Façade Leasing

Drivers and barriers to the delivery of integrated Façades-as-a-Service

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Abstract

The construction and renovation of the building envelope represents a significant fraction of a project's life-cycle costs. It also has a determinant effect on the potential reduction in energy use, as well as on the improvement of the building's indoor comfort. Nevertheless, the challenge of a low rate and depth in building energy renovations cannot be solved through technological innovation alone. Instead, the Façade Leasing research project proposes a systemic shift in economic and business incentives, towards the creation of a performance-based contracting model for integrated façades.

Façade Leasing explores an integral, cross-disciplinary model promoting accelerated strategic investment in energy-efficient building envelopes. A focus on performance delivery, rather than product sales, would in turn impulse ongoing innovation in products and management processes. It would also provide the foundations for Circular Economy strategies for the reuse and remanufacturing of building components, leading to a potential reduction in primary raw material consumption across the façade industry.
This study starts by describing the "Façade Leasing pilot project" developed and built at the TU Delft campus by a consortium of açademic and industry partners. It then outlines the main drivers and barriers to the commercial application of the Façade-as-a-Service concept in the Dutch public, non-residential real estate sector, from the perspective of four key stakeholder groups: Demand drive, or the decision-making process of real estate developers, owners, and managers; Supplier readiness, or the necessary reorganization of products and processes along the supply-chain; Finance, or the distribution of financial resources bridging the gap between initial investment cost and long-term service fees; and Governance, or the necessary regulatory innovation required to separate ownership of building and façade.

The research shows that, while further research and validation work is needed to test these principles in a controlled, case-study setting, the potential for façade-as-a-service delivery is within reach under the current legal and economic environment.

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Introduction

The share of global environmental impact for which the construction sector is directly or indirectly responsible has been well documented and is regularly quoted (Eurostat, 2017; Smith, 2003). Diverse impact mitigation goals have been established by regulatory bodies around the world to incentivise improvements both in terms of construction process and in the quality and efficiency of the new and renovated building stock. Until recent years, this debate largely focused on the energy consumption of buildings during their operational phase, and the gradual improvement that could be achieved through the application of innovative – and often active – building technologies (Allouhi et al., 2015; Konstantinou & Prieto Hoces, 2018).

This incremental process, with a focus on energy optimisation, has led to a significant increase in the complexity of construction techniques. Research and development in building envelopes has seen particular progress, as such systems have a distinctly determinant role in the overall energy and indoor-climate performance of the building. Multi-layered systems for both opaque and transparent building envelopes have become the norm, and a growing number of façade-integrated building services are constantly expanding the functionality and relevance of the building envelope (Athienitis, Bambara, O'Neill, & Faille, 2011).

This combination of envelope and service functions can result in the building envelope accounting for as much as 40% of a new building's construction costs (Parker & Wood, 2013). In the case of deep building retrofitting projects, in which site, structure, and other building systems are reused, a façade with integrated building services can make up over 90% of a project's initial investment (Dall'O, Bruni, & Panza, 2013). This rise in complexity and cost, however, has not always been followed by a thorough understanding of the effect such systems have on the Total Cost of Ownership (TCO) - both financial and environmental - of the building throughout its service life. This knowledge gap often results in suboptimal decisions being taken during a project's planning phase, where a focus on initial investment costs frequently prevents the adoption of more robust or energetically efficient systems. While technology advances to enable the construction of energy-neutral and even energy-positive buildings, the market-integration rate of such technologies tends to be slow, and often limited to a small group of elite projects (Mlecnik, Visscher, & Van Hal, 2010). The cause for this, this paper argues, lies in the economic and organisational processes underlying the system, rather than the availability or reliability of new, high-performance technologies.

