ORGANISING SUSTAINABLE TRANSITION: UNDERSTANDING THE PRODUCT, PROJECT AND SERVICE DOMAIN OF THE BUILT ENVIRONMENT

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Sustainable transition of the built environment construction industry is challenging the existing construction practices and business models. This article presents a framework for understanding and facilitating sustainable transition in the built environment. The framework was developed through a four years innovation project based on theories on sectorial and business model innovation and ten detailed case studies of different types of companies and their experimentation with different management and sustainability concepts. The framework interprets the construction industry as a collection of three generic domains - the Project, Product and Service domain - with widely different markets, companies, business models and regulation. Besides identifying the characteristics of the different domains, the findings show that these domains are interdependent, but largely live their own lives with internal agendas. Furthermore, it is shown that the domains are subject to more or less consciously coordinated innovation activities. The research concludes that the three-domain-model represents a promising framework for understanding and facilitating sustainable transition of the construction industry and built environment.

Keywords: sustainability, sectorial innovation, business models

INTRODUCTION

Construction has always been important in the shaping of society by creating the context in which human activities can flourish. Until recently the actors within construction have not considered the broader impact of their practices shaping not only society but also the world in which we are living especially when it comes to sustainable development.

It is widely acknowledged that the construction industry is crucial in the ambition of creating a sustainable society (International Energy Agency 2013). 40% of the CO2 emissions come from the buildings. Thus, there is great potential and need for a sustainable transition of construction products and practices. In Denmark the movement towards sustainable construction is now formulated as the general policy for the industry (Klima- Energi- og bygningsministeriet 2014) that specifically formulates targets for 2020 and 2050.

The starting point for this development has been an interaction between interest groups and the government focused on creating a regulatory frame for construction that is not only ambitious, but also realistic in relation to the skills and resources of the

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industry actors. Even though this perspective is important, it has not focused on companies' impact on innovation in construction. This lack of focus on corporate impact leads us to the purpose of this research.

Ambition

The aim of the paper is to lay the foundation for sustainable transition of construction by creating an understanding of how companies adopt sustainable construction practices within a wider innovation system.

Theorizing sustainable transition

Numerous researchers have taken up the challenge on theorising sustainable transition and several theories have been developed. One of these - the Multi-Level Perspective (MLP) (Schot and Geels 2008; Geels 2004) - look upon sectorial transition as a socio-technical phenomenon and identify three levels of socio-technical interaction (illustrated in figure 1) within which transition can be explained. This theoretical framing of sustainable transition is supported generally (Grin *et al*., 2010) and specifically for the built environment (Thuesen and Koch 2011; D. Gibbs and O'Neill 2014; D. Gibbs and O'Neill 2015)

