTextEntryValue/4 (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5 1/ChoiceTextEntryValue/5 (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6 1/ChoiceTextEntryValue/6 (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7 1/ChoiceTextEntryValue/7 (7)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

End of Block: Network Questions Part 2

Start of Block: Framing Questions

Trust typology **Section 2 – Framing Questions**

Trust typology In this Question, we are interested in learning your views on **the type of trust** you think exists in the PPI Ignite Network at this point in time. The six trust types and their associated definition **are listed below. Question 3: Please indicate your views on trust in the PPI Ignite Network at this time. Specifically, what type of trust do you think currently exists in the network?**

CLICK ONE OF THE FOLLOWING:

- Critical reflexive trust** (Trust that allows for mistakes and where differences can be talked about and resolved) (1)
- Proxy trust** (Partners are trusted because someone trusted invited them) (2)
- Functional trust** (Partners are working together for a specific purpose and time-frame, but trust may still be present) (3)
- Neutral trust** (Partners are still getting to know each other there is neither trust nor mistrust) (4)
- Unearned trust** (Trust is based on member's title or role with limited or no direct interaction) (5)
- Trust deficit (suspicion or mistrust)** (Partnership members do not trust each other) (6)

preparedness PPI preparedness question **Question 4: On a scale from (1) strongly disagree to (5) strongly agree, please rate the extent to which you agree with the following statement: "I feel my organisation is prepared to support PPI research at this time"**

CLICK ONE OF THE FOLLOWING:

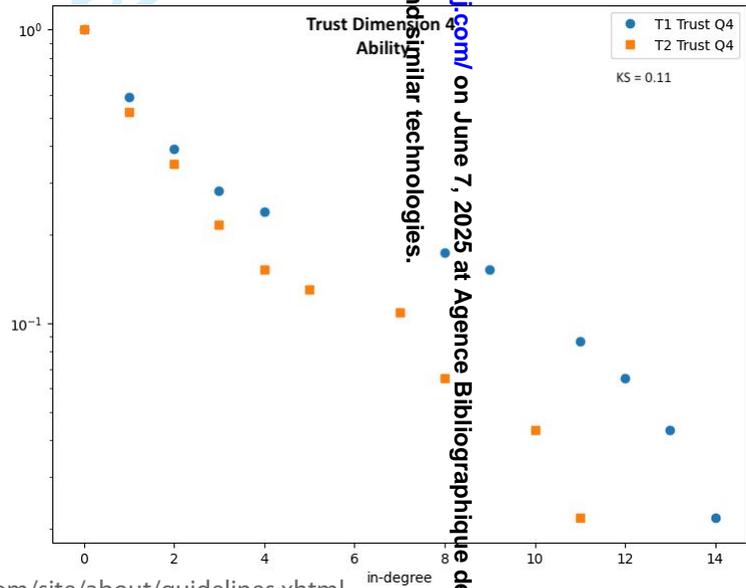
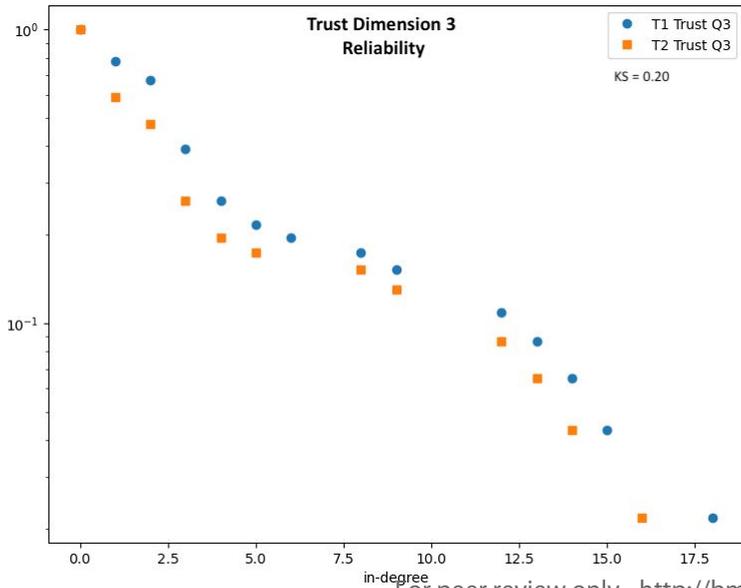
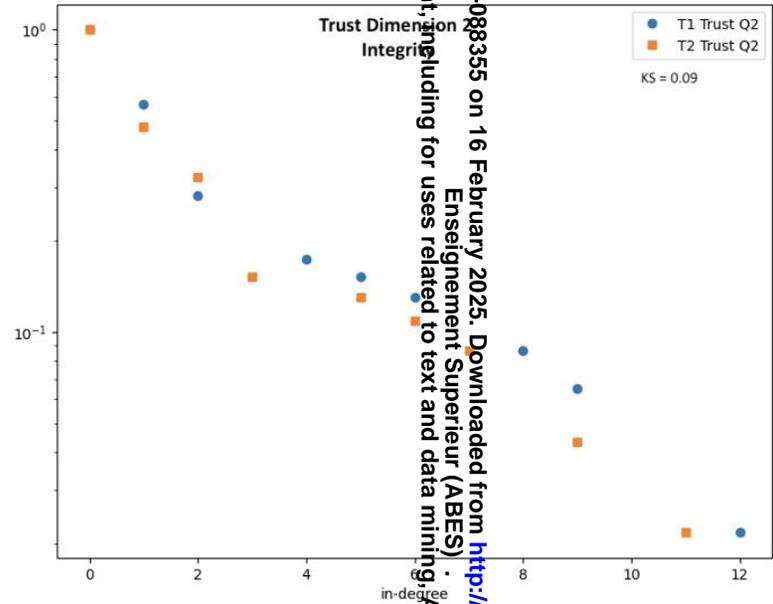
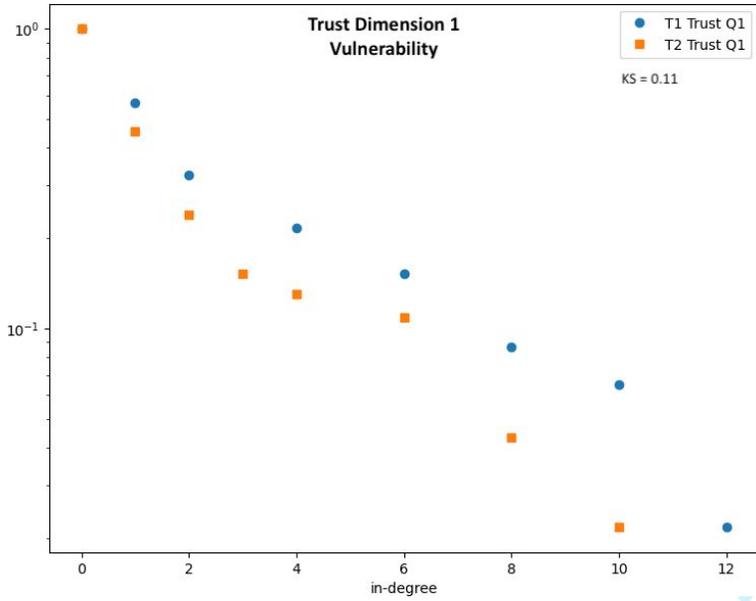
- 1 Strongly disagree** (1)
- 2 Disagree** (2)
- 3 Neither agree nor disagree** (3)
- 4 Agree** (4)
- 5 Strongly agree** (5)

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End of Block: Framing Questions

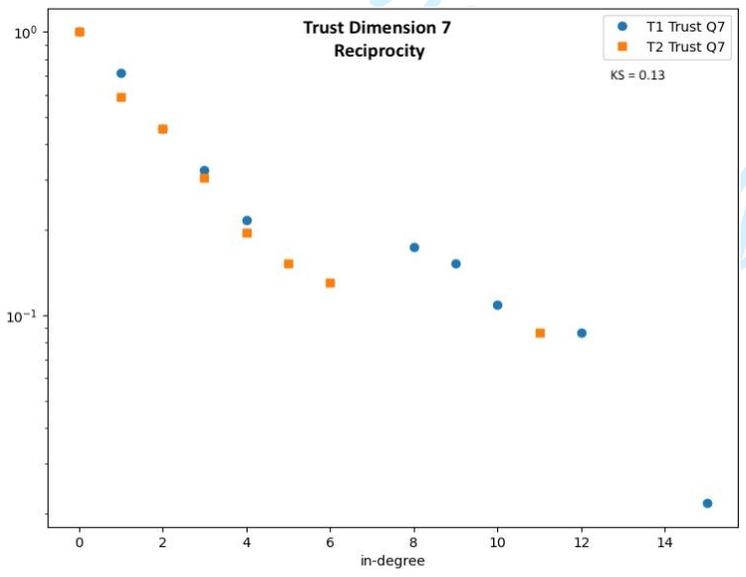
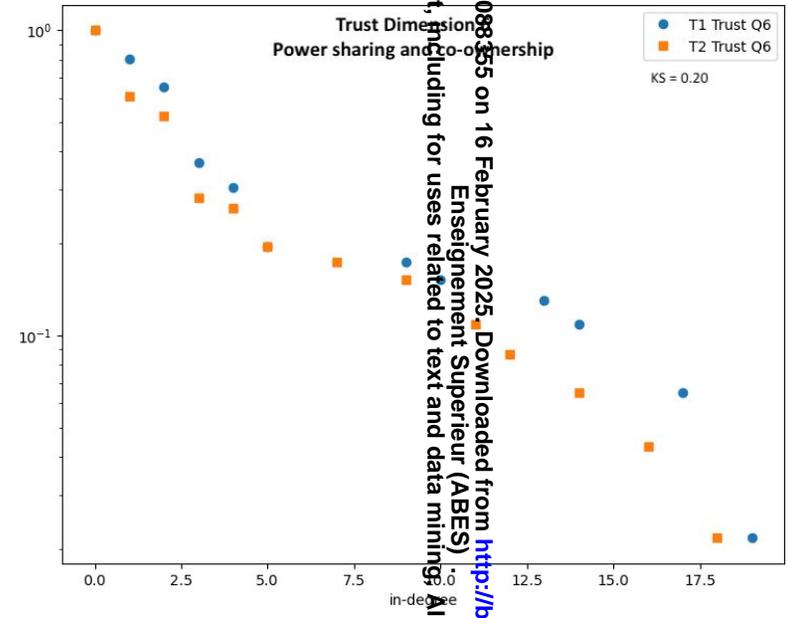
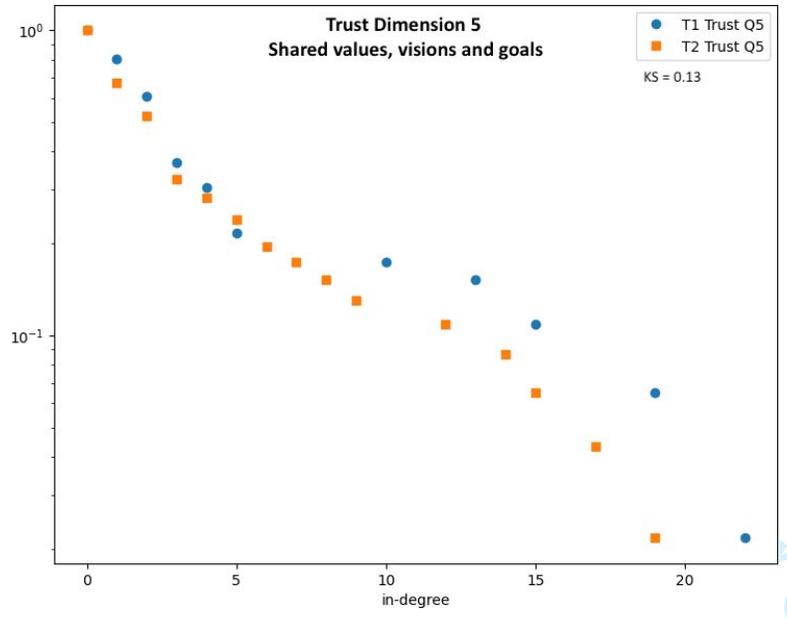
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Distribution plots and Kolmogorov-Smirnov test



