A social capital perspective to innovation management in construction

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Abstract

State-of-the-art products commonly outperform construction products that are used in day to day building practice. Also construction products appear to have a diffusion curve that differs from consumer products, slower at first, more rapid later. The social capital theory helps us to understand why certain actors are able to get their ideas adopted and why others do not. Aim of this paper is to explore to what extend social capital theory may provide explanations for the way in which innovative construction products are diffused. Therefore social capital literature and building process literature are compared.

Construction process literature shows that the industry is fragmented and contacts between the various professional networks are limited to that in the building projects. Even more so the contact in construction projects appears to be short-term oriented.

Social capital literature provides an explanation (network closure) for both opportunistic behavior in construction projects as well as lack of reward for those who put in extra effort when adopting an innovation. Also social capital literature shows that those who are able to bridge the gaps between networks (structural holes) are able to get their ideas adopted more easily and so are able to spread their innovations more rapidly. Social capital theory thus appears to be helpful to explain how the diffusion of building product innovation can be improved.

Introduction

Innovative products commonly outperform construction products that are used in day to day building practice. Market introduction of innovative products enhances the competitive position of a firm (Seaden and Manseau 2001). Innovative construction products appear to have a S-shaped diffusion curve that differs from consumer products, slower at first, more rapid later (Lichtenberg 2002).

S-curves are a model of reality, made to help us understand a reality that is otherwise too complex to understand. The S-curve is a plausible way to parameterize the diffusion process and is roughly consistent with the facts. 'Roughly consistent' because diffusion curves tend to be asymmetric in practice and also because of the fact that most innovations fail (i.e., they do not diffuse at all). (Geroski 2000)

What are the prime influences on the shape of the diffusion curve? Six primary influences driving or hindering construction innovation were identified by Blayse and Manley (Blayse and Manley 2004):

1. clients and manufacturers;
2. procurement systems;
3. regulations/standards;
4. the structure of production;
5. relationships between individuals and firms within the industry and between the industry and external parties;
6. the nature and quality of organizational resources.

However, the relationship between these influences themselves and with other aspects of business strategy is unknown. (Blayse and Manley 2004). From the perspective of a single business in the construction industry only the last three can be influenced. This research therefore further investigates the structure of production, relationships between individuals and firms within the industry, and the nature and quality of

organizational resources enhancing the diffusion of construction innovation.
For this research, the definitions for innovation used by Rogers (Rogers 1995) and Emmitt and Yeomans (Emmitt and Yeomans 2008) can be combined and re-written as: *An innovation is a building product that is perceived as new by a principal, specifier, or engineer.* The diffusion of an innovation is perceived as: *the process by which innovation is communicated through certain channels over time among the members of a social system* (Rogers 1995).

Social capital theory helps us to understand why an actor is able to get his ideas adopted and why some other can not (Burt 2004), and thus social capital may help us to understand why some construction firms are able to get their innovations diffused and why others do not.
All social relations and social structures facilitate some forms of social capital (Coleman 1988). Like physical and human capital, social capital is a productive resource. Social capital facilitates a firm's business operations. (Tsai & Ghoshal 1998). Nahapiet and Ghoshal (Nahapiet and Ghoshal 2005) define: *Social capital is the sum of the actual and potential resources embedded within, available through, and derived from the network of relationships possessed by an individual or social unit.*

It appears to be a useful perspective to help manage the diffusion of innovation.

The aim of this paper is to explore to what extent social capital theory may provide explanations for the way in which innovative construction products are diffused. To do so, literature on social capital theory and building process characteristics are compared.

Method

Literature is searched using both Google Scholar and the literature database ISI Web of Knowledge. Key words used for identifying construction process characteristics are:

- "characteristics construction process"
- "construction supply chain integration"
- "life cycle contracts construction"
- "technology diffusion construction innovation"

Key words used for searching descriptions of social capital theory.

- "definition social capital"
- "definition structural holes"
- "definition network closure Coleman"
- "slow diffusion; social network"
- "brokerage diffusion"

Results

Construction process characteristics

Construction process literature shows that (i) the industry is fragmented and (ii) contacts between the various professional networks are limited to that in the building projects. Furthermore, (iii) the contact in construction projects appears to be short-term oriented.

