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Research and knowledge networks in the European Network for Housing Research

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RESUMO

A presente pesquisa tem como objetivo analisar as grandes linhas de investigação que dominam na Europa em matéria de habitação. Como fonte de informação foi selecionada uma das principais redes de investigação europeia na área da habitação a European Network for Housing Research (ENHR).

Esta pesquisa pretende responder às seguintes questões em matéria de investigação em habitação:

- Que posição os diferentes países europeus têm no sistema de investigação a nível internacional? Que instituições europeias são centralizadoras das redes de investigação na área da habitação? As redes de produção de conhecimento privilegiam que ligações inter-institucionais? Que temas dominam na investigação europeia? Que instituições e redes são emergentes na investigação habitacional?

Para responder a estas questões compilamos numa base de dados todas as comunicações das conferências da ENHR, de 2007, 2009, 2011 e 2012, totalizando 1212 comunicações. A base de dados construída contém todas as comunicações, organizadas em torno dos seguintes atributos: ano, título, tema, autores, instituição do autor(es) e país(es) do autor(es). Em termos de atributos relacionais adotámos a produção de investigação desenvolvida de forma inter-institucional (autores pertencentes a diferentes instituições) ou envolvendo redes inter-países (autores residentes em diferentes países). Por outro lado, o facto de cada comunicação em cada colóquio anual estar classificada em diferentes temas, permite uma análise focada na filiação temática, ou seja uma sistematização das redes cognitivas em matéria de investigação na habitação.

Neste sentido, em termos de redes de conhecimento em matéria de investigação no domínio da habitação nas Conferências da European Network for Housing Research analisamos:

- as centralidades e as proximidades organizacionais, através da identificação das instituições centrais e periféricas e dos clusters inter-institucionais da ENHR;
- as centralidades e as proximidades geográficas, através da identificação dos países centrais e periféricos na investigação e dos principais clusters inter-países da ENHR;
- as centralidades e as proximidades cognitivas, através da identificação dos autores integrados nos sub-temas das Conferências

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da ENHR, avaliando os autores fortemente especializados e os autores que ligam diferentes temáticas de investigação.
A análise de rede foi realizada através da utilização do programa NodeXL, ferramenta que serve para apoiar o estudo das redes sociais.

Palavras-Chave | European Network for Housing Research; análise de redes de conhecimento; programa NodeXl

ABSTRACT | This research aims to analyze the broad lines of research which dominate in Europe with regard to housing. As information source was selected one of the main European research networks in the area of housing, the European Network for Housing Research.
This research seeks to answer the following questions in the field of research on housing: Witch position has the different European countries in the system of international research? Witch European institutions are the central of research networks in the area of housing? The knowledge networks favor inter-institutional links? Witch subjects dominate in European and international research? Witch institutions and networks are emerging in the research on housing?
To answer these questions we compiled in a database all communications of the 2007, 2009, 2011 and 2012 ENHR Conferences, 1212 communications in total. The database contains all the communications, organized around the following attributes: year, title, subject, authors, author institution and country. In terms of relational attributes we choose the research production developed in an inter-institutional manner (authors belonging to different institutions) or involving inter-country networks (authors resident in different countries). On the other hand, the fact that each communication in each annual conference was classified in different topics, allows a study focused on thematic or affiliation, i.e. a classification of cognitive networks for research in housing.
In this sense, in terms of knowledge research networks in the field of housing in the Conferences of the ENHR we analyze: the centers and nearby organization, through identification of core and peripheral institutions and inter-institutional clusters of ENHR; the centrality and geographic proximity, through the identification of the central and peripheral countries in the investigation and the main clusters of inter-country ENHR; the centrality and cognitive nearby, by identifying the authors integrated into sub-themes of the ENHR Conferences, evaluating the authors strongly specialized and authors that connect different thematic research.
The network analysis was supported in the program NodeX, tool that serves to support the study of social networks.

Keywords | European Network for Housing Research; knowledge networks analysis; program NodeXl

1. Introduction

The aim of this study is to examine the broad guidelines of housing research in Europe. We chose as a source of information one of the major European networks related to this field – the *European Network for Housing Research (ENHR)*, for the fact that it is unique and, moreover, this year it will celebrate 25 years of existence, which is one more reason to determine its relevance not only at European level, but also at global level.

This network is formed by 69 institutional members, 27 associated institutional members, and about 760 individuals mostly from European countries, forming 21 working groups distributed across different housing research themes.

The *ENHR* was established on 1st July 1988 in Amsterdam to provide an organisational platform for institutions and individuals actively engaged in housing research in Europe. It was chaired by Bengt Turner until 2007, the year of his death (*ENHR* 2013), and is now chaired by Peter Boelhouwer. The first *ENHR* conference was held in Amsterdam in 1988 under the theme *Housing, Policy and Innovation*, and every year the *ENHR* organises a conference dedicated to a specific theme (Table 1). Moreover, each different working group also holds its own meetings.

Table 1- *ENHR* Annual Conference

Year	City	Theme
2013	Tarragona, Spain	Overcoming the Crisis: integrating the urban environment
2012	Lillehammer, Norway	Housing: Local Welfare and Local Markets in a Globalised World
2011	Toulouse, France	'Mixité': an urban and housing issues?
2010	Istanbul, Turkey	Urban Dynamics and Housing Change
2009	Prague, Czech Republic	Changing Housing Markets: Integration and Segregation
2008	Dublin, Ireland	Shrinking Cities, Sprawling Suburbs, Changing Countrysides
2007	Rotterdam, The Netherlands	Sustainable Urban Areas
2006	Ljubljana, Slovenia	Housing in an Expanding Europe: Theory, Policy, Implementation and Participation
2005	Reykjavik, Iceland	Housing in Europe: Challenges and Innovations
2004	Cambridge, United Kingdom	Housing: Growth and Regeneration
2003	Tirana, Albania	Marking Cities Work
2002	Vienna, Austria	Housing Cultures – Convergence and Diversity
2001	Pultusk, Poland	Housing and Urban Development in New Europe
2000	Gävle, Sweden	Housing in the 21st Century: Fragmentation and Reorientation
1999	Balatonfüred, Hungary	New European Housing and Urban Policies
1998	Cardiff, United Kingdom	Housing Futures: Renewal, Innovation and Sustainability
1997	Piran, Slovenia	Housing in Transition
1996	Helsingør, Denmark	Housing and European Integration
1994	Glasgow, United Kingdom	Housing: Making the Connections
1993	Budapest, Hungary	Housing Policy in Europe in the 1990s: "Integration in West, Transformation in the East
1992	De Hague, The Netherlands	European Cities: Growth and Decline in the Netherlands
1991	Oslo, Norway	Housing Policy as a Strategy for Change
1990	Paris, France	Housing Debates - Urban Challenges
1988*	Amsterdam, The Netherlands	Housing, Policy, and Urban Innovation
1986	Gävle, Sweden,	International Research Conference on Housing Policy

** ENHR was established after this meeting*

Source: *ENHR* http://www.enhr.net/enhrconferences.php

For the purpose of this research, we have chosen the conferences held in 2007, 2009, 2011 and 2012, totalling 1212 papers, because these were the most recent years and the relevant papers and/or abstracts are available online.

