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RÉSUMÉ – Cet article vise à cartographier les changements structurels dans les écosystèmes de la construction et à retracer leur histoire. Les statistiques input/output révèlent l'importance des services professionnels dans la construction. Les changements dans l'écosystème provient principalement des clients gouvernementaux, plus à même d'initier des changements institutionnels. Au fil du temps, les clients ont renoncé à coordonner des prestataires de services multiples et de plus en plus spécialisés.

MOTS-CLÉS – Construction, services, ecosystèmes, coordination, histoire

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ABSTRACT – The purpose here is to map long-term structural changes in construction ecosystems and to trace the historical forces leading to these changes. Input/output statistics reveal a growing importance of professional services for the construction industry. Ecosystem change appears as originating primarily with government customers, who are more able to effect institutional change. Over time, customers have retreated from coordinating multiple providers of increasingly specialized services.

KEYWORDS – Construction, services, ecosystems, coordination, history

COORDINATION IN SLOWLY EMERGING SERVICE ECOSYSTEMS

Construction history

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INTRODUCTION

There is a growing number of in-depth case studies of actual service ecosystems (Overholm, 2015; Aal et al., 2016; Koskela-Huotari et al., 2016), but there are few investigations of how service ecosystems emerge and evolve over a longer time. Unlike recent provider-driven service ecosystems based on platforms created by focal firms, construction service ecosystems have evolved over a very long time. An opportunity for studying the long term dynamics of service ecosystems is the accumulated historical knowledge of the construction sector, a sector that is not found in standard industry classifications but which usually (cf. Pearce, 2006) is taken to cover both the construction industry in itself (= contractors) and at least its closely associated knowledge intensive business services in architecture and engineering. Since the concept of service ecosystems is new and can be interpreted loosely, there are reasons for discussing in this context how service ecosystems have been defined.

Although usually not classified under the service sector, construction contractors can be understood as providers of (mostly) business services

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with a heavy physical element. Numerous studies have been devoted to identifying factors that influence the success of construction projects. Following this research tradition, the applicability of the ecosystem approach to construction has been shown by Pulkka et al. (2016), who have formulated propositions oriented towards what facilitates value creation in construction ecosystems. In their six case studies they found that the project network of participants was conditioned by the governance system and a shared logic, referring to a shared vision and alignment of business models. While the governance system points towards a need for considering an institutional approach, the alignment of business models introduces a dynamic element.

The example of construction should therefore throw light on how ecosystems change over time and the mechanisms behind these changes. In a study of six cases with digital service platforms, Thomas and Autio (2015) distinguish three phases when ecosystems emerge: initiation, momentum and control. A crucial issue is however whether firms set out with a strategy to create an ecosystem–or constellations of firms arise spontaneously over time, as around construction projects. Since analysing recent innovations such as digital platforms allows little scope for studying ecosystem evolution over a long period of time, there might be dynamic mechanisms to be discovered in slowly emerging ecosystems.

Around construction contractors, increasingly complex service ecosystems have evolved in a project dominated environment. Architectural and structural engineering services are examples of knowledge intensive business services. Leasing of construction equipment is another service with an obvious physical element, just as logistics services for construction projects. Over time, hierarchical structures of contractors and subcontractors have emerged, largely replacing the principle of customers (= construction clients) themselves coordinating a number of specialist contractors. In recent decades, contractors under design-build contracts have been transformed into important buyers of knowledge intensive design services. The main purpose of the investigation is to map the long-term structural changes in construction ecosystems and to trace the forces leading to these changes. The approach followed here is inspired by transaction cost analysis, recognizing institutions that create incentives or disincentives for ecosystem actors.

The investigation is based on a wide range of published sources and official input/output statistics. The paper begins with definitional issues and the role of institutions in ecosystems, as a background to construction ecosystems. This is followed by a positioning of the construction industry in relation to service inputs and outputs, as well as an overview of historical transformations of construction ecosystems. Finally, conclusions are drawn, primarily relating to the role of government customers in shaping these ecosystems, mostly through institutional innovations, and their reasons for intervening.