A second challenge presented by a focus on energy performance is the effect this rising complexity has on the use and disposal of material resources. Emerging, low-carbon building technologies – from energy-generation and distribution systems to smart, user-responsive micro-grids – are quickly merging into what we would traditionally consider the Electrical and Electronic Equipment (EEE) sector. The demand on materials, in terms of both volume and diversity, is therefore growing exponentially (Vidal-Legaz et al., 2016): From the high-volume elements commonly used in construction, to the highly-specialised micro-volume elements needed to produce integrated circuits and other EEE components which are becoming increasingly embedded in our buildings (BIO Intelligence Service, 2013; Ecorys, 2014). While the construction industry has focused on an incremental improvement in terms of operational energy use, it has often overviewed the consequences of such decisions in terms of the embodied energy and CO_2 content of products and processes, the reliability of global supply-chains, or the eventual depletion of finite and highly valuable material resources.

The concept of a Circular Economy is a response to this material resource challenge, just as the energy efficiency movement has been a response to the environmental challenge presented by the use of mostly non-renewable energy-generation sources. One of the key principles of the Circular Economy is to involve companies and other industrial

organizations in the elaboration of new economic and business models for a more resilient use of resources. Energy-efficiency and other sustainable practices have often been seen as an additional short-term capital expense (i.e. a financial burden) for companies and their investors (Figge & Hahn, 2005). The Circular Economy concept, meanwhile, addresses this misperception by focusing on improving the overall strategic economic position of these companies, while safeguarding the long-term values of wider society (Webster, Blériot, & Johnson, 2013). A circular use of components and materials should lower manufacturing costs while reducing vulnerability to international raw material markets; a focus on service delivery rather than product sales should stabilize cash-flows across the value chain, protecting stakeholders from the volatility of, for example, real estate supply and demand cycles (Alix & Vallespir, 2010).

A number of authors have established a relation between the resource management theory behind the Circular Economy and the realignment of business incentives that can be achieved through the implementation of Product-Service Systems (PSS) (Mont, 2002; Stahel, 2016; Tukker, 2015). In line with other performance-based, pay-per-use models recently initiated in the construction sector, such as lighting and carpeting, the Façade Leasing project proposes the development of a PSS model for integrated building envelopes. The principle behind PSS models is to shift transaction value away from physical products, and instead assign this value to the performance results provided by these products to the target client and/or end-user (Baines & Lightfoot, 2013; Tukker, 2004). As a fixed and functionally critical system, however, the façade is subject to highly specific requirements – from the technical to the regulatory – which result in a new level of complexity in its transition towards performance-based contracting practices. The objective of this paper is hence to identify the knowledge gaps behind this complexity, the stakeholders these knowledge gaps are relevant for, and the incentives these actors might have to pursue a transition.

The EWI pilot project at TU Delft

In late 2016 construction was completed on the "EWI Façade Leasing pilot project" at the TU Delft campus in Delft, The Netherlands (Figure 1). This mockup façade renovation project consisted in the replacement of four unitary curtain wall panels at the building of the Electrical Engineering, Mathematics and Computer Sciences faculty (commonly known by its Dutch acronym, EWI). This iconic building, built during the 1960's, has in recent years suffered a series of building service failures, and is increasingly criticized by users and operators for both its inflexible spatial layout as well as its inadequate indoor comfort. The building has been therefore deemed the ideal target for a façade renovation prototype, particularly one showcasing the potential benefits of decentralized, façade-integrated building services. Its curtain wall façade, technically innovative for its time, consists of a ventilated, double-skin system, with an exterior single-glazed, metal-framed layer and an interior wooden-framed layer. The building layout, a long central corridor with adjacent offices and meeting rooms on both sides, provides the room depth and façade-to-floor ratio necessary for decentralised building services to perform effectively.

The purpose of the pilot project was twofold: On the one hand, it was intended to act as a technical demonstrator of the technological range and readiness of new, decentralized, façade-integrated technologies. Such technologies, not all of which were physically installed in the prototype due to financial or time constraints, include systems such as BiPV energy generation and storage, diverse interior, in-glass, and exterior sun-shading systems, ventilation and air-handling devices, automated operable windows, LED media façade elements, and self-supporting green façade systems. The pilot project, therefore, intended to showcase the wide range of façade-integrated services currently available on the market, and their capacity to deliver most, if not all, of the indoor comfort regulation services necessary for certain building typologies.