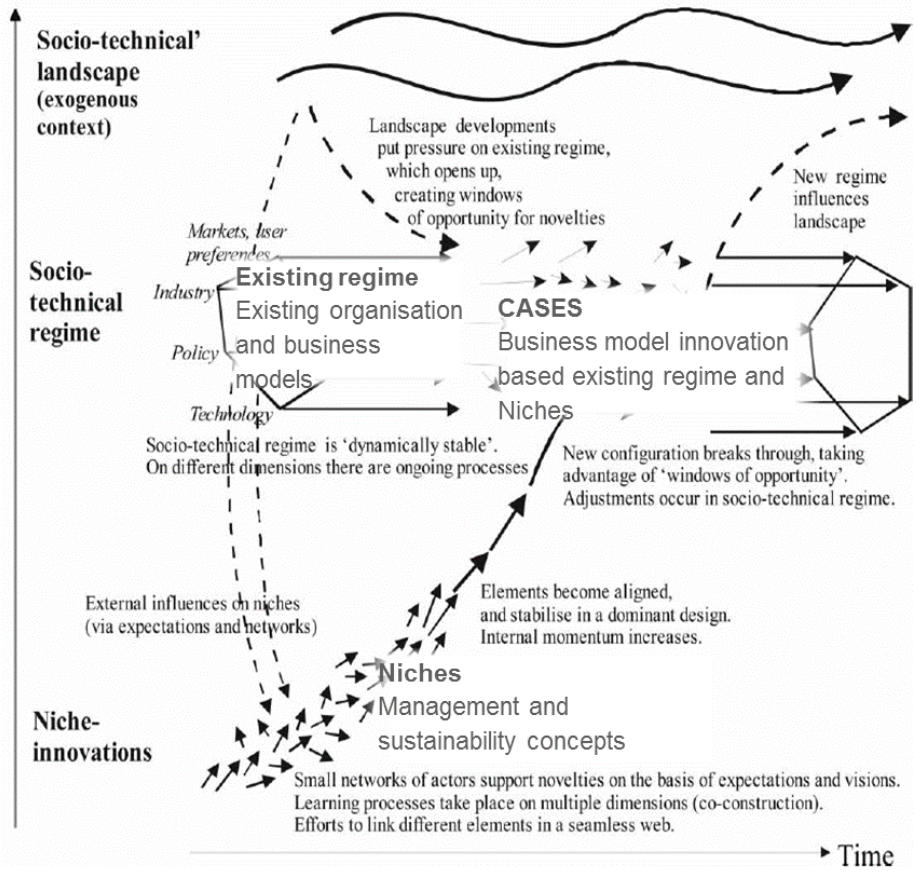

Figure 1: Framing Sustainable Transitions using the Multi-Level Perspective

The macro-level is formed by the socio-technical landscape, an exogenous environment beyond the direct influence of actors in the other levels (e.g. macro-economics, deep cultural patterns, macro-political developments). Here Gibbs and O'Neill (2014) suggest that the current environmental concerns and the policy shift to a green economy represent tensions, and thus creates a window of opportunity for exploration of new trajectories for green construction.

The socio-technical regime forms the meso-level, representing the dominating stabilised socio-technical pattern of interaction, which is reproduced by institutionalised learning processes. A socio-technical regime can for instance be the building and construction industry (Thuesen and Koch 2011; Gibbs and O'Neill 2015), and is defined by a common set of (unwritten) rules for practices and processes, ways of handling specific things and persons, ways of defining problems etc.

Niches form the micro-level where radical novelties emerge. According to Geels and Kemp (2007), several researchers within sociology of technology and evolutionary economics have stressed the importance of niches as innovation drivers, from where new socio-technical regimes can be developed (Levinthal 1998; Schot 1998). Niches work as incubation environments for new ideas by being protected from the traditional selection mechanisms of the marketplace. According to Schot and Geels (2008) sustainable transition can be facilitated by creating technological niches, i.e. protected spaces that allow the experimentation with the co-evolution of technology, user practices, and regulatory structures. By distinguishing between market and technological niches, Schot and Geels (2008) explain how innovation can be achieved through institutional learning processes linking technological niches to niche markets. To understand these learning mechanisms that usually takes place within and among companies, the project adapts the principles of business models innovation (Osterwalder and Pigneur 2013).

METHODOLOGY

The project is based on a series of case studies that introduce various examples of sustainable business model innovation (Maslesa *et al*., 2014) (an overview is presented in table 1). The method used is a multi-case-study (Yin 2012) with a focus on creating a holistic understanding of sustainable transition practices.

Table 1: Case overview

Case	Type	Domain	Management Concepts	Sustainability Concepts
1. Danish Energy Management DEM	Technical consultant	Project / service		ESCO
2. Domea	Building owner	Project / service	BIM, SysDel,	BR15*, Passive house
3. UNS4	Partnership	Project / product	BIM, SysDel	BR15*, Passive house
4. EnergyLean			Lean	
5. SE Big Blue	Energy provider	Service / project	Lean	Industrial Symbiosis
6. Adsbøll & sons	Contractor	Project	Partnership,	BR15*
7. Nilan	Producer	Product	Lean, SysDel,	BR15* Passive house
8. Årstiderne Arkitekter	Architect	Project	Partnership, SysDel,	BR15* Passive house
9. BM Byggeindustri	Contractor	Product / project	Partnership, SysDel,	BR15* Passive house
10. WorldFlex-home	Partnership	Product / project	Partnership, SysDel,	BR20* Active house

**) BR15/20: Danish Building Code of 2015 / 2020*

The case studies are based on semi-structured interviews (Kvale 2007) with central actors in selected companies, site visits, project reports, and meeting notes from specific projects. The focus of the empirical collection has been on how niches (in the form of management and sustainable concepts) creates changes in the way companies do business.