I. ECOSYSTEMS, INSTITUTIONS AND CONSTRUCTION

ECOSYSTEMS AND INSTITUTIONS

Most attempts to define service ecosystems are of the nature of complicated descriptions rather than minimal definitions. We find a service ecosystem, according to Maglio et al. (2009), defined as "a configuration of people, technologies, and other resources that interact with other service systems to create mutual value" or "a dynamic value-cocreation configuration of resources, including people, organizations, shared information (language, laws, measures, methods) and technology, all connected internally and externally to other service systems by value propositions". This appears as both a broad and a narrow interpretation, if we should understand all system connections to be of the nature of promises (= propositions, offerings) to potential customers that benefits will exceed prices, rather than a concern with the market exchange of services and perhaps goods.

It is therefore interesting to see how thinking on service ecosystems has been brought into contact with the field of supply chain management. Lusch (2011) asks how the customer can be integrated in the supply chain and prefers to see supply chains as nested in service ecosystems. Here, Lusch describes a service ecosystem as a "spontaneously sensing and responding spatial and temporal structure of largely loosely coupled value proposing social and economic actors interacting through institutions and technology, to: (1) coproduce service offerings, (2) exchange service offerings and (3) cocreate value".

Furthermore, institutional approaches are currently recognized also among marketing researchers (Siltaloppi et al., 2016). Vargo and Lusch (2016) now define or rather describe a service ecosystem as "a relatively self-contained, self-adjusting system of resource-integrating actors connected by shared institutional arrangements and mutual value creation through service exchange". Institutional arrangements are "sets of interrelated institutions", and institutions are "humanly devised rules, norms, and beliefs that enable and constrain action and make social life predictable and meaningful". This understanding of service ecosystems allows for a more meaningful application to the construction sector.

There are also definitions which start from the assumption that service ecosystems arise from a conscious strategy. Thus, reflecting their innovation perspective, Autio and Thomas (2014) define an ecosystem as "a network of interconnected organizations, organized around a focal firm or a platform, and incorporating both production and use side participants, and focusing on the development of new value through innovation". For construction sector ecosystems, like ecosystems found in nature, the presence of a focal firm or a platform is often not evident, although it can be argued that there are ecosystems dominated in some sense by large contractors. With the rise of building information modelling (BIM), which generates and manages building data, in principle over the life cycle of the facility, relying on 3D modelling software (Elmualim and Gilder, 2014), a major construction software platform provider such as AutoDesk can be thought of as a focal firm (Jansen et al., 2013) within the construction associated software ecosystem (Manikas and Hansen, 2013). But construction output is heterogeneous, and in many national markets, refurbishment and maintenance of existing facilities are much less dependent on BIM than e.g. projects for new commercial buildings.

In contrast to how service ecosystems tend to be defined, ecological definitions of ecosystems tend to be simpler: a "biotic community or assemblage and its associated physical (abiotic) environment in a specific place" (Pickett and Cadenasso, 2002). Depending on the purpose of an investigation, the ecosystem boundaries will be determined. The institutional context for construction projects is mostly national, and for the present investigation, the construction ecosystems are assumed to have national boundaries. Although it is often so that foreign contractors are present in large infrastructure projects, they find themselves in a national institutional context; on the other hand, the institutional context is modified increasingly by supranational regulatory initiatives such as those introduced by the European Union.

CONSTRUCTION ECOSYSTEMS

Can insights into construction service ecosystems be valid for a broader range of business services? There are other service industries that share one or more specific features with construction. There is the project nature of delivery, a high dependence on tangible inputs, and not least, the highly variable work load, varied nature of products and that work to be done at a particular site varies with the stages of the production process. These were three factors highlighted by Stinchcombe (1965) in his pioneering analysis of how general contractors are organized, in stark contrast to manufacturers. Furthermore, and throughout history, the co-production nature of most construction projects has been evident: "there is a direct relation between consumer and supplier that separates construction from industries that are oriented to more impersonal commodity markets" (Goldthwaite, 1980, p. 124).

The systems view

Construction as an industry was identified and explored as a system of organizations already in the 1960s wave of systems analysis (Napier, 1970). At that time, a focus on the individual organization (the firm) among mainstream management researchers did not offer appropriate theoretical tools for dealing with interaction between organizations (cf. Mele et al., 2010). The details of customer-provider co-production would be hidden when considering an organization in relation to its "environment", as done by Burns and Stalker (1961), who were one of Napier's sources.