On the other hand the pilot project acted as a central case-study promoting further discussion

FIGURE 1 ▶ PHOTOGRAPH OF THE COMPLETED "FAÇADE LEASING PILOT PROJECT" AT TU DELFT'S EWI FACULTY BUILDING.

Photograph credits: Marcel Bilow (2016)

within a wide-ranging consortium regarding the business and supply-chain modelling implications of a transition from façade product delivery to integral indoor comfort service provision. The consortium – made up of real estate investors and operators, façade fabricators, system suppliers, and industry branch organisations – as well as the design and engineering process followed to execute the project, have been described in the paper "A business-oriented roadmap towards the implementation of circular integrated façades" (Azcarate Aguerre, Klein, & den Heijer, 2016).

The planning, execution, and evaluation phases of the pilot project highlighted many of the systemic circumstances which currently lead to a slow energy renovation rate, and to suboptimal decision-making and missed opportunities in the technical depth of such renovations.

Methodology

While the EWI pilot project confirmed the commercial attractiveness of Circular Economy and PSS principles to a diversity of industry parties on both sides of the value chain, it opened new questions regarding the practical implementation of a performance-based business model for integrated façades. Further research has therefore been oriented towards understanding the current procurement and knowledge-sharing mechanism dictating projects' planning and execution phases, as well as exploring the impact a service-based façade contracting method could have towards improving technical decisions in new buildings and building envelope retrofitting projects. The research has been based on a series of interviews, working sessions, and public presentations, in which the research team actively engaged experts across the most relevant stakeholder groups within the construction and real estate sectors in the

Netherlands. The stakeholders have been asked to identify and elaborate on the main drivers and barriers they would expect in the implementation of a Façades-as-a-Service model.

Data gathered through this field exercise has then been compared and complimented with literature references and case-studies. These references have been largely collected from other economic sectors, such as the automotive and industrial design industries, with more experience in the application and financing of PSS business models.

Finally, a schematic business and value model has been created for the possible organisation of a façade-as-a-service contracting process. This model has then been evaluated by representatives of the different stakeholder groups, and a summary of cross-organisational drivers and barriers has been reached.

Stakeholder analysis

Following the methodology previously described, the objective of this analysis has been to map the current priorities and concerns of key players within the construction value chain. This map has then been used to develop a schematic plan to maximize potential collaboration between long-term client needs and key supplier and fabricator skills under a performance-based contract. While the "Façade Leasing Pilot Project" focused on the technological aspects of the Façades-as-a-Service concept, this stakeholder analysis led to specific suggestions – according to diverse fields of expertise – on its managerial aspects, and how this business model could be successfully implemented in a realistic setting.

Real estate owners and operators

The demand side of the built environment is represented by organizations that either own and/or use buildings (and land). When there is an intervention or transaction, they become clients that pay for products and/or services. As owners of buildings, clients will focus on residual value, life cycle costs, and return on investment. As users of these buildings, clients will concentrate on how their organisational performance is affected by the building.

Exploring new business models to match innovative supplier solutions with changing client demands gets more interesting when the owner and user perspectives are combined in a single client. Only then the strategic, functional, financial, and physical values need to be considered by one stakeholder (den Heijer, 2011). For this reason the research team focused on a specific client profile: the owner-user (or owner-occupier) of buildings. Dutch universities are examples of organisations that combine ownership and use of their buildings. The uncertainty in demand and the required flexibility in the functionality of buildings also plead for more flexible façade solutions, of which façades with integrated decentralized systems could be an example. TU Delft, as one of these organisations, served as a test case - and living lab - to identify "demand drive".

