Tampere University

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MARKET VALUE OF CONSTRUCTION INNOVATIONS

Empirical evidence from the EU

Master´s Thesis
Faculty of Built Environment
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ABSTRACT

Samu Heikkilä: Market Value of Construction Innovations – Empirical Evidence from the EU
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The purpose of this study is to examine the connection between innovations and the market capitalization of construction companies. This connection has been a largely unexplored topic in prior literature. The examination is conducted with an event study methodology utilizing innovation announcements as a proxy for innovation. According to earlier literature, innovation announcements contain valuable information to investors. Therefore, observing the change in company´s market capitalization after an innovation announcement should be an accurate way of assessing economic implications of innovation.

This study focuses on large publicly traded construction companies based in the EU. Hence, the empirical analysis of this study utilizes innovation announcement and stock market data specific to these companies. The innovation announcement data is sourced from the official press releases published by the analysed companies in the ten-year period from 2010 to 2019. Utilizing this data sample, an event study is conducted examining the abnormal returns to these innovation announcements. The obtained results are then validated by examining their statistical significance and robustness.

The main finding of this study is that innovation announcements and the market values of companies in the construction industry are positively associated. The obtained results suggest that innovation announcements lead to an average increase of 0.47% in the market capitalization of the examined companies. The increase can be observed on the day of the announcement, and given the rationality in the marketplace, it should reflect the economic impact attributable to innovation. These findings are in line with previous literature suggesting that innovations are a source of economic value.

Keywords: construction industry, innovation, market value

TIIVISTELMÄ

Samu Heikkilä: Rakennusalan innovaatioiden markkina-arvo EU:ssa
Diplomityö
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Tämän tutkielman tavoitteena on tutkia yhteyttä innovaatioiden ja rakennusalan yritysten markkina-arvon välillä. Tätä yhteyttä ei ole laajasti tutkittu akateemisessa kontekstissa aikaisemmin. Yhteyttä tutkitaan tapahtumatutkimusmetodologialla hyödyntäen innovaatioita koskevia lehdistötiedotteita innovaatiotoiminnan mittarina. Aiemman akateemisen kirjallisuuden mukaan innovaatioita koskevat lehdistötiedotteet ovat toimiva mittari innovaatiotoiminnan taloudellisille vaikutuksille, sillä niiden syy-seuraussuhde markkina-arvoon on selkeästi määritettävissä.

Tutkielman laajuus on rajattu suuriin pörssilistattuihin rakennusalan yrityksiin EU:ssa. Täten tutkielman empiirinen aineisto on kerätty kyseisten yritysten osakemarkkinadatasta sekä aikajakson 2010–2019 aikana julkaisemista lehdistötiedotteista. Empiirisessä analyysissä tapahtumatutkimusmetodologialla pyritään selvittämään innovaatioita koskevien lehdistötiedotteiden vaikutus niitä julkaisevien yritysten markkina-arvoihin. Tulokset validoidaan varmentamalla niiden tilastollinen merkitsevyys

Tutkielman päälöydös on, että innovaatioita koskevilla lehdistötiedotteilla on positiivinen vaikutus niitä julkaisevien yritysten markkina-arvoihin. Tutkielman tulokset implikoivat, että innovaatiota koskevat lehdistötiedotteet johtavat keskimäärin 0.47% suuruiseen nousuun yrityksen markkina-arvossa. Nousu on havaittavissa tiedotteen julkaisupäivänä ja markkinoiden ollessa rationaalisia sen pitäisi vastata suuruudeltaan tutkittujen innovaatioiden keskimääräistä markkina-arvoa. Tulokset antavat viitteitä siitä, että pörssilistatut rakennusalan yritykset voivat hyötyä investoinneista innovaatioihin myönteisten markkina-arvovaikutusten kautta.

Avainsanat: rakennusala, innovaatio, markkina-arvo

PREFACE

This study was written to fulfil the graduation requirements of the Master´s Degree Programme at the Tampere University. The purpose of this study is to add to the literature regarding construction innovations, and the results should be of interest to high-level decision makers in the construction industry.

The research question was formulated together with my supervisors Professor Kalle Kähkönen, Project Manager Juha-Matti Junnonen, and Dr. Juho-Kusti Kajander. I would like to thank my supervisors for their excellent guidance and support during the research process, as they were always available and willing to answer my queries.

Helsinki, 1 April 2021

Samu Heikkilä

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1. INTRODUCTION

Innovation is widely considered to be the main factor in developing global competitiveness and economic growth of nations. Additionally, its importance for companies has also been emphasized broadly in strategic literature, as it is not only seen as an essential way for companies to gain competitive advantage, but also as a way to encourage advancement and transformation of the whole industry in the long run (see *e.g.* Porter, 1985). However, even with its numerous benefits, innovation is inherently risky, as it is often associated with heavy upfront investments and riddled with uncertainty and a high probability of failure (Holmstrom, 1989, p. 61). This inherent riskiness has the potential to discourage operators from innovating, which can have adverse consequences for nations, industries, and companies alike.

This seems to be especially true in the construction industry, where the risk-averseness of the operators combined with low level of economic incentives for innovation has led to very low levels of innovation activity over the past decades (see *e.g.* Slaughter, 1998, 2000; Manley, 2008; Whyte and Sexton, 2011). The construction industry accounts for 6 to 9% of the national product of most developed nations, but despite this, the industry spends less than 1% of revenues on research and development activities (R&D) versus 3.5% to 4.5% for other comparable industries (Arditi and Mochtar, 2000; Seaden and Manseau, 2001; McKinsey & Co., 2016). Although R&D spending isn't a perfect indicator of innovation activity, it depicts a fairly accurate picture of an industry falling behind its peers in terms of productivity and quality growth (see *e.g.* Winch, 2003).

Besides the low level of economic incentives for innovation and the risk-averseness of the operators, there are also other more underlying reasons for the lack of innovation in construction. These reasons have been broadly recognized and documented in prior literature, and an analysis of the relevant literature indicates there are four primary influences. Firstly, authors such Barlow (2000); Dubois and Gadde (2002); and Barrett and Sexton (2006) note that construction production is often based on "one-off" projects, which increases the risks of innovation and also limits the applicability of a given innovation in other situations, therefore reducing the incentives to innovate. Secondly, Miozzo and Dewick (2002) and Blayse and Manley (2004) argue that as the end product of construction is expected to be highly durable, the incentives for innovation are further reduced since tried and tested methods are often preferred instead. Thirdly, according to Dulaimi, Ling and Ofori (2002), the supply chain in construction is more fragmented than in most other industries, which results in an environment where cascading legal contracts pass the risk down the supply chain hindering the parties´ ability and willingness to innovate. Finally, it seems that innovation in the industry suffers from financial restrictions caused by low profit margins and sensitiveness to economic cycle. Studies, such as the ones by Slaughter (1998) and Lim and Ofori (2007), explain that since the profit margins in the industry are continuously low, construction companies tend to differentiate themselves not in terms of technological capabilities but in terms of costs. Since innovation is seen as an additional cost, the risks associated with it often outweigh its benefits in executive decision making.

Despite these underlying challenges and motivated by them, this study aims to investigate whether the market provides a financial incentive for corporate-lead innovation in the industry. In business economics, the first step in convincing companies to engage in innovation is to build a quantifiable business case around it. Therefore, the research question of this study examines whether innovations have an impact on the market capitalization of construction companies, and if so, how big the impact is. Increase in market capitalization would not only incentivize investors to push for more innovations but would directly affect the stance of construction executives on innovation, as a significant amount of their compensation comes in the form of stock-based pay (Kotnik *et al*., 2018).

Surprisingly, the possible connection between innovations and the market capitalization of companies is largely an unexplored topic in construction innovation literature. However, the market value of innovations has for a long time been a focus for studies in the broader corporate innovation literature. For example, Chaney *et al*. (1991) study the impact of new product introductions on the market value of various US companies from 1975 to 1984 and find an aggregate abnormal cumulative impact of approximately +0.75% over a three-day period around the product announcement. Similarly, Sood and Tellis (2009) examine the market value of 5,841 innovation project announcements from 69 US firms across five industries from 1977 to 2006 and conclude that the average abnormal return to an isolated innovation announcement was +0.40% on the event day. In one of the only studies examining the market value of innovations in the construction sector, Kajander *et al.* (2012) analyse the abnormal return to sustainability business innovation (SBI) announcements of large construction companies from US, UK, France, Germany, Spain, Australia and Japan. The authors find an average abnormal event day return of +0.82% to a total of 35 SBI announcements.

This study aims to make an empirical contribution by investigating the link between construction innovation announcements and the market capitalization of construction companies in the member states of the European Union. Observing the change in market capitalization after an innovation announcement should be an accurate way of assessing the true rewards of innovation since the path of causality is clearer than, say, in comparing the effects of innovation on sales, profits, or market share (see e.g. Sood and Tellis, 2009). Further, the European Union is a lucrative environment for the study due to the coherent economic policies and mostly efficient capital markets of its member states (Onali and Goddard, 2011). The empirical analysis is conducted with event study methodology established by MacKinlay (1997) and utilizes stock market and press release data from 2010 to 2019. Discounting the European sovereign debt crisis in 2010, this ten-year period should be relatively free of any major stock market disturbances. This study focuses on companies in the NACE industry F41 (Construction of Buildings) that generated over a billion euros in revenues in 2019. Smaller companies are omitted from the scope of this study due to possible liquidity constrains caused by low trading volume which might skew the results. What is more, some authors even argue that the innovation activity in construction industry is largely concentrated to larger companies as smaller companies often have insufficient resources to undertake innovation (see *e.g.* McFallan, 2002).

This study adds to the existing academic literature in three main ways. Firstly, this study aims to increase the understanding of how the stock market investors value innovation in the field of construction. Secondly, by documenting the economic value-added impact of innovations it seeks to create an incentive for construction executives and owners to enhance innovation efforts. Thirdly, to the knowledge of the author this is the first study examining the market value of all construction innovations broadly in a unified environment, in this case the member states of the EU.

