

A Critical Review of Construction as a Project-based Industry: Identifying Paths Towards a Project-independent Approach to Construction

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Abstract

Construction is dominated by project-based production, and production organisations are constructed from relatively independent participants joining in constantly changing one-off coalitions of firms. This has influenced the industry's structure and methods leading to a highly fragmented sector with many different types of firms. As a consequence, the level of complexity of production in construction is relatively high and efficiency levels are relatively low. In this paper, construction as a project-based industry and construction as a project-based one-off undertaking are critically reviewed. Alternatively a more project-independent approach to construction is discussed and assessed, whether this would be more beneficial, for what kinds of construction, and under what conditions. First construction is characterised as a project-industry and the complexity of the sector is explained, including specific characteristics and contextual and structural features, as well as the benefits, basic problems and generic effects. Next reasons and rationale for project-independent construction are discussed, and paths to project-independent construction and supply chain integration are identified, both from the client and the supply chain perspective, for different sector in construction. Finally a possible future perspective is given on construction when developing towards a more project-independent industry.

Keywords: Construction, industry typology, project-based industry, project-independent production, supply chain integration.

1. Introduction

In contrast to manufacturing, construction is by nature vary much dominated by project-based one-off approaches and “pull”; often every project is different and delivered to a different client. In recent years, manufacturing has moved from process-driven “push” to more client-driven “pull” and to some extent a more project-based approach to production. Still, manufacturing has been dominated by a search for even higher levels of efficiency and alignment of supply chains through long-term but flexible relations between firms. In this paper, this path is inverted for

construction – from a project-based to a project-independent approach – but aimed at the same goal: higher levels of efficiency and alignment of the supply chain.

The characteristics of the industry have often been observed and criticised, and in by some it was even questioned whether construction is actually an industry [1], or rather a “loosely coupled system” of projects [2]. In these observations the nature of construction and particularly the strong project focus within the industry has often been identified as a basic cause of many of the limitations and problems of the industry [3]. Some have identified specific peculiarities of construction causing the problems, including the temporary organisation, one-off product and site production [4]. Construction projects have been described as coalitions of firms; ‘a number of independent firms coming together for the purpose of undertaking a single construction project and that coalition of firms having to work as if it were a single firm, for the purposes of the project’ [5]. Alternatively, the parties involved in construction projects have been interpreted as ‘organisational units joining and operating together as a single production organisation when it is advantageous’ [6]; a ‘temporary multiple organisation’ [7]; or a “quasi-firm” [8]. However, there are significant differences between different types of firms in terms of what they regard as important to project success. The determinants of project success are not always straightforward and unambiguous [9].

2. The Nature of Construction as a Project-based Industry

2.1 Typology of Industries: What Kind of Industry is Construction?

Characteristics of project-based industries vary from industry to industry. The production system of each industry has been shaped by the industry characteristics and history. Project production systems in project-based industries are aimed at a product mix that is ‘one of a kind or few’, process patterns are ‘very jumbled’, processes segments are ‘loosely linked’, and management challenges are dominated by ‘bidding, delivery, product design flexibility, scheduling, materials handling and shifting bottlenecks’ [10]. In addition, the fragmentation of the construction industry has been identified since decades as a major point of the complaints about the state of practice [11], reflected most characteristically by the predominant one-off approach in construction projects, or ‘unique-product’ production [12].

Construction can be typified as a specific kind of project-based industry. Construction has been related to engineer-to-order products (ETO) viewing construction as a type of project-based production system, rather than a type of manufacturing, referring to Assemble-to-Order (ATO), Make-to-Order (MTO), or Make-to-Stock (MTS) types of production system. ‘Treating construction as a type of manufacturing obviously neglects design, and arguably subordinates value generation to waste reduction, which inverts their proper relationship’, however ‘certain aspects of construction should move into the realm of repetitive making’ [13]. Production system types of different industries could be dominated by either (one-off) designing or (repetitive) making (Figure 1).