Specifically the research investigated three interlinked levels to conceptualise the transition processes: (1) The innovation project/initiative in which a concept/niche is tested and experiences are created. (2) The business level focusing on how the innovation is embedded, challenge and reshape the existing business model of the company. (3) The innovation system setting the context for the company's innovation activities through the sectorial organisation and different niches (concepts).

The selected cases are primarily from Denmark, with a specific focus on small and medium sized enterprises (SMEs) since these represent the majority of the companies in the industry and further are believed to be of outmost importance in the transition processes of the industry. The cases covered different types of companies: from manufacturers to service providers that all worked more or less intentionally with different types of niches covering both management and sustainability concepts.

Throughout the project, it became clear that the concept of sustainability is challenging to work with in practice, e.g. how to assess the sustainable impact of the company's choice. The aim of the project was not to develop specific models and methods for assessing which innovation type was more sustainable. This important field is widely covered by Life Cycle Assessment (LCA) research. Thus, this paper focuses on understanding how companies work with sustainable niches/concepts in their usual innovation activities. In line with (Geels 2010) we view sustainable construction as a normative goal and a collective good problem that establishes a vision serving as an orientation point for the development of the companies. The interesting part is not the final destination itself, but the way to arrive there.

ANALYSIS

The analysis is structured in two sections. The first section introduces a conceptualisation of the existing regime illustrated by three domains for understanding the constructions industry. The second section outlines different niches/concepts and how they are integrated in the cases and domains.

The existing regime: The construction industry organised in three domains

Overall, the construction industry can be conceptualised as a collection of three generic domains with widely different markets, companies, business models and regulations. The three domains the Project, Product, and Service domain illustrated in figure 2 are all central in the realisation and operation of the built environment.

The project domain

The project-oriented domain is the most prevalent and visible domain in construction today, as this is where buildings are realised. In the Project domain, traditional construction actors such as architects (case 1 and 8), consultants (case 4 and 1), contractors (case 2, 6, 9 and10) and various crafts (case 6 and 9) plan, design and construct buildings to the individual clients. The production form is project based. The building is realise by a unique team, on a unique location, and over a fixed timeframe.

The foundation of the business models in the project domain is based on selling hours. The hours are usually included in the tendering and competition models in which a customer can choose from a wide range of offers from companies to complete a task and to ensure cost control of the projects. The costs of the project are usually based on a cost+ model, where costs are determined from design and an overhead. Furthermore, the cost structure of these companies is based on low fixed-costs, and high variable-costs. These companies have usually no physical assets in the form of production facilities and machinery, but have a clear predominance of variable costs (primarily salaries).