The results of this study indicate that there is indeed a positive and statistically significant connection between innovation announcements and the market capitalization of construction companies in the member states of the EU. According to the empirical analysis of this study, innovation announcements explain on average a 0.47% increase in the market capitalization of the analysed companies. This average increase can be observed on the day of the announcement for the innovations, and given the rationality in the marketplace, it should reflect the average economic impact of the innovations.

Furthermore, this observed increase indicates that innovations are a relevant part of business development for construction executives and owners.

This study is structured in a following way. First, a review of the relevant literature regarding for example managerial risk-aversion in the construction industry, decision making incentives, and capital market efficiency is given. This is followed by Chapter 3, which discusses the specific methodologies employed in this study. Then, in Chapter 4, the data used in this study as well as the various sources used to obtain it are explained. In Chapter 5, the results from the empirical analysis are presented. Finally, the conclusions are derived.

2. THEORETICAL BACKGROUND

The purpose of this chapter is to lay out the theoretical background for the rest of this study. Firstly, the practical factors behind the risk-averseness of the operators are explored in the context of the construction industry. Secondly, the relevant literature on the importance of well-aligned executive incentives for innovation and corporate development is examined. Thirdly, the extensive research behind efficient capital markets is reviewed to lay the foundation for the empirical analysis of this study. Finally, prior literature is analysed in an effort of finding an unambiguous definition for construction innovation. Due to the empirical nature of this study, a great emphasis in this chapter is put on explaining the theoretical assumptions behind the economic models utilized later in the study.

2.1 Managerial risk-aversion

As briefly explained in the introductory chapter, construction industry has many distinguishing features that make it generally ill-suited for innovation. These include the "one-off" nature of projects, expectations of high durability for the end products, fragmented supply chains, and low profitability to name a few. What is more, construction companies can, by and large, remain moderately competitive and sustain themselves in the short-term even without participating in any innovation activity (Tawiah and Russell, 2008). That said, one can understand why companies in construction are not pouring their finite resources into high-risk innovation projects, despite innovation being a proven way to gain competitive advantage and ensure survival in the long-term (Pérez-Luño, Cabrera and Wiklund, 2007).

However, the same concern of companies not sufficiently innovating or investing into the future also persists to some extent in other industries outside construction. For example, many media outlets expressed worries as it was announced that the dollar amount of stock repurchases by the companies included in S&P 500, one of the most commonly followed equity indices, surpassed the dollar amount of R&D investments in the whole of the US in 2018 (Lazonick, Sakinç and Hopkins, 2020). Similarly, in the specific case of the EU, policy makers have expressed concern over the notably low R&D intensity of the private sector compared to that of competitors such as China, Japan and the US (Eurostat, 2019). These broader examples have of course their own set of complex and diverse underlying causes and explanations, but a common theme also relevant for exploration in the context of construction centres around the concept of managerial risk-aversion.

The concept of managerial risk-aversion explores the tendency for managers to prefer outcomes with low uncertainty to outcomes with high uncertainty, even if the projected average outcome of the latter seems more attractive (Werner, 2009). A risk-averse manager may become myopic in outlook and get tempted to invest in projects that assure returns in the short run. The manifold reasons for managerial risk-aversion have been widely researched in existing corporate literature. For example, a paper by Narayanan (1985), explores managerial incentives and finds that executives are biased towards short-term and low uncertainty projects due to career and job-safety concerns. Failures in high uncertainty projects, such as unsuccessful innovation initiatives, can lead to the permanent loss of managers´ employment income. What is more, similar studies by Holmstrom and i Costa (1986) and Hirshleifer and Thakor (1992), argue that failures can lead to reputational damage, which can likewise affect future employment options. Further, Graham, Harvey and Rajgopal (2005) survey 401 financial executives and find that the majority of the surveyed managers would avoid initiating a positive net present value (NPV) long-term project, if it meant falling short of the analysts´ earnings expectations in the short-term. These results express the managers´ reluctance to initiate projects that can reap benefits for their companies in the long-term, such as innovation initiatives, if the projects can also hurt the financial outlook of their companies and their career aspirations in the short-term. In the context of construction innovation, the adverse effects of managerial risk-aversion are accentuated by the already high barriers to innovation caused by the specific features of the industry.

This complex dynamic can be explored more thoroughly with the theoretical framework of principal-agent problem. The principal-agent problem, in business context, refers to the conflict in priorities between the stakeholders of the company and the managers hired to act on their behalf. More specifically in the context of this study, principal-agent problem can be used to describe the misaligned incentives of the parties regarding innovation; managers are not incentivized engage in innovative activities, even though the employing company could benefit from innovation in the long run.

The principal-agent problem was first mentioned in corporate literature by Berle and Means (1932) in their book regarding the potential drawbacks produced by the separation of ownership and control. The authors argued that the principal-agent problem is emphasized in well-established large corporations with wide-spread ownership base, *i.e.* publicly traded companies. Since then, the principal-agent problem has also received attention in the construction innovation literature, where the solution to the principal-agent problem is often referred to as one of the most important enablers of innovation. For example, a study by Dulaimi, Nepal and Park (2005) on innovation in the Singaporean construction industry concludes that successful innovation projects are supported throughout the implementation by high levels of managerial commitment. Likewise, in her study regarding construction innovation implementation, Ling (2003) articulated that adopting novel practises in the construction industry is only enabled if it is in the interests of all stakeholders of the company. Similar conclusions have been drawn by numerous other construction innovation papers, such as Egbu (2004), Manley *et al*. (2005) and Abadi (2014), all of which conclude that top managerial support is essential to the success of any innovation within a construction organization.

2.2 Incentivizing innovation

The early literature by Berle and Means (1932) has motivated a large subsequent literature focusing on the subset of the principal-agent problem concerning the mitigation of risk-related managerial incentive problems. More specifically, the topic of incentivizing executives to engage in innovation has received a lot of attention from scholars.

There is vast literature implying that the optimal incentive scheme that motivates innovation at the top levels of an organization includes long-term monetary incentives, such as stock options with long vesting periods. For example, Hirshleifer and Suh (1992), Hemmer *et al.* (1999) and Rajgopal and Shevlin (2002) show that stock options help mitigate the effects of managerial risk-aversion. Furthermore, a study by Lerner and Wulf (2007) finds that the amount of long-term monetary incentives (in this case stock options and restricted stock) given to the heads of research and development departments is strongly correlated with the number of cited patents. In the same vein, Manso (2010) proposes a framework to study the optimal incentives for innovation and shows that long-term monetary incentives *e.g.* granted stock options are quintessential for promoting innovative practises.

Put simply, a compensation contract that includes long-term incentives, such as stock options, motivates the manager to undertake all positive NPV projects regardless of their risk. Undertaking positive NPV projects maximizes the value of the company in the long-term, which also leads to a personal gain for the manager through the options contracts. A study by Francis, Hasan and Sharma (2011) exhibits this theory in practise. The authors empirically examine the relationship between CEO compensation and innovation using a broad sample of executive compensation data for S&P MidCap 400, S&P Small Cap 600 and S&P 500 companies from 1992 till 2005. They find that long-term incentives which enforce long-term commitment, including new options grants and previously granted unvested and vested options, have a positive relationship with patents and citations to patents.

Review of the relevant literature indicates that there is little to no construction specific empirical evidence on the topic. However, one could reasonably assume the above findings regarding the importance of monetary incentives for innovation are also present in the construction industry. If this assumption holds true, the topic of this study – namely the impact innovations have on the market capitalization of construction companies – becomes vital as it determines whether innovation is financially compelling or not. This impact is especially important to examine since stock-based pay amounts to 49% of the average total CEO compensation in S&P Europe 350 companies, and more specifically 46% and 60% in GICS sectors Industrials and Consumer Discretionary respectively, to which construction companies are classified to (Kotnik *et al.,* 2018).

2.3 Capital market efficiency

For stock-based incentives to work as intended, capital markets have to be efficient and accurate in valuing companies based not only on broad market conditions, but on the actions and announcements of individual companies. Put another way, stock-based incentive schemes assume that capital markets are efficient in rewarding companies for good management decisions and punishing them for bad ones. This assumption, on which the empirical analysis of this study is based on, is the backbone of the efficient-market hypothesis.

According to the efficient-market hypothesis, the market capitalization of a company should reflect all currently available information rationally and instantaneously (Fama, 1991). As new information about the company is made available to market participants, *e.g.* in the form of innovation announcements, the market participants should make a quick and correct adjustment into the market capitalization of the company. The adjustment is assumed to be proportional to the net present value of the new information, and thus, the incremental effect of the announcement on the value of the company can be observed. If the market capitalization of the company rises following an innovation announcement, the rise should reflect a positive change in future prospects and cash flows of the business through, *e.g.*, improved competitiveness. Correspondingly, a decrease in market capitalization should reflect a negative change in future business prospects through, *e.g.*, sunk innovation costs. Previous literature has shown that capital markets react to innovation announcements (see *e.g.* Chaney *et al.,* 1991; Sood and

Tellis, 2009; Kajander *et al., 2012*), and some studies even argue that abnormal returns to innovation announcements are the best means of assessing true rewards of innovation since the path of causality is clearer than, say, in comparing the effects of innovation on sales, profitsor market share (see *e.g.* Sood and Tellis, 2009).

Much of the theory surrounding efficient-market hypothesis was established by Eugene Fama (1970) in his now-famous paper, “Efficient Capital Markets: A Review of Theory and Empirical Work”. In his paper, Fama distinguishes three types of market efficiency: weak, semi-strong and strong. In weak-form efficient market, future returns cannot be predicted from past returns or any other market-based indicator. In semi-strong form efficient market, prices reflect all publicly available information about economic fundamentals, as well as the content of financial reports, company announcements, and so on. Finally, in strong form efficient market, prices reflect all public and private information. The strong form market efficiency serves mainly as a theoretical case, as it would require even private information from insiders to be reflected in prices.

Market efficiency is associated with low transaction costs and low costs of obtaining information (Fama, 1991). In the European Union, the target market for this study, transaction and information costs are relatively low, and hence, security markets in the European Union are thought to be relatively efficient (see *e.g.* Torun and Serdar, 2008). Further, the efficiency of European security markets has been empirically analysed on multiple occasions, by for example Borges (2010) and Onali and Goddard (2011). Although the empirical results from these studies provide mixed evidence on a country-by-country level, they prove European stock markets are generally at least weak form efficient.

