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Product service systems in construction supply chains

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Abstract

The shipbuilding, automotive and aerospace industries are examples of industries offering product service systems (PSS) to their customers, i.e. they combine physical products with services to add increased value. While product service systems are well established in many manufacturing industries, it has barley emerged in construction, which is mainly explained by the wellestablished project-based organisation of construction work. Thus, implementation of product and service systems in construction will challenge the established utilisation of technical solutions and systems, production processes and supply chains. The objective of this study is to identify and critically review examples of product service systems in construction supply chains, with the purpose of describing how it challenges prevailing business systems and organisation of construction work. The study rests upon empirical data collected in two case studies at Gyproc Saint-Gobain in Denmark and Celsa Steel Service in Sweden. The two case studies reveal significant challenges related to the implementation and marketing processes of product service systems. Companies that develop and expand their business offers by providing new product service systems find themselves operating in two parallel market segments, i.e. the traditional market of construction components and the new market of product service systems. The product service systems reviewed in the two case studies show a strong focus and emphasis on the development of the offer and the operational platform, while the companies' roles and market positions remain unchanged. Thus, the case study companies organise and operate their businesses and market relations as before the implementation of the product service system. The conclusion is that development and implementation of product service systems in construction supply chains, even at the low end of product complexity represented by single building components, require awareness in the companies' offer of products and services, development in operational platforms as well as clear market position.

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1. Introduction

A product is the result of a repetitive process that utilises a pre-developed structure of solutions for design and production [1]. The product approach is fundamentally different to the traditional project-based construction, where buildings are produced as uniquely designed, one-of-a-kind solutions, executed by temporary teams in loosely coupled supply chains [2,3]. A product-oriented company specialises in offering a specific range of products that allows for repetitions and continuous improvements over time, in order to establish an efficient manufacturing process and supply chain. Production methods, technical solutions and sub-systems can be predefined and enable efficient end-product configuration, due to the limitations of the scope of the product [4].

Product platforms constitute systematic structures of subsystems used for development and production of derivative products [1]. Robertson and Ulrich [5] describe product platforms by four distinctive aspects, namely components, processes, knowledge, people and relationships. Production platforms are optimised for efficient delivery by executing design, production and supply of materials in cooperative and recurring processes by integrated teams engaged on a long-term basis. Further, product and platform development require a clear perception of the customer's needs,

requirements and priorities in order to tailor attractive and competitive concepts [4] aimed at certain market segments [1]. The specific importance of including the customer focus in a product-oriented production system is also emphasised by Barlow and Ozaki [6], Barlow et.al. [7] as well as Lessing [8]. These authors conclude that product-orientation requires long-term investments in platform development, production facilities and accordingly, a clear understanding of the customers' needs is crucial for the design and development of product concepts.

Production-orientation implies control and predictability of the planning, design and, production processes, which allows for improved quality and customer value of the produced goods. Besides, product-orientation facilitates additional opportunities in a long-term perspective. Other industries such as the shipbuilding, automotive and aerospace industries show an increased focus on combining physical products with services [9]. Accordingly, the combination of products and services could provide similar opportunities for e.g. manufacturers of building materials and industrialised construction companies in order to expand their offerings.

A product is composed of a physical part, i.e. the tangible product that is manufactured and offered to the customers, and of an intangible part that consists of the various services that are offered to the customers [10]. Offerings that systematically combine both tangible and intangible products, i.e. products and services, are commonly referred to as product service systems (PSS). The concept of PSS has been defined by several authors, e.g. [11,12,13], only with minor variations in their definitions. The common understanding of PSS is that it represents a systematic way of structuring a combination of tangible products, services and the networks needed to satisfy customer needs. Manzini and Vezzoli [12], defines a product service system as a combination of physical products and services that affects the company's offerings and business scope:

"A Product Service System is an innovation strategy, shifting the business focus from designing (and selling) physical products only, to designing (and selling) a system of products and services which are jointly capable of fulfilling specific client needs".