This study sets out to answer the following questions on housing research:

- How do the individual countries stand in terms of the international research system? And, institutionally-speaking, which institutions are at the crossroads of housing research?

- What themes dominate European research? Are there thematic differences between European, Asian, North-American, and African research, among others?

To answer these questions, we have compiled all of the *ENHR* conference papers referred to above on a database, organised according to the following features: year, title, theme, authors, institution(s) the author(s) belong(s) to and country(ies) of origin.

In terms of relational features, the fact that each paper in every annual conference is classified under different theme groups enables an analysis focused on theme affiliations.

To this end, in terms of knowledge networks on housing research in *European Network for Housing Research* conferences, we have looked into:

- Geographical centralities and proximities, through the identification of central and peripheral countries and continents involved in the research;
- Organisational centralities and proximities, through the identification of central and peripheral institutions;
- Cognitive centralities and proximities, through the identification of authors integrated in sub-themes of *ENHR* Conferences, assessing the authors involved in highly expertise areas and authors that deal with various research themes.

Thus, following the introduction, our paper is sub-divided into four topics, the first one focusing on the conceptual framework of knowledge networks, followed by an explanation of the method used, an analysis of findings, and the conclusion.

2. Social and knowledge networks

The idea of social network was first used about a century ago to describe a complex set of relationships between members of a social system at different levels, from interpersonal to international. The concept of social networks was developed in the thirties and forties, in sociology and social anthropology. Social networks meaning a social structure formed by a group of agents (for example, individuals or organisations) linked by one or many types of relationships (Castilla *et al.* 2000:219). One of the key features in defining the networks is that they are open and permeable, allowing horizontal and non-hierarchical relationships among the participants.

Social networks have gained substantial relevance in modern society. A thread common to them is the sharing of information, knowledge, interests and efforts in pursuing common goals. In theory, in their structure the social agents (nodes) are characterised more by their relationships (connections) than by their features. Relational data refer to contacts, links and connections. According to Scott (2013:3*), "*relations are not the properties of agents, but of the relational systems of agents built from connected

pairs of interacting agents". Such relationships vary in density, the distances separating two agents being greater or smaller, and some agents may assume more central positions than others due to the existence of strong and weak ties. Knowledge networks have changed from a linear model (one-way relationships) to a systemic model (multidirectional and back-fed relationships), based on continuing processes of knowledge exchange, incorporation and generation.

Under such an approach, researchers, universities and research centres are the promoters of knowledge. Social networks of interaction among researchers and institutions are recognised in the scientific literature as important driving forces of production processes and dissemination of scientific knowledge because they represent transfer channels of information and resources. These processes are strongly rooted in a complex network of social practices and structures along the various analysis scales – local, regional and global (Ferreira and Marques, 2013).

The analysis of social networks lies in the characterisation of their agents and their connections using quite a number of support software programmes available today, for example, UNICET, NodeXL, Pajek, NetMiner, Siena, and so on. In this investigation we used the NodeXL. For detailed information on the methods of network analysis, we can refer to Scott (2013) and Scott and Carrington (2011).

Research on networks is normally organised at four levels (Sousa, 2012: 91): morphology, agents, connections and structure.

The morphological features identify the elements (nodes and connections), the size of the network (the number of nodes and connections), the number of components (is a group of agents connected as a group, but not related with others), the distance (between two pairs of agents, or the average distance between agents, and even the maximum distance between agents).

The characteristics or features of agents identify the position of each agent within the interactional network (more or less central) and the variety of existing agents (depending on the analysis level in question). Centrality can favour connections and, therefore, access to relevant information and resources. The literature identifies three centrality measures: *degree*, *betweenness* and *closeness*. Being targeted networks, the *out-degree* identifies the number of direct connections between an agent and other agents in the network (Scott, 2012:84). If an institution or a researcher has a greater number of direct connections, they will have a more central place within the network, hence a more favourable position for knowledge production interactions. Closeness centrality measures the proximity between an agent and all the other agents, meaning this is a global centrality measure. *Betweenness* centrality favours "intermediation", identifying the nodes that could be crucial in connections within the network.

Where connections are concerned, they should be evaluated for their intensity and diversity. The interactions of knowledge between researchers and institutions presume exchanges of information and resources, so they drive the production of new knowledge. Moreover, the diversity of themes on such interactions may trigger new processes of production of new knowledge (*relations variety*).

Finally, as regards network structure, a large number of indicators can be constructed. The intensity of the network provides the ratio between the number of

existing interactions and those that could exist if all authors/institutions were inter-connected. The levels of centralisation determine whether the network structure is organised around a number of central nodes.

3. Methodology

To answer the questions of this research, we have compiled a database with all of the *ENHR* conference papers for the years mentioned above. All these papers are organised in the database according to the following attributes: year, title, theme, authors, institution of author(s) and country(ies) of author(s). The database contains 1212 papers, 1417 authors/researchers who are part of 718 institutions belonging to 64 countries.

These papers represent individual or group work knowledge, wherein connections are established between researchers. Since we match the authors and their institutional membership, we are able to build inter-institutional connections.

Moreover, papers are grouped into the 21 thematic working groups that form the *ENHR*, apparent in almost every conference analysed. In some years, however, some working groups do not match those of the network; hence, in these cases, we have included them in one of the 21 *ENHR* working groups with the closest theme. Nevertheless, we need to point out that the working groups "Gender and Housing" (2009 and 2011) and "Tools to facilitate housing and urban process" (2007), the themes which we were unable to group into any of the 21 *ENHR* working groups, were recorded in the database and are referred to on the graph as other themes.