Just because of its heavy dependence on institutions, the construction ecosystem should be comparatively easy to map and analyse. Applying Mintzberg's (1980) approach to three coordinating mechanisms of standardization: of work processes, of output, and of skills and knowledge, Kadefors (1995) identified many examples of them in construction, highlighting that "interdependent and complex tasks, a large number of participants, unique coalitions of project team members and strong time-pressure" contribute to a great need for information processing and "a corresponding need for stable coordinating and uncertainty-reducing institutions". Size and complexity of buildings themselves were seen as linked to this; the limited flexibility of building project organizations can be explained as a result of technological factors. Government initiatives and industry self-regulation have led to standard contracts, standard specifications, organized professions, trade union agreements and educational systems that reproduce and reinforce long-standing institutional patterns.

Co-production in construction projects typically is a matter of information sharing related to design solutions. This customer-provider interaction has seldom been studied in detail. Foley and Macmillan (2005) have carried out a case study of a major building project, a lottery funded UK exhibition centre, under a traditional contract where the customer had contracted separately for design services and for construction. In addition to interaction during progress meetings and technical meetings, there were problem-solving meetings, all of which with participants from the customer and a variety of ecosystem firms: contractor, sub-contractor, quantity surveyor, funding body, architect and structural engineer. Meetings were dominated by time spent in communication between contractor, architect and project manager. The role taken by the user-client was "sensor" and engaging in "Observing and reflecting. Background player", according to this case study. Clearly, co-production takes place between at least three parties: the customer, the mediating knowledge-intensive service providers, and the provider(s) of construction itself. The nature of, and participation in, co-production are also likely to vary over the lifetime of a project.

Service inputs to the construction industry

OECD input/output statistics allow an impression of how the construction industry, narrowly defined as made up by contractors, depends on service sector inputs and how this dependence varies, both over time and between countries. There are obvious institutional differences between construction sectors in different national systems (Winch, 2000), not least because of national regulatory systems despite supranational initiatives to harmonize technical regulations and public procurement.

Pietroforte and Gregori (2003) have published an input-output analysis of the construction sector in eight developed economies, relying on OECD I/O tables. They found a steady increase of service inputs to construction throughout the 1970s and 1980s, interpreting this as partly caused by outsourcing of what used to be internal services in construction firms and as the effect of increasing complexity of the construction process. Also relying on OECD I/O data, Gundes (2011) found for the same period that over time, countries in their selection of nine developed economies tended to diverge in their dependence on real estate business services.

More recently, Gregori and Pietroforte (2015) have analysed I/O data for emerging economies: Brazil, India, Indonesia, China and South Africa. In these five countries, they found that the construction sector does not buy much from private services, except in South Africa, where they point to "the inclusion of renting of machinery, computer and related activities and research and development" in the collected data. In the South Africa case, 10.35 per cent of construction expenditure were found to come from private services in 2005. In general, and as emphasized by Pietroforte et al. (2009), historical comparisons in the longer term of the development of the proportion of private services as inputs to construction are complicated by imperfect data and changes in statistical classifications.

Nevertheless, an attempt has been made in Table 1 to assess the shift from manufacturing inputs to service inputs to the construction industry. Six countries are compared for the period between 1995 and 2011. As there appears to be national differences in aggregating construction industry data for the OECD I/O tables, the narrow measure chosen here is the ratio of the usually greatest domestic service input into construction (C45), 'R&D and other business activities' (DOM_C73T74) to the usually greatest manufacturing input, 'Other non-metallic mineral products' (DOM-C26, which includes important materials such as cement and concrete).

COUNTRY	1995	2011
Brazil	0.27	0.22
France	0.85	1.91
Italy	0.49	0.63
Sweden	1.01	3.37
UK	0.65	1.50
US	0.71	0.90

TAB. 1 – Construction domestic inputs, ratios of "R&D and other business activities" to "Other non-metallic mineral products".

