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EXPLORING THE FIELD OF PUBLIC CONSTRUCTION CLIENTS BY A GRAPHICAL NETWORK ANALYSIS

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Because public construction clients form the majority of construction clients and procure over 40% of the construction output in most countries, they are important actors in the construction industry. Yet, the field of research on clients is still underdeveloped. In order to identify the research gaps in this field, a graphical network analysis of existing literature is performed. The analysis is based on a query executed in the scientific database Scopus resulting in around 3,300 publications. By connecting the papers and their references as nodes in a network, an overview is created of the most important topics as previously studied by academic scholars. Collaboration, innovation and sociology are the most studied subjects found. Research methods, public sector and project management are other issues that have attracted scholars to perform research on public clients. Most of the topics are, however, not limited to public clients and based on a relatively low number of specific contribution from the perspective of the public client itself, it can be concluded that especially the public aspect of the construction field is neglected. This opens up interesting opportunities for future research.

Keywords: graphical network analysis, public construction clients, research agenda, research theme identification.

INTRODUCTION

Because clients are ‘the initiators of projects and those that contract with other parties for the supply of construction goods or services’ (Atkin, Flanagan, Marsh, & Agapiou, 1995), they are important actors in the construction industry. Opposite to clients in mass-production sectors, clients in the construction industry play a large role in the creation of a facility. They directly engage in the planning and construction and in this way they shape not only the product, but also the construction process (Hartmann, Reymen, & Van Oosterom, 2008). Construction clients can be classified as private individuals, private corporate, and public sector (Blackmore, 1990). The main interest of the private sector is achieving profit (Boyd & Chinyio, 2008), whereas the goal of public sector clients is maximising value for money (Morledge & Smith, 2013).

This paper focuses on public sector construction clients. The public sector consists of central and local government and nationalised corporations. Together with semi-public clients they form the majority of construction clients and procure over 40% of the construction output in most countries (Boyd & Chinyio, 2008). Many private sector clients, who have usually less experience in procuring goods or services tend to follow the model of the public clients (Winch, 2010). Public clients therefore play an

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important role in shaping the nature of the construction industry (Manley & McFallan, 2006).

Work in the public sector is carried out wholly or partly with public funds (Winch, 2010). Because of this, the public sector must be accountable to taxpayers in how projects and services are procured. Taxpayers have the right to know that their money is spent consistent with approved published policies. Contracts must be awarded fairly and without discrimination in a transparent and accountable way. A substantial body of (European and national) legislation and regulations has been developed to enforce these objectives. The obligations demand a high level of responsibility, transparency and accountability. Failure to comply with regulations could result in lawsuits or criminal prosecution. In extreme cases failure to comply can lead to taking-over of administration of an authority by central government (Morledge & Smith, 2013).

In the Netherlands a group of large public clients - the Dutch Construction Client Forum, consisting of ministries, the governmental housing department, railways, housing corporations and hospitals - expressed the need for developing a theoretical foundation on the challenges they face in this specific field. Because of the exemplary role in society and the strict playfield in which public construction clients operate, a scientific approach is needed. The results of a previous exploration of existing literature (Eisma & Volker, 2014) showed that the majority of the papers on public construction clients focus on projects, rather than the (internal) organisation of the client. Also public aspects are merely neglected. A more thorough analysis is therefore needed to gain a full understanding of the body of literature in this challenging field of study. This paper builds on this work in providing a broad qualitative analysis of the nature of the body of literature by means of a graphical network analysis. The aim of this paper is to create an overview of scientific research publications on public construction clients, to discover links between this field and other scientific fields, and reveal underlying patterns of research topics. The extended scope of this review could lead to new research themes that address the gaps in field of construction clients.