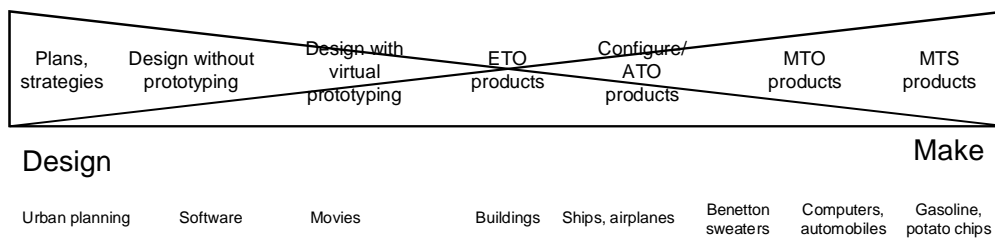


Figure 1: Production system types [13]

The production situation in construction could also be related to assemble-to-order production and “capability oriented production” systems [14]. Alternatively, construction could also be observed as a make-to-order, design-to-order, or even concept-to-order kind production system [15]. The characterisation of the production system of construction is largely dependent on the view taken and the definitions used.

When observed from a make-to-order perspective, the main management challenge is to capture the client order, avoid problems on interfaces in the supply chain and reduce time buffers in the information and materials flows [16]. In addition, compared to other project-based industries, whether it is site installation of prefabricated parts on site or mere on-site production, production in construction is always locally bound and dependent on physical factors such as soil and weather conditions. In addition, compared to most other project industries the volume and repetitiveness of projects in construction is mostly extreme low. The organisation of production and the supply chains is strongly adapted to these basic characteristics, and aimed at the convergence of logistics to one site, and delivery of the one-off, and often highly customised and capital intensive product to a single end customer [17].

2.2 Cultural, Structural and Management Characteristics of Construction

The culture in construction is rather multiform and inhomogeneous, caused by the relatively high fragmentation of the industry in different types and sizes of firms, and necessitated by the varying organisational configurations of projects. The culture within construction is a typical “project culture” and is often relatively informal compared to the often more formal “corporate culture”, which has dominated in other industries such as manufacturing. The high status of projects explains the existence of two cultural identities within the construction industry: the corporate culture (office), and a distinctive culture within each separate project. The rather strong disconnection between the more regulated office environment and the less regulated project environment often disables corporate innovation programmes effectively reaching the production on site (project). However on a construction site workers are continually producing new solutions to problems that occur on site every day, but may be taken for granted, and not regarded, managed and communicated as an innovation. This explains why construction industry is deemed being less innovative than for instance manufacturing. The fragmented production system, strong influence of project culture, relatively weak corporate culture, and lack of shared values particularly among subcontractors is also regarded as a reason for the low customer focus and

lacking possibilities to achieve value for the client. Main contractors must try and manage the rather random nature of subcontractor, which is amplifying the negative effects of project culture. Improved relationships, increased levels of supply chain integration and partnering with subcontractors should be aimed at increasing the identification of subcontractors with the main contractor's values, culture and the ultimate goal to achieve project success and customer value [18].

The structure of the construction industry has been rather fragmented, including many SMEs. Project characteristics differ noticeable across project-based industries. Usually the normative resource in construction projects is the budget and the completion date. The project success measure is cost, and completing the project by the scheduled date is often the most important scheduling objective [20]. Although this will be not quite different in various other project-based industries in general, there are differences in scope, for instance in the movies and software industries, where the emphasis is far more on the profits to be made when a movie or software is distributed and rights and royalties are yielding revenues.