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Distribution plots and Kolmogorov-Smirnov test



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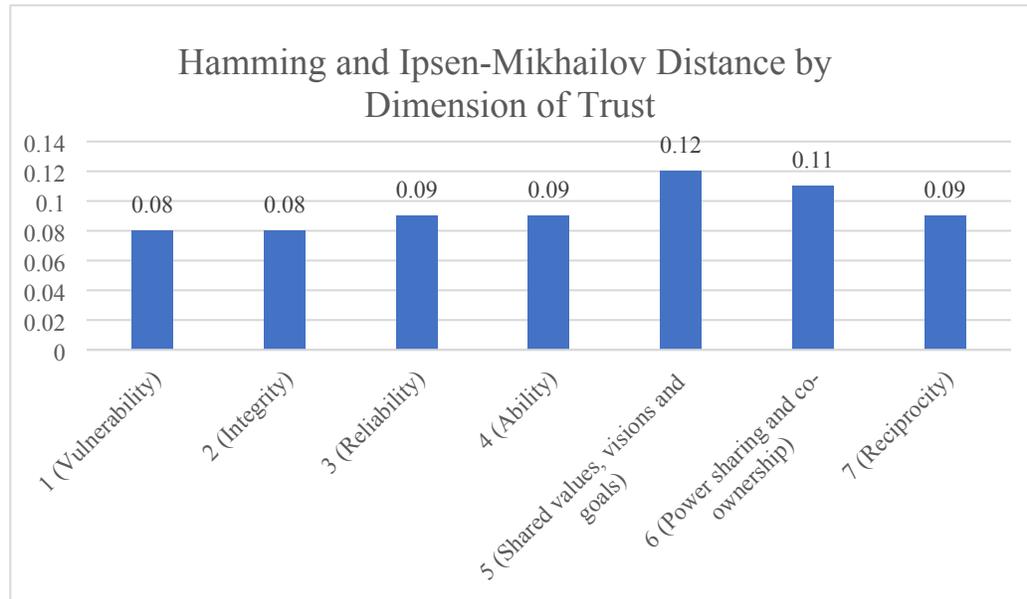
Distribution plots and Kolmogorov-Smirnov test

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Hamming and Ipsen-Mikhailov Distance by Dimension of Trust Over Time

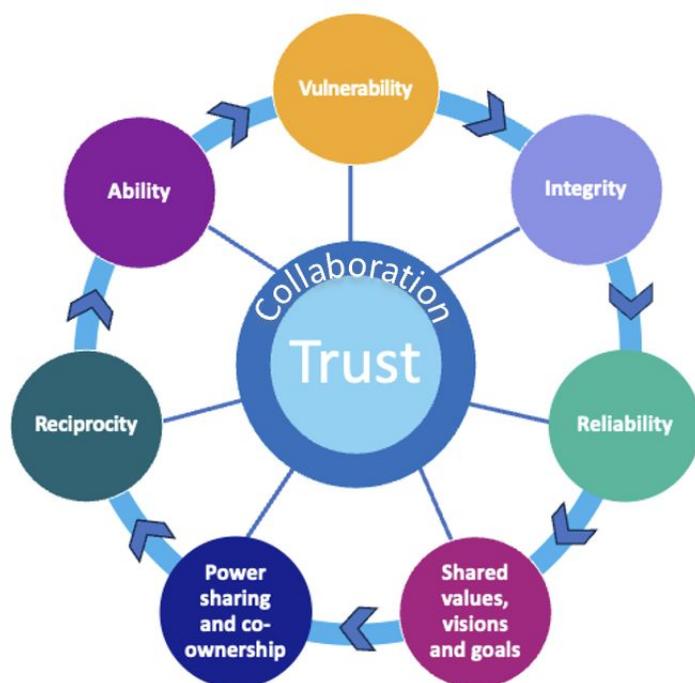


This metric combines the Hamming distance (Deza and Deza, 2009; Gao et al., 2010), which counts matching connections between two networks (i.e., trust dimensions at T1 and T2) and the Ipsen-Mikhailov distance, a spectral distance used to differentiate networks (Ipsen and Mikhailov, 2003). Spectral distances are global measures that evaluate the difference between the whole structure, though can miss differences between small sub-structures. The HIM distance (Jurman et al., 2015) yields a 0 if two networks are identical, or 1 if they are opposite. For example, two networks that are identical will have a HIM distance of 0, while a complete graph (a network where everyone is connected to everyone else) compared to a graph with no connections, will have an HIM distance of 1.

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Supplementary File 5: A Multidimensional and Dynamic View of Trust



Supplementary File 5: This updated figure displays the 7 dimensions of trust as identified in the scoping review by Gilfoyle et al., with arrows added to depict the dynamic nature of trust, also underscored in this work when applying a SNA approach to operationalise trust multidimensionally and over time.

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An Exploration of Trust in Participatory Health Research Partnerships Across Two Timepoints – A Network Approach

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Keywords:	Community-Based Participatory Research, Health, SOCIAL MEDICINE

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An Exploration of Trust in Participatory Health Research Partnerships Across Two Timepoints – A Network Approach

Meghan Gilfoyle^{1,2}, Jon Salsberg^{1,3*}, Anne MacFarlane^{1,3}, Miriam McCarthy⁴, and Pádraig MacCarron⁵

¹Public & Patient Involvement Research Unit, School of Medicine, University of Limerick Limerick, Ireland, V94 T9PX

²Postdoctoral Fellow, Women's College Hospital Institute for Health System Solutions and Virtual Care, Toronto, ON, Canada, M5S 1B2

³Health Research Institute (HRI), University of Limerick, Limerick, Ireland, V94 T9PX

⁴Health Sciences Academy, University of Limerick and UL Hospitals Group, Limerick, Ireland, V94 F858

⁵Mathematics Applications Consortium for Science and Industry (MACSI), Department of Mathematics & Statistics, University of Limerick, Limerick, Ireland, V94 T9PX

*Correspondence:

Jon Salsberg
Jon.Salsberg@ul.ie

ABSTRACT

Background: The value of a participatory approach to the generation of evidence for health and social services from a moral, methodological and policy level continues to gain recognition globally. Trust is a crucial mechanism in the participatory health research (PHR) process and is strongly influenced by context. However, gaps remain in conceptualising and operationalising trust over time in PHR partnerships.

Objective: This case study seeks to address these gaps by exploring the evolution of trust multidimensionally across two timepoints.

33 **Setting and Participants:** Participants in a PHR project called the Public and Patient Involvement
34 (PPI) Ignite Network in Ireland (n=57 (T1); n=56 (T2)) were invited to complete a network survey
35 at two timepoints. The PPI Ignite Network had local and national partners.

36 **Network Measures:** Several core social network measures were calculated at both timepoints to
37 characterize differences between trust dimensions and between local and national partners.

38 **Results:** Subtle changes were observed across most network measures over the two timepoints.
39 While there was a slight decrease in the number of connections for each trust dimension throughout
40 the PPI Ignite Network, connections that were consistently nominated in both timepoints increased
41 slightly. Some trust dimensions, such as vulnerability and integrity, were more similar, while
42 others, like integrity and shared values, visions, and goals, differed greatly, where national partners
43 consistently received more incoming connections compared to local partners.

44 **Conclusion:** These findings, 1) provide empirical support for using Social Network Analysis
45 (SNA) to operationalise trust comprehensively and multidimensionally over time in a participatory
46 partnership, 2) offer nuanced insights into the trust development process within the PPI Ignite
47 Network, and 3) enhance our understanding of trust in the community-based participatory research
48 model.

49 **Strengths and Limitations of this Study:**

- 50 • This study provides empirical support for using tools and techniques from network
51 science to clarify important conceptual and operational complexities of trust in
52 participatory health research partnerships across two timepoints. In doing so, we help
53 address critical ambiguities that hinder the application and evaluation of participatory
54 health research in health promotion.

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3 55 • Our approach to measuring trust in participatory partnerships embraces its
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5 56 multidimensional nature, allowing us to see how trust unfolds, across all its dimensions,
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7 57 over two timepoints.
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10 58 • By exploring trust in this way, we embraced the partnership environment, which plays an
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12 59 important role in trust and partnership synergy and sustainability.
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15 60 • This case study used a small network with two time points over a year. Considering trust
16
17 61 takes time to develop, it is possible that surveying trust at only two time points over a year
18
19 62 is restrictive.
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22 63 • As trust is inherently contextual, its evolution will likely vary depending on the partnership
23
24 64 of interest.

25
26 65 **Keywords:** participatory, community-based participatory research, trust, social network analysis,
27
28 66 social networks

31 67 **Patient and Public Involvement Statement**

32
33 68 This is one sub-study that is part of a larger study in which a Research Advisory Group was involved.
34
35 69 This group comprises four research partners representing academic, service, or community
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37 70 organisations in the PPI Ignite Network (further described in this manuscript). These partners were a
38
39 71 subset of individuals interested in this work, who were already working with co-authors JS, AM and
40
41 72 MG through a prior grant called PPI Ignite@UL. These partners provided input and approval for the
42
43 73 research objectives of this study, ensured all content in the network surveys and interview guide were
44
45 74 both accessible to participants and contextually relevant, reviewed and interpreted findings at a high-
46
47 75 level confirming from their perspective, if they agreed with the findings as a partner in the PPI Ignite
48
49 76 Network, acted as a soundboard for brainstorming ways to address any research challenges, provided
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51 77 suggestions/feedback for ensuring dissemination materials and outputs (e.g., conference posters and
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53 78 manuscripts), and were being communicated effectively for diverse audiences. One Research
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3 79 Advisory Group member has been further involved in the interpretation of the results as well as
4
5 80 reviewing and revising manuscript content and language, and thus, authorship of this manuscript (co-
6
7 81 author MMC). Co-author MMC was also involved in the dissemination of this work at an
8
9 82 international conference (*cf*[1])
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11 83 **BACKGROUND**