3.1 Levels of analysis

First, we provide a general description of the work under consideration. We are interested in finding evidence of the authors who produced the most for *ENHR* conferences (in number of papers) in the years under review, and from here take note of the institutions and countries who produced the most knowledge on housing. Based on the 21 theme working groups that form the *ENHR*, we will identify the strongest ones (with the most papers) in recent years. This is only a descriptive statistical analysis.

Secondly, we will look into the 21 theme networking groups. Each paper is part of one of the 21 working groups, so the authors and their institutional membership will be connected to different working groups according to the papers submitted to *ENHR* conferences in recent years. Hence, the fact that each paper in every annual conference is classified according to different themes allows us to focus on the theme affiliation, i.e., on the systematisation of cognitive networks on housing research per working group. Since each working group forms an interaction unit as regards housing research, following the goals and interests within the group, we assume that, over the years, stronger connections and interactions have developed within these groups.

Given the large number of working groups, we chose to represent them on the graphs in different colours, according to five themes we have defined:

- Housing Economics, Finance and Markets[4];
- Social Housing and Policy[5];
- Planning, Housing Regeneration, Urban Change[6];
- Housing, Urban Sustainability and Health[7];
- Housing in Developing Countries and East European[8];
- Others[9].

3.2 Axes of network analysis

In terms of network analysis, having regard to the objectives of this research, this methodological approach will favour some analytical axes:

- How to relate the authors with the 21 theme working groups;
- How to relate the institutions with the 21 theme working groups;
- How to relate the institutions with authors.

For instance, we will describe how the methodology works in cross-linking authors with the 21 theme working groups. As regards morphological features, we will compare the size of the different thematic networking groups, because each group involves a specific number of authors-researchers (represented by author-working group links).

As to the global network, we will identify the 21 thematic working groups and authors-researchers, the former being placed differently within the network, highlighting the more central and the more peripheral ones. We will also place authors according to the different levels of centrality. As such, we will be interested in analysing the authors who have produced the most (number of papers in the different working groups) and who focus on greater expertise (produce a lot but only for one thematic working group) or on greater diversity (produce a lot but for various thematic working groups). The *degree* of authors is proportional to the number of papers they have produced for the conferences in question, whilst the *out-degree* relating to groups shows the number of papers in each group.

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4 This theme groups: Housing Economics; Housing Finance; Private Rented Markets; Land Markets and Housing Policy and Home Ownership and Globalisation (green colour)

5 This theme groups: Social Housing: Institutions, Organisations and Governance; Residential Environments and People; Welfare Policy, Homelessness, and Social Exclusion; Poverty Neighbourhoods; Migration, Residential Mobility, and Housing Policy; Minority Ethnic Groups and Housing and Housing and Living Conditions of Ageing Populations (blue colour).

6 This theme groups: Housing Regeneration and Maintenance; Legal Aspects of Housing, Land and Planning; Metropolitan Dynamics: Urban Change, Markets and Governance and Residential Buildings and Architectural Design (black colour).

7 This theme groups: Housing and Urban Sustainability and Residential Context of Health (brown colour).

8 This theme groups: Housing in Developing Countries and East European Housing & Urban Policy (red colour).

9 This theme groups: Gender and Housing and Tools to facilitate housing and urban processes (pink colour).

In terms of network structure, we can analyse the network density (ratio between existing connections and the number of connections if all authors were to be linked to thematic working groups) and, in particular, the levels of network centralisation (we need to understand whether or not the network is organized around several central nodes, and what are the peripheral nodes).

4. Analysis of the results

In terms of general characterisation, we can point out that the stronger thematic working groups, i.e., with the highest number of papers, are:

- Housing Economics (154 papers);
- Social Housing-Institutions, Organisations and Governance (144 papers)
- Housing and Urban Sustainability (124 papers).

These three working groups represent 35% of the total number of papers (Figure 1). By contrast, the production of some thematic working groups was not significant in recent years, and these should be reconsidered.

Regarding countries, we can point out that Holland is the most representative case, with 237 papers, closely followed by the United Kingdom (194 papers), Turkey (75 papers), Australia and Sweden (71 papers). This distribution is probably due to the fact that the 2007 conference was held in Rotterdam, and because *ENHR* is based in Amsterdam (Table 2).

With regard to the representativeness of each continent in the production published by the *ENHR* (Figure 2), Europe clearly prevails (81% of papers submitted). The *ENHR* was established in this continent as a European platform to organise institutions and researchers, and gathers mostly European authors/researchers. Moreover, all the conferences are held in this continent. Asia ranks second in this research network (7% of the papers).

Figure 1 – Number of papers by theme

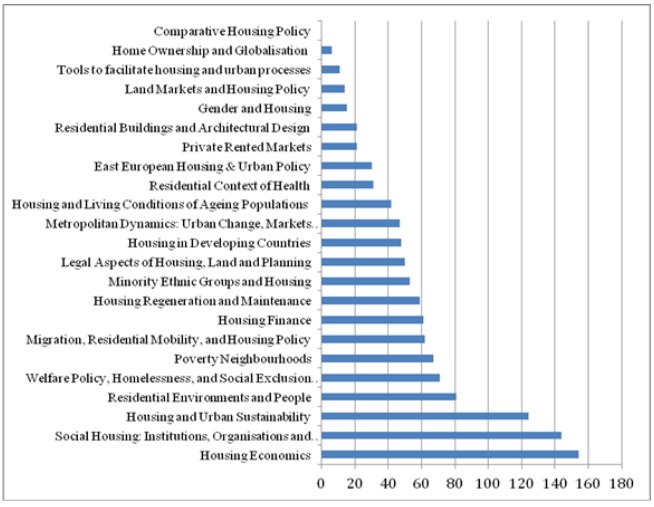
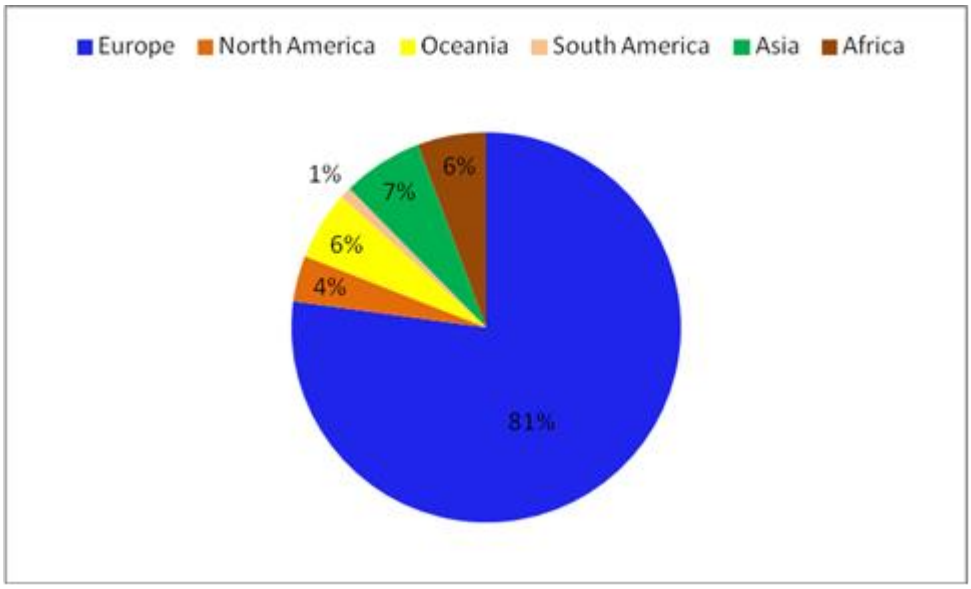