Because of the central role of projects in construction, the project management function and the project manager have an important role. The project manager has the responsibility for the design as well as the execution, matches the project and the customer needs, and takes care of the entire production management. The dilemma is that the more complex and large the project is, the more empowered the construction manager must be to exercise control and authority, but also the more he should delegate and trust his people [21]. The type of project management in construction differs much from other industries. The standards and models used in construction industry are relatively basic and tend to have similar characteristics for all types of projects, compared to many other industries. The relatively low level of competition and the economic stability in construction have played a role here [22]. Compared to manufacturing, project manager qualifications, project size and uncertainty characteristics are found to be relatively low in construction [23]. In terms of quality management, significant differences have been found between industries regarding to the level of quality management implementation and quality output performances [24]. Levels of quality management implementation and the emphasis on quality management in construction companies is relatively low compared to utilities and service companies. In construction the attitude tends to be oriented towards conformance to contractual specifications and not gaining additional financial benefits or competitive strength from quality improvement. Construction has been to be less customer-oriented or responsive, but oriented more towards production and getting the work done on time and within budget. Particularly in construction the management challenge is mainly focussed on projects, which together with the relatively informal culture, and the fragmented structure of the industry as a whole as well as the production system, causes basic differences with other technology-driven industries, and particularly with non-technology industries (Table 1).

Table 1: Construction compared to other technology-driven industries and non-technology industries [25]

	Construction	Other technology-driven industries	Non-technology industries
Culture	Informal	Formal	Dynamic
Structure	Fragmented	Consolidated	Integrated
Management	Project driven	Process driven	Customer driven

3. Project-independent Construction

3.1 Problems and Deficiencies Caused by Construction Nature

Basic characteristics of construction cause limitations to technology and problems to management [3]. The limitations and problems have been found to be very closely related to the nature of construction. Basic problems in the construction supply chain are caused by construction peculiarities. These may be called endemic problems that are difficult to resolve, including the causes behind them and the deficiencies stemming from them [26]. In most analyses, fragmentation of the industry and the predominant one-off approach to production are indicated as major characteristic as well as problematic factors. However, paradoxically, fragmentation, meaning involvement of many different specialised firms in projects, does not need to be associated with low levels of efficiency, but instead may increase efficiency of resource allocation and speed of information exchange between parties, particularly in the post contract period of construction projects. But still, these benefits combined with long term relationships are found to provide the potential for further benefits for supply chain parties involved [27].

3.2 Reason and Rationale of Project-independent Approach to Construction

From the notion that the one-off approach in construction is a major problematic factor, a more project-independent approach to construction has often been advocated explicitly and implicitly. Project-independent approach have been suggested, dependent on the construction sector to which it applies, varying from modular product concepts and pre-engineered housing concepts, to multi-project procurement. The usefulness of applying concepts from other industries has been discussed and demonstrated many times, for instance between automotive and housing [28]. It has been discussed also that translation is needed when studying the possible transfer and application of “exotic” concepts to a construction context [29].

The basic shift from a one-off approach to a project-independent approach in the construction supply chain is to stabilise the project and production environment, and achieve operational and competitive improvements across projects and firm boundaries. In that sense, supply chain integration and management play an important role to achieve project-independent construction.

From a client perspective this must be achieved through altering procurement strategies, and from a contractor/supplier perspective through altering production and marketing strategies, to increase the level of integration and alignment between the different “stages” in the supply chain, e.g. between the materials supply and the construction site (Figure 2).