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14 84 The value of a participatory approach to the generation of evidence for health and social
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16 85 services from a moral, methodological and policy perspective continues to develop on a global
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18 86 scale [2-4]. Participatory Health Research (PHR) can be defined as “systematic inquiry, with the
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20 87 collaboration of those affected by the issue being studied, for the purposes of education and taking
21
22 88 action or effecting change.”[5](pg.43) In PHR, “those affected” is intentionally broad
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24 89 encompassing individuals, community members, or groups such as patients, public, health
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26 90 professionals, and organisational representatives. These individuals/groups can be both directly or
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28 91 indirectly affected by a health issue.[6]
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33 92 With roots grounded in principles of social action, justice and emancipatory philosophy,
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35 93 PHR has the potential to tackle complex health problems and achieve more meaningful and
36
37 94 nuanced short and long-term outcomes [6-8]. PHR has been gaining recognition throughout
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39 95 research communities as an approach that serves to bridge the gap between research and
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41 96 practice.[6, 8, 9] Specifically, PHR helps to maximise the relevancy of research and usability of
42
43 97 its products, while simultaneously building capacity and addressing issues of social justice and
44
45 98 self-determination among end-user communities.[6, 8] The central tenet of PHR is its co-creation
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47 99 process, where those affected by the issue under investigation or who benefit from the knowledge
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49 100 being produced, are key to the knowledge production process, working as equitable partners with
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51 101 academics from idea conceptualisation to dissemination and beyond [6, 10].
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3 102 In this paper, we discuss PHR as an umbrella term for a variety of approaches (e.g.,
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5 103 participatory action research [11], participatory rural appraisal [11, 12], community-based
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7 104 participatory research (CBPR)[13, 14]). While terminologies may vary by country of origin,
8
9 105 discipline and research goals,[13, 15] they all strive to bridge the gap between knowledge and
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11 106 practice by harnessing inclusivity and recognising the importance of actively and meaningfully
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13 107 engaging those who the research serves to benefit in the research process [6].
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16
17 108 One widely recognised approach to PHR [6, 16] is CBPR. A conceptual model for CBPR
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19 109 was developed[17] and later adapted [8], providing a concrete framework for understanding how
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21 110 the CBPR process is influenced by contextual and process-related aspects that can affect the ability
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23 111 to achieve both short-term impacts (e.g. stronger partnerships) and long-term outcomes (e.g.
24
25 112 improved health, community transformation, and health equity). The intention of the model is to
26
27 113 act as a dynamic tool that evolves with research and understanding of CBPR. This includes a
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29 114 deeper understanding of how context, partnership characteristics, and processes contribute to
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31 115 research and intervention design, and ultimately lead to intermediate and long-term outcomes [18].
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33 116 However, challenges in operationalising aspects of the model limit our understanding and
34
35 117 evaluation of the PHR process. For instance, Oetzel et al.[19, 20] noted that additional longitudinal
36
37 118 research is required to better understand how CBPR processes lead to outcomes and under what
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39 119 conditions, to further substantiate the mechanisms in the model [19, 20].
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45 120 Trust is frequently identified as an important component of the CBPR model, described as
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47 121 “permeating and affecting all interactions and relationships in the partnership and as linking one
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49 122 [domain] to another [21](pg.14).” Trust has been underscored as a crucial mechanism [22, 23]
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51 123 essential to the PHR process that can affect the ability to achieve both intermediate impacts and
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53 124 long-term outcomes [24, 25]. For example, seminal work by Jagosh et al.[23] found that the
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3 125 building and maintenance of trust was a key mechanism for supporting partnership synergy, a
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5 126 universal feature of the collaborative process necessary for building and sustaining partnerships.
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8 127 Synergy has been described as “the power to combine the perspectives, resources and skills of a
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10 128 group of people and organizations (pg.183),” and influences partnership effectiveness [26].
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12 129 However, defining, measuring and operationalising trust in PHR is challenging given the
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14 130 overwhelming variation in how it is defined [27]. This reflects sentiments expressed by Misztal et
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16 131 al.[28](pg.117), underscoring that of Wuthnow et al.[29], describing trust as “one of the most
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18 132 complex, multidimensional and misunderstood concepts in the social sciences [28, 29](pg. 117).”
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22 133 As explicated by Lucero et al. [30], “although numerous CBPR scholars have discussed
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24 134 the importance of trust and offer anecdotal suggestions, very few systematically research it (pg.
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26 135 160).” Influential work by Lucero et al.[25, 30, 31], has provided important advancements in the
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28 136 study of trust in participatory literature presenting, for the first time to our knowledge, an
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30 137 alternative to the binary view of trust in CBPR (i.e., present or absent). As highlighted above,
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32 138 Lucero et al.[25, 30, 31] operationalised trust a typology of six categories from the lowest type
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34 139 being a trust deficit (suspicion) to the highest, called critical reflexive trust (having the ability to
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36 140 discuss and move on after a misstep). However, more work is still needed, especially exploring
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38 141 trust types over time.[25] With the recognition that trust is a dynamic, socially embedded process
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40 142 and extends beyond a simplified view as a variable, it requires a methodology that reflects this.[22]
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44 143 One approach is to view PHR partnerships as a *social network*. A social network describes
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46 144 the relationships among people, organisations or other social actors [32]. Social network analysis
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48 145 (SNA) is a methodology for describing and measuring contextual and relational dynamics among
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50 146 and between social entities like individuals or organisations [33]. Trust is a type of relation that
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52 147 has been commonly explored in the network literature in diverse fields [34-50], such as in health
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3 148 [51] and education [52]. As mentioned by Zolin and Gibbons,[50] “for a researcher, analysis of
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5 149 networks that are directly or indirectly related to trust may yield practical and theoretical insights
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8 150 that are not discoverable through other means...(pg.189)”. This is because, unlike other methods,
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10 151 SNA allows us to understand trust while embracing its social environment[50]. This is a key
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12 152 strength of SNA as it extends beyond the behaviour of the individual, embracing the social aspects
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14 153 of behaviour. Using SNA, we can consider the interdependent nature of human data.[32, 53]
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16 154 Further, as trust is a type of relation, it is inherently embedded in a network of relationships. This
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18 155 creates opportunity to explore a variety of research questions about trust [50]. For example,
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20 156 network questions can help us explore how trust is developed over time [50]. Indeed, viewing PHR
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22 157 partnerships as a social network, applying SNA tools and techniques to explore trust over time,
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24 158 could help address the challenges that persist in operationalising trust in the CBPR model, and in
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26 159 turn, improve our understanding and evaluation of trust in the PHR process.

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31 160 Recognising this potential, Gilfoyle et al.[54] then proposed a novel and interdisciplinary
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33 161 conceptual triad in their scoping review, with trust in the centre, connecting PHR and SNA, to
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35 162 explore how trust can be conceptualised, operationalised and measured in PHR and social
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37 163 networks literature. Results from this review[54] revealed two key findings. Firstly, it found trust
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39 164 to be multidimensional, identifying several key trust dimensions. Secondly, it underscored a lack
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41 165 of conceptual and operational consistency of trust, particularly in the PHR literature. Gilfoyle et
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43 166 al.[55] then empirically tested the merits of exploring trust in a PHR partnership, known as the
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45 167 national Public and Patient Involvement (PPI) Ignite Network (see Setting below),
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47 168 comprehensively and in a multidimensional way. This revealed important nuances between the
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49 169 different dimensions of trust between partners who had national and local roles, which become
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51 170 diluted when explored in combination.
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3 171 However, authors[55] were limited in that they explored trust cross-sectionally and without
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5 172 attention to specific attributes, such as partnership characteristics (e.g., local or national partners).
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8 173 This is problematic because trust develops over time [22, 25, 31], and networks are dynamic as
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10 174 their membership and social contexts change [56]. Further, network attributes, such as the roles of
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12 175 local or national partners, can influence collaborative behaviour [32], also warranting investigation
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15 176 over time. This is especially important in PHR where the importance of trust throughout all phases
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17 177 of the research process is underscored [21, 31], especially for ensuring partnerships are effective,
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19 178 equitable and long-term.[22, 25, 57, 58] Thus, if some types of partners (e.g., those who hold
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21 179 funding [cf [18]]) are developing trust and others (e.g., either local partner or national partners) are
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24 180 not, important goals and ultimately outcomes of a partnership may be jeopardized. Addressing
25
26 181 these limitations, this case study seeks to extend the findings from Gilfoyle et al.[55], better
27
28 182 understand the evolution of trust in the context of a participatory health research partnership (see
29
30 183 setting below). This is done by exploring specific features of a PHR network (the national PPI
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33 184 Ignite Network in Ireland) asking:

- 35 185 1. Do the trust characteristics of the PPI Ignite Network change from T1 to T2?
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37 186 2. Do the dimensions of trust identified differ at the local vs the national level? How did this
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40 187 evolve from T1 to T2?

42 188 **METHODS**

44
45 189 This study was granted ethics approval from the University of Limerick Education and Health
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48 190 Sciences Research Ethics Committee (#2021_03_16_EHS).

51 191 **Setting**

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3 192 In 2017, five universities across Ireland were funded as individual *PPI Ignite Teams* by the
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5 193 Irish Health Research Board (HRB) and Irish Research Council (IRC) to build capacity for PPI in
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7 194 health research. Building on and consolidating this work, the HRB and IRC then funded the *PPI*
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9 195 *Ignite Network* (March 2021-2026), “aim[ing] to provide a shared voice for PPI across Ireland,
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11 196 aiming to change the research culture, and an important contributor to improving health outcomes
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13 197 for the public.”

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16
17 198 The PPI Ignite Network brings together academic, service and community organisations who
18
19 199 co-designed the work programme and must collaborate in a synergistic and cohesive manner to
20
21 200 plan, implement and evaluate the PPI initiatives set, where trust plays a central role [22-25]. The
22
23 201 PPI Ignite Network’s work focuses on five key areas: 1) building capacity for PPI in community
24
25 202 and academic settings, 2) develop accredited education programmes for PPI, 3) enhance university
26
27 203 policies and procedures to support PPI, 4) develop quality improvement and impact; and 5) create
28
29 204 systems for national co-ordination and functioning (for further information on the PPI Ignite
30
31 205 Network see: <https://ppinetwork.ie/about-us/>).

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35 206 The PPI Ignite Network (n=57 at T1 and n=56 at T2 at time of sampling), a national PHR
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37 207 partnership, provides an ideal setting to better understand how trust evolves in a PHR partnership
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39 208 over time. At the time of sampling, the PPI Ignite Network included seven universities (called lead
40
41 209 sites, including the original five PPI Ignite Teams, and two additional institutions), a national
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43 210 office, 10 national-level community partners contributing to national-level governance and
44
45 211 activities, and 39 (at T1) and 38 (at T2) local-level partners contributing to governance and
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47 212 activities at one university in the PPI Ignite Network. This administrative structure of the PPI Ignite
48
49 213 Network resembles a hub and spokes model. The national office acts as the hub, at the center of
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51 214 the administrative structure, connecting with national partners and the seven universities, while

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3 215 the universities are further connected to their local partners. Within this structure, resource
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5 216 allocation and decision-making pertaining to goals and objectives are distributed across the
6
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8 217 Network. All partners (i.e., National and Local) in the PPI Ignite Network interact through multiple
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10 218 avenues, including, local partner meetings (i.e., site leads and their local partners), PPI Ignite
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12 219 Network-wide meetings (all partners), five work packages each addressing a specific function
13
14 220 central to the Network's goals (outlined as key work areas above) (open to all partners), and the
15
16 221 National PPI Festival^{PPI Ignite Network, #1001} (open to all partners and external participants). The PPI
17
18
19 222 Ignite Network functions as a participatory partnership where we explore the dimensions of trust
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21
22 223 in action for this study.

23
24 224 A Research Advisory Group, consisting of four research partners from academic, service, or
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26 225 community organisations within the PPI Ignite Network, provided input and approval for the case
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28 226 study's objectives. These partners were similarly involved in three other sub-studies. Their partner
29
30 227 contributions included: providing input and approval for the research objectives, ensuring all content
31
32 228 in the network survey and interview guide were accessible and contextually relevant, reviewing and
33
34 229 interpreting findings at a high-level confirming their agreement as Network partners, providing
35
36 230 feedback to ensure dissemination materials and outputs (e.g., conference posters and manuscripts)
37
38 231 effectively communicated findings for diverse audiences. One Research Advisory Group member
39
40 232 contributed further by interpreting results and reviewing and revising manuscript content and
41
42 233 language. This partner is listed as co-author MMC.