Table 2 – Number of papers by country

Country	No. of papers	Country	No. of papers	Country	No. of papers	Country	No. of papers
Netherlands	237	Ireland	18	Romania	4	Dubai	1
United Kingdom	194	Japan	18	Brazil	3	Greece	1
Turkey	75	Finland	17	Indonesia	5	Kenya	1
Australia	71	Portugal	14	Iceland	3	Latvia	1
Sweden	71	Hungary	13	Nepal	3	Lithuania	1
Norway	57	Switzerland	13	New Zealand	3	Luxembourg	1
Denmark	48	Cyprus	12	Serbia	3	Morocco	1
France	43	Slovenia	12	South Africa	2	Mauritius	1
Spain	38	Korea	10	Algeria	2	Mexico	1
USA	33	Poland	10	India	2	Peru	1
Germany	32	Taiwan	10	Macedonia	2	Syria	1
Czech Republic	30	Iran	7	Malaysia	4	Tanzania	1
Austria	26	Chile	6	Nigeria	2	Zimbabwe	1
China	24	Estonia	5	Zambia	2		
Canada	22	Israel	5	Albania	1		
Italy	21	Russia	5	Bosnia	1		
Belgium	20	Croatia	4	Colombia	1	**TOTAL**	**1275**

Figure 2 – % of papers presented at *ENHR* conferences by continent



The results of the network analyses are organised according to the cross-links mad:

- Production of knowledge on housing by thematic working groups per continent of origin (of researchers/institutions) (figure 3);
- Cross-linking the knowledge of authors/researchers with the 21 thematic working groups (figure 4);
- Relationships between thematic working groups and institutions (figure 5);
- Relationships between institutions and thematic working groups (figure 6);
- Relationships between Institutions and Authors (figure 7).

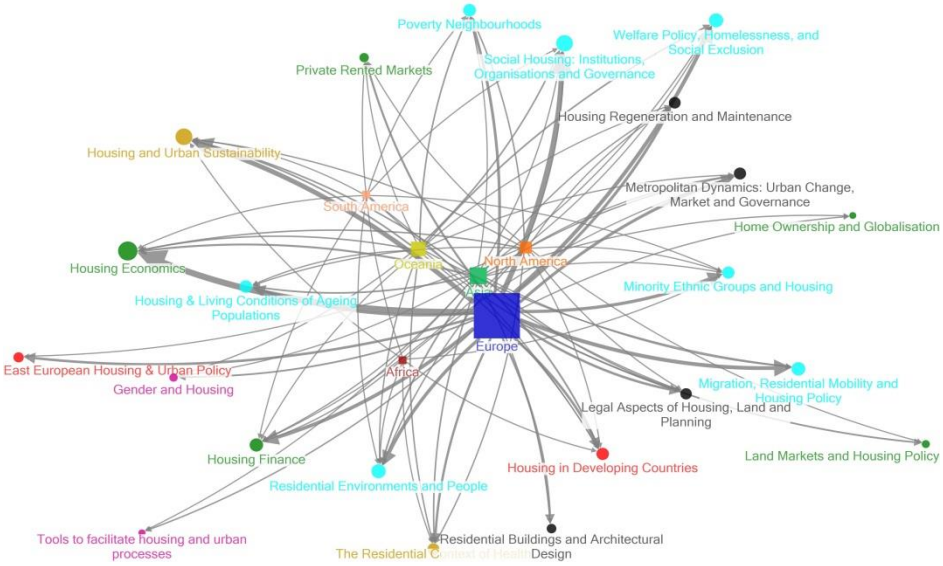
As we can see, Europe occupies a clearly central position within the knowledge network and is interconnected to all working groups, which means that European researchers produce knowledge for all 21 working groups of *ENHR* conferences. Asia has the most diversified production, producing for 19 working groups, North America for 17, Oceania for 16 and, lastly, South America and Africa, for 9 and 8 working groups respectively (figure 3).

In terms of working groups, only four received scientific contributions from the 6 continents: "Residential Environments and People"; "Housing and Urban Sustainability"; "Housing Finance" and "Housing in Development Countries". Having diversified inter-continental contributions can potentially create better conditions for the exchange of many different experiences and practices in terms of scientific production. Conversely, the more peripheral working groups in the network are those whose inter-continental contributions are less diverse: East European Housing & Urban Policy;

Home Ownership and Globalisation; Residential Buildings and Architectural Design; Land Markets and Housing Policy and Tools to Facilitate Housing and Urban Processes.

In terms of the morphological characteristics of the network (figure 4), as we can see, each working group has a specific number of authors-researchers. More precisely, the intensity of the link between the different authors and the working groups varies, as does their position within the network.

Figure 3 – Production of knowledge on housing by thematic working groups per continent of origin (of researchers/institutions)



Note 1: the graph represents the relationship between the knowledge produced by the different continents and thematic working groups. The continents are represented by squares with a size proportional to *in-degree* and with different colours – blue for Europe, yellow for the Oceania, green for Asia, brown for Africa, orange for North America and a lighter orange to South America. The thematic working groups are represented by circles with a size proportional to *out-degree*; the colours are those of the five thematic referred above.

In terms of centrality (*degree*), the working group with the most centrality is "Housing Economics", followed by "Housing and Sustainability" and "Social Housing: Institutions, Organisations and Governance" (table 3). By contrast, some of the working groups are clearly peripheral to this knowledge network, including "Home Ownership and Globalisation", "Tools to Facilitate Housing and Urban Processes", "Gender and Housing" and "Land Markets and Housing Policy".