2.4 Defining innovation

As this study investigates the link between construction innovation announcements and the market capitalization of companies, it is essential to clearly lay out what constitutes as an innovation. The word “innovation” is often thrown around abundantly in business context. However, when trying to define the concept of innovation it becomes obvious that there is not a single agreed-upon way of doing so. Nevertheless, this section aims to find a suitable definition for the scope of this study by reviewing relevant prior innovation literature. Firstly, this section discusses innovation definitions in broader corporate literature. Then, the definitions of innovation developed specifically for the construction industry are reviewed. Finally, the definition of innovation adopted for this study is presented.

2.4.1 Definitions of innovation in broader corporate literature

Unsurprisingly, there is no clear and exact definition for innovation. Innovation is variously understood in different disciplines and industries, and thus its definition is often vigorously debated. Case in point, as Shah, Gao and Mittal (2014, p. 3) describe in their book regarding innovation: *"The word innovation has come to mean a lot of different things to a lot of different people, and as is typically the case with words in vogue at different periods in time, this word has been used and abused to the point where the word may have begun to lose its meaning*".

However, there exists a few broad definitions in corporate literature that distinguish the key characteristics of innovation. In modern literature, the interpretation of innovation goes back to Schumpeter and his writings in the 1930s. In his paper, Schumpeter (1934, p. 66) provides a definition for innovation and emphasises that it must be dissociated from the definition of invention. Schumpeter describes innovation as new combinations of new or existing knowledge, resources, equipment, and other factors. According to Schumpeter's definition, a key difference between an innovation and an invention is that innovation is developed solely with commercialization in mind. Essentially, Schumpeter sees innovation as the process through which new ideas are generated and put into commercial practice in the form of new products.

Following this early definition, multiple attempts to define innovation have reached somewhat similar conclusions. In 1985, Peter Drucker (1985, p. 19) in his seminal book "Innovation and Entrepreneurship", describes innovation as a tool for creating new business opportunities through new or advanced technologies, products, services, processes and business models. This definition shares a lot in common with that of Schumpeter, as it describes innovation as a process of creating something novel that concludes with market introduction. However, many scholars, such as Rosenberg (1983), conversely argue that innovation doesn't always lead to a direct market introduction. According to Rosenberg´s definition, innovations can be divided into two distinct categories: qualitatively superior output (*i.e.* product innovation) and quantitatively greater volume of output (*i.e.* process innovation). Even so, Rosenberg emphasizes the importance of product innovations by referencing an earlier study by Kuznets (1971): "*All rapidly growing industries eventually experience a slowdown in growth as the cost-reducing impact of technical innovation diminishes*". Thus, according to Rosenberg (1983, p. 5), continued rapid growth eventually requires the development of new products.

To continue, a more recent study by Johannessen, Olsen and Lumpkin (2001) aims to build on these notions by providing a comprehensive framework that divides innovation into six distinct areas: new products, new services, new methods of production, opening new markets, new sources of supply, and new ways of organizing. According to the authors, innovation results from the application of new knowledge whether or not it takes shape through new products or new processes. This definition by Johannessen, Olsen and Lumpkin succeeds in synthesizing the key essence of innovation from previous literature: the vast majority of the varying definitions for innovation have the notion of newness as a common.

2.4.2 Definitions of innovation in construction literature

Since construction is partly manufacturing and partly services, innovations can occur in very diverse and varied economic areas, and often encompass a wide range of participants including governments, suppliers, vendors, designers, contractors, owners, associations, educational institutions, and certification bodies (Marceau *et al.,* 1999). Thus, it is no surprise that there are multiple equivocal definitions for innovation also in the construction literature. Still, it is evident that the definitions in construction context follow a similar structure to those definitions in the broader corporate literature.

Case in point, in one of the first studies discussing innovation in the context of construction, Bowley (1960) examines the British building industry and concludes that construction innovations can be classified into two distinct categories: those that introduce new aspects to products and those that introduce new aspects to processes. Following Bowley´s framework, Freeman (1989, p. 197) defines innovation in as "*the actual use of a nontrivial change and improvement in a process, product, or system that is novel to the institution developing the change*". According to the author, innovation has to have the ability to make "substantive changes" to standard practice in the organization. Since then, this classification has been broadly adopted and accepted within the construction industry by participants and academics. For instance, a series of academic papers examining innovation in the real estate discipline by Slaughter (1998; 2000) adopt this exact definition from Freeman´s work. Likewise, Blayse and Manley (2004) and Kumaraswamy *et al.* (2004) also indirectly quote Freeman through referencing Slaughter´s definitions.

Nevertheless, multiple studies have still sided with somewhat differing definitions for construction innovation. Perhaps the most detailed construction specific definition is offered by Toole (1998, p. 2) in his investigation into the adoption of innovations by small- and medium-sized home building firms across the US. Toole defines innovation as "*the application of technology that is new to an organisation and that significantly improves* *the design and construction of a living space by decreasing installed cost, increased installed performance, and/or improving the business process, e.g., reduces lead time or increases flexibility*". Further, Dulaimi, Nepal and Park (2005) identify innovation as the generation, development, and implementation of ideas that are new to an organisation and that have practical benefits. The authors emphasize that the ideas do not have to be new to the world, but new to the particular organisation. Moreover, Lim and Ofori´s (2007) research into construction innovation in Singapore adds further granularity to the matter by defining that construction innovations have to either produce a sustained competitive advantage, reduce construction costs and improve productivity, or convince clients to pay more.

2.4.3 Definition of innovation adopted for this study

It is clear from the literature review that there are multiple varying definitions for innovation, all of which could provide slightly varying empirical results in the empirical analysis of this study. While some of the definitions are more specific and some more general, the literature is quite unanimous on the fact that the notion of newness is essential to innovation.

Since this study aims to produce as reliable and reproducible results as possible, the empirical analysis of this study utilizes the most prominent and broadly adopted definition of construction innovation. Therefore, the definition of innovation adopted for this study is the one by Freeman (1989, p. 197), which defines innovation as "*the actual use of a nontrivial change and improvement in a process, product, or system that is novel to the institution developing the change*".

3. METHODOLOGY AND HYPOTHESES

This chapter presents the methodology employed in the empirical part of this study as well as the examined key hypotheses. Firstly, the general principles of the event study methodology are discussed. The event study methodology is utilized in the empirical analysis of this study to measure the impact of innovation announcements on the market value of construction companies. Secondly, the exact specification of the utilized event study methodology is presented. Finally, the chapter is concluded by discussing the key hypotheses of this study along with the statistical tests used to test them.

3.1 Event study methodology

An event study is a statistical method for assessing the impact of an event on the market value of a company to examine whether investors believe the event will create or destroy shareholder value. Event studies are commonly used in corporate literature and research, as they can be used to investigate stock market responses to a variety of company specific and economy wide events, including mergers and acquisitions, earnings announcements, and – in the context of this study – innovation announcements (see *e.g.* MacKinlay, 1997; Kajander *et al.*, 2012). The basic idea is to find the abnormal return attributable to the event being studied by adjusting for the return that stems from the price fluctuation of the market as a whole. The abnormal return can then be attributed to the event, as the markets are presumed to be efficient in valuing the implications of the specific event.

The modern methodology of event studies was established by Ball and Brown (1968), in their study investigating the impact of annual earnings announcements on stock prices, and by Fama *et al.* (1969), in their study examining the stock price behaviour around stock splits. Since then, the event study methodology has been a major focus of research and the methodology itself has continued to evolve (MacKinlay, 1997).

MacKinlay (1997) provides an often-referenced explanation of the general event study methodology. According to MacKinlay´s explanation, the methodology first estimates what the “normal returns” of the affected company should be around the event (*i.e.,* during the event window). Thereafter, the methodology deducts these “normal returns” from the actual returns to receive the “abnormal” returns attributed to the event.

MacKinlay adds that the two of the most commonly used methods for calculating “normal returns” are the constant mean return model and the market model. In the simpler of the methods, constant mean return model, the company is expected to generate the same return it averaged during a previous estimation period. In the market model, the return of the company is related to the return of a portfolio of stocks used to represent the overall market. As such, the market model represents a potential improvement over the constant mean return model by removing the portion of the return that is related to variation in the market´s return (MacKinlay, 1997).

The constant mean return model is expressed as:

$$R_{it} = \mu_i + \zeta_{it} \tag{1}$$

, where R_{it} is the period-t return on security i and ζ_{it} is the time period t disturbance term for security i with an expectation of zero and variance $\sigma^2_{\zeta_{it}}$ (MacKinlay, 1997).

The market model is expressed as:

$$R_{it} = \alpha_i + \beta_i R_{mt} + \epsilon_{it} \tag{2}$$

, where R_{it} and R_{mt} are the period-t returns on security i and the market portfolio, respectively, and ϵ_{it} is the zero mean disturbance term with variance $\sigma^2_{\epsilon_i}$, while α_i and β_i are the parameters of the market model (MacKinlay, 1997).

The period-t, which can also be referred to as the estimation period, must be chosen to be long enough to capture the normal return for the security. During the estimation period, the typical relationship between the returns of the stock and its reference index is derived through a regression analysis. Existing literature has used estimation periods from 200 to 250 days (see *e.g.* MacKinlay, 1997; Kajander *et al.*, 2012).

3.1.1 Specification of the utilized event study methodology

This study follows the market model event study methodology. MacKinlay (1997) argues that the accuracy of the market model could be improved further by introducing additional factors such as industry index factor or the similar sized portfolio factor. However, these factors would require more than one company to represent an industry in each of the studied markets, and as such, they cannot be incorporated to this study.

The abnormal returns can be calculated by deducting the “normal returns” from the actual returns:

$$AR_{it} = R_{it} - \widehat{\alpha_\iota} - \widehat{\beta_\iota} R_{mt} \tag{3}$$

, where AR_{it} is the period-t abnormal return for security i, R_{it} is the period-t “normal return” for security i, and R_{mt} is the period-t normal return on market portfolio m (MacKinlay, 1997).