Except for the case of Brazil, it is evident that construction has become clearly more dependent on a typical knowledge intensive service input and that in 2011, this service input weighs heavier than a typical manufacturing input in four of the six countries. Correspondingly, but perhaps more of a surprise, is that the construction industry nowadays is one of the greatest recipients of the output from 'R&D and other business activities'.

Taking the example of Sweden, national input-output tables allow a more detailed analysis of service inputs to construction. The 2013 Swedish input-output tables indicate that 17.2% of total construction industry (F = 41+42+43) output corresponded to inputs from Architectural and engineering services; technical testing and analysis services. Only 0.8% of inputs were identified as delivered by Computer programming, consultancy and related services; information services. Land transport services corresponded to 2.2% of output; rental and leasing services 0.7%. Another small percentage is for Repair and installation services of machinery and equipment, 0.8%. Thus other service inputs to the construction industry are overshadowed by knowledge intensive services. It should also be noted, again relying on Swedish statistics, that out of total construction industry output, 32.5% were delivered to "Real estate services, excluding imputed rents".

Several factors may explain why the knowledge services input has increased between 1995 and 2011: outsourcing of business processes, greater reliance on equipment that is leased, and shifts away from new construction into a higher proportion of refurbishment projects. There might also have been a shift away from concrete as a structural material. Transformations of coordination patterns in construction ecosystems might be an important explanation, such as a higher frequency of design-build contracts, where the contractor provides not only physical construction but also detailed design. This is typically produced using architectural and engineering services purchased from specialized consultants, rather than by having such employees in the contracting firm.

II. HISTORICAL TRANSFORMATIONS OF CONSTRUCTION ECOSYSTEMS

EARLY INSTITUTIONALIZATION

Construction projects for public customers developed a high degree of institutionalization already in ancient societies. Judging by inscriptions related to Greek temple building, there were standard contracts, accounts and established procedures for conflict resolution (Burford, 1969). Craftsmen were specialized, although it was not unusual that carpenters would also work as architects (Burford, 1972) and provide coordination on construction sites. A sophisticated payment scheme for contractors is mentioned by Vitruvius (1934, x.pr.1): there was a law in Ephesus imposing target cost contracts and a fixed risk-distributing incentive scheme for public contractors. From the Roman world, few construction contracts have survived, although legal texts indicate a coexistence of contractual arrangements where the customer supplied the materials and contracts where this was the contractor's responsibility (Anderson, 1997, p. 71). The extant contracts, as well as the model contract in Cato's manual *On Agriculture* (1935, xiv.1–5), include highly detailed specifications of the construction work to be carried out.

Despite the lack of historical continuity, similar institutional patterns of coordination recur much later. Medieval English documents reveal that in some building projects, the contractor is to supply all materials, while in others it is the client who does so, the contractor providing only labour and tools (Salzman, 1967, p. 52). Other contracts indicate a divided responsibility, often that the client undertakes the logistics of materials. In Renaissance Florence, there was again the same contractual patterns, including that of direct labour where the client becomes the employer of individual craftsmen (Goldthwaite, 1980, p. 126).

Good documentation in the context of sixteenth century Vicenza throws light on both co-production and its opposite, customer retreat from an active role as coordinator. The 1550/51 *provedditore*, municipal commissioner/superintendent, for the multi-year project of the loggias of the Vicenza Basilica, Girolamo Chiericati, was simultaneously his own client for the Palazzo Chiericati (Burns, 1991). Thus he himself ordered bricks, stone and wood separately from a number of suppliers for his own palace. As customer, he was heavily involved in the actual construction of his palace, "propels the work forward", and closely supervised the logistics on site, being more present than his architect, Palladio.

The choice of contractual relations shifted in 1572 for the Vicenza Basilica project, from coordination of multiple contracts by means of a municipal commissioner to a single (general) contract (Burns, 1991). The explicit reason given in the new contract was that a properly defined contract would let the city know how much it had to spend on the building. This is a clear statement of how single-point responsibility of one contractor would reduce the customer risk of cost escalation in conflict with the budget allocation for a public project. Among the many cost escalation factors identified in construction management literature, scope changes and scope creep in projects (Shane et al., 2009) emerge as symptoms of client-contractor co-production.

