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Industrialized and project-based construction - Standards versus business models

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Abstract

Digitalization transforms the design, construction and operation of buildings and brings promises of integrated information exchange, ease of communication and productivity improvements for the whole construction sector. These promises depend significantly on the establishment of common information standards, i.e. rules and classification of information. However, despite rigorous efforts on development of standards and considerable technology advancements, standards are not yet fully adopted in construction and benefits from digitalization are not fully capitalized. The objective of this study is to review the adoption of standards and business model renewal for industrialized suppliers of precast concrete elements, with the purpose of reaching enhanced understanding of the mechanisms of standards adoption and business model renewal. The study identifies driving forces for adoption of standards that counteract with arguments for business renewal, explained in terms of a market versus a hierarchy approach in this context. The market approach promotes adoption of open standards for enhanced competition, ease of communication and information exchange as well as improved utilization of industrialized construction. The existing lack of common standards for precast elements, identified in this study, render e.g. waste due to structural re-design and liability uncertainties. However, on a market with open standards, the precast suppliers find it difficult to fully utilize and benefit from their existing operational platforms. Precast supplier search for adoption of the whole value chain of precast structural frameworks, i.e. a hierarchy approach, to protect their market position and maintain their business offerings of complete structural frameworks that include design, manufacturing, logistical services as well as on-site assembly. The integrated hierarchy approach concurs with arguments for industrialized construction, i.e. collecting experiences from design, manufacturing, logistics and assembly as a basis for continuous improvements. The study thus contributes to the understanding of drivers and impediments for adoption of standards versus business renewal in construction.

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1. Introduction

A strong driver for digitalization in construction is the request for continuous and integrated information exchange between all actors of the construction process [1, 2], but the potential of integrated and digital communication and information exchange in construction depend significantly on the establishment of common information standards [3], file formats and, business models [4].

There are numerous examples of national and international classification systems developed to support the increasing digitalization in construction. CoClass is one example of a new Swedish classification system designed to improve information management in the construction and asset management sector [5]. Similar classification systems are e.g. the Danish Cuneco Classification System [6], the OmniClass [7], created and used by the North American architectural, engineering and construction industry (AEC) and the Uniclass, that supports the construction sectors of the UK.

The civil infrastructure sector demonstrates an example of the need of open standards due to digitalization in the development project called “The Virtual Construction for Roads”. In the real estate sector, five Swedish public construction client organizations have taken a similar initiative with the purpose of developing open standards to facilitate systematic use of BIM in building projects and real estate management [2]. Within land surveying there is a standard data model and exchange format called CityGML that enables common 3D urban objects of cities and landscapes, such as buildings, roads, rivers, bridges and vegetation, to be shared and exchanged between applications. The establishment of COBie, Construction Operations Building Information Exchange, provides an example of a standard data spreadsheet format that facilitates information deliveries from BIM systems to Computer Aided Facility Management (CAFM) systems for facility’s operation and maintenance (FM) [8]. BuildingSMART [9] has developed bsDD, the buildingSMART data dictionary, which constitutes an open and international standard library of construction concepts and their attributes [10].

Thus, there are several examples of local, national and international standard classification systems that share the same fundamental idea of facilitating integrated information flow between systems and actors of the construction process. Such an integrated information infrastructure reaches beyond the architectural, engineering and construction (AEC) industry, and includes urban planning, civil infrastructure, real estate management, building material manufacturing, industrialized construction and other aspects of the construction sector.

1.1. Problem statement

Despite rigorous efforts on development of information standards and considerable advancements in technology, standards have not yet been fully adopted and benefits from digitalization have not been fully capitalized upon by industry stakeholders [11]. Research report on a number of impediments for the implementation of digital solutions and adoption of standards in construction, e.g. with references to business risks and challenges related to the implementation of new technology and work processes [12], commercial and legal barriers [13] and, requirements for legal governance and contractual systems [14, 15]. Accordingly, construction digitalization and adoption to new standard systems provide thorough change processes for all stakeholders that need to reconsider their business models, protect and/or reconfigure their commercial offers and balance the risk distribution with their customers and suppliers in order to develop their competitive advantage and maintain their revenue [16].