The market beta coefficient $\widehat{\beta_i}$ and alpha coefficient $\widehat{\alpha_i}$ and their constituents can then be formulated as:

$$\widehat{\beta_i} = \frac{\sum_{\tau-\tau_0}^{\tau_1}(R_{i\tau} - \hat{\mu}_\tau)(R_{m\tau} - \hat{\mu}_{r\tau})}{\sum_{\tau-\tau_0}^{\tau_1}(R_{m\tau} - \hat{\mu}_m)^2} \tag{4}$$

$$\alpha_i = \hat{\mu}_i - \widehat{\beta_i}\hat{\mu}_m \tag{5}$$

$$\hat{\mu}_i = \frac{1}{L_1}\sum_{\tau-\tau_0}^{\tau_1}(R_{i\tau}) \tag{6}$$

$$\hat{\mu}_m = \frac{1}{L_1}\sum_{\tau-\tau_0}^{\tau_1}(R_{m\tau}) \tag{7}$$

, where L_1 is the number of days in the estimation period (MacKinlay, 1997). This study utilizes an estimation period of 200 days.

Furthermore, the length of the event window must also be determined to be long enough for it to capture the whole impact of the event – in this case the innovation announcement. Therefore, this study considers two different scenarios. In Scenario 1, the length of the event window is determined to be only the day of the announcement. Scenario 1 presumes that the announcement will be fully priced on the same day it is announced. Then, in Scenario 2, the length of the event window is extended to consider five days before and five days after the announcement. In this way, Scenario 2 considers a longer time horizon around the event, to capture for example the possible anticipation of the event or a slower reaction to new information by the market participants. However, due to the longer event window, Scenario 2 is more susceptible to disturbances. Figure 1 below presents an illustration of the timeline for the utilized event study methodology.

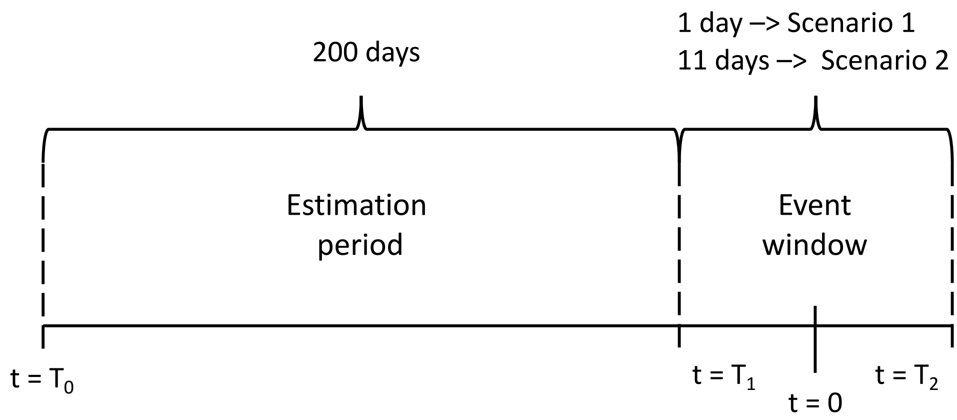

Figure 1. *Illustration of the timeline for the utilized event study methodology.*

To summarize, regression analysis is used during the estimation period to calculate the coefficients that explicate the typical relationship between the company´s stock and its reference index. These coefficients are then used to predict the “normal returns” for all days of the event window. “Normal returns” are then deducted from the actual returns to calculate the daily abnormal returns.

The calculated abnormal returns are jointly distributed with a zero conditional mean and conditional variance that can be defined as:

$$\sigma^2(AR_{it}) = \sigma_{\epsilon_i}^2 + \frac{1}{L_1}\left[1 + \frac{(R_{m\tau} - \hat{\mu}_m)^2}{\hat{\sigma}^2{}_m}\right] \tag{8}$$

, where t is summed over the estimation period T_0 to T_1 (MacKinlay, 1997). As can be seen, the conditional variance has two components. The first component is the disturbance variance $\sigma_{\epsilon_i}^2$ attributed to the market model (2), and the second component is the additional variance due to the sampling error in α_i and β_i. As the estimation period L_1 lengthens, the second component approaches zero as the sampling error of the parameters vanishes. As $L_1 = 200$, it is reasonable to assume that the contribution of the second component to the variance of the abnormal return is zero (MacKinlay, 1997).

3.1.2 Significance testing and key hypotheses

To draw inferences and conclusions from the event study, the abnormal returns must be aggregated through time and across securities – in this case across innovation announcements. Aggregation through time for an individual company is done by calculating $CAR_i(\tau_1, \tau_2)$, the sample cumulative abnormal return from τ_1 to τ_2, where $T_1 < \tau_1 \leq \tau_2 \leq T_2$:

$$CAR_i(\tau_1, \tau_2) = \sum_{\tau=\tau_1}^{\tau_2}(\mathrm{AR}_{i\tau}). \tag{9}$$

When L_1 is sufficiently large, the variance of CAR is:

$$\sigma_i^2(\tau_1, \tau_2) = (\tau_2 - \tau_1 + 1)\, \sigma_{\epsilon_i}^2. \tag{10}$$

The distribution of the cumulative abnormal return can then be used to test the significance of the results:

$$CAR_i(\tau_1, \tau_2) \sim N(0, \sigma_i^2(\tau_1, \tau_2)) \tag{11}$$

However, tests with one observation are often not of interest, so it is necessary to aggregate the abnormal returns also across multiple events (MacKinlay, 1997). If there is no overlap in the event windows of the included events, it is assumed that the cumulative abnormal returns are independent across securities. Aggregation through both time and announcements is formulated as:

$$\overline{CAR_\iota}(\tau_1, \tau_2) = \frac{1}{N}\sum_{i=1}^{\mathrm{N}} CAR_i(\tau_1, \tau_2). \tag{12}$$

Similarly, the variance can be formulated as:

$$var(\overline{CAR_\iota}(\tau_1, \tau_2)) = \frac{1}{N^2}\sum_{i=1}^{\mathrm{N}} \sigma_i^2(\tau_1, \tau_2) \tag{13}$$

The significance of the results can then be tested using distribution:

$$\overline{CAR_\iota}(\tau_1, \tau_2) \sim N[0, var(\overline{CAR_\iota}(\tau_1, \tau_2))] \tag{14}$$

The significance of the results is given by means of hypothesis testing. The fundamental aim of this study is to examine whether announcing an innovation leads to a measurable increase in the market capitalization of a construction company. In other words, this study aims to examine whether innovation announcements generate statistically significant cumulative abnormal returns. To fulfil this aim, this study considers two slightly different hypotheses which are built upon the prior research implying that innovations are a source of economic value. The first hypothesis for this study can be read as follows:

> $\boldsymbol{H_{1\mathrm{A}}}$ = Innovation announcements have a positive impact on the market capitalization of construction industry companies on the day of the announcement.

This hypothesis implies that innovation announcements generate abnormal returns, and that the abnormal returns can be observed on the day of the announcement. It is reasonable to assume that if the impact of the innovation announcement would be at its highest on the day of the announcement. To test this hypothesis, cumulative abnormal returns are calculated for Scenario 1, which only considers the day of the announcement. However, in addition to this, Scenario 2 is also considered to measure whether innovation announcements have a long-lasting impact on the market capitalization. Accordingly, the second hypothesis for this study can be read as follows:

> $\boldsymbol{H_{1\mathrm{B}}}$ = Innovation announcements have a positive impact on the market capitalization of construction industry companies over the extended event window.

This hypothesis is tested by calculating the cumulative abnormal returns for the extended event window of Scenario 2 which includes five days before and five days after the announcement. The hypothesis testing framework utilized in this study can be formally written for both of the hypotheses as follows, where the null hypothesis (H_0) claims that the cumulative abnormal returns are not positive, and alternative hypothesis (H_1) suggests the opposite:

$$H_0: \overline{CAR_\iota}(\tau_1, \tau_2) \ngtr 0$$
$$H_1: \overline{CAR_\iota}(\tau_1, \tau_2) > 0 \tag{15}$$

The hypothesis testing is done by applying a parametric statistical test, most common of which is the t-test, where the obtained t-statistics are compared with the critical values of the Student´s t-distribution. The distributional result is asymptotic with respect to the number of events N and the length of the estimation window L_1 (MacKinlay, 1997). H_0 can be tested using a value θ_1:

$$\theta_1 = \frac{\overline{CAR_\iota}(\tau_1, \tau_2)}{var\left(\overline{CAR_\iota}(\tau_1, \tau_2)\right)^{\frac{1}{2}}} \sim N(0,1). \tag{16}$$

There is some evidence that during times of high volatility, the t-test might overstate the significance of the abnormal returns (see *e.g.* Chen, 2014). However, in stable market conditions, the t-test should be a fairly reliable way of testing the significance of the results. As the period of interest for this study is relatively stable and free of disturbances, utilizing the t-test is deemed appropriate.

An important underlying assumption in the t-test is the normality of abnormal returns. Non-parametric statistics do not require as stringent assumptions about the probability distribution of returns. Thus, in addition to the t-test, the significance of the results is also examined with a non-parametric Wilcoxon signed-rank test. Wilcoxon signed-rank test compares the sample median against a hypothetical median to see whether the difference is statistically significant. Fama *et al.* (1969) argue that it is advisable to use the Wilcoxon signed-rank test in a sample which contains small cross-sections. The test uses ranks to include the magnitude of the median abnormal return. The lowest rank will be given to the observation with the smallest relative difference to "normal return" and vice versa. Then, both negative and positive ranks are summed to examine which of the ranks is closer to zero. The observed figure is then used to calculate a value θ_2:

$$\theta_2 = \frac{\mathrm{W} - \frac{n(n+1)}{4}}{\sqrt{\frac{n(n+1)(2n+1)}{24}}} \sim N(0,1). \tag{17}$$

, where W is the absolute value of the lowest summed signed rank and n is the total number of observations.