43 44 234 **Data Collection**

45
46 235 A social network can be defined as the set of connections among people, organisations or
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48 236 other social actors [32]. This study invited all 57 individuals at T1 (May 2021) and 56 individuals
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50 237 at T2 (May 2022), in the PPI Ignite Network, to complete the same network survey at these two
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53 238 timepoints. This timeframe was chosen based on discussions with the Research Advisory Group,
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3 239 recognizing that the initial stages of partnership development as crucial for the trust development
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5 240 process [59], while also ensuring sufficient time for trust to build.
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8 241 A network survey is a questionnaire designed to generate names and connections among
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10 242 individuals in a network [32]. The network survey in this study was developed based on the
11
12 243 dimensions of trust identified by Gilfoyle et al.[54] and in collaboration with the Research
13
14 244 Advisory Group to ensure its clarity and appropriateness (See Supplementary File 1 for the
15
16 245 Network Survey). The survey was administered electronically via Qualtrics software (Version
17
18 246 May 2021 to December 2022). Survey questions included seven network questions corresponding
19
20 247 to the dimensions of trust identified as important in previous work [54] (shown in Table 1).
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24 248 To generate each trust dimension network, all participants were asked to name up to seven
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26 249 organisations when responding to the network survey questions (the same seven organisations for
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28 250 each question), and to consider the *individual* representing each organisation in their responses.
29
30 251 This distinction is critical as this case study is focused on trust within a collaborative partnership,
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32 252 not organisational trust.
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35 253 The seven dimensions of trust and their corresponding network questions were informed by
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37 254 a scoping review by Gilfoyle et al.[54], which comprehensively synthesised how trust had been
38
39 255 conceptualised and operationalised in both the PHR and social network literature, and if/where
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41 256 convergence existed. This scoping review [54], included a thematic analysis of the extracted
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43 257 literature, to better identify the conceptual and operational linkages of trust across and within the
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45 258 PHR and social network literature through their thematic groupings. The relational constructs (i.e.,
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47 259 sub-themes from this review) along with discussions from the Research Advisory Group, informed
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49 260 the dimensions of trust identified. An overview of how the dimensions of trust were conceptualised
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261 and operationalised is presented in Table 1 below, informed by [54] and also presented in previous
 262 work [55]. A subsequent study provided empirical support for the scoping review findings.[55]
 263 **Table 1:** Conceptual and operational descriptions for each trust dimension (also presented in
 264 previous work [54, 55])

Dimension of Trust	Definition	Network Question
1 – Vulnerability	Describes the willingness of an actor (trustor) to be vulnerable to the actions of another actor (trustee). The trustor does not have complete control over how the trustee will behave and is thus, uncertain about how the individual will act, which also implies that there is something of importance to be lost, and in turn, risk involved. Therefore, to be vulnerable, there must be an opportunity for risk where the trustor must then decide if they are willing to take the risk of placing trust in the trustee. Furthermore, if there is the possibility of risk, this implies that there will be some level of uncertainty regarding how the trustee will behave. It is noted that if there is trust between partners, there is a lower level of uncertainty between how the trustee will behave. In summary, for this sub-theme we consider uncertainty and risk as necessary aspects of vulnerability.	“I would discuss with [name of network member X] how I honestly feel about my work, negative feelings and frustrations.”
2 – Integrity	Concerns the extent to which the trustor thinks that the trustee will act in their best interest and the belief that the trustee will follow a set of principles, deemed acceptable by the trustor, such as they will say what is true.	“[name of network member X] keeps my interest in mind when making decisions.”
3 - Reliability	Describes the confidence in and extent to which the trustor believes the trustee's will follow-through on commitments, perform a given task, and/or make decisions about something.	“[name of network member X] is dependable. For example, they stick to their word and makes sure their actions and behaviours are consistent.”
4 - Ability	Describes an individual's (trustee) ability to perform a given task or make decisions about something based on	“I am comfortable asking [network member X] to take responsibility for project tasks even when I am

	their perceived skill set and competence from the perspective of another individual (trustor).	not present to oversee what they do.”
5 - Shared values, visions and goals	Highlights the need to have shared visions, values and goals in partnerships. Specifically, common goals, missions, and plans can promote trust.	“I feel that [network member X] shares a vision with PPI Ignite Networks vision and goals?”
6 - Power sharing and co-ownership	Sharing power and fostering co-ownership in partnerships as a dimension of trust.	“I feel that [network member X] is open to discussion* about matters pertaining to the PPI Ignite Network.” *Note: When we say open to discussion, we mean that this individual is willing to engage in frank, open and civil discussion (especially when disagreement exists). The person is willing to consider a variety of viewpoints and talk together (rather than at each other) and you are able to communicate with this individual in an open, trusting manner.
7 - Reciprocity	This sub-theme describes the presence of trust based on the notion that they think the trustee also trusts them back. Thus, if a trustor thinks that the trustee also trusts them, trust is thought (by the trustor) to be reciprocated (by the trustee).	“I feel that [network member X] trusts me.”

265 Analysis

266 Individual networks for each dimension of trust were constructed from participant
 267 responses to the seven trust statements included in the network survey at both timepoints.
 268 Responses were quantified by assigning edge (i.e., connection between two individuals) weights
 269 from -1 to +1, based on a 5-point scale (strongly disagree to strongly agree), with intervals of 0.5.
 270 For example, a response of ‘agree’, was assigned a weight of 0.5, while ‘strongly agree’ received
 271 an edge weight of 1. Conversely, responses of ‘neither agree nor disagree’, ‘disagree’, or ‘strongly
 272 disagree’ did not result in an edge (i.e., connection in the network). This is because, in alignment
 273 with the literature on trust, we did not want to infer neutral agreement or disagreement with each

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3 274 statement as an expression of *distrust*. Distrust is said to differ conceptually from trust [60] and
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5 275 more specifically stated by Jones (1996) “the absence of trust is not to be equated with distrust
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8 276 [61].” Thus, by focusing explicitly on trust connections that were present, we avoid
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10 277 misinterpretation of neutral and negative responses,

11 12 278 *Network Measures*

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15 279 Several network measures were used to analyse each of the seven trust dimensions at both
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17 280 T1 and T2. Specifically:

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19 281 • *In-degree measures* the number of incident edges an individual in the PPI Ignite Network
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21 282 has, i.e., the number of times a person in the network was nominated by another individual
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23 283 in the network. This metric helped identify trust relationships between individuals (i.e.,
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25 284 who trusts whom).
- 26
27 285 • *Weighted in-degree* represents the total strength of agreement for each trust statement
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29 286 (described further in the analysis).
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31 287 • *Average in-degree*, as reported in this paper, reflects the mean number of received
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33 288 nominations across the network, providing insight into the overall level of trust in the
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35 289 network. Additionally, *average in-degree* allowed us to assess changes in the number of
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37 290 incoming edges received in the network as a whole (i.e., agreement or strong agreement
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39 291 for a specific dimension of trust) over time.
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41 292 • *Clustering coefficient* measures the extent to which individuals cluster together in the PPI
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43 293 Ignite Network, specifically examining the proportion of closed triads (i.e., triangles) in
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45 294 the network [62]. For example, if there are three individuals in a network, A, B, and C and
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47 295 individuals A and B trust each other, and B and C trust each other, then, if this is a closed
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3 296 triad, A and C will also trust each other. The clustering coefficient tells us how frequently
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5 297 this occurs. This identifies how trust is shared within groups throughout the network.
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8 298 • *Reciprocity* at the network level measures the proportion of reciprocated edges in the
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10 299 network [62]. A reciprocated edge occurs when trust is mutual (e.g., both individuals agree
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12 300 or strongly agree on the same trust dimension). The concept of reciprocity is often
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14 301 recognized as a critical mechanism of trust [46, 57].
15
16
17 302 • *Freeman Centralisation about the in-degree* measures the positional importance
18
19 303 (centrality) of individuals in the trust dimension network [63]. A higher value for one (or
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21 304 a small number of) individual(s), suggests that they hold a position of influence for a
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23 305 specific trust dimension. Conversely, a *decentralised* indicated that influence is distributed
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25 306 across many individuals.
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28 307 These measures allowed us to compare the structural properties of trust dimensions.
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31 308 Additionally, a separate network was constructed to include only the connections present
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33 309 at both timepoints. This provided a basis to compare changes in average in-degree and
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35 310 centralisation about the in-degree for individuals who consistently selected the same people at both
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37 311 timepoints (i.e., individuals whose rate of agreement remained stable over time). This enabled us
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39 312 to examine how trust evolved over time for those naming new individuals in T2 (e.g., due to staff
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41 313 turnover, new partnerships, or interactions driven by work package preference), compared to those
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43 314 who maintained their nominations from T1.
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46 315 *Analysis of trust over two timepoints* 47 48

49 316 To compare trust networks across T1 and T2, we only included responses from individuals
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51 317 that participated in both timepoints. First, we performed a two-sample Kolmogorov-Smirnov (KS)
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53 318 test on the degree distributions. The KS-test, a non-parametric test for comparing two probability
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3 319 distributions, calculates the maximal difference between the cumulative forms of the two
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5 320 distributions. This provides a measure of the differences between the distributions, allowing us to
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7 321 assess the extent to which trust dimension networks differ over time. While degree distribution
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9 322 analysis reveals the nature of connections in the networks, it does not provide insights into specific
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11 323 patterns, such as who is connected to whom, or whether participants with a low in-degree tend to
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13 324 connect with others of a low in-degree or those with a high in-degree.
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17 325 To further examine differences, we calculated the Hamming-Ipsen-Mikhailov (HIM)
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19 326 distance. This metric combines the Hamming distance [64, 65], which measures the number of
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21 327 matching edges between two networks (i.e., trust dimensions at T1 and T2), with the Ipsen-
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23 328 Mikhailov distance, a ‘spectral distance,’ used to assess differences in the overall network
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25 329 structure [66]. Spectral distances are useful for assessing global structural differences but may
26
27 330 overlook variations in smaller sub-structures. The HIM distance [67] ranges from 0 to 1, where a
28
29 331 score of 0 indicated identical networks, and 1 indicates opposite networks. For example, a
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31 332 complete graph (a network where everyone is connected to everyone else) compared to a graph
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33 333 with no edges would yield an HIM distance of 1.
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35 36 37 334 *Local vs National Partners*

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39 335 To determine whether trust dimension networks differed between local and national
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41 336 partners, we stratified each trust dimension network accordingly by type (i.e., local or national).
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43 337 Due to the small sample size and given their role in governing the national network, we combined
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45 338 the national office (n=1) and lead sites (n=7) with the national partners (n=10) into a single
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47 339 overarching *national* category. We then calculated the network measures described above at both
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49 340 T1 and T2, to examine changes in the trust dimension networks over time for each local and
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51 341 national partner.
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342 RESULTS

343 In T1 (May 2021), 57 individuals from the PPI Ignite Network were invited to complete
 344 the network survey, with 43 participants (75%) responding. By T2 (May 2022), one organisation
 345 had left the network, reducing the total number of invitees to 56. Of these 56 individuals, 33
 346 individuals (59%) participated in the T2 survey. A detailed breakdown of participation by
 347 partnership type is provided in **Table 2**.

348 **Table 2:** Response rate by partner type

Partnership Type	Time 1 - May 2021 (n=43)		Time 2 - May 2022 (n=33)	
	Count	Participation rate by partnership type	Count	Participation rate by partnership type
Site leads*	8	100%	7	88%
National partners*	8	80%	7	70%
Local partners	27	69%	19	50%

349 *Combined site leads and national partners for local vs. national analysis

350 **Table 3** below presents the network-level measures calculated at T1 and T2 for the seven
 351 trust dimensions, including new collaborations. Over time, the number of connections (those
 352 who agree or strongly agree with that trust dimension) and the average in-degree (the number of
 353 incoming edges) decreased. On average, participants received approximately one fewer incoming
 354 connection compared to T1. This indicates that individuals were agreeing and strongly agreeing
 355 slightly *less* often on trust statements at T2.