The most fundamental factor determining the success of a new business model is the client's willingness to invest in its added value proposition. In economics "willingness to pay" is connected to "value." Since value is hard to operationalise - if it combines strategic, financial, functional, and physical aspects - the extra payment is equally difficult to calculate. However, the incentives to invest in a product-service combination, rather than a product, can be made explicit.

As owners of buildings clients are becoming increasingly socially responsible, environmentally conscious, and willing to invest in resource-efficient solutions that contribute to a more Circular Economy. Of course, financial incentives still play a role that is larger for commercial organisations and smaller for organisations that are funded with public money, like universities. Residual value, or the value of reused component and materials, and lower energy costs are demand drivers: they influence decision-making by owners of buildings.

As a user of buildings, a client is increasingly aware of the shorter functional lifetime of building systems

and the high costs of either new investments or decreasing productivity (den Heijer, Arkesteijn, de Jong, & de Bruyne, 2016). Anything that jeopardizes the performance of the organisation could have considerably higher costs and risks than implementing more flexible solutions or more flexible processes to provide a service. Clients are therefore receptive towards the concept of paying for a performance and service while not having to put in the effort, and hire the staff necessary, to support it. They also acknowledge that this is simpler for well-defined performances, like "enough light for the activities in the room" than for "keeping us comfortably productive". The more complex the primary processes, the more complex it is to establish performance indicators against which correct performance can be measured and hence productivity guaranteed.

The potential negative impact of a suboptimal decision, during the building envelope planning and construction phase, could be disproportionately high at a business operational level. While a building envelope with integrated services can, as mentioned, represent as much as 40% of a new building project's initial cost, this total initial cost is deemed to represent only about 40% of an average project's TCO (Ive, 2006). Furthermore, the building's TCO generally represents only about 12% to 15% of a business' operational expenses over the project's service-life (e.g. 30 years), while the other 85% to 88% consists of non-building-related human and material resources needed to run the business (Hughes, Ancell, Gruneberg, & Hirst, 2004). Savings in initial investment, for example by procuring a lower-performance façade, can therefore have exponential negative consequences for the business' bottom-line. These consequences would be the result of higher operational costs – for example due to a higher building energy consumption – and to a potentially even larger extent due to a drop-in staff productivity as a consequence of indoor discomfort (Loftness, Hartkopf, & Gurtekin, 2003; Terrapin Bright Green, 2012).

From both the owner and user perspective the long-term relationship with suppliers is important for safeguarding shared responsibility for sustainability goals, by being able to adapt to new standards, change components, or upgrade existing systems to innovative solutions during the functional lifetime of the building. Trading uncertainty for certainty, even at the cost of a higher financial fee, can be preferable.

Façade fabricators and system suppliers

Traditionally in the façade supply chain the contractor is the integrator. Suppliers as well as designers play a minor role, particularly in the Netherlands. Besides, the role of the client and demand specifications are dominant, with over-specified tenders focused on technical solutions rather than outcome (Uyarra, Edler, Garcia-Estevez, Georghiou, & Yeow, 2014). Contractors and thus suppliers tend to follow demand rather than developing and supplying integrated products.

In the near future, the role of contractors is expected to decrease. This offers the opportunity for groups of suppliers to potentially take over the role of system integrators of sub-assemblies including the façade. In such a scenario the business model for coalitions of suppliers would be to develop circular products and develop leasing, upgrading, or take-back services for those products. This is dependent on financial and legal implications for coalitions of suppliers and whether they will be able to cope with and co-organize those responsibilities within the group of firms. In fact the supply chain of suppliers would then act as a single 'quasi-firm' (Eccles, 1981) or 'extended enterprise' (Boardman & Clegg, 2001). The 'quasi-firm' points towards the notion of coalitions of firms behaving as one firm. This raises the issue of core competences of firms making up an 'extended enterprise' in a resource-based view (Prahalad & Hamel, 2000).