4. DATA DESCRIPTION

The data used in the empirical part of this study is constructed from three different datasets: company selection, financial data, and innovation announcements. This chapter explains the data gathering process and the main data sources for this study. Firstly, the company selection criteria are explained in detail. Secondly, the data sources for the utilized financial data are discussed. Finally, the chapter is concluded by explaining the innovation announcement review process, as well as the measures taken to mitigate possible disturbances. All of the data utilized in this study is gathered from publicly available sources so that the results can be reproduced and beneficially applied in industry or future research.

4.1 Company selection

This study focuses on public construction companies based in the member states of the European Union. As a way of limiting the scope of this study and ensuring the validity of the empirical results, companies were screened with the following criteria explained in detail below.

Firstly, the selected companies had to generate over a billion euros in revenues in 2019. This arbitrary figure was selected as a proxy to confine small construction companies from the scope of this study, as these companies could possess features that might skew the results, such as low trading volume, liquidity constraints, and so on. What is more, according to McFallan (2002), in most countries the innovation activity in the construction industry is largely concentrated to larger companies as smaller companies often have insufficient resources to undertake innovation. Therefore, concentrating in larger companies is meaningful for the purposes of this study.

Secondly, the companies´ main field of activity as of 2019 had to be in the NACE industry F41 (Construction of Buildings). NACE is a structure used to designate statistical classifications to economic activities in the European Union. This specific criterion was used to omit multi-industry conglomerates from the company selection, some of which only generate a fraction of their revenues from construction. A drawback of using the NACE coding is that it might not be an accurate representation of the companies´ actual main activities over the whole ten-year period examined in this study. Despite this drawback, utilizing an industry criterion such as the NACE coding is one of the few objective ways for categorizing companies. Hence, is it deployed in this study.

Finally, the selected companies had to be publicly traded on European stock exchanges and have sufficient financial data available for conducting the event study. The sufficient financial data includes historical daily data of closing prices, trading volumes, as well as a publicly available archive of press releases.

These aforementioned criteria were applied in a search executed in the Orbis company database (https://www.bvdinfo.com/en-gb/our-products/data/international/orbis). The search produced a total of 19 companies from 10 member states of the European Union. Most of these companies operate internationally in several different markets, mostly in the fields of construction project development, construction-related services, engineering and infrastructure, and property solutions.

4.2 Financial data

Financial data for the selected companies was then acquired from Yahoo Finance (https://finance.yahoo.com). The acquired data includes historical daily closing prices for the companies as well as their country-specific benchmark indices. The closing prices are adjusted for stock-splits and dividends, and thus, daily logarithmic returns for each company and each index can be calculated with minimal disturbances. Further, data of the historical daily trading volumes for each of the companies was also acquired for the volume analysis used to examine the robustness of the empirical results.

This study focuses on innovation announcements for the ten-year period from 2010 to 2019. To ensure sufficient return data for the 200-day estimation period required by the utilized event study methodology, the financial data obtained for this study ranges from April 2009 to December 2019. Discounting the European sovereign debt crisis, the considered time-period should be relatively free of any major stock market disturbances and thus more than suitable for the purposes of this study. Table 1 below exhibits the selected companies along with their key details, such as turnover, country of origin, ticker symbol, stock exchange, and the corresponding benchmark index.

Table 1. *Breakdown of the selected companies with key details such as turnover, country of origin, ticker symbol, stock exchange, and the utilized benchmark index.*

Company	Turnover (€, bn., 2019)	Country ISO code	Ticker	Stock exchange	Utilized bench-mark index
Acciona	7.9	ES	ANA	Bolsa de Madrid	IBEX-35
ACS	39.4	ES	ACS	Bolsa de Madrid	IBEX-35
Astaldi	1.6	IT	AST	Borsa Italiana	FTSE MIB
Bonava	1.5	SE	BONAV-B	Nasdaq Stockholm	OMXS30
Budimex	1.8	PL	BDX	Warsow Stock Exchange	WIG20
CFE	3.7	BE	CFE	Euronext Brussels	BEL20
Eiffage	18.7	FR	FGR	Euronext Paris	CAC40
ELLAKTOR	1.3	GR	ELLKY	Athens Stock Exchange	ASE
Heijmans	1.8	NL	HEIJM	Euronext Amsterdam	AEX
JM	1.5	SE	JM	Nasdaq Stockholm	OMXS30
NCC	5.5	SE	NCC-B	Nasdaq Stockholm	OMXS30
PEAB	5.2	SE	PEAB-B	Nasdaq Stockholm	OMXS30
PORR	5.0	AT	POS	Wiener Börse	ATX
Royal BAM	7.2	NL	BAM	Euronext Amsterdam	AEX
Sacyr	4.5	ES	SCYR	Bolsa de Madrid	IBEX-35
Skanska	33.6	SE	SKA-B	Nasdaq Stockholm	OMXS30
SRV	1.0	FI	SRV1V	Nasdaq Helsinki	OMXH25
VINCI	44.3	FR	DG	Euronext Paris	CAC40
YIT	3.1	FI	YIT	Nasdaq Helsinki	OMXH25

ES = Spain, IT = Italy, SE = Sweden, PL = Poland, BE = Belgium, FR = France, GR = Germany, NL = Netherlands, AT = Austria, FI = Finland.

4.3 Innovation announcements

The companies presented in Table 1 were then reviewed for innovation announcements for the years 2010–2019. Only announcements disclosed through official press releases were included in the scope of this study. Therefore, as a next step in the data gathering process, the hundreds of press releases issued by the selected companies from 2010 to 2019 were sourced from the companies´ websites and reviewed. To aid with the discovery of the press releases concerning innovation, following keywords were used to search the topics as well as the contents of the press releases: *“innovation”, “innovative”, “invention”, “new”, “novel”, “invests”, “investing”, “research”, “green”, “carbon”, “renewable”, “efficiency”, “efficient”, “sustainability”, “sustainable”, “energy”, “modular”, “lean”, “automation”, “robotics”, “virtual reality”, “augmented reality”, “data”,* *“prefabrication”, “prefabricated”, “drone”, “BIM”, “advanced”, “state-of-the-art”, “artificial intelligence”, “disruption”, “disrupting”, “disruptive”, “tech”, “technology”, “launches”, “launch”, “start-up”, “industrial”, “industrialized”, “safety”, “megatrends”, “development”, “developed”, “develops”, “factory”, “expand”, “smart”, “digital”, “introduce”, “offers”.*

Following this initial search, the discovered press releases were analysed further to see if they could be included in the study. As explained earlier (please see Section 2.3), this study follows the broadly accepted definition of innovation by Freeman *et al.* (1989): “*The actual use of a nontrivial change and improvement in a process, product, or system that is novel to the institution developing the change*”. Accordingly, the tentative press releases and their contents were then evaluated using this definition as a criterion in two expert group workshops. Three industry professionals participated in the workshops and focused on the qualitative evaluation of the nontriviality and novelty value of the press releases by comparing them to the state-of-the-art advances in the industry. As a result, several announcements describing for example intangible and trivial developments were excluded from the final sample.

Furthermore, the innovation announcements were screened for other significant press releases during the event window. For instance, innovation announcements that were published around the same time with earnings announcements, profit warnings, or other significant shareholder events were excluded from the final sample. The remaining announcements, of which there are 58, form the final sample of this study. Surprisingly, only 14 of the selected companies had at least one innovation announcement eligible for this study during 2010–2019. Table 2 below showcases the number of eligible innovation announcements by company, as well as the time periods for the announcements. In addition, Appendix A showcases the topics of the announcements sorted by the day of the announcement.

Table 2. *Breakdown of the eligible innovation announcements by company, and the time periods for the announcements.*

Company	Number of announcements	Period of innovation announcements
Acciona	9	16 February 2016 – 30 October 2019
ACS	1	29 May 2017
Astaldi	0	–
Bonava	0	–
Budimex	2	28 June 2017 – 9 August 2018
CFE	4	19 September 2016 – 19 December 2019
Eiffage	4	15 October 2015 – 26 June 2019
ELLAKTOR	0	–
Heijmans	5	17 December 2013 – 16 June 2016
JM	1	29 August 2011
NCC	7	11 March 2010 – 30 October 2018
PEAB	1	5 September 2011
PORR	0	–
Royal BAM	7	12 June 2012 to 28 November 2019
Sacyr	0	–
Skanska	4	4 January 2012 to 23 April 2018
SRV	1	8 March 2016
VINCI	2	2 September 2015 – 18 June 2019
YIT	10	11 October 2010 – 29 March 2019

The event study estimations are then conducted with this final sample of innovation announcements. Some of the innovations that form the final sample were announced outside of the opening hours of the corresponding stock exchange, and thus, the calculations in the event study estimations are adjusted by utilizing the closing price of the next trading day. Moreover, some of the events have overlapping event windows in the extended Scenario 2 and are therefore only eligible for computing Scenario 1. Therefore, the results for Scenario utilize the full sample of 58 innovation announcements, whilst Scenario 2 utilizes a reduced sample of 53 announcements.

5. RESULTS

This chapter exhibits the empirical findings of this study. Firstly, the results from Scenario 1, where the length of the event window for the event study is determined to be only the day of the announcement, are presented. Secondly, this chapter presents the results from Scenario 2, where the event window is extended to consider five days before and five days after the announcement. In both of the scenarios, the statistical significance of the results is interpreted with statistical tests, such as t-test and Wilcoxon signed-rank test. Finally, the chapter is concluded by discussing the robustness of the results.

5.1 Scenario 1: the day of the announcement

Scenario 1 examines the impact of an innovation announcement on the company's market capitalization on the event day. This examination is done using the market model specified in the previous chapter and utilizing the full data sample presented in Table 2. Therefore, Scenario 1 considerers a total of 58 innovation announcements. Table 3 presents the event-day abnormal returns for the innovation announcements, as well as the conditional variances for each event. Further, Table 4 presents the cumulative abnormal returns, cumulative variances, and cumulative t-statistics for the same announcements.

Table 3. Event-day abnormal returns and variances for the innovation announcements.