The potential for basing construction on a scientific approach led to the rise of the engineering profession, beginning in the second half of the eighteenth century. In France, it was a government initiative for providing specialized higher education in engineering, as with architecture, while England relied on apprenticeships (Addis, 2007, p. 237ff.). Germany and other countries often adopted what was basically the French institutional model.

For residential housebuilding, there are examples of shifts between private and public customer action. Stressing the importance of the general small scale of housing projects in Scotland and market volatility during the 1860–1914 period, Rodger (1979) has highlighted the changing financial arrangements available to speculative builders, those with a more direct relation to dwellers, the ultimate customers. The size of the local building market and also of the local financial market appeared as determinants of the scale of housing projects. Rodgers mentions the activities during the second half of the nineteenth century by cooperative building societies and of employers in providing new housing. Around 1900, municipal housing schemes were increasingly important. During the interwar years and afterwards, council housing projects in the UK were often produced through employees as direct labour, until central government discouraged this practice with 1980s legislation requiring compulsory competitive tendering (Ball, 1988, p. 197). Direct labour on a large scale at the end of the nineteenth century can be observed in the extreme case of the Elan Valley dams project in Wales. These dams were constructed relying on direct labour, not through competitive tendering among contractors (Holt, 2016). The workforce was selected carefully, and a workers' village was built. Access to the relevant engineering skills and ability to monitor construction quality are probable explanations for how this infrastructure project was organized.

GENERAL CONTRACTORS

Maglio et al. (2009) take construction as a prominent instance of service systems, especially where a contractor functions as an "operant general contractor function" They see two alternatives, an hierarchical service system and a "market-based arrangement", which is what is usually termed trades contracting and where it is the customer who coordinates a set of specialized firms. The hierarchical service system is based on one contractor coordinating subcontractors; for the customer, there is then a single point of responsibility, but it is not obvious whether general contracting is associated with deeper customer engagement in co-production.

Historically, there has been a significant ecosystem shift with the introduction of subcontracting in construction. Many clients shifted the coordination responsibility to general contractors.

There are studies of the growth of general contracting in particular countries: Belgium, England, Japan and the US. These country studies illustrate both a common trend towards general contracting and a variety of co-existing contractual patterns. Various categories of clients and types of construction work also show differences. In some countries, it was public clients for infrastructure (heavy civil engineering) projects who encouraged contractors to organize with subcontracting. In the case of Belgian public works contractors in the nineteenth century, the inherited medieval organization of projects based on trades and guilds gave way to provider coordination of specialist contractors (Bertels et al., 2011). Considering institutional arrangements, it should be noted that there was no real differentiation between architects and contractors in the Code Napoléon, but successive legislative changes impacted on the system of roles for public works. The development of training regimes occurred in parallel with increasing specialization in the transformation of artisan-builders into general contractors. Technical schools arose around the mid-century. There was also a greater polarization between architects and supervisors, as well as between contractors and craftsmen. Associations were formed.

The complexity of coordination is evident in the case of house building in England and especially London in the early nineteenth century. Cooney (1955) distinguished between four meanings of ‘builder’: (1) Master craftsman, undertaking work only in his own trade; (2) Master craftsman, undertaking responsibility for constructing all parts of buildings, directly employing workers only in his own trade, subcontracting with other master craftsmen; (3) Builder (often an architect or a merchant) erecting complete buildings, contracting with master craftsmen in the various trades; (4) Master builder, erecting complete buildings, employing more or less permanently a large body of labourers and workmen in all principal crafts.

The considerable increase of government demand for barracks during the Napoleonic wars was one factor behind the rise of large contractors; some firms would grow in size still relying only on their own employees. Cooney (1955) emphasized that Thomas Cubitt as a builder abandoned subcontracting (Type 2) for Type 4 when demand increased and sharp time limits had to be met for projects. In general, customer demand appears to exert a strong influence on the organization of contracting. This is also the case for the nature of construction contracts and their being awarded through competitive tendering based on fixed price, instead of payment according to successive measurement and valuation of what had been built. Fixed price projects increased both outlays and uncertainty for contractors and may have made it more risky and difficult for smaller builders. Architects criticized the danger of bad work with many subcontracts, which obviously imposed a heavier burden on the architect's powers of supervision. Architects agreed that they should not have a financial interest in building firms, and the emerging profession of quantity surveyors made it easier for architects to provide competing builders with a comprehensive description of projects. Clarke (1992) emphasizes the push from government customers, as manifested by the 1828 UK Commission, to separate the roles of architects, contractors and producers of materials, in other words a public customer strategy for transforming an ecosystem in the interests of efficiency and accountability for construction projects.