(i) Fragmented

There are many relatively small companies in the construction industry. In the Netherlands, almost 90% of all building companies have no more than ten employees, and almost 10% of the companies are medium-sized firms with from ten to 100 employees (Priemus 2004). Dulaimi e.a (Dulaimi et al. 2002) conclude that the fragmentation and especially the segregation of design and construction activities are the main barriers to an improved performance of the industry.

(ii) Project-based contacts

Dubois and Gadde (Dubois and Gadde 2002) studied the operations and behaviors of firms as a means to dealing with complexity. Industry as a whole is featured as a loosely coupled system. The pattern of couplings builds on two interdependent layers: tight couplings in individual projects and loose couplings based on collective adaptations in the permanent network. They concluded that the characteristics of the industry seem to favor short term productivity while hampering innovation and learning. Van Hal (van Hal

2000) concluded that one of the prime factors hampering the diffusion of innovation in the housing industry is the lack of information transfer between projects. This information transfer must be based on unambiguous evaluations and an innovation champion is needed in order to implement the innovation successfully.

(iii) Short term orientation

Vrijhoef en Koskela (2000) characterize the construction process as short term oriented. In contrast to manufacturing systems, where multiple products pass through the factory, and are distributed to many customers, the `construction factory' is set up around the single product. Therefore every project creates a new product or prototype. In general there is little repetition. As a result, the construction supply chain is typified by short term organizations, instability, fragmentation, and especially by the separation between the design and the construction of the built object. Kumaraswamy (KUMARASWAMY 1998), wonders why the construction industry's short-term orientation did not lead to innovative managerial techniques.

Key innovations actors

Seaden and Manseau (2001) defined no less than ten key actor types involved in construction who can undertake innovation activities:

1. Building materials producers,
2. Machinery manufacturers,
3. Building product component manufacturers,
4. Sub-assemblers (trade specialty and installers),
5. Developers and facility assemblers (or main contractors) ,
6. Facility/building operators who manage property services and maintenance,
7. Architects and specifiers,
8. Consultants and engineers,
9. Providers of complementary goods and services such as transportation, distribution, cleaning, demolition and disposal.
10. Institutional environment actors such as financial institutions and business/trade general labour regulations and standards.

Vrijhoef and Koskela (Vrijhoef and Koskela 2000) drew a supply chain based on a traditional construction supply chain, see figure 1. Based upon this supply chain one may identify two more key actors:

1. Residents,
2. Principals.

The total of different types of actors in the construction industry added up twelve.

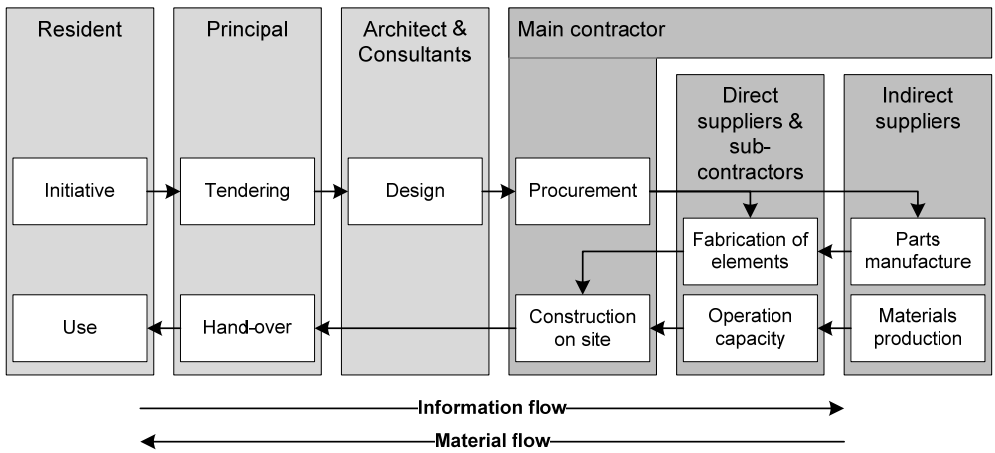

Figure 1: Typical configuration of the traditional construction supply chain (Vrijhoef and Koskela 2000)

Integrated contracts

The characteristics mentioned so far specifically describe the traditional construction process. Since the 1990's however, several alternatives to the traditional construction process came to market (Briscoe and Dainty 2005). Amongst those are the design and build contract, the private finance initiative (PFI), the public private partnership (PPP), and the build, own, operate and transfer (BOOT) (Briscoe and Dainty 2005; Brady, Davies and Gann 2005; (Ndekugri and Turner 1994)).