Scenario 1							
Date	**Company**	AR_τ (%)	$\hat{\sigma}_\tau^2$	**Date**	**Company**	AR_τ (%)	$\hat{\sigma}_\tau^2$
11.03.2010	NCC	+1.444	0.031	29.03.2017	NCC	+1.409	0.008
11.10.2010	YIT	+0.977	0.022	27.04.2017	Eiffage	+0.787	0.008
12.10.2010	YIT	+1.188	0.022	29.05.2017	ACS	+1.219	0.011
14.10.2010	YIT	+0.113	0.022	13.06.2017	NCC	+0.727	0.007
26.05.2011	NCC	+0.085	0.021	20.06.2017	Eiffage	-0.135	0.009
29.08.2011	JM	+1.753	0.018	28.06.2017	Budimex	-0.192	0.037
05.09.2011	PEAB	+0.612	0.023	08.12.2017	Skanska	+0.130	0.009
04.01.2012	Skanska	+1.571	0.009	01.03.2018	YIT	-0.329	0.022
31.01.2012	YIT	+1.461	0.034	17.04.2018	NCC	+0.171	0.019
13.06.2012	Royal Bam	-3.890	0.049	23.04.2018	Skanska	-0.169	0.017
18.06.2012	Skanska	+0.855	0.009	15.06.2018	Acciona	+1.071	0.012
03.07.2012	YIT	+0.055	0.032	26.06.2018	Acciona	+2.184	0.013
19.02.2013	Royal Bam	+1.494	0.041	06.08.2018	Royal Bam	-0.053	0.055
17.12.2013	Heijmans	+2.702	0.023	09.08.2018	Budimex	-0.296	0.062
06.05.2015	Royal Bam	+3.672	0.140	21.09.2018	CFE	-0.481	0.027
15.06.2015	Heijmans	-1.503	0.056	27.09.2018	Acciona	+0.749	0.012
18.06.2015	Heijmans	+1.584	0.057	30.10.2018	NCC	+0.297	0.022
03.09.2015	Vinci	-0.704	0.009	17.12.2018	Acciona	-0.227	0.014
15.10.2015	Eiffage	+0.246	0.017	24.01.2019	Acciona	+0.059	0.014
16.10.2015	Heijmans	+1.817	0.084	25.01.2019	Royal Bam	+1.251	0.026
16.02.2016	Acciona	+1.285	0.013	29.03.2019	YIT	+1.249	0.031
08.03.2016	SRV	+0.277	0.032	16.05.2019	Acciona	-4.162	0.014
18.05.2016	YIT	-1.333	0.066	19.06.2019	Vinci	+0.976	0.006
16.06.2016	Heijmans	-0.123	0.092	26.06.2019	Eiffage	-2.259	0.010
24.06.2016	Acciona	+2.503	0.015	27.06.2019	Royal Bam	+1.401	0.031
04.07.2016	YIT	-0.743	0.060	18.07.2019	CFE	-1.007	0.018
19.09.2016	CFE	+0.287	0.034	30.10.2019	Acciona	+2.351	0.015
01.12.2016	NCC	+0.160	0.011	28.11.2019	Royal Bam	+1.390	0.072
21.02.2017	YIT	+1.014	0.025	19.12.2019	CFE	-0.024	0.016

AR_τ (%) = abnormal return on the event day, $\hat{\sigma}_\tau^2$ = conditional variance

Table 4. Cumulative abnormal returns, cumulative variances, and corresponding t-statistics for the innovation announcements.

Scenario 1							
Date	$\overline{CAR_t}$ (%)	$var(\overline{CAR_t})$ (%)	**t-test**	**Date**	$\overline{CAR_t}$ (%)	$var(\overline{CAR_t})$ (%)	**t-test**
11.03.2010	1.444	0.031	0.826	29.03.2017	0.676	0.001	1.955
11.10.2010	1.211	0.013	1.059	27.04.2017	0.679	0.001	2.023
12.10.2010	1.203	0.008	1.324	29.05.2017	0.696	0.001	2.129
14.10.2010	0.931	0.006	1.200	13.06.2017	0.697	0.001	2.191
26.05.2011	0.761	0.005	1.111	20.06.2017	0.673	0.001	2.169
29.08.2011	0.927	0.004	1.509	28.06.2017	0.648	0.001	2.116
05.09.2011	0.882	0.003	1.547	08.12.2017	0.634	0.001	2.120
04.01.2012	0.968	0.003	1.885	01.03.2018	0.608	0.001	2.069
31.01.2012	1.023	0.002	2.046	17.04.2018	0.596	0.001	2.068
13.06.2012	0.532	0.003	1.060	23.04.2018	0.576	0.001	2.038
18.06.2012	0.561	0.002	1.208	15.06.2018	0.589	0.001	2.125
03.07.2012	0.519	0.002	1.151	26.06.2018	0.628	0.001	2.310
19.02.2013	0.594	0.002	1.337	06.08.2018	0.612	0.001	2.256
17.12.2013	0.745	0.002	1.744	09.08.2018	0.590	0.001	2.179
06.05.2015	0.940	0.002	1.999	21.09.2018	0.566	0.001	2.117
15.06.2015	0.787	0.002	1.693	27.09.2018	0.570	0.001	2.171
18.06.2015	0.834	0.002	1.815	30.10.2018	0.564	0.001	2.179
03.09.2015	0.748	0.002	1.712	17.12.2018	0.547	0.001	2.149
15.10.2015	0.722	0.002	1.720	24.01.2019	0.537	0.001	2.144
16.10.2015	0.777	0.002	1.831	25.01.2019	0.552	0.001	2.228
16.02.2016	0.801	0.002	1.964	29.03.2019	0.566	0.001	2.307
08.03.2016	0.777	0.002	1.955	16.05.2019	0.473	0.001	1.958
18.05.2016	0.685	0.002	1.729	19.06.2019	0.483	0.001	2.034
16.06.2016	0.652	0.002	1.628	26.06.2019	0.431	0.001	1.845
24.06.2016	0.726	0.002	1.874	27.06.2019	0.449	0.001	1.938
04.07.2016	0.669	0.001	1.742	18.07.2019	0.422	0.001	1.847
19.09.2016	0.655	0.001	1.741	30.10.2019	0.457	0.001	2.024
01.12.2016	0.638	0.001	1.748	28.11.2019	0.473	0.001	2.088
21.02.2017	0.650	0.001	1.826	19.12.2019	0.465	0.001	2.076

$\overline{CAR_t}$ (%) = cumulative abnormal return, $var(\overline{CAR_t})$ (%) = cumulative variance, t-test = t-statistic for the null hypothesis. The critical t-statistic values for the applied sample are as follows: 1.282 at a 10% significance level, 1.645 at a 5% significance level, 1.96 at a 2.5% significance level.

As Table 3 illustrates, the abnormal returns to innovation announcements are mostly positive. Of the 58 considered announcements, 40 have a positive abnormal return while 18 have a negative abnormal return. Further, when looking at the aggregated abnormal returns to these innovation announcements from Table 4, it becomes apparent that there is a clear positive average abnormal event-day return of +0.465%. The obtained t-statistic of 2.076 indicates that this abnormal return across announcements is significant even at a 0.025 significance level.

Furthermore, the corresponding median abnormal event-day return for Scenario 1 is 0.455% significant at a 0.025 significance level according to Wilcoxon signed-rank test, thus supporting the findings. The null hypothesis for Scenario 1 claims that the cumulative abnormal return to innovation announcements is not positive on the day of the announcement. Evidently, we can reject this hypothesis on the notion that the findings suggest that innovation announcements produce an average abnormal return of +0.465% on the event day.

5.2 Scenario 2: extended event window

In Scenario 2, the length of the event window is extended to consider five days before and five days after the announcement. As the considered time-horizon around the events is extended, some of the innovation announcements end up having overlapping event windows. Thus, in Scenario 2, five innovation announcements published on the following days are omitted from the sample: 11.10.2010; 12.10.2010; 14.10.2010; 15.06.2016; 18.06.2016. Therefore, Scenario 2 is computed with 53 innovation announcements. It is assumed that the cumulative abnormal returns for these remaining announcements are cross-sectionally independent. Table 5 presents the average cumulative abnormal returns and their t-statistics for the innovation announcements over the extended event windows. The presented abnormal returns are aggregated through time and across announcements.

Table 5. Average abnormal returns and their t-statistics over the extended event windows.

Scenario 2				
Event window			Descriptive statistics	
Begins	Ends	Days	Average CAR (%)	t-test
0	0	1	0.464	2.003***
0	1	2	0.491	1.499*
0	2	3	0.825	2.057***
0	3	4	0.756	1.631*
0	4	5	0.942	1.819**
0	5	6	1.217	2.145***
-1	0	2	0.147	0.449
-1	1	3	0.174	0.433
-1	2	4	0.508	1.097
-1	3	5	0.439	0.847
-1	4	6	0.625	1.102
-1	5	7	0.900	1.468*
-2	0	3	0.247	0.616
-2	1	4	0.274	0.591
-2	2	5	0.608	1.174
-2	3	6	0.539	0.949
-2	4	7	0.725	1.183
-2	5	8	1.000	1.526*
-3	0	4	0.072	0.155
-3	1	5	0.099	0.190
-3	2	6	0.433	0.763
-3	3	7	0.363	0.593
-3	4	8	0.550	0.839
-3	5	9	0.824	1.186
-4	0	5	0.477	0.920
-4	1	6	0.503	0.887
-4	2	7	0.838	1.367*
-4	3	8	0.768	1.173
-4	4	9	0.955	1.374*
-4	5	10	1.229	1.678**
-5	0	6	0.384	0.677
-5	1	7	0.411	0.670
-5	2	8	0.745	1.137
-5	3	9	0.676	0.972
-5	4	10	0.862	1.177
-5	5	11	1.137	1.480*

Average CAR (%) = avg. cumulative abnormal return, t-test = t-statistic for the null hypothesis. *** implies significance at a 0.025 level, **implies significance at a 0.05 level, *implies significance at a 0.1 level.

As can be seen from Table 5, all of the examined event windows show positive abnormal returns. However, only a handful of these returns are statistically significant. The null hypothesis for Scenario 2 claims that the cumulative abnormal return over the extended event window is not positive, and thus, the null hypothesis cannot be rejected in most of the event windows.