Close ties between innovative technologies and a resurgence of subcontracting have been underlined by Cooney (1993), who notes that reinforced concrete work was taken more readily into the main contractor's organisation, as "wet work on site was already established in bricklaying and concreting, and the carpenters needed for formwork were already part of his Iabour force". Raw materials undergoing slow chemical reactions on site would have a determining effect on project time schedules and point to the main contractor as the efficient coordinator of specialist contractors engaged in operations that had more of an assembly character.

General contracting in the US began in the 1870s, when builders took "single, or whole, contracts to erect all, or at least the bulk, of large and complicated buildings" (Wermiel, 2006). There had been earlier single contracts for small projects, and also public buildings such as lighthouses where contracts had been awarded by the Treasury Department, but it seems that government customers "did not jumpstart the general contracting business". Wermiel attributes the growth of general contractors for building to increased specialization and complexity of construction projects, and contemporary comments mentioned friction, interference and delay on building sites as an argument for introducing general contracting. She also hints at changing financial arrangements necessitated by general contracting. Her Norcross Brothers example is an 1870s general contractor avoiding subcontracting but integrating upstream, being in part its own supplier of materials through quarry ownership. Furthermore, she discusses the parallel existence of two contractor revenue models: lump-sum contracts and cost-plus contracts for general contracting. Cost-plus payment to contractors was probably inspired by how architects were paid as professionals at the time, in proportion to total building costs. This revenue model reduces contractor risk and thus the requirements for capital. It also promoted speed in construction projects, as required by skyscraper projects since around 1900, since work could begin before all design drawings where delivered by architects and complete. The demand for speedy construction arose from the subsequent service delivery of rentable space in the finished building.

In the case of Japan, the history of general contracting dates from the seventeenth century (Reeves, 2002). Feudal lords contracted for the construction of castles, temples and shrines. Under the general contractor, there was a conservative system, *nakama*, similar to specialized guilds. After the shogunate was abolished, large general contractors re-emerged with subcontractors now as members of cooperative associations. Public procurement policies contributed to the creation of very large general contractors. After 1945, the emphasis on competitive tendering for public infrastructure projects in Japan increased successively (Isohata, 2009). The US-Japan negotiations on construction in the late 1980s had consequences for public procurement: there was institutional change intended to support international market enlargement.

In conclusion, as already in Vicenza in 1572, the emergence of general contractors in these four countries appears to have been influenced by the need for government customers to reduce budgetary risks in construction projects. This can be understood as the main reason for outsourcing coordination to a single-point private provider. It appears as an organizational innovation driven by conflicting institutional arrangements (Siltaloppi et al., 2016). Additionally, and further shaping construction ecosystems, government customers can be seen to have taken initiatives to stabilize professional roles, separating design from construction in order to increase transparency and accountability in public construction projects.

THE NEXT STEP: DESIGN-BUILD CONTRACTS

If general contracts imply a structure of contracts with specialized subcontractors which relieves customers of coordinating site production, the next step is to transfer more of the design responsibility to the general contractor under a design-build contract. In actual practice, it is a matter of degree: the client may continue to rely on design consultants to some extent, and for some projects, the client will see to it that there are detailed design documents, for which the contractor will assume responsibility (Xia et al., 2012).

Cacciatori and Jacobides (2005) have analysed the historical processes behind the rise of design-build projects against the background of the earlier institutional arrangements that separated design professionals from construction contractors in the UK. What happened is not a return to a primitive ecosystem with vaguely defined and combined roles; it is rather a trend towards restructuring relations and communication between increasingly specialized firms and individuals.