Design and Build contracts reduce fragmentation. Figure 2 shows the typical configuration of its supply chain.

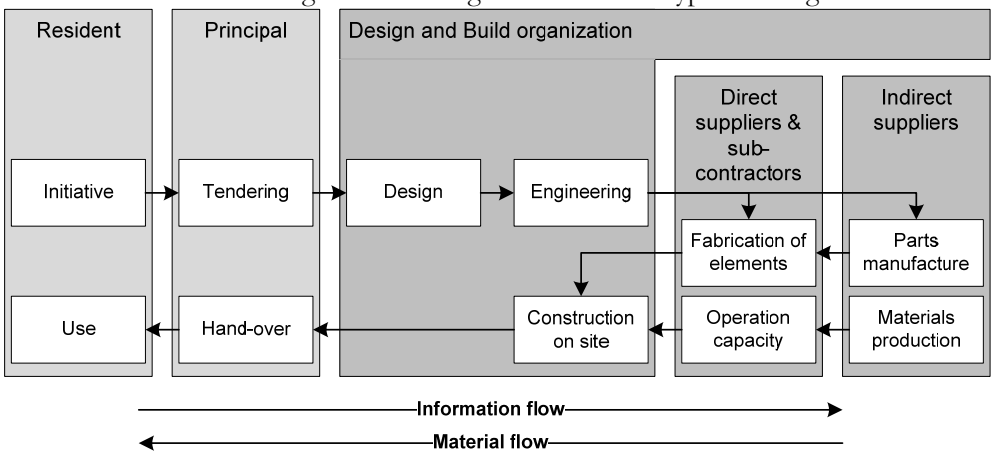

Figure 2: Typical configuration of the design-and-build supply chain (based on: Vrijhoef and Koskela 2000)

The growth in projects procured under the PFI, the PPP, and under BOOT arrangements should result in less short term orientation. Where even maintenance services are part of the contract, the focus will probably be on the complete lifespan of the building. (Briscoe and Dainty 2005)

(Brady, Davies, and Gann 2005) found that the construction industry perceptions of value, systems integration and integrated solutions suggest that the integrated and long term contracts are still at an early stage in its development. They suggest that best opportunity for the introduction of integrated and long term contracts is in the context of private finance initiatives in the public sector or large clients who require repeatable solutions in the private sector.

Social capital theory

Social capital theory helps us to understand why certain actors are able to get their ideas adopted and why others do not (Burt 2004). The term social capital was originally used to describe the relational resources, embedded in cross-cutting personal ties. Later research has applied the concept to a broader range of social phenomena, including relations within and beyond the firm. (Tsai and Ghoshal 1998). For long there have been two approaches to social capital: (i) The network closure approach focuses on the density of the network. Whereas (ii) the structural holes approach focuses on the gaps between several dense networks.

(i) Network closure approach

Coleman (Coleman 1988) considered network closure to be conditional for the existence of obligations, expectations, and social norms within a network.

These arise as attempts to limit negative actions of actors or encourage positive ones. In an open network like that of figure 3a, actor A, having relations with actors B and C, can carry out actions negative for B or C or both. Since they have no relations with each other, but with others instead (D and E), they cannot combine forces to sanction A in order for him to stop his actions. Unless either B or C alone is sufficiently harmed and sufficiently powerful to sanction A alone. In a network with closure, like that of figure 3b, B and C can combine to provide a collective sanction, or either can reward the other for sanctioning A.

(ii) Structural holes approach

Structural holes may exist as either empty spaces or as negative ties between alters and/or groups. Both types of structural holes act as buffers, like an insulator in an electric circuit… people on either side circulate in different flows of information (definition by (Oliver, Kalish, and Yair 2007) based on a definition of Burt).