The extended enterprise implies a higher level of integration between firms. In order to achieve higher levels of supply chain integration, there is a need to strengthen inter-firm relationships, achieve mutual benefits and build trust (Dainty, Millett, & Briscoe, 2001). Then the extended enterprise will be able to be the single point of contact with the

client, façade manufacturer, and service provider. In most supply chains one of the firms would be the 'system integrator' who will lead and integrate the whole supply system. Generally this is the largest firm in the supply chain, taking most of the financial risk. The integration of the supply system is not only driven by economic arguments but also includes organisational and social aspects between firms and teams of people involved (Bridge, 2005).

Financial organisations

Regardless of scale, project financing in the real estate sector has traditionally been secured by the market value of the real estate property which is being financed. This value, while sensitive to volatile trends such as the behaviour of the real estate market, can in most cases be effectively calculated based on a long industry track-record taking into account factors such as location, quality, function, year of construction, operational risks, among many others (Pagourtzi, Assimakopoulos, Hatzichristos, & French, 2003).

The loss of basic functionality, for example if the building envelope is missing or inoperative, can have dramatic consequences on the project's financing model, as a building without an operative façade is not occupiable. It therefore loses its quality as a complete asset which can be directly sold on the market. This loss of value due to functional incompleteness is the main concern behind property law (as will be discussed in the following section).

A fully Circular construction supply chain is likely to result in a building which is no longer a single integration of components and materials which fulfil a rentable function, but instead would become a collection of ongoing service-contracts connecting a large number of suppliers and service providers. Ownership of diverse building systems would be held by a number of parties, meaning no functionally solid and fully transferable real estate property could be defined.

Looking at the specific case of the building's façade being used as an asset to secure a loan by the façade manufacturer, it is deemed to be an unlikely proposition. The façade, if removed from the building, has minimal intrinsic value. Reselling the façade elements in the market would most likely result in high disassembly, transportation, storage, and remanufacturing costs, which would render the whole exercise economically unfeasible. The value of raw materials, even under the most optimistic forecasts, is not likely to become high enough to justify the process by simply reusing these materials as raw industrial input. Since the physical asset (the façade) holds no significant residual value, an asset-based loan is not an option.

Innovative cash-flow-based project financing mechanisms, such as those being used in the wind energy sector, could provide a solution to this financing barrier. If energy improvement performance can be reliably backed by a documented body of energy-renovation projects, the income and productivity resulting from the renovation could act as guarantee, securing the necessary cash-flow to cover the loan repayment. Such is the mechanism behind the growing Energy Service Performance Contracting (ESPC) model (Sorrell, 2007). Since track-record history and risk assessment methods are yet to be developed for the financing of façade renovation projects, large and financially solid client organisations - such as publicly-supported universities - could provide the ideal circumstances for a commercial pilot project. Their operational stability and above-average credit rating would act as further guarantee of service fee payment.

Governance

Circular Economic practices based on the delivery of performance services departs radically from the traditional ownership model on which property law has been based since Roman times. Construction projects have been traditionally considered as functionally complete entities. A developer will procure a plot of land and the human and material resources necessary to erect a building. The building will then be sold either as a whole or subdivided into functional units such as apartments or offices.

Even if a diversity of transaction models exists, full ownership of a complete, functional space unit measured in terms of square meters between structural walls, has been the legal construct by which real estate value is calculated. Financial and Legal aspects of a Circular Economy model for construction are therefore closely tied.

To move the Façade-as-a-Service concept forward, perhaps the most important distinction to start with is that between legal ownership and economic property. While the latter is not a notion in the Civil Code, it is particularly relevant in fiscal law.

Legal ownership is a generally understood concept, it represents "an enforceable claim or title to an asset or property and is recognized as such by law" (BusinessDictionary.com, 2018). The owner of the land will normally be also owner of the buildings constructed on it (the buildings being fixtures) as well as of the building's constituent parts such as slabs, walls, roof, doors and windows. Economic ownership allows a user to obtain full enjoyment of the object, including bearing financial risk for it, while not being its legal owner. Long-term leasing of real estate property such as land or built objects is another example of such a structure (Ploeger, Prins, Straub, & van den Brink, 2017).