Design-build contracts where the construction contractor employs the architect were known in the US already in the beginning of the twentieth century, and then driven by private sector owners for bank buildings and similar projects (Willis, 2003). Single-responsibility building projects were actively fought by the US architectural profession and in practice made difficult through legislation protecting the profession and divided responsibility. This type of contracts was revived in the US around 1970, illustrating the shift in understanding of how rigidly institutionalized professional roles may cause inefficiency.

For the Chilean housing sector, Brahm and Tarziján (2013) have shown that integration between design and construction is associated with a higher likelihood of integration between ownership/development and construction activities. Explaining these interdependent boundary choices, they refer to a production costs effect rather than concern with transaction hazards and coordination/monitoring. The costs effect was ascribed to joint development of capabilities.

Customer-provider co-production was not facilitated by a customer emphasis on strict distribution of contractual responsibilities. Around 1990, however, growing awareness of the negative effects of adversary relations between public clients and private contractors led to client initiatives in the US and UK for relational contracting, mostly known as partnering in construction (Bresnen and Marshall, 2000; Dewulf and Kadefors, 2013). The concept of partnering refers to a number of collaborative tools and practices: contractor selection procedures taking into account ability to contribute to a collaborative process (Kadefors et al., 2007), letters of intent (charters), target cost (incentive) design-build contracts, team-building exercises, co-location of specialists, continuous improvement programmes and dispute resolution procedures.

Nevertheless, anticorruption safeguards that have been institutionalized through legislation or industry standards may restrict customer-provider co-production in public construction projects. Le et al. (2014) have identified four anticorruption strategies: transparency mechanism, ethical code, project governance, and audit and information technology. To take one example, the limited role of negotiations preceding contract award according to the European public procurement directive (2014/24/EU) reflects concerns with transparency.

CONTRACTORS VERTICALLY INTEGRATING SERVICES

Studying UK construction during the last two centuries and in particular the transformation of general contractors in Bristol and London from the mid-nineteenth century onwards to 1939 (Powell, 2002), Powell (2003) identified several factors that have influenced builders' "make-or-buy" decisions: (1) extent of the market; (2) building owners' attitudes to risk; (3) building owners' ideology; (4) workload fluctuations. Then there were four factors internal to the firm: (5) availability of capital/credit; (6) ease of integration of technology; (7) transaction costs; (8) technical innovation. These factors can be found also in other countries and for other periods.

Transaction cost analysis reveals the significance in general of a few background factors, as Casson (1987, p. 153ff.) has done in his study of the scope of the firm in the construction industry. In particular, there are cyclical factors and their consequences for the regularity of employment; fluctuating demand is important for the choice of employment or non-employment of specialists. It also appears that specialists recruited as employees of contractor organizations may find it more difficult to update their skills, thus increasing the vulnerability of the firm to innovative technologies.

Construction contractors have entered, and sometimes left, the downstream market for facilities management services (Bröchner, 2008). Upstream integration into materials manufacturing is not unknown, and for road contractors, owning gravel pits is another example of vertical integration.

The construction industry with its different customer segments and heterogeneous outputs operates along a scale between the extremes of pure manufacturing and pure services. Prefabricated single-family houses are clearly close to the manufacturing extreme, whereas refurbishment of existing facilities (or road maintenance) has obvious service characteristics (Holm, 2000). At one end of the scale, service ecosystems are launched by producers, as is typical of servitization in the manufacturing industry. Producers of Japanese prefabricated homes have added numerous service options (inspection, maintenance, renovation) tied to long guarantees over the building life cycle, based on producer precise technical knowledge of the buildings (Linner and Bock, 2012).

Again, a contractor-led services expansion reduces customer needs to coordinate multiple provider firms. Relying on a design science approach, Hellström et al. (2016) propose a service configurator based on modules and service levels in the sales process to reduce customer investment uncertainties. They derived the configurator from a study of an equipment supplier that had expanded its offering to engineered turnkey solutions including civil works for a variety of customers, thus acting as both a systems seller and a systems integrator. Hellström et al. (2016) suggest modules for project management, engineering, logistics, purchasing, construction management/installation supervision, commissioning & testing. Another case with a similar development over a number of years has been presented by Razmdoost and Mills (2016), performing a 2002–2009 case study of one firm. Here, there was a transition through services expansion, multi-level distributed interactions and process-oriented performance management in projects. The firm was found to have enabled the transition through the evolution of both institutional mechanisms, such as contracts and organizational structure, and people attributes such as capabilities and culture.