METHOD

The increasing amount of research papers can make the identification of relevant publications for a certain topic time consuming. When searching for relevant publications in a scientific database such as Scopus, there is a tension between finding as much papers as possible and defining a specific search query in order to avoid the risk of leaving important publications out. It can, therefore, be fruitful to find a way to distinguish the important publications from the ones that appear to be less relevant for a specific aim. For this purpose a graphical network approach is used. This network, in which papers form the nodes and references are the links, is the result of authors that cite other authors. Networks of publications and researchers evolve under influence of peer pressure, rules of conduct and funding (Chappin & Ligtoet, 2014). The concept is that good science is continued and that good scientists are credited. However, due to the large quantity of scientific research projects and publications, important results may be overlooked. Analysing the citations in scientific networks enhances the understanding of the cohesion, quality, level, and coverage of a specific part of the literature (Chappin & Ligtoet, 2014).

In this research the network of papers on public clients is constructed from possibly relevant publications and their references included in Scopus. To ensure a wide range of publications, it was important to devise a search query that covers all potential relevant sources and topics. Terms for specific topics can vary between different

research fields (Murray, 2009). Therefore multiple synonyms for every term were included. The search query was developed in an iterative way and was finalised in February 2014. It is reflected in figure 1:

```
TITLE-ABS-KEY(client OR commissioner OR {local authority} OR principal OR sponsor OR buyer OR owner) AND TITLE-ABS-KEY(construction OR infrastructur* OR urban* OR transport* OR project OR maint*)AND TITLE-ABS-KEY(public) AND(TITLE-ABS-KEY(brief* OR purchas* OR procur* OR contract* OR tender* OR administration OR {public private} OR ppp OR govern* OR perform*) OR TITLE-ABS-KEY(architect* OR project OR process OR information OR {supply chain} OR portfolio OR facility OR accommodation OR housing)) AND PUBYEAR > 1989AND (LIMIT-TO(LANGUAGE, "English"))
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Figure 1: Search query

To limit the number of publications, only publications from 1990 or later that are written in English are included. Certain topics, such as Medicine, Earth and Planetary Sciences and Nursing were excluded to eliminate non relevant publications. The search query produced around 3,300 publications. The network was created using the method described by Chappin and Ligtvoet (2014). In short, this method goes as follows: first the references, including their citations are exported. Google Refine is used to clean the data, removing typing errors and combining different spellings of the same reference (for instance P.E.D. Love and P. Love). If this step is not performed, the real structure of the network will not be displayed because of non-valid scattering of the data. The results highly depend on the accuracy of this step since a shared reference is only recognised when it is spelled exactly the same in both instances. Because Google Refine is only able to remove those multiple spellings to a certain degree, a manual correction was also needed.

Then the file was imported in Gephi, a program which recognises references between documents. It connects the documents retrieved from the search query (3,300 documents) with their references (in total around 67,000) in a network. This resulted in a network of around 70,000 nodes and mutual connections. To increase clarity, nodes with less than four references were filtered out. In this way, non-relevant publications were omitted, while maintaining the structure of the network. Subsequently the size of the nodes was made dependent on the number of times the publication was cited: the more citations, the larger the node. Significant publications directly attract attention in the graphical view. If a publication is only incidentally cited, it remains a small node or is even completely left out of the network.

In the final step, nodes were grouped based on modularity. With this function, Gephi analyses the network and groups nodes that share references. This enables the identification of common themes and topics in the literature on public construction clients. Each group was given its own colour to be easily distinguished. By looking at the titles and abstracts of publications in a certain group, the groups are then labelled according to the topic that is addressed.