Those that are able to circumnavigate the structural holes are the ones that are able to combine ideas from both networks into an invention or enable innovations to flow from one network to the other. According to Burt (2004) it is the intermediate actor, or broker, that provides social capital:
Opinion and behavior are more homogeneous within than between networks, so people connected across networks are more familiar with alternative ways of thinking and behaving. Brokerage across the structural holes between networks provides a vision of options otherwise unseen, which is the mechanism by which brokerage becomes social capital (…) The between-networks brokers are more likely to express ideas, less likely to have ideas dismissed, and more likely to have ideas evaluated as valuable.

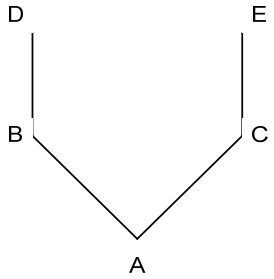

Figure 3a: Network without closure

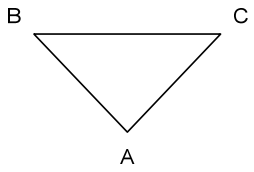

Figure 3b: Network with closure (Coleman 1988)

Diffusion of innovation

Both network closure and structural hole theory view reciprocity as the mechanism that turns relationships into the assets that define social capital (Gargiulo and Benassi 2000). Burt (Burt 2000) integrated them into one integrated theory: *Structural holes are the source of value added, but network closure can be essential to realizing the value buried in the holes. (p…)*

Network closure may sometimes hamper the diffusion of innovation. For instance:
*The more a manager was strongly tied to a cohesive group of peers, the less able he or she was to adapt his or her communication network to the changes brought about by the global organizational change (…).*Gargiulo & Benassi (1998, p…)

On the other hand, network closure may also enable the diffusion of an innovation. Rogers (1995) identified, compatibility of an innovation with the norms and values of an actor as an important factor enabling their adoption of the innovation. Therefore, the diffusion of innovation is easier amongst a network with high closure.

So, depending on the values and norms within a network, closure can either hinder or enhance the diffusion of an innovation.

Spencer (Spencer 2003) showed an association between a firm's status as a global knowledge broker in the last period before dominant design emergence and its ability to successfully make the transition into commercial production by installing large-scale manufacturing facilities. Brokers apply, filter, and reframe knowledge as they pass it on. And this intentional or unintentional reframing may help innovating firms shape the emerging institutional environment to favor the diffusion of their own technologies.

Conclusion: fragmentation vs. integration, short-term orientation vs. life cycle approach, structural holes and network closure in the construction industry.

From a social capital perspective the construction industry is a large sector with little network closure and many structural holes. The lack of network closure results in the short term orientation. The fragmentation and project based contacts result in many structural holes.

The lack of network closure enables actors in the construction industry to aim for short term benefit and behave opportunistic. Because of the combination of 1) temporary organizations and 2) fragmentation, the chances that actors B and C (see figure 3a) are able to enforce their norms upon actor A are next to zero. Something that is even more difficult when it comes to principals. Many of whom build only once in their lifetime. The lack of network closure is not only the reason why opportunistic behavior is not punished. It also causes that putting in extra effort (which is most likely needed when adopting an innovation) is not rewarded.

At least twelve different key innovation actors may be identified which encounter each other only in temporary projects. However, there are some lasting networks in the construction industry, but these are amongst groups of peers. Architects meet each other in their architects association, as do engineers in their engineers association, builders in their builders association, etc, etc. The only interdisciplinary contact, or brokerage opportunity, exists within the construction project. Deroians' (Deroian 2002) statement that some innovations need delay to diffuse, others often fail seems to apply to product innovation in construction. He suggests that the formation of social networks explain the diffusion of innovation. Interaction is conceived as influence effects and the network of interpersonal influences is learning step-by-step. The gradual formation of the social network leads, after a period of latency, to a collective evaluation of the innovation. Given the large amount of structural holes this might explain why innovative construction products appear to have a diffusion-curve that differs from consumer products, slower at first, more rapid later. In the construction industry it takes longer for the social network to form around the many structural holes and come to the collective evaluation.