356 The mean clustering coefficient, which measures the number of trust triangles, also
 357 declined over time. Similarly, the number of reciprocal edges (where trust is mutual between two
 358 individuals) decreased at T2. For in-degree centralisation, there was a slight *increase* for most
 359 trust dimensions, except for trust dimension 5 (shared values, visions, and goals) and trust

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3 360 dimension 7 (reciprocity). This suggests that over time, incoming trust connections became
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5 361 slightly more concentrated among an individual/group of individuals. Despite this subtle
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7 362 increase, the networks remained relatively decentralised at both timepoints.
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10 363 In general, the magnitude of change in each network measure varied depending on the trust
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12 364 dimension. For instance, trust dimension 6 (power sharing and co-ownership) consistently reported
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14 365 one of the highest total number of connections (i.e., the trust statement most likely to receive
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16 366 agreement or strong agreement) at both timepoints. However, trust dimension 6 also had the
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18 367 greatest decrease in connections over time, indicating the largest decline in agreement compared
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20 368 to other trust dimensions. In contrast, trust dimension 2 (integrity), had one of the lowest numbers
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22 369 of connections at both timepoints, reflecting fewer individuals agreeing or strongly agreeing with
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24 370 the integrity statement. Additionally, trust dimension 2 exhibited the smallest change in
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26 371 connections over time, suggesting relative stability across timepoints. For other network measures,
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28 372 such as mean clustering coefficient (i.e., average number of trusted groups), there was no change
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30 373 from T1 to T2 for trust dimension 4 (ability). However, a relatively large reduction was observed
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32 374 for trust dimension 5 (shared values, visions, and goals) over time.
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38 375 Network measures also revealed that certain trust dimension networks exhibited
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40 376 similarities. For example, trust dimension 1 (vulnerability) and trust dimension 2 (integrity),
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42 377 showed comparable network measures, as did trust dimension 5 (shared values, visions, and goals)
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44 378 and trust dimension 6 (power-sharing and co-ownership). However, while dimensions 1
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46 379 (vulnerability) and 2 (integrity) were similar to each other, they were notably different from
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48 380 dimensions 5 (shared values, visions, and goals) and 6 (power-sharing and co-ownership). This
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50 381 finding was consistent over time.
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54 **Table 3: Network-level measures over time***
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Networks	Number of Edges [±]	Weighted In-degree Mean (std) [±]	Clustering Coefficient Mean (std) [±]	Weighted In-degree Centralisation [±]	Reciprocity [±]
Trust Dimension 1^a (Vulnerability)	66 50	1.98 (3.00) 1.33 (2.29)	0.10 (0.20) 0.04 (0.11)	0.23 0.25	0.28 0.06
Trust Dimension 2^b (Integrity)	64 53	1.78 (2.84) 1.54 (2.55)	0.11 (0.23) 0.04 (0.11)	0.24 0.29	0.34 0.19
Trust Dimension 3^c (Reliability)	103 86	3.61 (4.40) 2.70 (4.09)	0.13 (0.20) 0.11 (0.18)	0.33 0.34	0.37 0.19
Trust Dimension 4^d (Ability)	83 59	2.65 (3.92) 1.76 (2.72)	0.06 (0.12) 0.06 (0.14)	0.26 0.27	0.29 0.24
Trust Dimension 5^e (Shared values, visions, and goals)	130 98	4.17 (5.68) 3.39 (4.80)	0.20 (0.25) 0.13 (0.21)	0.41 0.38	0.45 0.18
Trust Dimension 6^f (Power sharing and co-ownership)	126 90	3.91 (5.04) 3.09 (4.53)	0.16 (0.21) 0.10 (0.17)	0.35 0.37	0.43 0.20
Trust Dimension 7^g (Reciprocity)	102 75	2.91 (3.92) 2.26 (3.15)	0.15 (0.24) 0.11 (0.21)	0.28 0.23	0.41 0.21

383 *This table includes all connections including new collaborations at time. ^aNon-bolded values are
384 T1, and bolded values are T2. ^{2a}Trust Network 1 question “I would discuss with [name of network
385 member X] how I honestly feel about my work, negative feelings and frustrations”, ^bTrust
386 Network 2 question “[name of network member X] keeps my interest in mind when making
387 decisions”, ^cTrust Network question: “[name of network member X] is dependable. For example,
388 they stick to their word and makes sure their actions and behaviours are consistent, ^dTrust
389 Network 4 question: “I am comfortable asking [network member X] to take responsibility for
390 project tasks even when I am not present to oversee what they do”, ^eTrust Network 5 question: “I
391 feel that [network member X] shares a vision with PPI Ignite Networks vision and goals?”,
392 ^fTrust Network 6 question: “I feel that [network member X] is open to discussion* about matters
393 pertaining to the PPI Ignite Network”, ^gTrust Network 7 question: “I feel that [network member
394 X] trusts me”

395 Kolmogorov-Smirnov (KS) test

396 After calculating the KS statistic, a non-parametric test for comparing two probability
397 distributions, we did not find a statistically significant difference in the in-degree distribution

398 across any of the trust dimensions from T1 to T2. This suggests that the two samples were drawn
399 from the same distribution. Such consistency aligns with expectations, as participants ideally name
400 others in a similar way across timepoints, rather than thoughtfully at T1 and randomly at T2.

401 However, the KS statistic revealed some variation among the trust dimension networks
402 over time. For instance, trust dimensions 3 (reliability) and 6 (power sharing and co-ownership),
403 showed the largest KS statistic (0.20), indicating relatively greater changes over time, while trust
404 dimension 2 (integrity) had the smallest KS statistic (0.09), suggesting minimal change. Although
405 these changes in KS statistic were subtle overall, the variation highlighted differences across the
406 trust dimensions and how they evolved from T1 to T2. For plots see Supplementary File 2.

407 *Hamming and Ipsen-Mikhailov (HIM) distance*

408 As our networks had a low density of connections, we recognized that HIM distance,
409 exploring whether connections between individuals change over time, would never be close to one.
410 Therefore, we focused less on the overall magnitude of the HIM distance value and, more on the
411 relative differences across trust dimensions. We observed a small range in HIM distance across
412 the dimensions of trust, ranging from 0.08 – 0.12. Specifically, networks for trust dimension 2
413 (integrity) (HIM = 0.08) were more similar from T1 to T2 compared to trust dimension 5 (shared
414 values visions and goals) (HIM = 0.12). See Supplementary File 3 for further details.

415 Indeed, both the KS statistic and HIM distance revealed greater differences across trust
416 dimensions than within each dimension from T1 to T2.

417 *Local vs National Comparison*

418 Findings for the weighted mean in-degree and clustering coefficient by type of node (local
419 vs national) T1 and T2, are presented in **Table 4** below. We observed a decrease in the weighted
420 mean in-degree (i.e., average number of incoming connections) for both local and national partners

421 across trust dimensions over time. However, the weighted mean in-degree was higher for national
 422 partners than the local partners at both time points, across all trust dimensions. This suggests that
 423 individuals who were national partners or site leads in the PPI Ignite Network, received more trust
 424 nominations (i.e., more people agreeing or strongly agreeing with trust statements about them)
 425 compared to local partners. We noted the largest difference between local and national partners in
 426 trust dimension 5 (shared values, visions, and goals) at both T1 and T2, while trust dimension 2
 427 (integrity) showed the smallest difference between these groups over the same periods. In contrast,
 428 the clustering coefficient did not show consistent trends across partnership type. For example, at
 429 T1, some local partners exhibited a higher clustering coefficient (i.e., more trust triangles)
 430 compared to national partners. However, by T2, these trends reversed, with local partners having
 431 a lower clustering coefficient for certain trust dimensions. This was evident in trust dimensions 5
 432 (shared values, visions, and goals), 6 (power sharing and co-ownership), and 7 (reciprocity).

433 **Table 4:** Network Measures for Trust Dimensions at T1 and T2 stratified by Local vs National
 434 Node Type

	Node Type (Local [n=27] and National [n=15])	Weighted In-degree Mean (std)		Clustering Coefficient	
		Time 1	Time 2	Time 1	Time 2
Trust Dimension 1^a (Vulnerability)	<i>Local Nodes</i>	0.55 (0.94)	0.27 (0.54)	0.11 (0.23)	0.07 (0.16)
	<i>National Nodes</i>	4.40 (4.06)	3.27 (3.11)	0.11 (0.16)	0.03 (0.05)
Trust Dimension 2^b (Integrity)	<i>Local Nodes</i>	0.59 (0.94)	0.36 (0.64)	0.11 (0.23)	0.03 (0.11)
	<i>National Nodes</i>	4.00 (3.95)	3.80 (3.37)	0.13 (0.26)	0.08 (0.13)
Trust Dimension 3^c (Reliability)	<i>Local Nodes</i>	1.50 (1.31)	0.77 (1.00)	0.16 (0.25)	0.10 (0.21)
	<i>National Nodes</i>	7.20 (5.96)	6.60 (5.17)	0.11 (0.13)	0.18 (0.16)
Trust Dimension 4^d (Ability)	<i>Local Nodes</i>	0.63 (0.87)	0.45 (0.72)	0.04 (0.11)	0.01 (0.05)
	<i>National Nodes</i>	6.20 (5.44)	4.33 (3.42)	0.09 (0.08)	0.17 (0.20)
	<i>Local Nodes</i>	1.50 (1.34)	1.18 (1.53)	0.27 (0.30)	0.15 (0.27)

Trust Dimension 5^e (Shared values, visions and goals)	<i>National Nodes</i>	9.20 (7.58)	7.93 (6.02)	0.17 (0.17)	0.17 (0.14)
Trust Dimension 6^f (Power sharing and co-ownership)	<i>Local Nodes</i>	1.63 (1.33)	1.00 (1.31)	0.20 (0.25)	0.08 (0.20)
	<i>National Nodes</i>	8.20 (6.82)	7.40 (5.69)	0.15 (0.15)	0.16 (0.14)
Trust Dimension 7^g (Reciprocity)	<i>Local Nodes</i>	1.18 (1.11)	0.81 (1.11)	0.19 (0.27)	0.12 (0.27)
	<i>National Nodes</i>	6.20 (5.29)	5.27 (3.86)	0.16 (0.25)	0.16 (0.16)

^aTrust Network 1 question “I would discuss with [name of network member X] how I honestly feel about my work, negative feelings and frustrations”, ^bTrust Network 2 question “[name of network member X] keeps my interest in mind when making decisions”, ^cTrust Network question: “[name of network member X] is dependable. For example, they stick to their word and makes sure their actions and behaviours are consistent”, ^dTrust Network 4 question: “I am comfortable asking [network member X] to take responsibility for project tasks even when I am not present to oversee what they do”, ^eTrust Network 5 question: “I feel that [network member X] shares a vision with PPI Ignite Networks vision and goals?”, ^fTrust Network 6 question: “I feel that [network member X] is open to discussion* about matters pertaining to the PPI Ignite Network”, ^gTrust Network 7 question: “I feel that [network member X] trusts me”

Figures 1 and 2 illustrate the networks for these two trust dimensions over time. The networks appeared less dense for trust dimension 2 (integrity) over time (Figure 1), while they became denser for trust dimension 5 (shared values, visions, and goals) (Figure2). This indicates that rate of agreement differed across these trust dimensions, highlighting an important nuance detected when examined as distinct networks. Additionally, we observed that more partners were disconnected from the networks in T2 compared to T1 for both dimensions of trust. This is particularly pronounced for Trust Dimension 2 (integrity). The disconnection of partners suggests that trust connections for these partners no longer existed at T2 for the respective trust dimension.