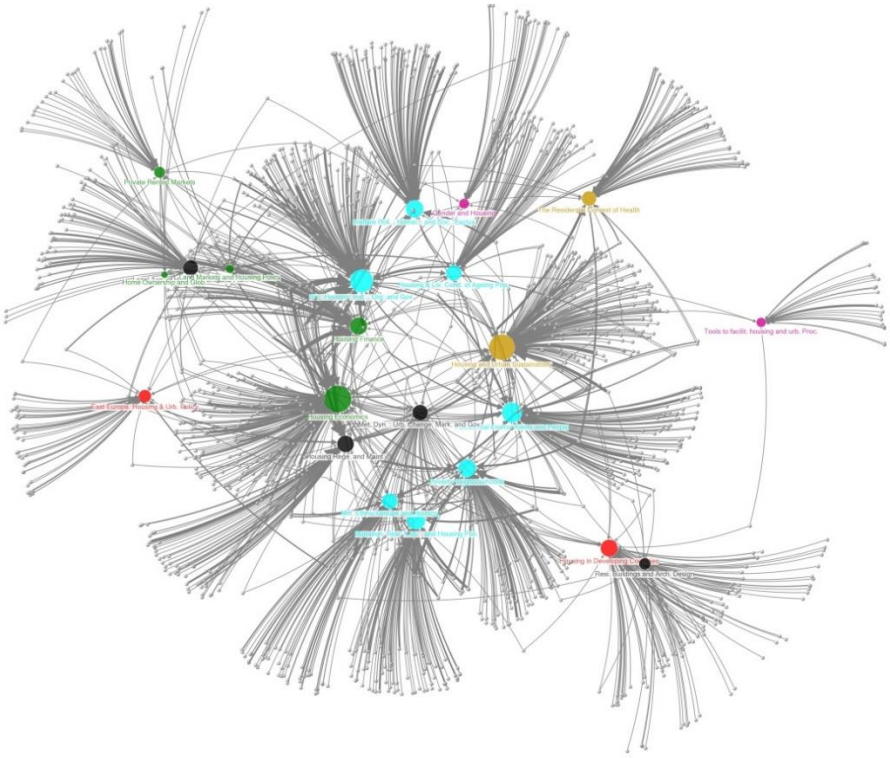
The index of *betweenness centrality* favours the "intermediation", identifying the working groups that can be crucial to connections within the network. The three groups with the most centrality (*degree*) also have a key role in the intermediation of knowledge (betweenness centrality).

The position of authors will also reveal different levels of centrality. What is interesting in this context is to analyse the authors who diversify the production of knowledge on housing the most (they communicate in various working groups). The analysis of the *degree* of authors identifies 4 authors who work for 5 working groups: Marja Elsinga, Ade Kearns, Sarah Monk and Montserrat Pareja-Eastaway.

There were 12 authors with papers for 4 working groups, including Reinout Kleinhans, Sasha Tsenkova, Joris Hoekstra, Marietta Haffner, Michael Oxley, Sandra Marques Pereira, among others.

But there were also authors with oriented and specialized work, producing a lot for one workshop, for example, David Mullins and Gerard van Bortel for "Social Housing: Institutions, Organisations and Governance", submitting 7 papers in 4 conferences.

Figure 4 – Cross-linking the 21 thematic working groups with authors/researchers



Note 2: the graph represents the links between the thematic working groups (represented by circles with a size proportional to *degree* and with colours depending on the five thematic referred above and authors (grey circles).

When looking into the network structure (Figure 4), we realise that the positions of working groups on the graph are quite different. The proximity between working groups means that there is greater sharing of authors-researchers. For example, "Residential Environments and People" is close to "Minority Ethnic Groups and Housing", to "Poverty Neighbourhoods" and "Migration, Residential Mobility, and Housing Policy",

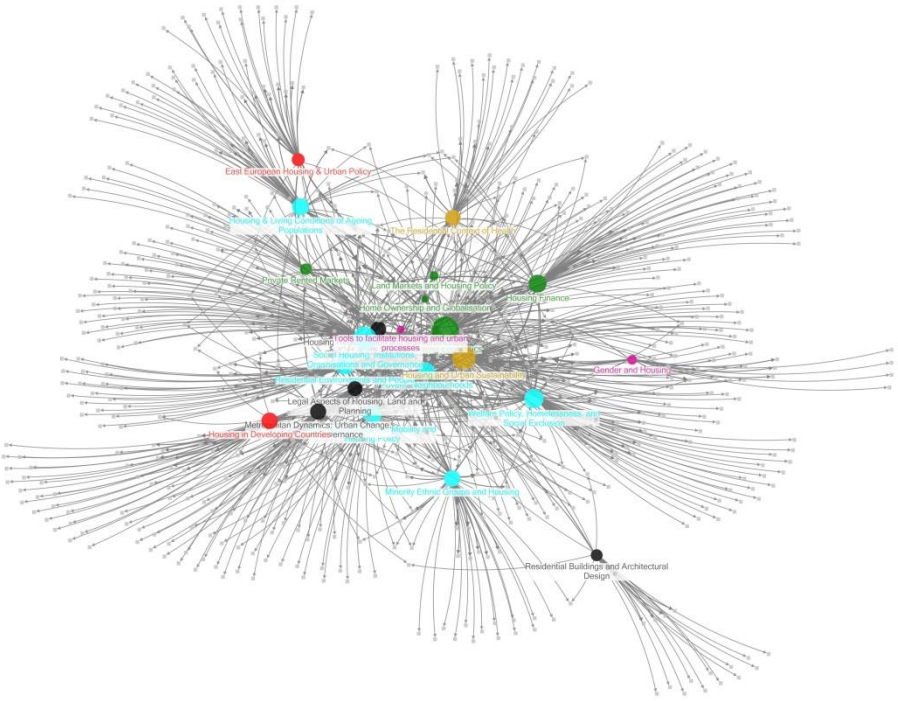
as there are a significant number of researchers who submit papers in these three working groups. "Housing Finance" is close to "Social Housing: Institutions, Organizations and Governance", "Welfare Policy, Homelessness, and social Exclusion" and "Housing and Living Conditions of Ageing Populations.

The more peripheral their position on the graph, the less authors share with other working groups, for example, "Tools to Facilitate Housing and Urban Processes".