Social capital theory thus appears to be helpful to explain how the diffusion of building product innovation can be improved. In order to be able to actually manage the social capital of actors in construction further research is needed on both:

- Network closure: how can good conditions for the adoption of an innovation be created? What actors (fragments) appear to have the least short term orientation?
- Structural holes: how does the collective evaluation take place? How fragmented is the construction industry really?

References

[1] Blayse, A. M. and K. Manley, "Key influences on construction innovation," Innovation 4 (3): 1-12 (2004).

[2] Brady, T., A. Davies, and D. Gann, "Can integrated solutions business models work in construction?," Building Research & Information 33 (6): 571-579 (2005).

[3] Briscoe, G. and A. Dainty, "Construction supply chain integration: an elusive goal?," Supply Chain Management-An International Journal 10 (3-4): 319-326 (2005).

[4] Burt, R. S. 2000. The network structure of social capital. Vol. 22, 2000. NEW YORK: JAI-ELSEVIER SCIENCE INC.

[5] Burt, R. S., "Structural holes and good ideas," American Journal of Sociology 110 (2): 349-399 (2004).

[6] Coleman, James S., "Social Capital in the Creation of Human Capital," The American Journal of Sociology 94: S95-S120 (1988).

[7] Deroian, Frederic, "Formation of social networks and diffusion of innovations," Research Policy 31 (5): 835-846 (2002).

[8] Dubois, A. and L. E. Gadde, "The construction industry as a loosely coupled system: implications for productivity and innovation," Construction Management and Economics 20 (7): 621-631 (2002).

[9] Dulaimi, M. F. et al., "Enhancing integration and innovation in construction," Building Research and Information 30 (4): 237-247 (2002).

[10] Emmitt, S. and D. T. Yeomans. 2008. SPECIFYING BUILDINGS: A Design Management Perspective.Butterworth-Heinemann.

[11] Gargiulo, M. and M. Benassi, "Trapped in Your Own Net? Network Cohesion, Structural Holes, and the Adaptation of Social Capital," Organization Science 11 (2): 183-196 (2000).

[12] Geroski, P. A., "Models of technology diffusion," Research Policy 29 (4-5): 603-625 (2000).

[13] KUMARASWAMY, M. M., "Industry development through creative project packaging and integrated management," ENGINEERING CONSTRUCTION AND ARCHITECTURAL MANAGEMENT 5 (3): 228-237 (1998).

[14] Lichtenberg, J. 2002. Ontwikkelen van projectongebonden bouwproducten.Ph D thesis). Delft, 2002.

[15] Nahapiet, J. and S. Ghoshal, "Social capital, intellectual capital, and the organizational advantage," Sumantra Ghoshal On Management: A Force For Good (2005).

[16] Ndekugri, I. and A. Turner, "Building Procurement by Design and Build Approach," Journal of Construction Engineering and Management 120: 243 (1994).

[17] Oliver, Amalya L., Yuval Kalish, and Gad Yair, "Reflections on "Brokerage and Closure"," Social Networks 29 (2): 330-339 (2007).
[18] Priemus, H., "Dutch contracting fraud and governance issues," Building Research and Information 32 (4): 306-312 (2004).
[19] Rogers, E. M. 1995. Diffusion of Innovations.Free Press.
[20] Seaden, G. and A. Manseau, "Public policy and construction innovation," Building Research & Information 29 (3): 182-196 (2001).
[21] Spencer, J. W., "Global Gatekeeping, Representation, and Network Structure: A Longitudinal Analysis of Regional and Global Knowledge-Diffusion Networks," Journal of international bussiness studies 34 (5): 428-442 (2003).
[22] Tsai, W. P. and S. Ghoshal, "Social capital and value creation: The role of intrafirm networks," Academy of Management Journal 41 (4): 464-476 (1998).
[23] van Hal, A. 2000. Beyond the Demonstration Project: The Diffusion of Environmental Innovations in Housing.Uitgeverij Aeneas BV.
[24] Vrijhoef, R. and L. Koskela, "The four roles of supply chain management in construction," European Journal of Purchasing and Supply Management 6 (3-4): 169-178 (2000).