Though, it is noteworthy to point out that all of the event windows from the announcement till five days after the announcement exhibit positive abnormal returns significant at least at a 0.10 significance level. This could suggest that the positive reaction to innovation announcement lasts for a few days after the announcement, as market participants are slow in reacting to the new information. On the other hand, the considerable abnormal returns on event day could increase the statistical significance of the subsequent event windows. To examine the abnormal returns around the event day further, additional event windows are computed for pre-event, event, and post-event periods. Table 6 illustrates the average and median abnormal returns and their descriptive statistics for these additional periods.

Table 6. Average abnormal returns, median abnormal returns, and their descriptive t-statistics and Wilcoxon signed-rank test statistics over the pre-event, event, and post-event periods.

Scenario 2					
	Event window	**Average CAR (%)**	**p^a**	**Median CAR (%)**	**p^b**
Pre-event	[-5, -1]	-0.080	(0.439)	+0.324	(0.530)
	[-3, -1]	-0.392	(0.164)	-1.543	(0.738)
	[-1]	-0.317	(0.086)*	-0.185	(0.039)**
Event	[0]	+0.464	(0.023)***	+0.297	(0.001)***
Post-event	[1]	+0.027	(0.453)	-0.097	(0.491)
	[1, 3]	+0.292	(0.233)	+0.318	(0.296)
	[1, 5]	+0.753	(0.073)*	+0.287	(0.084)*

Average CAR (%) = avg. cumulative abnormal return, Median CAR (%) = median cumulative abnormal return, p^a = p-values for the null hypothesis using t-test, p^b = statistical significance for the median obtained with Wilcoxon signed-rank test. *** implies significance at a 0.025 level, **implies significance at a 0.05 level, *implies significance at a 0.10 level.

As the results from Table 6 illustrate, bulk of the abnormal returns are contributable to the event day. In timeframes where the announcement date is not included, namely the pre-event and post-event periods, the observed abnormal returns are marginal in comparison. Thus, it cannot be concluded that the positive reaction to innovation announcement lasts after the announcement. Curiously, some negative cumulative abnormal returns can be observed in the pre-event period, specifically in the day leading up to the announcement. These negative cumulative abnormal returns are however only significant at a 0.10 significance level and could be caused by disturbances for which the Scenario 2 is more prone to due to the longer event window.

The obtained empirical results imply that the null hypothesis for Scenario 2, claiming that the cumulative abnormal return to innovation announcements over the extended event window is not positive, cannot be rejected. Put another way, the innovation announcements do not seem to have a long-lasting impact on the market capitalization of the construction companies.

Nevertheless, these findings enforce the anticipated notion that market participants react positively to innovation announcements on the event day. Even in the extended event window of Scenario 2, the largest average daily abnormal return can be observed on the announcement day of the innovation. Using the smaller sample in Scenario 2, the average abnormal return on event day is +0.464% significant at a 0.025 significance level. These findings are also supported by the positive median abnormal event-day return of +0.297%, which is also significant at a 0.025 significance level according to Wilcoxon signed-rank test.

5.3 Robustness of the findings

The empirical evidence from both considered scenarios suggests that innovation announcements have a positive effect on the market capitalization of construction companies. According to the empirical analysis, innovation announcements explain on average a 0.465% increase in the market capitalization of a construction company announcing the innovation. The observed abnormal return is statistically significant at a 0.025 significance level and can be attributed to the day of the announcement. That said, some caution should be imposed when interpreting the results, since there are multiple limitations and biases that might affect the results in one way or another. This section discusses the robustness of the main findings through potential limitations and biases that the utilized dataset and methodology poses.

5.3.1 Volume analysis

First and foremost, as a way of examining the robustness of the findings, an analysis assessing the trading volumes on the event day versus the three-month average was carried out. Prior literature (see *e.g.* Morse, 1981) has shown that excess trading volumes occur around interesting announcements, such as interim or annual reports. One could assume that the days for the innovation announcements exhibit excess trading volumes in a similar fashion.

Moreover, the utilized sample of announcements is also reviewed for low trading volumes. Low trading volumes means there are fewer shares trading, and fewer shares means less liquidity across the broad market. Prior research has shown that low trading volumes can indicate that the securities are slower and more inefficient in reacting to new information, skewing the results of event studies (MacKinlay, 1997). In general, any stock that trades at fewer than 10,000 shares a day is considered a low-volume stock. Table 7 presents the event-day volumes, three-month average volumes, and the ratio of the two figures.

Table 7. Volume analysis for the innovation announcements.

Volume analysis							
Date	**Event-day**	**3-month average**	**Ratio (%)**	**Date**	**Event-day**	**3-month average**	**Ratio (%)**
11.03.2010	1081k	735k	147	29.03.2017	464k	331k	140
11.10.2010	527k	572k	92	27.04.2017	298k	250k	119
12.10.2010	337k	566k	60	29.05.2017	558k	1524k	37
14.10.2010	469k	566k	83	13.06.2017	191k	362k	53
26.05.2011	639k	646k	99	20.06.2017	296k	323k	91
29.08.2011	603k	437k	138	28.06.2017	15k	12k	120
05.09.2011	367k	416k	88	08.12.2017	1179k	1393k	85
04.01.2012	2289k	1887k	121	01.03.2018	719k	696k	103
31.01.2012	477k	859k	83	17.04.2018	363k	471k	77
13.06.2012	1749k	1151k	152	23.04.2018	1613k	1719k	90
18.06.2012	1888k	1837k	103	15.06.2018	307k	214k	144
03.07.2012	231k	611k	38	26.06.2018	211k	211k	100
19.02.2013	900k	1235k	73	06.08.2018	764k	1603k	48
17.12.2013	57k	114k	50	09.08.2018	6k	12k	54
06.05.2015	2794k	4385k	64	21.09.2018	15k	14k	111
15.06.2015	71k	176k	41	27.09.2018	192k	150k	128
18.06.2015	71k	174k	41	30.10.2018	734k	632k	116
03.09.2015	1678k	1889k	89	17.12.2018	117k	123k	95
15.10.2015	227k	279k	81	24.01.2019	121k	123k	98
16.10.2015	120k	143k	84	25.01.2019	1363k	1365k	100
16.02.2016	589k	278k	212	29.03.2019	110k	470k	23
08.03.2016	8k	38k	22	16.05.2019	140k	117k	120
18.05.2016	267k	582k	46	19.06.2019	1297k	1159k	112
16.06.2016	89k	133k	67	26.06.2019	326k	273k	120
24.06.2016	335k	294k	114	27.06.2019	947k	2000k	47
04.07.2016	294k	497k	59	18.07.2019	30k	15k	204
19.09.2016	11k	16k	71	30.10.2019	63k	88k	72
01.12.2016	207k	287k	72	28.11.2019	1030k	2677k	38
21.02.2017	632k	537k	118	19.12.2019	11k	11k	98

Event-day = event-day trading volume, 3-month average = avg. trading volume for the prior three-month period, Ratio = event day trading volume / 3-month trading volume average.

As Table 7 illustrates, there is a large discrepancy in the trading volumes around the events: some of the announcements have up to two times the normal trading volume on the event day, while some of the announcements have less than half. Surprisingly, of the 58 announcements only 22 have a higher volume on the event day than the three-month average, while 36 have a lower volume than the three-month average. Across the announcements, the average trading volume on the event day is 9% lower than the average trading volume for the prior three-month period.

These findings indicate that most of the innovation announcements cannot be classified as “interesting events” for the market participants. This is somewhat surprising, given the statistically significant positive abnormal return to the announcements. However, the average volume for the three-month period can include frequent announcements that are more interesting to the market participants, consequently raising the average volumes. Further, given the large discrepancy in the trading volumes on the days of the announcements, it might be the case that innovation announcements with certain characteristics are more interesting for the market participants than others. However, the data sample in this study is not comprehensive enough to explore this notion further.

Moreover, according to the analysis, only one of the announcements (9 August 2018, Budimex) has a peculiarly low trading volume below 10,000, indicating that the company could be inactively traded around the announcement. However, since all of the other announcements seem to have sufficiently high trading volumes, this concern should not affect the results of this study.

5.3.2 Other potential issues

To continue, a number of other issues can arise when conducting an event study. These issues include the sampling interval, event date uncertainty, and other possible biases (MacKinlay, 1997). In the case of this study, the sampling interval should not be a problem since daily data is used to calculate the returns. Similarly, it is assumed that event date uncertainty is not a problem since the event information is gathered from the official press releases of the companies, often accompanied with the exact time of publishing. However, there are some inevitable biases associated with the event study methodology that are addressed below.

First of all, this study considers only a single time ten-year time period from the European Union. As such, the results from this study might not be applicable to other timespans or other markets. Secondly, the event study methodology only considers the effect of an announcement on the market capitalization around the day of the announcement, and thus, a positive reaction to the announcement is not a guarantee of increased market capitalization in the long-term. Some alternative methods to event studies with longer time-horizons have been developed, but most scholars note that these alternative methods have their own limitations, such as sensitivity to many more disturbances which obscure the path of causality (see *e.g.* Sood and Telis, 2009, Chen, 2014). Given the rationality in the marketplace, the effects of the announcement should be rapidly reflected in prices, and thus, it should be possible to measure the announcement´s economic impact over a relatively short time period.

Finally, the utilized data sample poses its own set of possible limitations, such as sample heterogeneity, inaccuracies in company categorization, and disturbances from other corporate events and press releases. The heterogeneity in the data sample could affect the results in a way where the positive returns might not be related to innovation announcements, even though it seems that they are related. For example, there might be some other reasons behind the abnormal returns, such as size-, location-, or industry-based characteristics. The inaccuracy in company categorization might also affect the results. The company selection in this study is based on their NACE coding as of 2019, and thus, this criterion might not be an accurate representation of the companies´ actual main activities over the whole ten-year period. Further, although the innovation announcements included in the data sample of this study were screened for other significant press releases in the event window, other corporate events or announcements, such as announcements made outside the official press releases, could contribute to the abnormal returns. The innovation announcements included in the data sample can also contain other important elements, such as winning of contracts and partnership deals, which could also skew the results.