Figure 1: Trust Dimension 2 – Integrity - at T1 and T2

[insert here]

Figure 2: Trust Dimension 5 – Shared Values, Visions and Goals at T1 and T2

[insert here]

458

459 *Persistent Connections in T1 and T2*

460 Findings comparing network measures of persistent connections (i.e., the same person nominated
 461 in both T1 and T2) are outlined in Table 5¹ below. In this analysis, individuals who formed new
 462 collaborations and nominated new individuals in T2, were excluded. This approach allowed us to
 463 focus specifically on trust connections persisted over time. Interestingly, the average number of
 464 weighted incoming connections across all trust dimensions increased from T1 to T2. This suggests
 465 that, for individuals who were nominated consistently across T1 and T2, the level of agreement
 466 regarding trust statements increased.

467 Table 5: Network-level measures over time*

Networks (n=59)	Weighted In-degree Mean (std)		Weighted In-degree Centralisation	
	T1	T2	T1	T2
Trust Dimension 1^a (Vulnerability)	0.85 (1.74)	1.02 (1.88)	0.17	0.16
Trust Dimension 2^b (Integrity)	0.83 (1.89)	1.09 (2.10)	0.17	0.18
Trust Dimension 3^c (Reliability)	1.57 (2.64)	1.89 (3.01)	0.22	0.24
Trust Dimension 4^d (Ability)	1.09 (2.04)	1.37 (2.34)	0.21	0.20
Trust Dimension 5^e (Shared values, visions, and goals)	2.02 (3.02)	2.37 (3.60)	0.23	0.29
Trust Dimension 6^f (Power sharing and co-ownership)	1.98 (3.00)	2.30 (3.59)	0.23	0.30

¹ Non-weighted properties such as clustering coefficient and reciprocity are not included as they would not change over time as we are only including persistent connections.

Trust Dimension 7^g (Reciprocity)	1.26 (2.29)	1.67 (2.65)	0.18	0.19
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468 **This table explores connections that were persistent over time (i.e., excludes new collaborations*
 469 *in T2). ^aTrust Network 1 question “I would discuss with [name of network member X] how I*
 470 *honestly feel about my work, negative feelings and frustrations”, ^bTrust Network 2 question*
 471 *“[name of network member X] keeps my interest in mind when making decisions”, ^cTrust*
 472 *Network question: “[name of network member X] is dependable. For example, they stick to their*
 473 *word and makes sure their actions and behaviours are consistent, ^dTrust Network 4 question: “I*
 474 *am comfortable asking [network member X] to take responsibility for project tasks even when I*
 475 *am not present to oversee what they do”, ^eTrust Network 5 question: “I feel that [network*
 476 *member X] shares a vision with PPI Ignite Networks vision and goals?”, ^fTrust Network 6*
 477 *question: “I feel that [network member X] is open to discussion* about matters pertaining to the*
 478 *PPI Ignite Network”, ^gTrust Network 7 question: “I feel that [network member X] trusts me”*

479 In summary, findings highlighted:

- 480 • An SNA approach revealed subtle changes over time in when exploring trust
 481 multidimensionally in the PPI Ignite Network. On average there was a slight decrease in
 482 trust connections across each trust dimension from T1 to T2 on a global level. This indicates
 483 that, at the second time point, fewer individuals agreed or strongly agreed with a given trust
 484 statement about the individual they nominated in the network compared to the first timepoint.
 485 However, trust connections that remained consistent over time, showed an increase across
 486 all dimensions of trust.
- 487 • More distinct differences emerged when stratifying trust by partnership type (i.e., local or
 488 national partners). National partners and site leads in the PPI Ignite Network received more
 489 trust nominations, meaning more people agreed or strongly agreed with trust statements
 490 about them, compared to local partners.

491 DISCUSSION

492 This case study extends the work by Gilfoyle et al., [54, 55] by comparing the dimensions
 493 of trust across two timepoints, stratified by local or national partnership types, and more broadly,
 494 by contributing to the conceptual and operational gaps related to trust in participatory research

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3 495 partnerships [54, 55]. By analysing the different dimensions of trust as separate networks, we
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5 496 identified changes across these timepoints and provided empirical support for a comprehensive,
6
7 497 multidimensional exploration of trust as it evolved within the PPI Ignite Network.
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10 498 Our analysis revealed a general decrease in the number of trust connections across most
11
12 499 trust dimensions over the two timepoints at the network level. However, trust connections that
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14 500 were consistent from T1 to T2 showed increases across all trust dimensions, suggesting that when
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16 501 partnerships were maintained from T1 to T2, trust increased. Comparatively, the slight overall
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18 502 decrease in trust across the PPI Ignite Network may reflect the formation of new collaborations
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20 503 (e.g., new employees or partners given staff and partnership turnover and/or interacting with new
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22 504 people depending on their work package), where trust had not yet been established/sustained. This
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24 505 aligns with existing literature, which emphasizes that trust must be built and sustained over time,
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26 506 while new collaborations or changes in personnel can impact its development and maintenance
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28 507 [22, 68].
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33 508 We also observed that some trust dimensions were more similar both visually (e.g.,
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35 509 network maps) and across network measures (based on the KS-test and HIM distances), such as
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37 510 vulnerability and integrity. Others were markedly different, like integrity and shared values,
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39 511 visions, and goals with a higher number of incoming connections for national partners compared
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41 512 to local partners. These findings contribute meaningfully to the literature by providing empirical
42
43 513 support for using SNA to operationalise trust in a comprehensive, context-sensitive, and
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45 514 multidimensional way over time. This approach avoids treating trust as a composite measure,
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47 515 which can overlook the unique influence of individuals trust dimensions in a PHR partnership.
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49 516 This distinction is critical as PHR emphasizes the need for contextually derived and driven
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51 517 knowledge production, to address the needs of the communities [8, 69], as highlighted in the CBPR
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3 518 conceptual model [18]. Operational techniques must, therefore, consider the partnership context
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5 519 so that partners can both understand and evaluate if their goals are being met and if they are on a
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8 520 trajectory toward success. A lack of contextual consideration is a limitation of traditional
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10 521 quantitative methods [70], yet a strength of SNA. By incorporating both individual and system-
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12 522 level perspectives , SNA captures complex social-relational processes, like trust, while accounting
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15 523 for the social context and its influence on individuals within it [71].

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17 524 Using SNA provided valuable “insight[s] into the relationships, positions, structure and
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19 525 strength of [the] network [72](pg.4)” across two timepoints. Through network maps, we observed
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21 526 where trust connections existed or were absent in the PPI Ignite Network over time, while also
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23
24 527 gaining an understanding of the implications of individual positions and the overall network
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26 528 structure. For example, central actors - individuals occupying highly connected positions within
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28 529 the network - are often viewed as opinion leader with prestige and influence [32]. These actors
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31 530 play a critical role in the diffusion of ideas and behaviour [32], which has important implications
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33 531 for the trust-building process. By equipping the PPI Ignite Network members with a better
34
35 532 understanding of their network structure, SNA can guide strategic interventions (i.e., strategic
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37 533 actions that or remove links between social entities [73]) within the trust dimension networks to
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39
40 534 ensure trust is built and maintained throughout the next five years of working together and beyond.

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42 535 For instance, partners can identify areas of weakness in the trust dimension networks, such
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44 536 as areas of fewer connections or individuals positioned on the periphery of the network, and take
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47 537 deliberate action to strengthen these areas. This could include fostering strategic collaboration
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49 538 opportunities, between central individuals (thought to have higher influence) and peripheral
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51 539 individuals (who have fewer connections in a given network).

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3 540 Equipping partners with an enhanced understanding of the trust development process
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5 541 within their specific context, could in turn dictate the strategic allocation of (often limited) time
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7 542 and resources to enhance trust and, ultimately, partnership functioning. For instance, given the
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9 543 finding that local partners were less central compared to national partners (i.e., had fewer
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11 544 collaborations and incoming connections across trust dimensions), immediate interventions could
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13 545 include creating opportunities for local partners to have more influence within the PPI Ignite
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15 546 Network. This might involve offering local partners leadership roles in key initiatives or work
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17 547 packages. If partnership capacity is an issue, interventions could focus on the (re)distribution of
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19 548 resources and providing more targeted supports for local partners. Indeed, conceptualising and
20
21 549 operationalising trust in this manner also helps to address a significant gap in the PHR literature.
22
23 550 As noted, "the majority of trust and community-based participatory research literature
24
25 551 conceptualised trust as an outcome and acknowledges that research on trust development is lacking
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27 552 [30](pg.62)."

32 553 *Limitations*

34 554 Although embracing context is important, readers should consider this when interpreting
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36 555 and/or applying findings to their own research. This case study examines a small network with two
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38 556 timepoints over a year. Considering that trust takes time to develop, surveying trust at only two
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40 557 timepoints may be restrictive. Additionally, not all partners in the PPI Ignite Network participated,
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42 558 and some who did participate did not complete both network surveys. To facilitate comparisons
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44 559 across timepoints, those who did not complete both network surveys were excluded, resulting in a
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46 560 smaller sample size. As such, the views reflected in case study might not be representative of the
47
48 561 entire PPI Ignite Network and should be interpreted accordingly. However, consistent with
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50 562 findings from previous work[55], network properties differed only at the second decimal place,
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3 563 suggesting that the smaller sample size likely had a minimal impact on the results. Furthermore,
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5 564 as trust is inherently contextual, its evolution will likely vary depending on the partnership of
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8 565 interest. This variability should be considered when applying these findings to other settings.
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10 566 Finally, while this case study employed a novel approach to operationalising trust across different
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12 567 contexts, it does not reveal why the networks evolved as they did. This limitation is addressed in
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14
15 568 a follow-up study published elsewhere (see [74]).

16 17 569 *Future Research*

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19 570 Areas of future work could investigate if the conceptualisation and operationalisation of
20
21 571 trust within the PPI Ignite Network led to improved partnership outcomes. For instance, ‘readiness’
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23
24 572 for public and patient involvement at a national level and within individual institutions was a
25
26 573 priority outcome of the Network. Future studies could examine whether changes in trust networks
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28 574 are associated with achieving the PPI Ignite Network’s objective of building capacity for PPI
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30 575 readiness. Additionally, future research could explore whether certain trust dimensions (among the
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33 576 7 identified) are particularly relevant to certain aspects of the CBPR model[8, 17]. For example,
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35 577 the CBPR model emphasizes power dynamics as a critical factor influencing both context and
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38 578 partnership processes.[75] With our enhanced understanding of trust - particularly the trust
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40 579 dimension ‘power-sharing and co-ownership’ - it may be possible to identify where power
41
42 580 dynamics exist by pinpointing asymmetrical trust relationships within this trust dimension
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45 581 network. Finally, as this is a case study exploring trust in one context, future work could expand
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47 582 to explore the trust development process across other PHR partnerships to compare findings across
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49 583 multiple study contexts.

50 51 584 **CONCLUSION**

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3 585 This case study employs a novel and interdisciplinary lens, integrating insights from both
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5 586 the social network and PHR literature, to further clarify important conceptual and operational
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7 587 complexities of trust. By extending the findings of Gilfoyle et al.[54, 55], we consistently and
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9 588 comprehensively analysed trust *over time* in a real-world partnership, the PPI Ignite Network. The
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11 589 findings provide empirical support for using SNA to examine the evolution of trust as a
12
13 590 multidimensional concept in PHR partnerships over time. Future research could consider exploring
14
15 591 trust over more extended periods, to gain deeper insights into its development and sustainability
16
17 592 in different contexts.