RESULTS

Figure 2 shows the network that was constructed in the graphical network analysis as described in the previous section. This figure depicts a little more than 1,000 nodes and almost 2,000 connections. This generates two types of results: four insights in the structure of the network and an overview of the six most important research themes. Both contribute to the exploration of the field of construction client research and identification of current research themes, which can be used to set up a research agenda for the coming years.

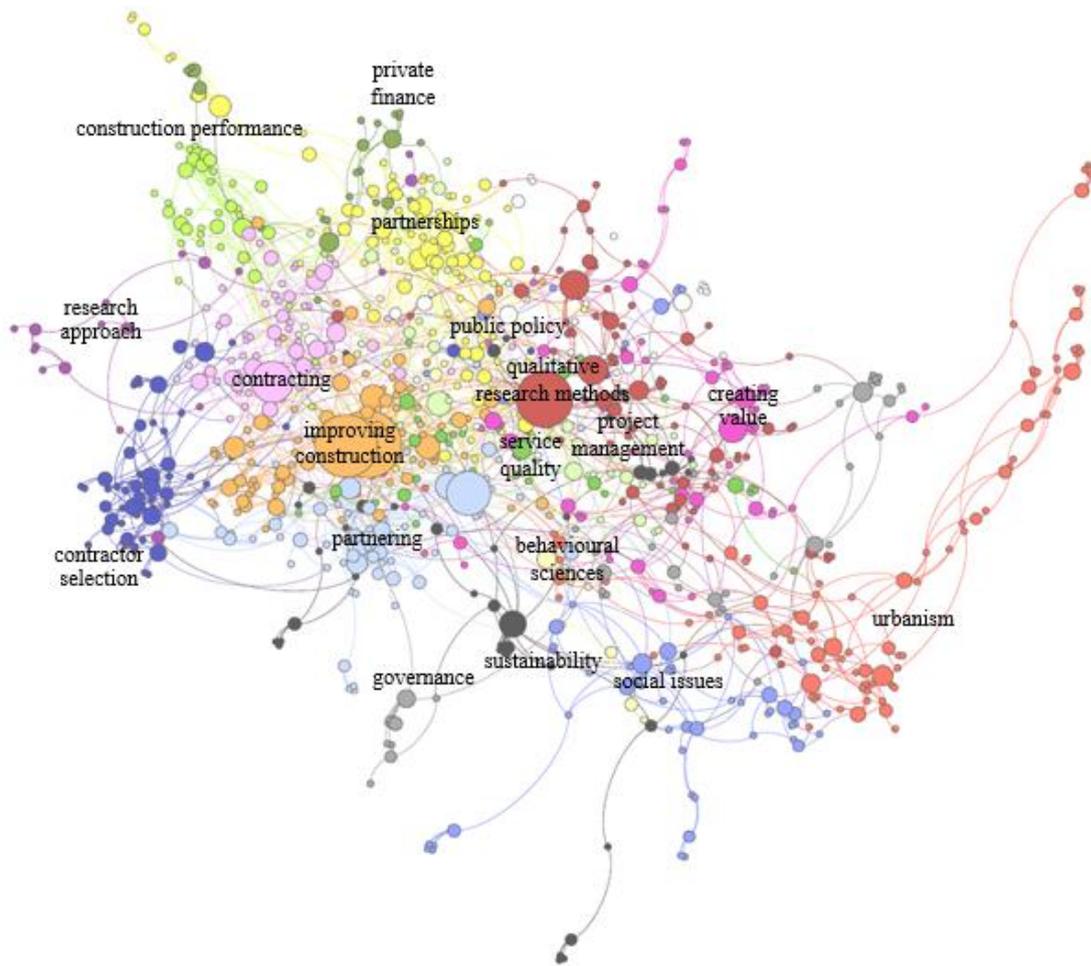


Figure 2: Network of papers and references from search query

Network structure

The structure of the network has a number of characteristics. First, it indicates that the research performed on public client is a rather coherent group. The left side of the graph shows a concentrated area with tightly interwoven nodes. This means that the authors of these papers often cite each other. The right side is more dispersed, indicating looser mutual connections and less links to the core of public client literature. Some groups in this part spread across the network, indicating less uniform groups.

Second, a total of 18 groups are identified. This shows the multidisciplinary nature of the body of literature in this field. Third, despite the coherency, there are a number of outliers: nodes that have only one connection to the rest of the network. The reason for this loose connection to public construction client literature could be a recent publication date or a low familiarity of the publication.

Finally, the size of the nodes shows the relative importance of five generally well known publications used by the scholars in this field. These are: 1. Egan's report, 'Rethinking Construction' (1998) (cited 50 times); 2. Latham's report, 'Constructing the Team' (1994) (cited 45 times); 3. 'Case study research - Design and methods' by Yin (2003) (40 times); 4. 'The Economic Institutions of Capitalism' by Williamson (1985) (cited 30 times); 5. 'Comparison of U.S. Project Delivery Systems' by Konchar (1998) (28 times). This confirms the importance of generic reports on change in the construction industry, such as the Egan and Latham reports, for the

development of a field. Even twenty years after appearance, these publications still offer relevant information and serve as reasons to focus on clients as research subject. The use of Yin's publication acknowledges the character of the performed research that is often based on case studies and qualitative research. Furthermore, 'The Economic Institutions of Capitalism' and 'Comparison of U.S. Project Delivery Systems' characterize the movement from publicly financed and traditionally Design Bid Build projects towards integrated and PPP based collaborations.

Research themes

Based on the network we were able to identify 18 groups of research topics. To enhance the analysis of these groups, they were manually clustered in themes. This clustering was performed by an analysis of the title and abstract of publications in those groups, leading to the recognition of six major research themes (See Table 1). These themes are: Collaboration, Innovation, Sociology, Public sector, Research methods, and Project Management. Looking at the size of the groups in numbers of nodes, these findings indicate a strong focus on improving construction beyond the project context with numerous partners on an urban scale in dedicated partnerships.

Size of group (number of nodes)	Colour	Group	Theme
111	Yellow	Partnerships	1. Collaboration
105	Orange	Improving construction	2. Innovation
97	Red	Urbanism	3. Sociology
87	Dark red	Qualitative research methods	5. Research methods
73	Magenta	Creating value	4. Public sector
72	Pink	Contracting	1. Collaboration
65	Light blue	Partnering	1. Collaboration
60	Blue	Social issues	3. Sociology
56	Dark blue	Contractor selection	1. Collaboration
47	Black	Sustainability	2. Innovation
45	Grey	Governance	4. Public sector
44	White	Public policy	4. Public sector
42	Light green	Project management	6. Project management
40	Lime	Construction performance	2. Innovation
36	Green	Service quality	2. Innovation
24	Dark green	Private finance	1. Collaboration
22	Light yellow	Behavioural sciences	3. Sociology
21	Purple	Research approach	5. Research methods

Table 1: Overview of groups and themes in the network