1.2. Purpose, objectives and delimitations

The objective of this study is to identify and review adoption of standards and business model renewal for industrialized suppliers of precast concrete elements with the purpose of bringing light on the driving mechanisms for adoption of standards versus business model renewal. The study operates in the interrelation between industrialized and project-based construction. The industrial suppliers of precast concrete elements, in this study referred to as precast suppliers, are geographically limited to the Swedish construction market.

2. Method

The study rests upon eleven semi-structured interviews with key representatives from eight different companies and one trade association. All interviews were recorded and transcribed and the transcriptions were sent back after transcription to the respective respondents for proofreading and eventual corrections in the documentation.

Abetong AB [17], a precast supplier, StruSoft AB [18], an engineering software provider for the precast building industry and Tyréns [19], a community development consultancy, represented the industrialized side of construction. One precast supplier wanted to stay anonymous. The project-based side of construction was represented by IKANO Bostad [20], Veidekke Bostad [21] and NCC [22], contractors and property developers and, Akademiska Hus [23], a Swedish state-owned property company and The Association of Swedish Building Materials Merchants [24].

3. The business model framework of precast suppliers

The review of business models and information standards among precast suppliers in this study has its starting point in the business model framework for industrial house-building companies presented by [25]. This business model consists of the operational platform, the market position and, the offering (see figure 1).

3.1. The operational platform

The operational platform describes the precast suppliers' internal structure of resources, competencies and production facilities, but it also includes activities and operations such as management, planning, design, supply chain and information and communication systems [26, 27].

All the precast suppliers in this study have made considerable investments in sophisticated industrial production facilities, capable of producing all kinds of precast elements. The operational platforms also includes sophisticated services in terms of customisation of elements, structural design of building systems, planning and logistical services as well as clash detection and coordination with MEP-suppliers.

3.2. The offering

The offering represents the products and services provided by the precast suppliers. There are two distinct types of offers identified among the precast suppliers. The first is the traditional offer of precast elements such as concrete pillars, columns, stairs, walls and slabs. The other type of offering includes the whole concept of structural design, manufacturing, logistical services and assembly of complete precast concrete structural frameworks for whole buildings. This offering is an example of complex structural concrete frameworks composed by a number of standardized and well-documented building elements of precast concrete slabs, walls, pillars and beams. Offerings that systematically combine both tangible products and intangible services are commonly referred to as product service systems, PSS [28, 29]. This study will refer to the precast suppliers' offerings of complete precast structural frameworks as PSS-offerings.

3.3. The Market position

The market position of the business model framework describes how the precast suppliers' relate to their customers on the market. The precast suppliers in this study operate in two principal lines of business. The offering of standard precast elements represents the traditional line of business in which the precast suppliers act solely in the role of a manufacturer of building elements.

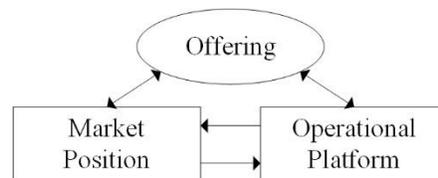


Fig. 1. The business model framework used as the basis of analysis in this study [25]

The other line of business represents the PSS-offerings of complete precast structural frameworks and additional services. In this line of business, the precast supplier operates as a contractor with full responsibility for the design and construction of the structural framework. Accordingly, the precast supplier acts on behalf of the building client, cooperates with the design team, operates side by side with the general contractor and are directly involved in the design and onsite building production.

4. Standards versus business models

4.1. Standards for precast concrete elements

The precast suppliers in produce more or less the same set of products. However, despite of the almost identical range of products there is no common standard for classification of the various precast elements and their properties. Instead, all precast suppliers have developed their own company specific classification systems (see table 1).

Table 1: Examples of precast suppliers' naming of the different types of concrete elements

Product	Supplier A	Supplier B	Supplier C
Wall (solid)	V	RV	V
Wall (sandwich)	RW	RW	W
Pillar (circular)	P or OP	OP	P
Pillar (rectangular)	P or RP	RP	P

The lack of common standards impedes the precast suppliers' communication and information exchange with their client or members of the design team. Besides, it prevents integration between structural design of precast and in-situ frameworks and renders numerous situations of rework, i.e. waste, when a structural design solution for in-situ production needs translation into a corresponding solution for precast manufacturing [30].

Finland and Norway show a different situation about national standards for the design of structural frameworks. The Finish BES system represents a specific standard system for precast elements that builds upon standard modular dimensions for slabs, interior and external walls, bathrooms, staircases and other precast elements of standard dimensions [31]. Corresponding standard systems for industrialized construction is prevalent in Norway [11].