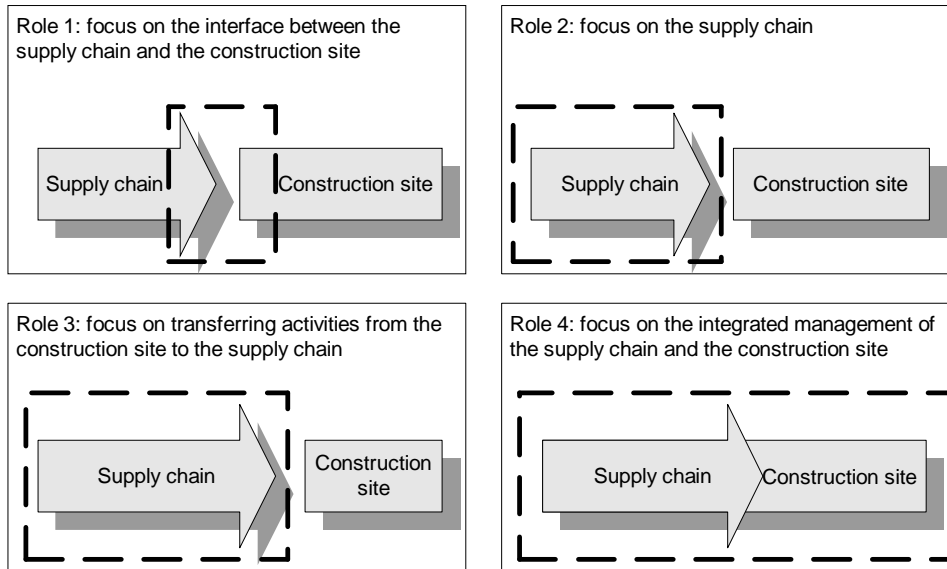


Figure 2: Four roles of supply chain management integrating materials supply and the construction site [26]

4. Paths Towards a Project-independent Approach to Construction

4.1 Client Driven Initiatives Towards Multi-project Procurement Strategies

Since construction is still project driven, obviously, there is lack of comprehensive guidelines for managing multi-projects in construction [30]. However, some advanced and “professional” clients with “buying power” can and have created multi-project environments and manage their procurement through a programmed or “portfolio” approach, based on the repetitiveness and similarities between multiple projects and the degree of project certainty within a programme [31]. In some cases, clients have successfully introduced a strategic long-term approach to procurement, which has proved to be particularly effective for certain sectors in construction [32]. Through these strategic approaches, clients have integrated project activities and procured these packages to integrated supply chains or “clusters” for longer periods of time by applying alternative procurement methods, such as prime contracting and framework agreements, and alternative contract formats, such as PFI en “DBFMOT” kinds of contracts [33].

However, the majority of clients are not in the position to exercise power over the supply chain, because they are too small or their portfolio of projects is, but also because of ad hoc

procurement methods and sometimes misunderstanding of the marketplace. A lack of continuity of relationships hinders gaining the full advantages of long-term collaboration and transfer of experience and knowledge across projects [34]. Clients who have the power to alter their procurement strategies vis-à-vis the marketplace are in the position to align the supply chain effectively, and implement supply chain integration successfully [35]. Performance and financial incentives are to be applied by clients to the whole team, sharing pain and gain, relying on the positive effect of long-standing supply chain relationships [36]. Ultimately, the incentives are aimed to reinforce relationships and commitment, and foster trust for longer periods of time, which cannot be achieved through one-off approach to single projects [37].

4.2 Supply Chain Driven Initiatives Towards Project-independent Production Strategies

At the supply side, parties may evolve towards more integrated production and business formats, through project-independent collaboration with neighbouring parties in the supply chain as well as internalisation of neighbouring activities of businesses. In both cases operational and competitive advantages, through higher levels of productivity and efficiency as well as delivering better client value must be the drivers for this kind of supply chain integration. In the case of vertical integration, often the so-called make-or-buy decision is often dominant whether or not to internalise or outsource a business activity. In practice consequences of integrating or outsourcing activities are not always clear. Often this is driven by mere economic arguments, but for successful business integration need to observe more relational aspects between firms than economic aspects only [38].

Companies in different industries, including automotive, but also construction, where design information and new product development play an important role, could benefit from applying multi-project strategies to design information and product development activities, reusing information, components and establishing long-term relations with closely linked parties, including suppliers, resulting in competitive and operational advantage in relation to competitors [39]. In some cases, these kind of inter-organisational formats are referred to as modular production networks, where fixed relations and reuse and interchange between standard components and firm in the supply chain (production network) are the basis of speed and flexibility of assembly, and this collective competitive advantage [40]. In construction the modular approach to product development, including flexible customisation and postponement of decisions, has been reflected by the concept of open building, including integration is trades and the supply chain, and project-independent approach to construction [41]. Generic project-independent production strategies, such as platform strategies and modularity, in some cases, particularly housing, have thus demonstrated to be possible as well as beneficial [42].