Only a minor portion is dedicated to private financing of public works, corresponding with the current state of the construction industry in which a lot of projects are still based on a traditional way of financing. Issues that belong to the core of public client research, such as social issues, governance, behavioural sciences and public policy, are addressed by scholars but not as prominent as expected. On the other hand, we notice that improving construction is definitely considered as a responsibility of public clients. Finally, we see the relative importance of project management related issues

that are shaped by the client, such as contracting, partnerships and contractor selection. Below the research themes are discussed in detail.

Theme 1: Collaboration

Most groups in the network can be assigned to the theme of collaboration, consisting of publications on the topics of Partnerships, Contracting, Partnering, Contractor selection, and Private finance. These groups are situated at the centre of the network, indicating that these topics are most prominent in the literature on public construction clients.

Because of the large group size and the central position, we conclude that the group on partnership agreements and ambitions is the most important topic for our field. It consists of papers on partnerships, PFI/PPP (Private Finance Initiative/Public Private Partnership) and briefs. It does however not feature large nodes, which indicates that no papers really stand out; they are more or less equally cited. The group Contracting features papers on contract choice, tendering and procurement. This group has strong links with Partnering and Improving construction, meaning these authors (such as Alhazmi and McCaffer (2000)), seek to improve construction by (new) contract types. Partnering consists of papers on collaboration between partners and integrated teams. It links with Improving construction, which indicates that the papers in Partnering focus on a close cooperation between different kinds of construction parties to improve the complete industry and the potential success and fail factors, see for instance Black, Akintoye, and Fitzgerald (2000).

Contractor selection, located at the left edge of the network, features papers on selection of contractors and competitions. It has strong ties with Improving construction and Contracting, which also relate to team composition and contracting. Contractor selection differs from these groups by a focus solely on the contractor, such as the work of Chinyio, Olomolaiye, Kometa, and Harris (1998) and Fong and Choi (2000). Private finance at the edge of the network focuses on corporate finance, BOT (Build Operate Transfer), and privatised infrastructure. This can be characterised as PFI or PPP. The strong connection with the Partnerships group, which includes for example the publications of Walker and Smith (1995) on privatised infrastructure and Fisher and Babbar (1996) on private financing of toll roads.

Theme 2: Innovation

The second largest theme can be characterised by innovation and consists of the groups Improving construction, Sustainability, Construction performance, and Service quality. These groups are mostly located in the centre of the network.

Improving construction focuses on problems of the construction industry: inefficiency, poor on-site safety, waste and failure to deliver the desired quality to time and cost (Mead & Gruneberg, 2013). Improvement is sought in multiple approaches: briefing (Barrett & Stanley, 1999), procuring (Khalfan, 2011), and partnering (Humphreys, Matthews, & Kumaraswamy, 2003). Sustainability is a much dispersed group, only recognised by a common drive to search for sustainable solutions. The authors in this group, such as Sourani (2011), see a special role in this for the government. This aspect makes this group interesting for our research.

Construction performance is located near the edge of the network, which means that this is not very prominent in the public construction client research. This is probably due to a focus on all actors in a construction project, not solely on the client. It consists of publications focusing on reducing construction time and costs and enhancing quality, such as that of Chan and Kumaraswamy (1996). This group is

connected to Service quality, Partnering, Improving construction and Contractor selection. It links topics such as collaborating with improving the performance of the construction industry. Service quality is a dispersed group, situated in the centre. It includes mainly papers on the quality of contractor's services and is connected to Partnering and Partnerships. This indicates a focus on close collaboration between clients and contractors.

Theme 3: Sociology