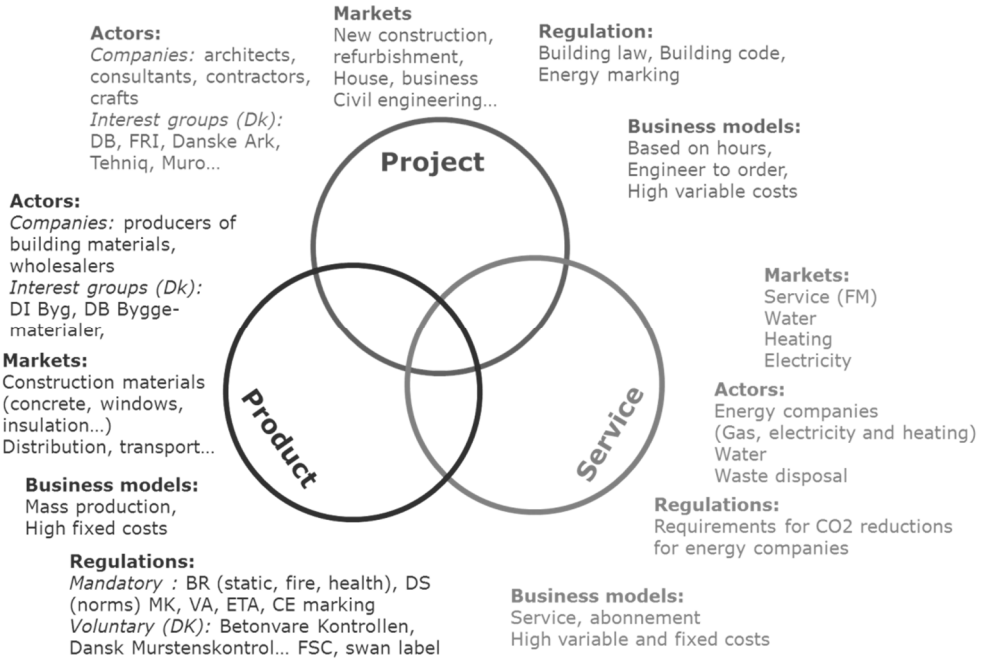

Figure 2: The three domains of the construction industry

The regulations of the Project domain focus on products and processes of the projects. In Denmark, concepts such as AB92, ABR, Working Environment Act etc. regulate the process while the built product is regulated by the building code (BR). This regulation ensures that the specific building meets common standards for energy consumption, fire protection and accessibility regulations. At the same time, the temporal dimension of the domain is underpinned by short liability periods (e.g. 5-10 years) compared with the building's overall lifespan. This ensures that companies are not constrained by the old projects, but may pertain to new.

The product domain

The product-oriented domain represents all the materials and products that go into the building – represented by the construction material industry. Historically, the construction material industry has been limited to simple types of materials such as wood, concrete, and bricks. However, over the last century the industry has witnessed an explosion of new building products. Since the range of building products and their variance increases, it is a challenge to navigate among the many options. The vast majority of the building products are produced through mass production, produced to stocks where the project-oriented companies subsequently can request their materials (case 9). This also means that there are considerable amount of wholesalers, connecting producers and building projects. These wholesalers have not been a part of the current research, though.

The regulations of the construction materials industry focus on the application of the product and the process for installing the product at the site. At the same time, the regulations ensure competition between products and enable continuous innovation in the industry. With the rise of the "internal market" of the European Union, the Product domain is heavily regulated by the EU, but also national regulations apply. Therefore, a wide range of rules, norms and standards exist, like the mandatory CE marking and fire protection standards, as well as the voluntary standards like Concrete Control and the Swan label.

The business models in the Product domain are primarily based on mass production in manufacturing environments with high fixed-costs. The vast majority of construction materials are produced for stock and delivered to the construction site through wholesalers, representing a store for the most common building products such as wood, tile, plumbing and electrical components. Compared to the Project domain, the business models are based on a strong separation of value and costs, and the price of the products is a result of what the market is willing to pay, not what it costs to produce the products.

The service domain

The service-oriented domain includes organisations and companies that provide services to the buildings at different operational levels. It may be cleaning, maintenance and other Facilities Management services, but also include service-providers of energy (case 5), water, sewage and waste disposal.

These organisations are usually not considered as a part of the construction industry, but this is changing. After entering office, the previous government in Denmark created a joint ministry for Climate, Energy and Buildings. Thus, the construction was introduced as part of the energy system with the purpose of realising the government's overall climate goals. This regulatory change introduced a number of new players to the Danish construction industry: energy and utilities companies.

The regulation of the Service domain has traditionally not attracted much focus within the Danish construction industry, but with the introduction of the construction sector in the energy system, new niches are created. One of the Danish regulatory initiatives is the requirement for energy companies to reduce their own CO2 emissions. To fulfil this requirement, energy companies have now an obvious interest in advising their customers how energy consumption in their buildings can be reduced. Therefore, the intersection between the Project and Service domain is changing.

The business models for businesses in the Service domain are selling services often in the form of subscriptions on energy supply (case 5), water, sewage and waste disposal.