Table 3 – Degree, in-degree and *betweenness centrality* per working group

Vertex: Thematic Working group	In-Degree	Betweenness Centrality
Housing Economics	213	607426,118
Housing and Urban Sustainability	192	521026,304
Social Housing: Institutions, Organisations and Governance	153	405673,080
Residential Environments and People	115	296103,385
Migration, Residential Mobility, and Housing Policy	93	221397,275
Poverty Neighbourhoods	92	228529,253
Welfare Policy, Homelessness, and Social Exclusion	88	208773,890
Housing Finance	85	218069,794
Housing in Developing Countries	83	210859,054
Housing Regeneration and Maintenance	79	185412,637
Minority Ethnic Groups and Housing	67	147494,465
Metropolitan Dynamics: Urban Change, Markets and Governance	66	159828,551
Housing & Living Conditions of Ageing Populations	66	156809,770
Legal Aspects of Housing, Land and Planning	64	154096,803
The Residential Context of Health	59	137369,372
East European Housing & Urban Policy	44	105468,261
Residential Buildings and Architectural Design	36	82960,257
Private Rented Markets	33	68293,368
Gender and Housing	26	62311,014
Tools to facilitate housing and urban processes	23	57926,422
Land Markets and Housing Policy	15	22203,203
Home Ownership and Globalisation	9	11343,722

Figure 5 – Relationships between thematic working groups and institutions



Note 3: the graph represents the links between the thematic working groups (represented by circles with a size proportional to the *degree* and with colours depending on the five thematic referred above) and the institutions (grey circles).

As regards morphological features (Figure 5), the size of the network of institutions around the different thematic working groups (each working group involves a specific number of institutions) is very different. As shown on the graph, the position of some institutions and working groups is in the centre of the graph, while others are clearly peripheral.

The centrality (degree) of the OTB Research Institute-Delft University of Technology (The Netherlands) and the Delft University of Technology (The Netherlands) clearly stands out, since they submitted papers in 16 working groups (Table 4). The scientific production of this unit is quite varied, making it possible for it to participate in a distinctly high number of working groups. The maximum reached by other institutions was 10 (In-degree, Table 4). The order of the more "intermediating" institutions (Table 4) is as follows: Delft University of Technology, OTB Research Institute (The Netherlands), Institute of Sociology Academy of Sciences of the Czech Republic (Czech Republic), Istanbul Technical University (Turkey), Institute for Housing and Urban Research Uppsala University (Sweden), Danish Building Research Institute, Aalborg University (Denmark) and University of New South Wales (Australia).

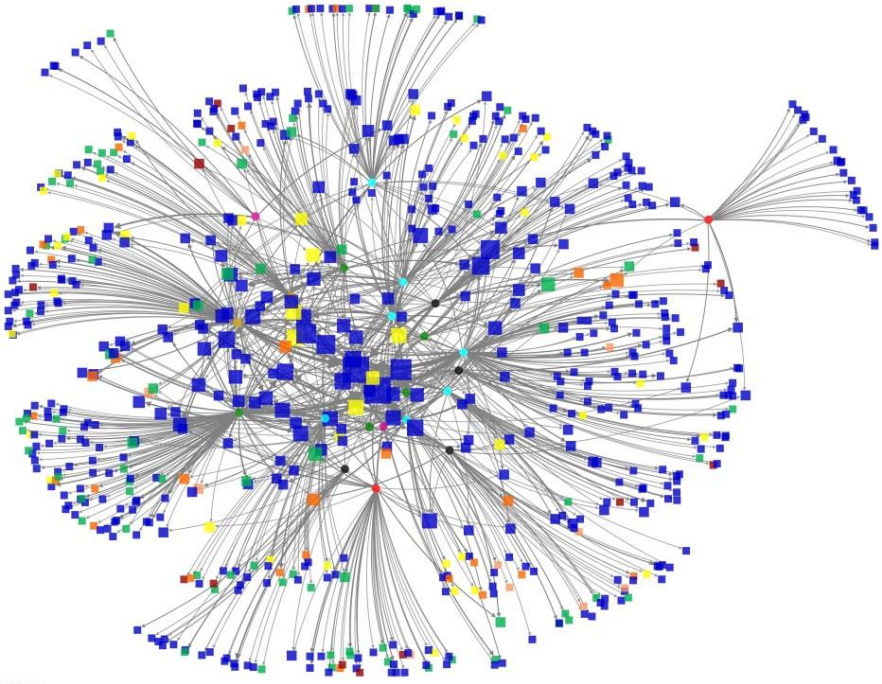
Table 4 – Indicators relating to the *In-degree* and *Betweenness Centrality* for the principal network institutions, with regard to thematic working groups

Vertex: Institutions	In-Degree	Betweenness Centrality
OTB Research Institute | Delft University of Technology | The Netherlands	16	48 074,889
Delft University of Technology | The Netherlands	16	70 537,741
Istanbul Technical University | Turkey	10	22 272,936
Institute for Housing and Urban Research | Uppsala University | Sweden	9	20 115,241
Danish Building Research Institute | Aalborg University | Denmark	8	13 861,160
Institute of Sociology | Academy of Sciences of the Czech Republic | Czech Republic	8	27 024,379
University of Cambridge | United Kingdom	7	8695,876
University of Glasgow | United Kingdom	6	7975,142
University of Barcelona | Spain	6	8557,135
University of New South Wales, Australia	6	10 660,208
London School of Economics | United Kingdom	6	6554,067
Heriot-Watt University | United Kingdom	6	8248,788
University of Amsterdam | The Netherlands	6	7201,566
University of St Andrews, United Kingdom	5	4410,134
Uppsala University | Sweden	5	4216,205
Royal Institute of Technology, Stockholm, Sweden	5	4840,985
Swinburne University | Australia	5	4454,849
Sheffield Hallam University | United Kingdom	5	4602,059
Norwegian Institute for Urban and Regional Research | Norway	5	5899,372
RMIT University | Melbourne | Australia	5	4319,792
Urban Planning Institute of the Republic of Slovenia | Slovenia	5	6237,710
City Futures Research Centre, University of New South Wales, Australia	5	8124,732

Using the graph presented (Figure 6) to pinpoint the *degree* or centrality of the institutions, we are able to identify at the centre a quite respectable number of institutions, most of which are European and some are Asian. A rather significant number of institutions lie in the periphery of the network because they have produced papers for a single working group.