The third theme consists of groups with a sociological nature: Urbanism, Social issues, and Behavioural sciences. Urbanism is situated at the edge, which means it has a weak connection to other topics in the network. Although it is a large group, it involves small nodes, indicating little citations. This group features topics related to urbanism: gentrification, poverty and cities. It is connected to Social issues, Governance and Creating Value, indicating a relation with public sector aspects.

Social issues deals with papers on competitive advantage, social cost, homeownership and collective action. It is also situated at the edge, indicating a weak link with public construction client literature. Yet, this topic is closely connected to Urbanisation, but also links to Improving construction, Service quality and Creating Value because it is a widespread group. The group Behavioural sciences is small and dispersed, connected mainly to Social issues. It does, however, feature some interesting publications on characteristics of public clients for innovation adoption, amongst others the publications of Hartmann *et al.* (2008) and Songer and Molenaar (1997).

Theme 4: Public sector

Public sector features the groups Creating value, Governance, and Public policy. Creating value directs at an important task of public clients: being cost efficient and focusing on value creation. This group is situated both at the edge of the network and in the centre, which means it directly relates to public client literature, but also papers outside the field of construction. Governance consists of papers on public services, public management and governance structures. Because of its situation at the edges of the network, it is not prominent in the literature on public clients. This is striking, because these aspects are generally considered as important issues in public client operations. The group Public policy features topics such as public policy, innovation, and major projects. It is dispersed but centrally located, which indicates connections to various topics in the core of field.

Theme 5: Research methods

Research methods features groups that are not related by content to public construction client research but by methodology: Qualitative research methods and Research approach. The first group consists of publications on qualitative and case study research methods. Because of the large and dispersed number of connections to other groups, it shows that many papers in the network apply mostly qualitative types of research. The group Research approach, which is significantly smaller than Qualitative research Methods, consists of papers on research approaches in general, not only qualitative methods. Despite being at the edge of the network, it is connected to Construction performance, Service quality, Governance, and Improving construction. This means that qualitative as well as quantitative research is done on these topics.

Theme 6: Project management

The sixth theme consists of only one small group: Project management, containing publications on project/strategic management, stakeholder approaches, and incentives. The scattering of the group means that it is connected to a lot of topics in the network. The lack of coherence indicates that project management often involves a combination with other topics, such as innovation, partnering and collaboration, see for instance Agranoff (2007).

CONCLUSION

This paper provides an overview of the current literature on all aspects of public commissioning. The network analysis of existing literatures showed a multidisciplinary compilation of a range of 18 groups of topics, spread over six major research themes on issues in the field of the public client. The broad range of topics included aspects that relate 1) to the construction industry in general, such as innovation, improvement, sustainability, partnerships and social issues, 2) the project, topics such as collaboration, project management, contractor selection and contracting, but 3) also concerns that specifically related to the public character of these type of clients, such as governance, partnering and public policy. This resulted in the distinction of the following six research themes: Collaboration, Innovation, Sociology, Research Approach, Public Sector and Project Management.