Shared among all the three domains is a desire to satisfy specific needs in the markets in and around the built product. These markets are not the same, but they are connected. For example, there is an obvious link between the market of new buildings and construction materials. Similarly, there is a link between the Project and Service domain, since each construction project must have a technical infrastructure in form of electricity, heating, pluming and water. Although the markets are not the same, they ultimately relate to the same users. Over the three domains is thus a user perspective, which is important for the actual products, projects and services provided. The end-users are the ones who create demand and thus promote or impede innovation.

Niches/concepts

This section introduces a selected number of niches that challenge the existing organisation and practices of the industry. The niches represent both agendas that have an explicit sustainability focus (sustainability concepts) and more general management concepts. The management concepts include Partnerships, Lean, BIM and System deliveries (SysDel) while the sustainability concepts include the future Danish building code BR15/BR20, the Passive house and Active house concepts, ESCO models and Industrial Symbiosis (Bisgaard *et al*., 2012). Figure 3 illustrates how the different concepts is situated in the different domains.

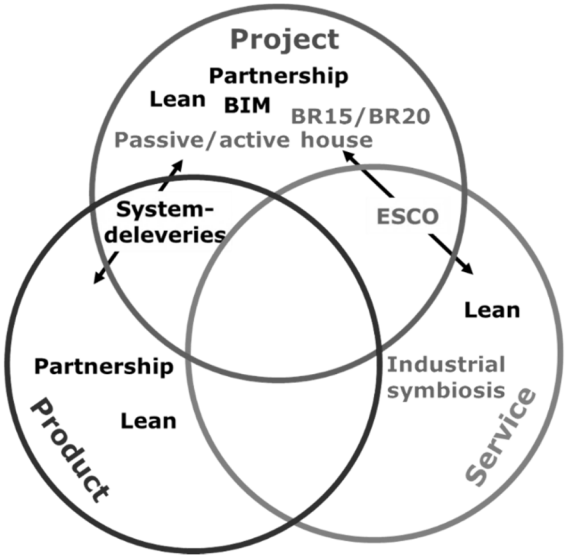

Figure 3: Managerial and sustainable concepts' connection in the three domains.

Through all the cases, it was found that these niches/concepts reshape the existing construction practices and business models. Thus, the model of the three domains is not to be understood as static. It is constantly changing and therefore dynamic. This change is not only happening within the each of the domains, but also in the interfaces between them. A number of niches have an impact on the future organisation of construction. Some examples here are the continuous development of the system deliveries (SysDel) and the interest of energy companies in energy savings. In other words, the boundaries between the domains represent new business opportunities followed by potentially new business models.

System deliveries (Case 2, 3, 7, 8, 9 and 10) are placed in the intersection between the Project and the Product domain. System deliveries are system products, products that are produced and adapted specially for the individual customer. These products may be concrete elements, facades, escalators etc. As these products are adapted to each customer, the purchase of these products does not include only production, but also a design process in which customer needs are translated into specific solutions. Some of these design processes are supported by configuration systems to ensure that the designed solutions comply with the requirements for the product, and at the same time are optimised for production and logistics.

The ESCO or Energy Service Companies (case 1) concept positions itself between the Project-oriented and Service-oriented domain. ESCO focuses on developing practical solutions for energy savings and is financed by the ESCO-supplier who in the end receives the financial benefit of energy savings. This model means that the supplier and the customer are tied together over a number of years, depending on the specific

ESCO-project. This long-term relation requires cooperation, because the behaviours of the building users directly affect energy savings.

DISCUSSION: SUSTAINABLE CONSTRUCTION?

The three domain model creates a holistic view of construction and offers a nuanced basis for understanding the sustainable transition of companies in the various domains.

The window of opportunity for the transition of sustainable construction will have a direct impact on niches and concepts within the individual domains. The central question is how to ensure that each individual domain contributes to this transition? The following table formulates the challenges associated with each of the domains and indicates relevant niches/concepts, which in different ways deal with the challenge.