The table 5 helps complete the analysis of the chart since it shows the main flows (number of papers) that interconnect among some working groups and institutions. The OTB Research Institute participates actively in various working groups, especially in "Social Housing: Institutions, Organizations and Governance", "Housing Economics", "Poverty Neighbourhoods", "Housing Regeneration and Maintenance", "Residential Environments and People" and "Legal Aspects of Housing, Land and Planning". The Istanbul Technical University (Turkey) produces actively for "Housing and Urban Sustainability" and "Residential Environments and People".

Figure 6 – Relationships between institutions and thematic working groups

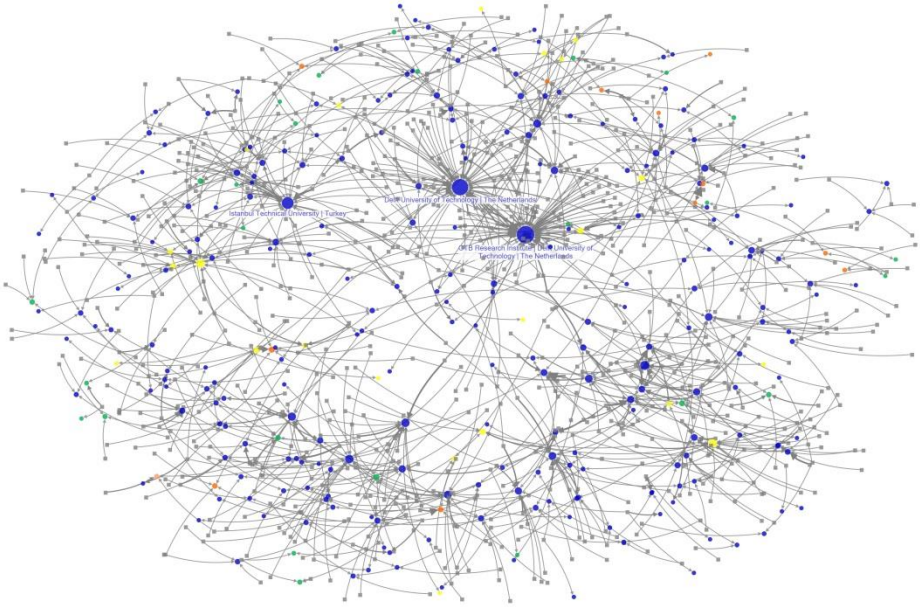


Note 4: The graph represents the links between institutions and working groups. The institutions are represented by squares whose size is proportional to their degree, and the colours reflect the continent where they are found (blue for Europe, yellow for the Oceania, green for Asia, brown for Africa, orange for North America and a lighter orange to South America). The thematic working groups are represented by circles (the colours reflect the thematic referred above).

Table 5 – The Indicators of Edge Weight (papers submitted) cross-linked with thematic working groups and institutions

Vertex : Working groups	**Vertex: institutions**	**Edge Weight**
Social Housing: Institutions, Organizations and Governance	OTB Research Institute | Delft University of Technology | The Netherlands	31
Social Housing: Institutions, Organizations and Governance	Delft University of Technology | The Netherlands	27
Housing Economics	OTB Research Institute | Delft University of Technology | The Netherlands	25
Housing and Urban Sustainability	Delft University of Technology | The Netherlands	24
Poverty Neighbourhoods	OTB Research Institute | Delft University of Technology | The Netherlands	21
Housing Regeneration and Maintenance	OTB Research Institute | Delft University of Technology | The Netherlands	19
Housing Regeneration and Maintenance	Delft University of Technology | The Netherlands	17
Tools to facilitate housing and urban processes	Delft University of Technology | The Netherlands	15
Residential Environments and People	OTB Research Institute | Delft University of Technology | The Netherlands	14
Housing and Urban Sustainability	Istanbul Technical University | Turkey	13
Legal Aspects of Housing, Land and Planning	OTB Research Institute | Delft University of Technology | The Netherlands	12
Residential Environments and People	Istanbul Technical University | Turkey	12
Housing Economics	University of Glasgow | United Kingdom	11
Migration, Residential Mobility and Housing Policy	University of St Andrews, United Kingdom	10
Poverty Neighbourhoods	University of Glasgow | United Kingdom	10

Figure 7 - Relationships between Institutions and Authors



Note 5: The graph represents the relationship between institutions and authors. The institutions are represented by circles whose size is proportional to the *degree*, and the colours represent the continent where they are found (blue for Europe, yellow for the Oceania, green for Asia, brown for Africa, orange for North America and a lighter orange to South America). Authors are represented by grey circles.

In terms of authors, again we can see the centrality (Figure 7, table 6) shown by the OTB Research Institute, Delft University of Technology and Delft University of Technology (The Netherlands), who presented 79 and 68 authors-researchers, respectively, at the *ENHR* Conferences. The network of researchers from the Istanbul Technical University, in Turkey, also stands out fairly in this graph. In terms of "intermediation" capacity (betweenness centrality), several institutions stand out, including the OTB Research Institute and the Delft University of Technology (The Netherlands), the City Futures Research Centre University of New South Wales (Australia), and the University of St Andrews, Scotland, United Kingdom (table 6).

Table 6 – Indicators of the *In-degree* and *Betweenness Centrality* for Institutions, with respect to Authors

Institutions – authors Vertex	**In-Degree**	**Betweenness Centrality**
OTB Research Institute | Delft University of Technology | The Netherlands	79	60 027,000
Delft University of Technology | The Netherlands	68	31 217,579
Istanbul Technical University | Turkey	34	2 378,000
University of Glasgow | United Kingdom	18	1 772,667
University of St Andrews, Scotland, United Kingdom	15	10 436,000
Sheffield Hallam University, Sheffield, United Kingdom	15	210,000
City Futures Research Centre University of New South Wales, AUSTRALIA	15	16 401,000
Institute for Housing and Urban Research | Uppsala University | Sweden	14	2 515,000
RMIT University | Melbourne | Australia	14	552,333
Heriot Watt University, United Kingdom	13	7 396,000
KTH - Royal Institute of Technology | Sweden	13	307,000
Utrecht University | The Netherlands	12	8 918,000
Eastern Mediterranean University | Turkey	12	289,000
Danish Building Research Institute, University of Aalborg, DENMARK	12	490,000
NOVA - Norwegian Social Research | Norway	11	565,000
University of York | United Kingdom	10	1388,000
University of Cambridge | United Kingdom	10	489,000
Uppsala University | Sweden	10	3 179,000
Norwegian Institute for Urban and Regional Research | Norway	10	148,000
University of Barcelona | Spain	9	200,000
London School of Economics | United Kingdom	9	550,000

As regards the flows in the number of papers per author, in a total of 1417 researchers attending the *ENHR* Conferences, 1087 (77%) submitted only one paper, hence their connections in the network are rather weak. It should however be noted that 75 researchers are very active at the Conferences (Table 7).