Institutional arrangements may lie dormant for a long time in construction and then reappear. Concessions can be thought of as ecosystems of their own, with a long tradition, especially in France (Barjot, 2011). The Suez Canal where construction and operation was bundled in the nineteenth century is the best-known example of a significant concession, a mechanism to be revived only in the early 1990s on a broader international scale as the Build-Operate-Transfer type of projects for privatized infrastructure. The policy launched in the UK as the 1992 Private Finance Initiative, later known as Public Private Partnerships, and concessions in general are typical of a (public) customer imposing a specific structure of long-term collaboration between provider firms, with a project consortium company receiving the concession; the project company subsequently awards a construction contract (design-build) to a construction company and an operating (services) contract to an operating company.

DISINTEGRATION: NEW SPECIALIZED PROFESSIONAL ROLES AND FIRMS

Three examples of new specialized professional roles and firms illustrate how construction service ecosystems continue to develop. The first example concerns effects of new IT use to support construction projects, the second one is related to increased consumer awareness of environmental problems associated with construction, and the third case is where a regional government client disintegrates and reintegrates contractor functions in order to coordinate site logistics more efficiently with non-construction transportation.

Central government clients may prescribe that innovative technologies such as building information modelling (BIM) should be used for public projects, as in the UK policy initiative mentioned by Shibeika and Harty (2015). This ensures a broader market for specialized IT applications knowledge. BIM could imply changed roles in construction projects for clients and other participants, and there is an emerging specialist profession of a 'model manager' (Sebastian, 2010) or 'VDC (Virtual Design and Construction) professional' (Gustafsson et al., 2015). It is too early to claim that this is more than a temporary role in construction organizations.

At present, environmental experts also fill new roles in construction ecosystems (Gluch and Bosch-Sijtsema, 2016). Lawrence et al. (2016) have analysed the rapid development of the building certification profession since the first initiatives of the US Green Building Council around the year 2000. This is an example of consumer pressure for environmental sustainability being met by industry-led professionalization rather than leading to government initiatives.

In the opposite direction (disintegration of traditional bundles of contractor services): growth and spinning off support services such as third party logistics (TPL) (Ekeskär and Rudberg, 2016). Here in a case study of a major hospital project with both additional buildings and refurbishment, the client required the main contractor to contract with a TPL provider for handling all the logistics and for materials handling on the construction site. Multiple contractors were to be involved, and the client wished to ensure that ambulance transports would not be disturbed by contractors on site and therefore imposed a high degree of logistics coordination. Thus, the presence of multiple contractors led to the unbundling of contractor tasks and the introduction of a new TPL specialist service.

CONCLUSIONS

There are varieties of construction service ecosystems, although some general observations can be made. Input/output statistics have revealed a strong and in many countries a growing importance of professional services for the construction industry. Analysing the emergence of general contractors and the diffusion of design-build contracts, ecosystem change appears as originating primarily with government customers, who are more able to effect institutional change. The development paths have varied in different national settings, but the underlying trend is that over a long period, customers have retreated from coordinating multiple providers of increasingly specialized services. Institutional changes aiming at a clear demarcation of roles in construction ecosystems have been made in order to reduce budgetary risks and to safeguard transparency and accountability in contracts for public construction projects. However, the fragmentation of responsibilities leading to inefficient resource use in projects has been mitigated during the last quarter of a century by strategies for supporting collaboration, encouraging joint problem solving and other forms of customer-provider co-production.

In many countries, public procurement of construction services stands for a high proportion of construction industry output, sometimes approaching half the total market. Within the service sector, there are other types of services where local and central government are important customers who also dictate or at least influence the institutional arrangements. Although, or perhaps just because, construction is special in its highly localized nature and project character, as well as by the strict requirements on the durability of the resulting physical products, there are good reasons for doing comparative studies. Such studies could lay a foundation for a general understanding of the more spontaneous dynamics of how service ecosystems emerge and develop.

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