1.1. Problem statement

While product service systems are well established in many manufacturing industries, it has barley emerged in the construction industry. Construction is characterised as an industry producing complex one-of-a-kind projects, in temporary organisations using mainly onsite production methods [2,3]. Supply chain integration is scarce due to a fragmented process dominated by short-term relations [13]. Temporary design teams from different consulting firms carry out the design and a variety of contractors use project-specific production methods on site [14]. The traditional organisation of construction work offers limited incentives and possibilities to establish systematically repeated and improved methods, design solutions and processes in a long-term perspective [15].

The implementation of product service systems in construction can however, provide new business opportunities by combining physical products (e.g. building materials, components, prefabricated elements, building blocks etc.) with intangible services. The knowledge and experiences of product service systems in construction is still limited, as there is only a limited amount of research done in the field. Some researchers, however, touch upon the topic. For example, Brady et.al. [16] explore the opportunities and obstacles for applying integrated solutions in the construction industry, which are described as combinations of products and services that address customers' requirements, and thus are conceptually similar to PSS.

Brady et.al. [16] state that companies need to structure its business around repeatability in terms of both technical systems and services offered, as well as standardised processes, in order to implement integrated solutions. Further, they conclude that a PSS-approach requires maturity in the PSS-offering, investments in operational capabilities and a surrounding market that is open for the PSS-offering. Besides, Lessing [8] mentions PSS as an opportunity for industrialised construction companies to develop their offering and create new business models and revenue streams.

1.2. Purpose and objectives

The objective of this study is to identify and critically review examples of product service systems in construction supply chains, with the purpose of describing how it challenges prevailing business systems and organisation of construction work.

2. Method

The study rests upon a literature study and empirical data collected in two case studies of which one was carried out together with Celsa Steel Service in Sweden [17] (referred to as Celsa in this context) and the other one was done in collaboration with Gyproc Saint-Gobain in Denmark [18] (referred to as Gyproc). The case studies were carried out in order to identify and critically review examples of product service systems in the two companies.

The collection of empirical data was primarily done by semi-structured interviews, which was supplemented by company and product documentation. Altogether, eight interviews were carried out with key-representatives from the two companies of the case studies. All interviews were recorded, transcribed and returned to the respective respondents as a quality check.

3. Product service systems in construction

Research on business models for house building and construction companies is scarce [19], but emerging. Brege et.al. [20] were some of the first to present an evaluation of business models in the construction context of industrialised building. Other resent research contributions on business models in this field have been presented by e.g. Höök et.al. [21] and Lessing and Brege [22]. Brege et.al. [20] made a central contribution in terms of a business model framework based on three cornerstones required for describing a house-building company's business model, namely the operational platform, the market position and the offering, see Fig. 1.



Fig. 1. The business model framework used as the basis of analysis in this study [20].

The business model framework provides the basis of analysis for the two case studies in this context. The offering in this case, represents the PSS-value proposition, i.e. the product and the service provided by the respective companies. The operational platform describes the company's resources and competences, e.g. production facilities, supply systems, information infrastructures, R&D-support etc. The market position describes the company's role in the market place and supply chain.

3.1. Case 1: Celsa Steel Service – prefabricated reinforcement cages

Celsa [17], one of seven companies of the Celsa Group [23] is a leading European manufacturer of a wide range of reinforcement solutions such as detailing, carpet reinforcement, prefabricated welded products, pile cages, just-in-time delivery and client management systems.

3.1.1. The PSS-offering

The PSS-offering described in the Celsa case study includes prefabricated reinforcement cages, e.g. for foundations, pier footings, beams, pillars etc. and the additional services includes structural reinforcement design in 3D, quantity take-offs, industrial (i.e. automated) prefabrication and colour coding and other logistical services. Celsa's main arguments for the PSS-offering are improved health and safety, time and cost savings, quality improvements etc. for the contractor, which are accomplished when moving the hazardous and tedious reinforcement work from the construction site to prefabrication in an industrial and automated production facility.

3.1.2. Operational platform

The operational platform of Celsa consists of a highly automated industrial facility producing all the various prefabricated reinforcement products, e.g. the reinforcements cages highlighted in this case study. The service part of the operational platform supports the production line and provides services in terms of 3D-design, quality control and clash detection, logistical services and an information management system.