Table 7 – No. of papers for Authors who have participated the most in the 4 conferences under analysis

Authors	No. of papers	Authors	No. of papers	Authors	No. of papers
Ade Kearns	11	Andre Mulder	4	Jie Chen	4
Reinout Kleinhans	10	Angela Spinney	4	Jos Smeets	4
Christine Whitehead	9	Anke Van Hal	4	Kathleen Scanlon	4
Marja Elsinga	9	Berit Nordahl	4	Kees Dol	4
Sasha Tsenkova	9	Caroline Newton	4	Kristof Heylen	4
Gerard van Bortel	8	Clarine van Oel	4	Lena Magnusson Turner	4
David Mullins	7	Darinka Czischke	4	Margrit Hugentobler	4
Joris Hoekstra	7	David Manley	4	Morten Skak	4
Marietta Haffner	7	Eva Bosch	4	Nadia Charalambous	4
Mark Stephens	7	George de Kam	4	Nessa Winston	4
Nico Nieboer	7	Gulcin Pulat Gokmen	4	Pascal De Decker	4
Sarah Monk	7	Guy Johnson	4		
Eli Støa	6	Hal Pawson	4		
Glen Bramley	6	Hans Skifter Andersen	4		
Gwilym Pryce	6	Heidrun Feigelfeld	4		
Henny Coolen	6	Hélène Bélanger	4		
Jens Lunde	6	Henryk Adamczuk	4		
Sake Zijlstra	6	Hugo Priemus	4		
Sandra Marques Pereira	6	Inga Britt Werner	4		
Vincent Gruis	6	Iván Tosics	4		
Andre Ouwehand	5	Phil Mason	4		
André Thomsen	5	Richard Sendi	4		
Arne van Overmeeren	5	Roland Goetgeluk	4		
Eva Andersson	5	Ronald van Kempen	4		
Gemma Burgess	5	Sako Musterd	4		
George Galster	5	Susanne Søholt	4		
Gideon Bolt	5	Tomislav Šimecek	4		
Maarten Van Ham	5	Tony Gilmour	4		

Mark Livingston	5	Wenda Doff	4
Michael Oxley	5	Willem K. Korthals Altes	4
Montserrat Pareja-Eastaway	5	Yoko Matsuoka	4
Rebecca L. H. Chiu	5	Jardar Sorvoll	4

4. Conclusion

Bearing in mind the goals of this research (scientific networks in research on housing), we will systematise some conclusions and identify the course of action in subsequent approaches.

a. The geographical influence of the *ENHR* network

Although the *ENHR* is a knowledge platform at European level, its international interest is shown by the relevance of papers from non-European countries. About 20% of papers are from non-European countries and, in this context, Asia stands out slightly compared to other continents (more papers and a broader range of themes). As to representation by countries, the Netherlands and the United Kingdom clearly stand out, followed by Turkey, Australia and Sweden. Within the more productive countries, we can also add Norway, Denmark, France, Spain, USA, Germany, Czech Republic and Austria.

With respect to themes, European institutions are engaged in research for all the thematic working groups, producing many papers. Asia, North America and Oceania are slightly less overarching (present in 19, 17 and 16 working groups, respectively), and South America and Africa are clearly peripheral in this knowledge network, submitting a small number of papers.

b. Thematic production of the *ENHR* network

Overall, the thematic working groups "Housing Economics", "Housing and Urban Sustainability", "Social Housing: Institutions, Organisations and Governance", and "Residential Environments and People" are more directly connected to authors, being more central in the network, and are therefore in a more favourable position for interactions on the production of knowledge on housing. As for "Housing Economics", we have 213 authors; for "Housing and Urban Sustainability", 192 authors; for "Social Housing: Institutions, Organisations and Governance", 153 authors, and for "Residential Environments and People", 115 authors.

Some themes, however, are clearly marginal in this knowledge network, in particular "Home Ownership and Globalisation" and "Land Markets and Housing Policy", not very significant in terms of the number of papers and of authors involved. The poor critical mass of these working groups (less than twenty authors) does not provide the necessary conditions for the exchange, dissemination and absorption of knowledge.

c. The power of institutions in the *ENHR* network

Institutionally-speaking, the centrality of the OTB Research Institute, Delft University of Technology (The Netherlands) and the Delft University of Technology (The Netherlands) clearly stands out in the *ENHR* knowledge network, since they have spread their scientific production across 16 working groups. This thematic coverage also places them in a pivotal position in the dissemination of knowledge on housing.

But there are other highly central institutions within this knowledge network, for example, Istanbul Technical University (Turkey), Institute for Housing and Urban Research - Uppsala University (Sweden), Danish Building Research Institute - Aalborg University (Denmark), Institute of Sociology - Academy of Sciences of the Czech Republic (Czech Republic), University of Cambridge (United Kingdom), University of Glasgow (United Kingdom), University of Barcelona (Spain), University of New South Wales (Australia), London School of Economics (United Kingdom), Heriot-Watt University (United Kingdom) and University of Amsterdam (The Netherlands).

d. The authors/researchers in the *ENHR* network

The profile of authors is highly diversified, with some choosing to produce significantly for a single thematic working group (thematic specialization) and others for a diverse number of topics. About 16 researchers have submitted papers in 4 or 5 thematic working groups; this profile of researchers may have an important role in the exchange of knowledge between the different working groups.

e. Subsequent approaches

In terms of future research (scientific networks in research on housing), we are currently developing the co-authorship networks based on the co-authored papers presented in EHNR Conferences. In a total of 1212 papers, 548 are co-authored. Whenever the authors/researchers belong to different institutions, we build the institutional network based on the papers produced in inter-institutional partnerships. It is also important to understand the position that the heterogeneity of agents (research centres, universities, companies, banks, etc.) have in the production of knowledge.

At the same time, we are focusing our research on the strongest thematic working groups and the more central institutions within the *ENHR* knowledge network, aiming to analyse authors/researchers at the core of these themes and the course that the research is following based on keywords of the various papers. The analysis of bibliography used in the papers submitted can also provide relevant contributions to the analysis of knowledge networks on housing.

To discuss this matter further, we are preparing a questionnaire to be sent to the main knowledge-producing institutions.

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