Despite the obvious advantages of open standards for precast structural frameworks, the Swedish precast suppliers express hesitation about adoption of open standards. Any structural engineer can execute structural design for precast elements based on open standards and the situation is the same for logistical services and assembly of precast elements on site. Consequently, open standards for precast elements will challenge the market for PSS-offerings and reduced the precast suppliers' to mere manufacturers of precast elements.

4.2. Business models for precast suppliers

The precast suppliers require early involvement in the project process in order to harvest the full business potential of their PSS-offerings. Too late involvement will lead to unnecessary waist in terms of re-design of the structural framework and will render uncertainties about responsibilities for the structural design. The precast suppliers get involved early in a project e.g. when hired directly by the building client, which can be the case in separated coalitions.

Early involvement can also be the case when the main contractor in an integrated project coalition procures the precast supplier. However, the contractors' decision about whether to choose a precast or a traditional in-situ structural framework are sometimes a concern of the construction managers on site rather than the technical engineers in the design phase. Consequently, decisions about applying precast suppliers are sometimes taken late even in integrated project coalitions.

The given situation, with two parallel design solutions, raises important questions and uncertainties about responsibilities between the original team of the architectural and structural design and the structural designer of the precast structural framework [30].

5. Conclusions

This study, operating in the business interface between industrialized and project based construction, identifies driving forces for the adoption of standards from a market perspective that counteracts with the precast suppliers' arguments for market protection. Incentives for adoption of standards as well as renewed business models provide an example of a power balance between market and hierarchy (see e.g. [32]).

The market approach promotes adoption of open standards for the prefabrication industry, as in Finland. This approach will open up the market and making it possible for different actors using the same set of common standards to perform their respective part of the value chain of precast elements. For example, one actor can do the structural design while another actor do the manufacturing of precast element and a third performs the logistical service as well as the assembly of the precast elements on site. Open standards thus promote increased competition, supports information exchange and prevents the identified problems design rework when shifting from in-situ to precast structural frameworks. The market approach, however, implies a product focus where the market position of the precast supplier is reduced to a mere manufacturer of precast concrete. Competition is based on lowest price for standard elements of low complexity and business relations are described by delimited and project-based contracts, see figure 2.

With open standards, the precast suppliers cannot fully utilize and benefit from their existing operational platforms with e.g. qualified structural design competences, logistical services and resources for onsite assembly. The reserved attitude to adoption of standards among precast suppliers identified in this study, concur with Koch [3], who found that actors on markets with no a legal demands for the use of standards will only consider adoption of standards if it generates immediate benefits for the business.

In the hierarchy approach, the precast suppliers try to align the whole value chain of precast structural frameworks in order to provide PSS-offerings and to secure the most efficient use of their operational platforms. As a supplier of PSS-offerings, precast suppliers act as turnkey contractors responsible for the design, manufacturing, deliverance as well as assembly of the precast structural framework. This integrated work process provides opportunities for the precast supplier to gather experiences from the design, manufacturing, logistics and assembly of the precast elements as a basis for continuous improvements. The hierarchy approach enables early involvement, shared risk and rewards and, close collaboration with the design team as well as other contractors. Besides, business relations rely on trust rather than strict contractual agreements, the product is unique and complex and competition is a matter of capabilities and qualities of the expected results. Accordingly, precast suppliers promote their PSS-offers as a way to climb the value chain and get more closely involved in the project-based construction.

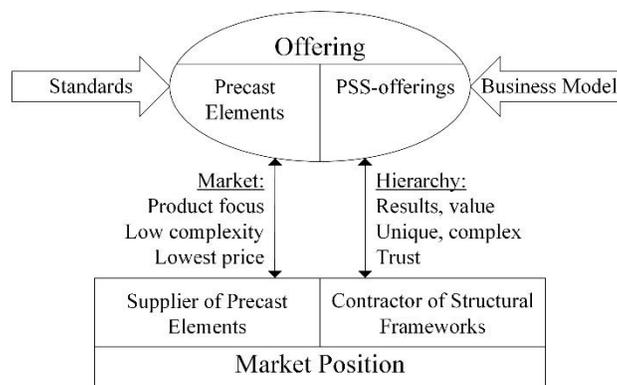


Fig. 2. Implications of standards and business models on offerings and market position

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