The broad range and mixture of societal, financial, economic and managerial aspects indicates that the field of public clients is multifaceted by nature. The groups also displayed promising links to other scientific fields such as social sciences, public administration, business administration and innovation sciences. The prominence of research approach as a research theme can be considered as deviant, but could also be interpreted as a sign that the field values empirical data. Furthermore, it is a result of the method used to provide this overview, which does not distinguish between particular research topics and chosen research methods. Based on the fact that five out of 18 groups focus on this subject, we conclude that collaboration (with a specific focus on partnering) is the most important topic in this research field. Hence, we cannot tell if this means that this topic is the most important for clients or the most popular in the literature. Contracting and contractor selection are also prominent in the theme Collaboration.

Although our search terms were specified on public clients, most topics are not limited to these specific actors in the construction industry. For instance, the topics Contractor selection, Construction performance, and Project management can be researched both for private and public clients and from contractor perspective or client perspective. The same applies to groups like Sustainability and Partnering, which can be seen as important tasks for public clients, but are not limited to these actors groups in construction. Only three topics can be directly attributed to public clients: Creating value, Public Sector and Public policy. These are however not large groups, which means that only a small portion of the retrieved results focus solely on aspects that directly and specifically relate to public clients. These groups include typical responsibilities of public clients, such as accountability, transparency and policy making. These findings indicate that additional research is needed to evenly develop the knowledge on public construction clients. An important next step would be to connect the currently identified research topics and themes to current and upcoming research gaps and translate it to a research agenda for the future of research on public commissioning.

Finally, we all know that clients have an important role as change agent in the construction industry and initiator of projects. Especially public clients have to deal with a complex system of public and professional values in an industry that is undergoing significant changes due to financial restrictions and changing responsibilities. A strong need therefore exists among public clients to develop a scientific foundation about the approach to face the challenges existing in the industry. This study shows that despite the numerous publications in which the client is mentioned, the client is still relatively under-acknowledged as a research field which deserves significant attention from scholars in the field of construction management.

DISCUSSION

As shown above, a network analysis can be useful to investigate a large body of literature for several reasons. First, with a graphical network analysis it is not necessary to define a very specific search query. This contributes to the user friendliness of the method. Second, because automated scripts are used, the amount of publications is not an issue. The only condition is that all synonyms for a term are present in the query to cover all possible relevant publications. Third, the method is useful for filtering out non-relevant papers. Depending on the applied filter, only publications with a certain number of citations is displayed. This means that, although the search query was broad, only relevant papers appear in the network. The incidental reference with no other connection to the network is not displayed. This saves time when reviewing all references returned from a search query. Four, important papers directly stand out, because the size of a node depends on the number of citations. Although it is also possible to see the number of citations in Scopus, the network analysis also shows not only the importance of the citing publications, but the total structure of citations and references.

A drawback of this method is that it does not distinguish between non-relevant publications and new relevant publications that are not cited yet. A manual check of the newest publications is therefore necessary to ascertain that all relevant references are included. The choice for the filter value is also important. If the value is set too high, there is the possibility of filtering relevant papers and losing the structure of the network. If it is set too low, the structure remains intact, but too much non-relevant papers remain in the network. This increases the chance of overlooking important publications. Overall, a graphical network analysis appears to be a promising method to create an overview of the current state of knowledge on a specific field among the ever growing body of literature in the field of construction management.

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