593 **AUTHOR CONTRIBUTIONS**

594 All authors have made substantive intellectual contributions to the development of this study. MG
595 conceptualized and led the study, drafted, and edited the final manuscript. MG is responsible for
596 the overall content as guarantor. PMC analysed the data and contributed to the study design, data
597 analysis and interpretation, writing, and editing of the manuscript. JS secured funding, contributed
598 to the study conceptualisation, data analysis and interpretation, and contributed to the writing and
599 editing of the final manuscript. AMF contributed to the study conceptualisation, writing, and
600 editing of the final manuscript. MMC contributed to study conceptualisation, interpretation of
601 results, reviewed and approved manuscript. ChatGPT4o was used only in the revision stages of
602 this manuscript to help with grammar and sentence structure, like removing redundant language,
603 suggesting word synonyms to reduce repetitiveness, and suggestions to reduce long sentences into
604 shorter, more digestible sentences. All authors verified and reviewed final content.

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615 **COMPETING INTERESTS**

616 None declared.

617 DATA AVAILABILITY STATEMENT

618 The data that support the findings of this study are available from the corresponding author, JS,
619 upon reasonable request.

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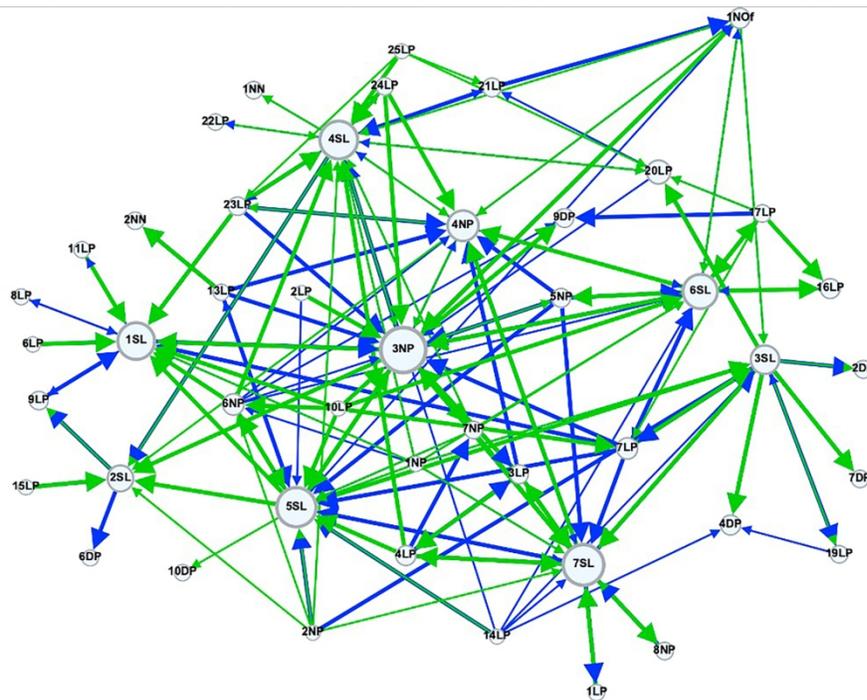
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827 **List of Figure(s):**

828 **Figure 1:** Trust Dimension 2 – Integrity - at T1 and T2

829 **Figure 2:** Trust Dimension 5 – Shared Values, Visions and Goals at T1 and T2



Note: Blue arrows indicate T1 connections. Green arrows indicate T2 connections. The size of the node pertains to the number of incoming nominations for that individual. A larger node has more people 'agreeing' or 'strongly agreeing' with that statement of trust about them. NP = National Partner; LP = Local Partner; SL = Site Lead; DP = nominated but did not participate in network survey; NN = nominated but not in the PPI Ignite Network.

169x119mm (300 x 300 DPI)

(Time 1) Network Survey and Framing Questions - PPI Network

Start of Block: Information sheet and consent form

Information Sheet **Before continuing, please review the information sheet for volunteers by clicking the link below:**

LINK: [removed for peer review]

[consent form removed for peer review]

Consent By clicking 'Yes' below, I am providing my consent to participate as indicated above OR click 'No' below, if you choose not to participate at this time.

- Yes, I consent to participate (1)**
- No, I choose not to participate at this time (2)**

End of Block: Information sheet and consent form

Start of Block: Network Questions Part 1



Question 1

Thank you for taking part in this study!

You have read the study information letter and have signed an informed consent form, so you understand the purpose of the study and the use to which its findings will be put.

Individuals and institutions will be anonymised in all wider reporting of results.

This questionnaire should take approximately 15 minutes to complete.

Section 1: Network Questions

Level of Collaboration

For the following questions we are asking you to name organisations you are collaborating with on the PPI Ignite Network. When choosing an organisation, think about the specific individuals that represent the organisation in the network. *For example, if you were collaborating with [example name].*

Once you start typing an organisation's **full** name, an auto fill drop-down box will appear. Select the organisation you want. If needed, click here for a full list of network organisations.

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Question 1:

- a. Enter up to 7 organisations that you collaborate with on the PPI Ignite Network.**
- b. Beside each of the selected organisations, rank your intensity of collaboration.**

For peer review only

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(Please refer to Table A to guide your ranking)

Table A

Level	Definition	(0) No interaction
	No interaction, not aware of individual in this organisation	
	(1) Networking	I am aware of the individual(s), but we have loosely defined roles, little communication, and all decisions made independently
	(2) Cooperation	We provide information to each other, have somewhat defined roles, formal communication, but all decisions are made independently
	(3) Coordination	We share information and resources, have defined roles, frequent communication, some shared decision making
	(4) Coalition	We share ideas and resources, have frequent and prioritised communication, and have a vote in each other's decision making
	(5) Collaboration	We belong to one system, our frequent communication is characterized by mutual trust, consensus is reached on all decisions

	0 No Interaction (1)	1 Networking (2)	2 Cooperation (3)	3 Coordination (4)	4 Coalition (5)	5 Collaboration (6)
Type organization 1 here: (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Type organization 2 here: (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Type organization 3 here: (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Type organization 4 here: (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Type organization 5 here: (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Type organization 6 here: (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Type organization 7 here: (7)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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End of Block: Network Questions Part 1

Start of Block: Network Questions Part 2

Statement 1 **Relational questions about 7 PPI Ignite Network Members** For each of the organisation names (up to 7) you listed in Question 1, please answer the following:

Question 2: On a scale from (1) strongly disagree to (5) strongly agree, please rate the extent to which you agree with the following 7 statements:

**Note: statement 6 has additional descriptions to help guide your selection*

	1 Strongly Disagree (1)	2 Disagree (2)	3 Neither agree nor disagree (3)	4 Agree (4)	5 Strongly agree (5)
1 $\{\text{Question 1/ChoiceTextEntryValue/1}\}$ (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2 $\{\text{Question 1/ChoiceTextEntryValue/2}\}$ (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3 $\{\text{Question 1/ChoiceTextEntryValue/3}\}$ (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
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6 $\{\text{Question 1/ChoiceTextEntryValue/6}\}$ (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7 $\{\text{Question 1/ChoiceTextEntryValue/7}\}$ (7)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Statement 5 .

	1 Strongly Disagree (1)	2 Disagree (2)	3 Neither agree nor disagree (3)	4 Agree (4)	5 Strongly agree (5)
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1/ChoiceTextEntryValue/2 (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
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Statement 6 .

	1 Strongly Disagree (1)	2 Disagree (2)	3 Neither agree nor disagree (3)	4 Agree (4)	5 Strongly agree (5)
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1/ChoiceTextEntryValue/6 (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
1/ChoiceTextEntryValue/7 (7)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Statement 7 .

	1 Strongly Disagree (1)	2 Disagree (2)	3 Neither agree nor disagree (3)	4 Agree (4)	5 Strongly agree (5)
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Statement 8 .

	1 Strongly Disagree (1)	2 Disagree (2)	3 Neither agree nor disagree (3)	4 Agree (4)	5 Strongly agree (5)
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Statement 9 .

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Statement 10

	1 Strongly Disagree (1)	2 Disagree (2)	3 Neither agree nor disagree (3)	4 Agree (4)	5 Strongly agree (5)
1/ChoiceTextEntryValue/1 1 {Question (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
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1/ChoiceTextEntryValue/3 3 {Question (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
1/ChoiceTextEntryValue/4 4 {Question (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
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1/ChoiceTextEntryValue/7 7 {Question (7)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

End of Block: Network Questions Part 2

Start of Block: Framing Questions

Trust typology **Section 2 – Framing Questions**

Trust typology In this Question, we are interested in learning your views on **the type of trust** you think exists in the PPI Ignite Network at this point in time. The six trust types and their associated definition **are listed below. Question 3: Please indicate your views on trust in the PPI Ignite Network at this time. Specifically, what type of trust do you think currently exists in the network?**

CLICK ONE OF THE FOLLOWING:

- Critical reflexive trust** (Trust that allows for mistakes and where differences can be talked about and resolved) (1)
- Proxy trust** (Partners are trusted because someone trusted invited them) (2)
- Functional trust** (Partners are working together for a specific purpose and time-frame, but trust may still be present) (3)
- Neutral trust** (Partners are still getting to know each other there is neither trust nor mistrust) (4)
- Unearned trust** (Trust is based on member's title or role with limited or no direct interaction) (5)
- Trust deficit (suspicion or mistrust)** (Partnership members do not trust each other) (6)

preparedness **PPI preparedness question Question 4: On a scale from (1) strongly disagree to (5) strongly agree, please rate the extent to which you agree with the following statement: "I feel my organisation is prepared to support PPI research at this time"**

CLICK ONE OF THE FOLLOWING:

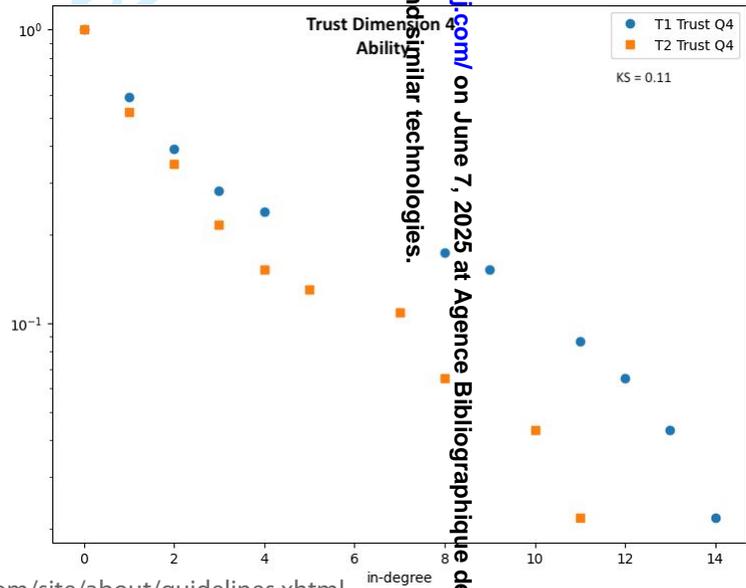
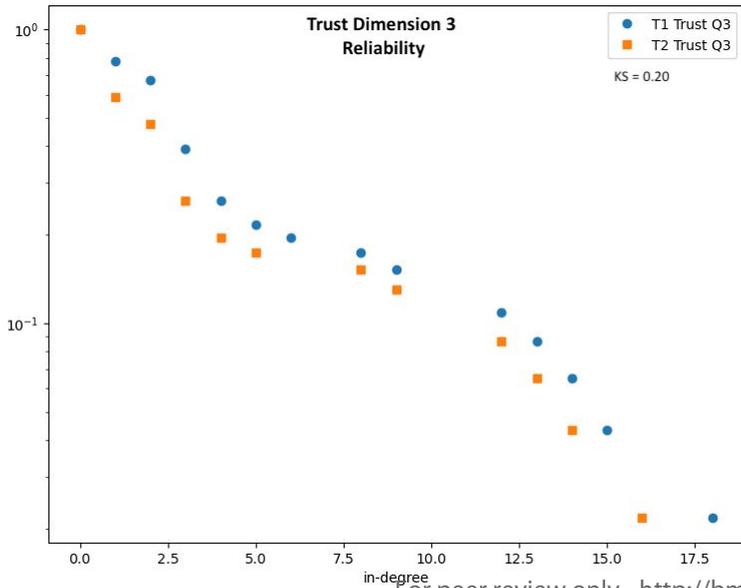
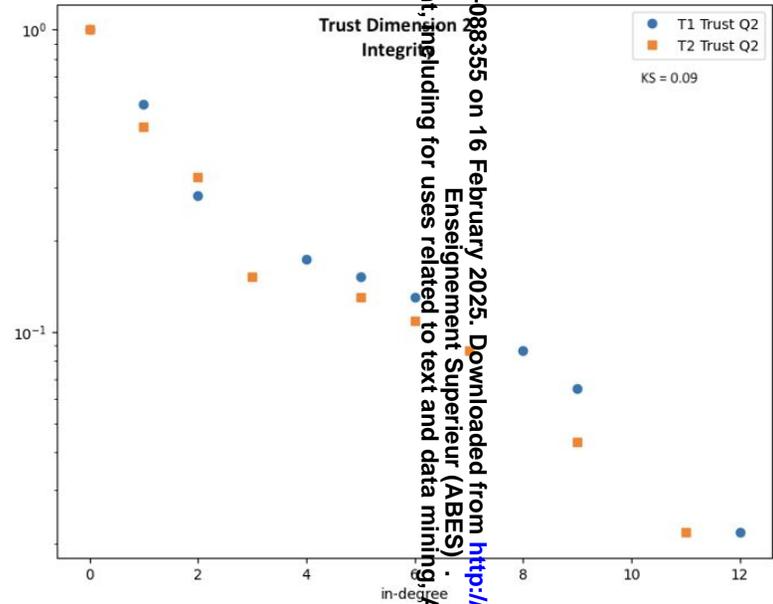
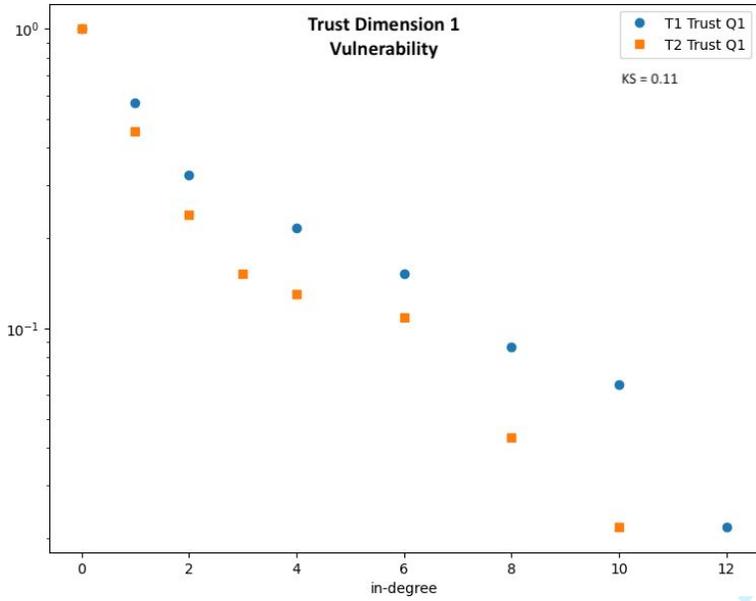
- 1 Strongly disagree** (1)
- 2 Disagree** (2)
- 3 Neither agree nor disagree** (3)
- 4 Agree** (4)
- 5 Strongly agree** (5)

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End of Block: Framing Questions

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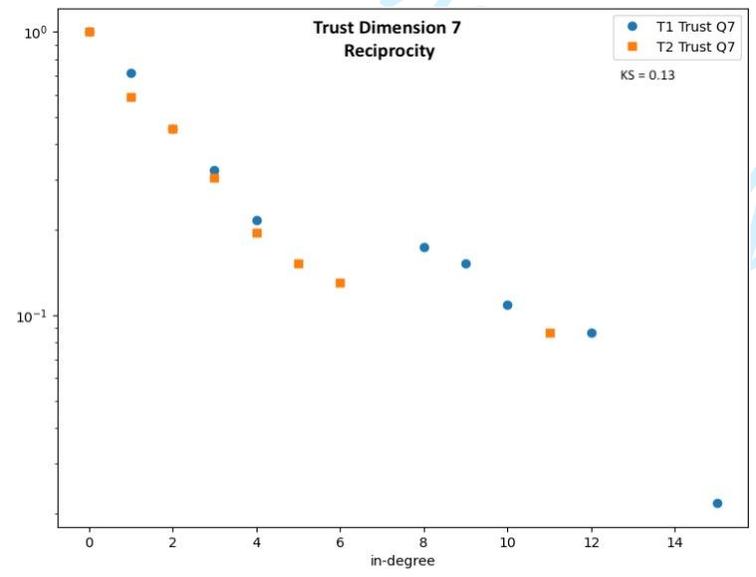
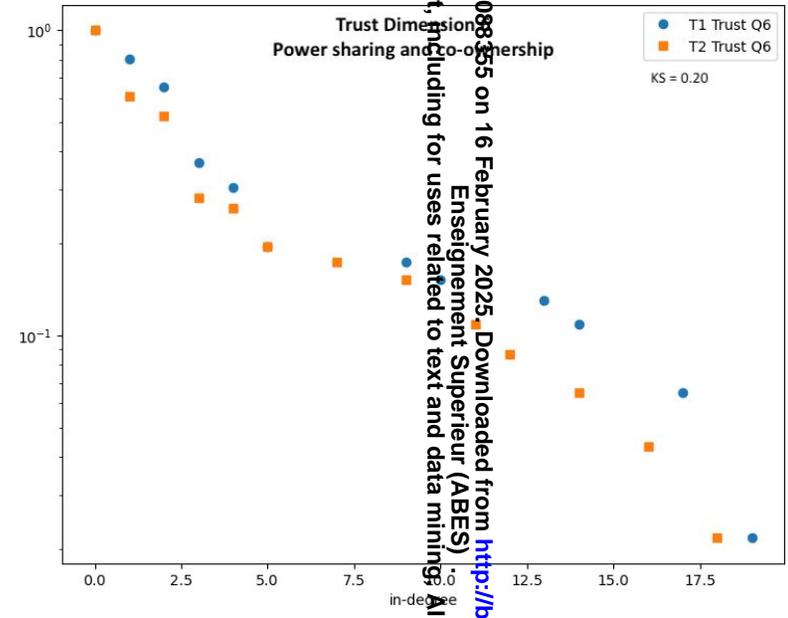
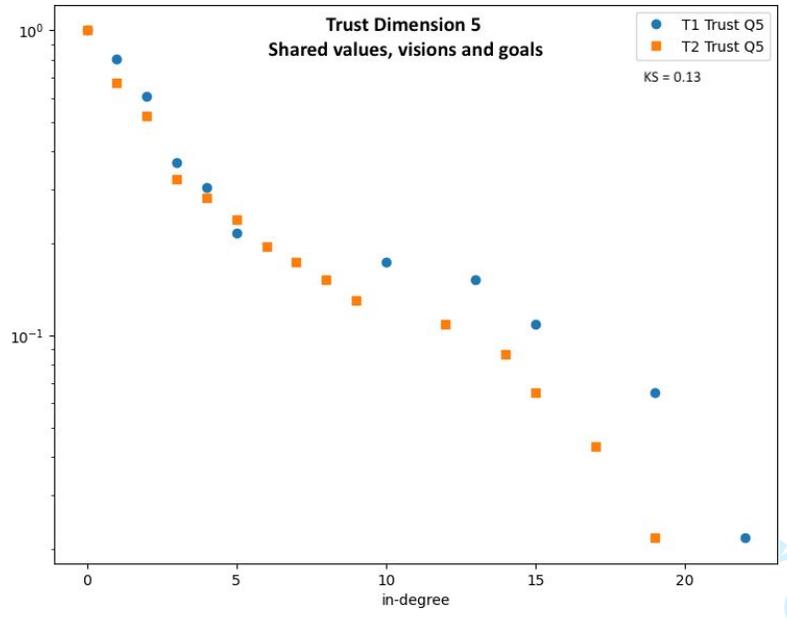
Distribution plots and Kolmogorov-Smirnov test



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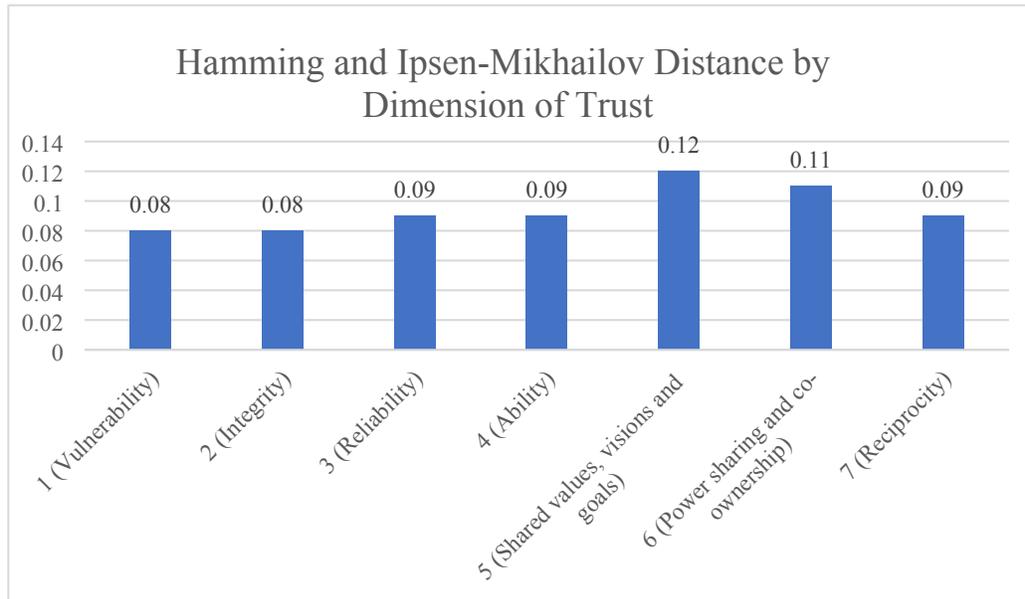
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Hamming and Ipsen-Mikhailov Distance by Dimension of Trust Over Time



This metric combines the Hamming distance (Deza and Deza, 2009; Gao et al., 2010), which counts matching connections between two networks (i.e., trust dimensions at T1 and T2) and the Ipsen-Mikhailov distance, a spectral distance used to differentiate networks (Ipsen and Mikhailov, 2003). Spectral distances are global measures that evaluate the difference between the whole structure, though can miss differences between small sub-structures. The HIM distance (Jurman et al., 2015) yields a 0 if two networks are identical, or 1 if they are opposite. For example, two networks that are identical will have a HIM distance of 0, while a complete graph (a network where everyone is connected to everyone else) compared to a graph with no connections, will have an HIM distance of 1.

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