3.1.3. Market position

The company has two lines of businesses. The first and original one is the production of raw standard reinforcement products such as bars, coils and wire rods sold by tonnage. The other line of business represents the refined prefabricated reinforcement products and additional services as described in the PSS-offering in this study. The development of PSS-offerings and its added value to their customers is a way for Celsa to answer to the increasing competition from international suppliers of raw, unrefined, reinforcement products.

3.1.4. Review of Celsa's PSS-offering

The PSS-offer of Celsa represents a resource-based, i.e. an inside out [24], business approach based on the company's technological knowledge and competences, production facilities, information and logistical infrastructure and other resources. An essential requirement for this approach is the ability to exploit the internal and external competences, but also to find a market demand and to create value for their customers [25,26].

However, Celsa has not yet fully managed to create this market demand for their PSS-offer. Contractors principally ask for raw reinforcement products for single building or construction projects and select their reinforcement suppliers by lowest price per tonnage. Accordingly, Celsa still competes with other suppliers by lowest prices on raw reinforcement products, and their PSS-offering is reduced to a potential after-sale if they win the original bid.

Thus, this is an example of where the market position and business models are not renewed in parallel with the development and implementation of the PSS-offering. Instead, Celsa still operates in the traditional market place of raw reinforcement products, and consequently, face difficulties to promote and market their PSS-offering.

3.2. Case 2: Gyproc – The XRoc wallboard system

The Gyproc case reviews the product and services related to the new XRoc wallboard system, initially introduced in a hospital building project in Denmark called "Det Nye Rigshospital" (in Danish) [27].

3.2.1. The PSS-offering

This PSS-offering is represented by Gyproc's new wallboard system called XRoc and its related services in terms of technical design, assembly instruction and performance validation. The XRoc wallboard is specially designed to absorb ionising radiation (e.g. X-Rays) from CT scanners and similar devices frequently used in hospitals. The XRoc wall system is free from lead, which significantly improves the health and safety aspects compared to the handling and erection of traditional lead-based wallboards.

3.2.2. Operational platform

Gyproc is an international company with 12 000 employees in 56 countries with a long experience in developing, manufacturing and distribution of lightweight gypsum plasterboard systems for interior walls and ceilings and other building materials [28]. Gyproc's operational platform is competitive, well developed and is supported by the global Saint-Gobain Group [29], of which Gyproc is one of about 1 000 companies. The XRoc wallboard system is a result of internal research and development carried within the Saint-Gobain Group.

3.2.3. Market position

Gyproc's business partner in the hospital project of this case study is a wholesaler of building materials, from which the contractor orders the XRoc system, traditional gypsum boards and other goods provided by Gyproc. Thus, Gyproc has a remote market position, with no direct business relations to the contractor or other actors of the building project.

3.2.4. Review of Gyproc's PSS-offering

Gyproc's PSS-offer represents a market–based, i.e. an outside-in, business approach where the contractor's demands and needs provide the starting point [30]. During the project the contractor turned to Gyproc asking for help and support with the design and validation of technical solutions for e.g. ventilation ducts, electrical switches, walls plugs, door cases other connections through the XRoc wallboard system. Traditional led-based solutions were not allowed in the project due to client demands.

It is perfectly in line with Gyproc's general business idea to develop and market technical solutions for their customers. However, Gyproc's market position in the hospital project did not support this strategy. As Gyproc had no business relation with the contractor of the building project, there were questions and uncertainties about the liabilities and warranties of the technical solutions provided and not least, the reimbursement for Gyproc's services. Obviously,

Gyproc needs to establish a market position higher up in the value chain in order to support the PSS-offering of the XRoc wallboard system.

4. Conclusion

The two case studies reveal significant challenges related to the implementation and marketing processes of product service systems. The companies that are developing and expanding their business offers by providing new product service systems find themselves operating in two parallel market segments, i.e. the traditional market of construction components and the new market of product service systems. The product service systems reviewed in the two case studies show a strong focus and emphasis on the development of the offer and the operational platform, while the companies role and market position remains unchanged. Thus, the case study companies organise and operate their businesses and market relations as before the implementation of the product service system. The conclusion is that development and implementation of product service systems in construction, even at the low end of product complexity represented by single building components, require awareness in the companies' offer of products and services, development in operational platforms as well as clear market position.

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