4.3 Differentiating between Sectors of Construction

Construction is consisting of various relatively different and disconnected sectors. As such *the* construction industry does not exist. Per sector possibilities, obstacles, paths and implications project-independent construction are different. Here, three major sector are distinguished: housing, commercial building (offices etc.), and civil (roads, railways etc.). Per sector client driven and supply chain driven initiatives can be identified in construction practice (Table 2). Besides many different other sectors may be distinguished.

Table 2: Differentiating between client driven and supply chain driven initiatives towards project-independent construction in different construction sectors

Initiatives towards project-independent construction	Client driven	Supply chain driven
Housing	Individual clients generally lack power to integrate the supply chain; large housing corporations may develop a supply chain strategy	Supply chain parties may engage in strategic collaboration to develop and introduce pre-engineered housing concepts to the marketplace
Commercial building	For instance real estate developers or large companies may involve integrated supply chains for their real estate stock	Supply chain parties may join to develop multiple commercial buildings, however commercial risks and variability of design etc. may be too high
Civil	Particularly public or semi-public clients may introduce portfolio procurement strategies for multiple projects	Supply chain parties may deliver multiple integrated projects, but mostly initiated by the client; but not through pre-engineered concepts

5. Future Perspective on Construction: Project-based or Project-independent?

5.1 From One-off to Repetitive Construction?

Still construction is dominated by one-off approaches and ad hoc production organisation. Many projects are being planned separately from others, even within one construction company, or client. Traditionally this is mainly because many projects are unique, or regarded to be unique. Particularly large projects are complex undertakings involving a vast spectrum of demanding (clients, users, stakeholders etc.) and supplying parties (contractor, subs, suppliers, consultants, architects etc.). For these kinds of projects in specific sectors of construction, project-based working will stay to be the dominant management format. However, in some sectors, in some cases, clients or contractors or other parties in construction have developed such procurement,

business and production strategies that aim to increase the repetition between projects, within the own organisation and for the own business, or with other parties in strategic cooperation arrangements.

5.2 From Construction to Manufacturing??

Some companies in construction (contractors, specialty contractors, suppliers etc.) have increased the repetition factor between projects by developing and introducing complete product concepts (e.g. housing concepts), or integrated components of building (e.g. integrated facades for offices), to the marketplace including all engineering, parts manufacture, logistics and site assembly, rather than delivering one-off projects, based on mere project specifications. To certain extent these companies have redefined their traditional business and processes towards a manufacturing kind of format. In construction practice, one can see that these companies choose to be excelling in a certain niche market, where they think and mostly succeed in being successful in terms of achieving higher productivity and profit levels, compared to traditionally operating competitors.

5.3 Implications for the Construction Supply Chain

The increase of repetition and move towards project-independent construction has considerable consequences for the supply chain. When taking initiative towards project-independent construction, one or few parties in the supply chain will increase their power and leadership vis-à-vis other parties in the supply chain through strategic collaboration or integration of businesses and activities. As a consequence the level of integration will increase and the level of autonomy of parties in the supply chain will decrease. Clients who take initiative to project-independent construction and supply chain integration arrangements will generally involve teams for longer periods of time, e.g. through prime contracting and framework agreements. Supply chain parties who take initiative to project-independent construction and supply chain integration will generally need to concentrate their business to certain niche markets and integrate all activities needed to deliver complete products to the marketplace, either concentrate on core capabilities within strategic collaboration with other supply chain parties in order to deliver integrated products to the marketplace collectively.

6. Discussion and Conclusion

The construction industry has traditionally been dominated by project-based one-off production. Often the traditional approach to construction, particularly the one-off approach to projects and the fragmented structure of the industry has been criticised for not being efficient. For most kinds of projects and sectors of construction though, the project-based approach is logical and sometimes inevitable, particularly for large civil projects. However, for smaller kinds of projects, in certain sectors, and by developing an alternative strategic approach to procurement or delivery it is possible to achieve project-independent construction to different extents and in different

forms. Both clients and supply chain parties may choose to follow the path of project-independent construction. This requires certain strategic decisions and playing another role in the supply chain, and higher levels of supply chain integration, through internalisation of more activities or through strategic collaboration with other supply chain parties.

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