That said, a considerable effort has been put into the data acquisition to mitigate these possible limitations and to produce as thorough an empirical analysis as possible. Results from event studies are always associated with some inevitable contingencies, but it seems reasonable to believe that as long as they are considered, the empirical results of this study are reliable enough to make well-grounded conclusions.

6. CONCLUSIONS

This study was set to examine the possible connection between innovations and the market capitalization of construction industry companies in the member states of the European Union. Innovation is widely considered to be the main factor in developing global competitiveness, but it is also riddled with uncertainty and a high probability of failure (see *e.g.* Porter, 1985; Holmstrom, 1989). This inherent riskiness has the potential to discourage operators from innovating, which can have adverse consequences for nations, industries and companies alike. A positive association between innovations and the market value of construction companies could improve the perceived return on innovation investment in the industry and could potentially convince companies to engage in more innovation activities.

Despite its importance, the possible connection between innovations and the market capitalization of companies is largely an unexplored topic in construction innovation literature, as studies on the similar subject have been mostly carried out in other industries and disciplines (see *e.g.* Chaney et al, 1991; Sood and Tellis, 2009). The research question of this study was aimed to fill this void.

The overall contribution provided to the existing construction innovation literature is three-fold. Firstly, this study provides evidence of how the stock market participants value innovations in the construction industry. The construction industry has many distinguishing features that make it generally ill-suited for innovation, and thus it is of interest to examine how market participants balance the risks and rewards associated with innovation. The results from this study suggest that despite the industry-specific challenges, market participants still value the innovation endeavours of the construction companies. Secondly, this study discovers that there is a monetary incentive for construction executives and owners to enhance innovation efforts, as the observed positive impact that innovations have on the market value of construction companies is not insignificant in size. Hence, innovations should be a relevant part of business development for construction executives and owners alike. Thirdly, this study examines the market value of construction innovations in a unified environment of the European Union with a large dataset covering a decade worth of observations. As such, the results of this study provide uniquely comprehensive data on the subject.

This study utilizes innovation announcements as a proxy for innovation. Observing the change in market capitalization after an innovation announcement should be an accurate way of assessing the true rewards of innovation since the path of causality is clearer than, say, in comparing the effects of innovation on sales, profits, or market share. The focus of this study is on the large publicly traded construction companies from the EU, and hence, the data sample utilized in the empirical analysis is sourced from the official press releases published by these companies in the ten-year period from 2010 to 2019. Utilizing this data sample, an event study is conducted examining the abnormal returns to these announcements. After running a series of econometric tests to examine the robustness and significance of the results, the main findings are finally presented.

The obtained results clearly indicate that innovation announcements and the market values of companies in the construction industry are positively associated. The results suggest that innovation announcement leads to an average increase in the market capitalization of 0.47% in the examined companies and that the increase is statistically significant. The increase can be observed on the day of the announcement, and given the rationality in the marketplace, it should reflect the economic impact attributable to innovation. These findings are in line with previous literature suggesting that innovations are a source of economic value – in other industries, but also in construction (see *e.g.* Chaney *et al.*, 1991, Sood and Tellis, 2009; Kajander *et al.*, 2012). As such, the outcome of this study should be of interest to many stakeholders in the construction industry, including construction executives and owners.

However, some caution should be imposed when generalizing the results. For example, this study considers only a single time ten-year time period from the European Union. Hence, the results from this study might not be applicable to other timespans or other markets. Further, the observed abnormal returns might not be related to innovation announcements, even though the statistical tests imply that they are. For example, there might be some other reasons behind the abnormal returns, such as size-, location-, or industry-based characteristics. Lastly, this study only considers a short time period around the day of the announcement, and thus, the observed abnormal returns to innovation are not a guarantee of a prosperous innovation project in the long-term.

Due to these aforementioned limitations and the small number of academic papers on the subject there are still multiple areas for further research. Firstly, it would be of great interest to examine whether the abnormal returns to construction innovation announcements persist in other markets and other time periods. In addition, the long-term implications of innovation in the construction industry warrant further research. Although there are multiple challenges and limitations in examining the longer-term economic impact of innovations, further research could shed more light on the subject and have major implications for the industry. Finally, to alleviate the concerns that the abnormal returns stem from other sources than innovation announcements, it would be relevant to examine the results from this study could be replicated using alternative proxies for innovation, such as patents, citations to patents, or R&D expenditures.

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APPENDIX A: INNOVATION ANNOUNCEMENTS

This table showcases the innovation announcements utilized in the empirical analysis of this study.

Event date	Company	Announcement
11.03.2010	NCC	NCC first to issue green tenders – 1,000 climate-neutral tenders to be submitted annually
11.10.2010	YIT	Already over 1,000 low-energy YIT homes in Finland
12.10.2010	YIT	HOAS and YIT collaborate in saving energy consumed in buildings
14.10.2010	YIT	Industry has significant opportunities to improve energy efficiency
26.05.2011	NCC	NCC launches industrialized residential construction
29.08.2011	JM	JM Implements Housing Energy Rating System
05.09.2011	PEAB	Varvsstaden in Malmo becomes an environmentally certified district
04.01.2012	Skanska	Skanska's intranet appointed one of the ten best in the world
31.01.2012	YIT	YIT and Lahti Pensioner Housing Fund build the onnelanpolku sheltered home as a nearly zero energy building in Finland
12.06.2012	Royal BAM	Breakthrough CO2e protocol launched for the world's construction sector
18.06.2012	Skanska	Skanska instrumental in the first global standard for carbon dioxide reporting in the construction industry
03.07.2012	YIT	YIT and RWE Energiedienstleistungen join forces in the field of energy contracting
19.02.2013	Royal BAM	New technology set to make Britain's commercial buildings cheaper to manage
17.12.2013	Heijmans	Heijmans strengthens smart metering market position through the acquisition of the Brinck Group
06.05.2015	Royal BAM	New advanced technology used to construct Advanced Technology Centre
15.06.2015	Heijmans	Heijmans and MX3D collaborate on 3D printing of a steel bridge in Amsterdam
18.06.2015	Heijmans	Heijmans Unique field test started for Solar Noise Barriers
02.09.2015	Vinci	Vinci acquires French cloud builder APX Intégration
15.10.2015	Eiffage	Two-fold success as Eiffage scoops prizes in French road and street innovation committee contest and TP 2015 awards
16.10.2015	Heijmans	Heijmans 3D Printing a Metal Bridge in Amsterdam starts
16.02.2016	Acciona	Acciona Service integrates Reality Capture into its range of services
08.03.2016	SRV	REDI the only site in Finland heated renewably with biogas
18.05.2016	YIT	YIT introduces Smartti, a flexible and affordable housing solution
16.06.2016	Heijmans	Heijmans: Test with 3D-Printed Concrete Formwork a Success
24.06.2016	Acciona	Acciona introduces its Large Scale 3D Printing technology at the Feria In(3D)ustry From Needs to Solutions in Barcelona
04.07.2016	YIT	YIT to begin construction on its first Smartti apartments in Lahti
19.09.2016	CFE	DEME launches the world's most advanced subsea cable installation/trenching vessel 'Living Stone'
01.12.2016	NCC	NCC finalist of Circular Economy at World Economic Forum
1.02.2017	YIT	YIT's Hack the Living jury were impressed by ideas for use of space and for making everyday life easier

29.03.2017	NCC	NCC’s Loop Rocks challenges the haulage industry
27.04.2017	Eiffage	Eiffage signs a strategic cooperation agreement with the start-up OliKrom, specialised in smart pigments
29.05.2017	ACS	Hochtief realizes Mercedes Platz with innovative hollow-body ceiling technology
13.06.2017	NCC	NCC’s Loop Rocks start-up entering Denmark
19.06.2017	Eiffage	Eiffage selected Finalcad as a strategic partner to accelerate digital transformation of its construction sites
28.06.2017	Budimex	Budimex to Construct a Prototype Section of Road Pavement
08.12.2017	Skanska	Skanska invests about SEK 250M to increase the capacity in BoKlok's factory in Gullringen, Sweden
01.03.2018	YIT	YIT offers its residents a more extensive housing service solution in co-operation with its partners
17.04.2018	NCC	NCC launches Loop Industries – a tech company for digital start-ups in the construction industry
23.04.2018	Skanska	Skanska launches virtual classroom for health and well-being
15.06.2018	Acciona	Acciona picks eight startups for its corporate accelerator
26.06.2018	Acciona	Acciona conducts first trials of driverless public works machinery at its Toledo depot
06.08.2018	Royal BAM	XblocPlus in the spotlights
09.08.2018	Budimex	Budimex tests innovative lighting
21.09.2018	CFE	DEME unveils innovative nodule collector pre-prototype ‘Patania II’
27.09.2018	Acciona	Acciona pioneers the use of blockchain technology to guarantee the renewable origin of stored energy
30.10.2018	NCC	The transition to renewable fuel helped lower NCC’s carbon emissions 35 percent
17.12.2018	Acciona	Acciona will extend blockchain traceability to its renewable generation globally
24.01.2019	Acciona	Acciona develops smart façade to achieve buildings with 'near-zero energy consumption'
25.01.2019	Royal BAM	BAM acquires stake in Irish modular homes specialist MHI
29.03.2019	YIT	YIT to adopt building information models across the board – all housing projects in Finland and Russia are now BIM-based projects
16.05.2019	Acciona	Acciona, a pioneer in the hybridization of solar panels with wind power towers
18.06.2019	Vinci	Vinci Construction launches Concreative, its new subsidiary focused on 3D printing of high-performance concrete
26.06.2019	Eiffage	Eiffage launches Sekoya, the first carbon & climate platform dedicated entirely to low-carbon materials and processes
27.06.2019	Royal BAM	Europe’s first hyperloop a step closer to offering a green alternative to short-haul flights
18.07.2019	CFE	Expert consortium including DEME explores pioneering high-wave offshore solar technology
30.10.2019	Acciona	Acciona launches global 3D printing center in Dubai
28.11.2019	Royal BAM	Converge launch world’s first commercial machine learning program for concrete
19.12.2019	CFE	DEME deploys autonomous plastic collector on the river Scheldt