Table 2: Domain challenges and solutions for sustainable transition

Domain	Challenge	Sustainability concepts
Product	Design and production of quality products with a long life and high energy efficiency and minimal consumption or maximum recycling of resources	LCA, C2C, CE marking, DFD (Design for Disassembly), SCS (Supply Chain Sustainability), TBM (Take Back Management)
Project	Design and construction of buildings with high architectural value that are energy efficient, environmentally friendly, well-insulated and has a good indoor climate.	DGNB, BREEAM, LEED, DFD (Design for Disassembly), sustainable construction site
Service	Operation and maintenance of buildings, ensuring a good indoor climate while energy costs are reduced.	SFM (Sustainable Facilities Management), ESCO, Green leases

Through the cases, we have investigated how construction companies orientate their development in the sustainable transition highlighting the role of business model innovation. The models and tools associated with the business models do not include a special focus on sustainability. However, by achieving a larger focus from the authorities and society, sustainability is increasingly incorporated into business practises.

According to Bisgaard *et al*., (2012), companies can be sustainable (green) by producing green products and services to other companies or customers, or they can become more sustainable by making the processes responsible for the interactions in the value chain more green. However, it can be difficult to assess these movements since an optimisation of a product / service or process can have negative trade-offs in other contexts.

At the same time, it is important not only to look at products / services and the underlying processes, but also to see whether companies help solve a sustainability challenge. It is not enough just to produce a "sustainable" new building when the main challenge of creating a sustainable built environment is associated with reducing energy consumption in the existing building stock.

Common to most of the cases are that the projects fail to manifest themselves in the business over a longer period. This was e.g. the case for the partnership UNS4 (case 4) and Adsbøll (case 6) that discontinued their strategies. These findings supports (Schot and Geels 2008) that sustainable transition is a matter of experimentation. Not all initiatives will survive, but some might influence future activities. In the abovementioned cases the barriers for pursuing sustainable innovation was associated

with market fluctuation and price sensitivity for the clients. However, it also illustrates a willingness to experiment among the actors of the industry.

The construction industry is often accused for being conservative and non-innovating. However, the selected cases clearly illustrate a wide range of innovation activities at all levels of the industry: from the large players (case 5 and 2), over SMEs (case 1, 8 and 9) to one-man initiatives (case 3 and10); and in all types of companies: architects (case 4, 8 and 10), consultants (case 1 and 4), producers (case 3, 7, 9 and 10), and service providers (case 2 and 5).

Furthermore, the cases studied show how regulation is a major driver of the sustainable innovation activities in the companies. This is particular the case regarding the transparency of the future Danish building code (BR15/20) which enables the companies to orientate themselves towards future building requirements (case 2, 3, 6,7,8, 9 and 10). Furthermore, the entrance of energy companies illustrates also how regulations create incentives for changes in the industry structure (case 5). Today, the construction industry in Denmark is not viewed and regulated as a separate entity, but considered as a part of the bigger picture of societal development.

DIRECTIONS FOR FURTHER RESEARCH

The introduction of the three-domain-model give rise to further research questions like:

- How are other management concepts and sustainable concepts contributing to the sustainable transition? This could include concepts like Eco-labelling and certification schemes (e.g. DGNB, LEED, BREEAM) and Circular economy models like C2C
- What is the role of different type of companies in sustainable transition of the built environment? Especially the role of the wholesalers connecting producers and building projects would be worthwhile investigating.
- What happens in detail at the company level? How are sustainable concepts selected, adapted and implemented to the specific company profile?
- How can companies be supported in the process of sustainable transition? Do we need to rethink the current tools and practices to support the specific domain?
- What is the role of regulation and policy making?

CONCLUSION

This article has introduced a new framework for understanding and facilitating sustainable transition in the built environment. The framework interprets the construction industry as a collection of three generic domains the Project, Product and Service domain - with widely different markets, companies, business models and regulations. All domains are central in the realisation and operation of the built environment.

The challenge is that these three domains are interdependent, but largely live their own lives with internal development agendas and concepts. The domains are not static, but exposed to a more or less consciously and coordinated influence of the companies with different strategies. Thereby the three domain framework creates a holistic view of construction that offers a more nuanced basis for understanding the sustainable transition of the construction industry.

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