In principle, immovable property is not an absolute right, but may be determined through the establishment of building lease contracts, keeping ownership on the side of the manufacturer or a third party, such as a lessor. Lack of precedence doing this specifically for façades means that no guarantee of its success can be given without a pilot case in which the appropriate contracts can be structured and tested against property and fiscal law. Previous contracts elaborated for elevators and solar panels owned by third parties show that it can be done in theory, but it depends on how much the façade, or some of its components, can be argued to be independent of the building's core functions.

The Façade-as-a-Service model

The stakeholder analysis presented above has resulted in the elaboration of a schematic model (Figure 2) for the contracting of performance-based façades-as-a-service. This model takes into account the core competences of the diverse stakeholders, the ongoing relations between parties, as well as sources of long-term social and corporate costs and values beyond the directly financial. The model makes a distinction between tangible products and the intangible services delivered by such products. It also proposes a stepped transition in which, at first, only the service

FIGURE 2 ▸ FAÇADE-AS-A-SERVICE SCHEMATIC MODEL OF STAKEHOLDER RELATIONS, ACTIVITIES AND FORMS OF VALUE CREATION IN A SERVICE-BASED FAÇADE CONTRACTING MODEL.

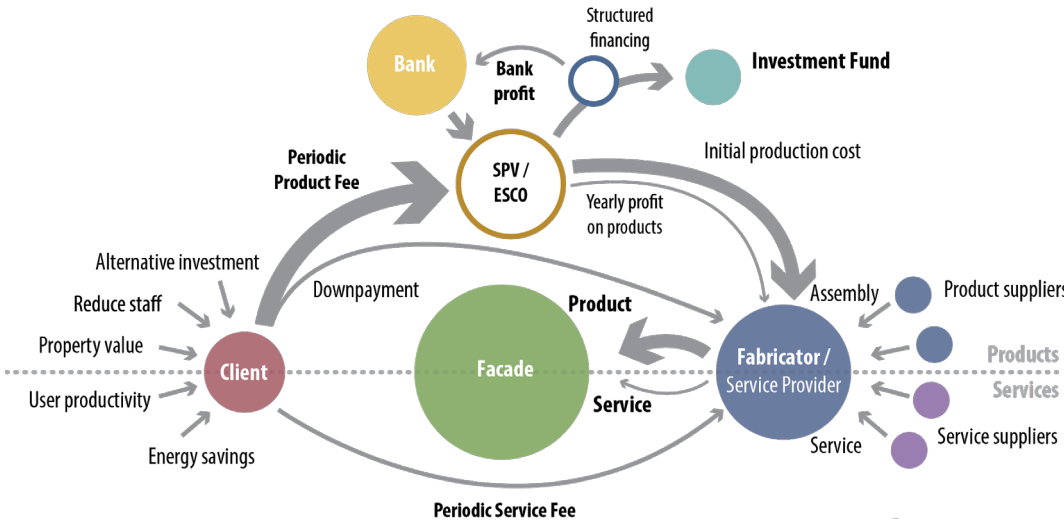

TABLE 1 ▸ SELECTED DRIVERS AND BARRIERS TO THE IMPLEMENTATION OF A FAÇADE-AS-A-SERVICE CONTRACTING MODEL, ACCORDING TO MAIN STAKEHOLDER GROUPS.

	Drivers	Barriers
Client	Outsource non-core processes (e.g., façade maintenance schedules and indoor comfort performance monitoring).	Partial third-party ownership of organisation's real estate.
	Accelerate rate and depth of portfolio retrofitting.	Possibly high risk-premium while track-record is created.
	Stabilise cash-flow, lower upfront capital requirements.	Cash-flow based financing limited to relatively large clients.
	Improve functional flexibility of portfolio.	Contract setup and management costs.
Service provider	Access to new service-based markets.	R&D investment on system and service integration.
	Stabilise cash-flow, reduce impact of real estate cycles.	Lower upfront profit.
	Higher profit margin for services. Incentivise innovation and quality.	Development of new processes required (staff and training).
	Enhance raw material security.	Financial model sensitive to global material / commodities market trends.
	Gather valuable data on the use, performance, and failure of products. Contributing to updated engineering and manufacturing practices.	Data collection and privacy issues.

provider needs to engage in PSS activities, while second-tier suppliers and sub-suppliers continue to provide product-based offerings. Such a gradual supply-chain reorganisation process is deemed to be a more likely proposition than a radical, cross-industry shift.

The Façade-as-a-Service model has been evaluated by representatives from the diverse stakeholder groups. A summary of the main drivers and barriers identified by these actors has been elaborated and is presented in Table 1.

Conclusions

The cutting-edge in façade-integrated technologies is often overlooked due to the knowledge-transfer process between the technical experts responsible for the project development and construction, and the management experts responsible for the investment in, and operation of, the building (Klein, 2013). A focus on lower initial investment cost still widely dominates the sector and defines most procurement processes. Such focus favours products and systems which are often simpler, lower-performing, or subject to require a higher maintenance effort. Such decisions could result in a higher TCO – in terms of both financial and environmental impact – than the use of more robust, higher-performance alternatives which also entail a higher initial investment.

The assumption of this project, and indeed of PSS theory in general, is that the alignment of long-term interests between suppliers of products and consumers or users of such products could lead to a more efficient management of global resources. Both ends of the construction value chain could co-create a new value segment by sharing the burden of managing a building's life-cycle according to their core skills and competences. Ownership of materials and responsibility for the effective and updated function of components would be retained by parties with experience in the manufacturing and development of technology,

reducing the need for duplicated knowledge. This could meanwhile expand the economy of scale potential of suppliers beyond the production phase and into the ongoing operational, service-delivery phase.

A comprehensive methodology to compare linear and circular contracting processes in terms of their Total Cost of Ownership is still necessary. The TCO needs to be balanced against the total value of ownership (TVO) when managing a portfolio of buildings. This long-term value balance is not easy to assess, especially for non-profit organisations. But even the TCO is not easy to measure: allocation of capital costs, maintenance costs, and energy costs to specific spaces and users is quite difficult within large organisations or for large buildings. The owner and user of buildings can find incentives to implement a new business model: safeguarding user productivity during the lifetime of the building, reducing internal management staff, saving energy expenses, having liquidity for (or higher return from) alternative investments, and increasing the residual value of their property as it reaches its end-of-service.

Large amounts of data from diverse stakeholders must be analysed and organised to create a map of direct and indirect costs and savings resulting from the reorganisation of the supply-chain. In the past fifteen years, universities have worked hard to improve databases, compare ratios, and generate management information to support campus decisions (den Heijer et al., 2016). Determining value and costs has become easier, but still requires thorough scenario and risk analysis for new business models. As has been proposed by other authors, public procurement offers a low-risk, long-term environment which can catalyse early adoption of innovation in technologies and processes (Edler & Yeow, 2016). To support this, practice-oriented research such as the one hereby presented provides intermediation between stakeholders with diverse, and often traditionally conflicting, commercial interests.

More effective decision-making tools could support long-term, multi-stakeholder planning, and unlock more sustainable contracting models for the construction industry, resulting in a lower consumption of energy and material resources. The business model and stakeholder analysis described in this paper show that, in principle, all stakeholder groups identify potential value creation in the pursuit of this Circular Economic-inspired model. It also shows that the key assumptions behind more sustainable industry practices within a CE and PSS frameworks can be achieved in such a specific and practical example as that of Façades-as-a-Service.

Significant shifts have to be done in certain areas: for example the transition from asset-based to cash-flow based financing of real estate described in the Financial section; as well as distributed ownership models based on fiscal economic ownership practices and creative application of apartment law, as described in the Governance section. However such shifts are not, in principle, radically innovative, and can build upon contracting and procurement models for which pertinent precedents exist.

About the author

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