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The role of green public procurement in enabling low-carbon cement with CCS: An innovation ecosystem perspective

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ABSTRACT

As a result of the increase in carbon emissions and climate change, it is imperative to innovate and implement new sustainable solutions across industries, including construction. The current study explores how an early upstream supplier (EUS) can influence actors in its innovation ecosystem and the degree to which the effect of green public procurement (GPP) can be increased. An increased degree of GPP is sought as an enabler for the EUS to succeed with its green business process innovation. Using a holistic case study methodology, comprising literature review, semi-structured interviews, and document analysis, we examined the direct and indirect paths the EUS could utilize to influence public actors' degree of GPP. The case study is based on a Norwegian cement producer currently developing low-carbon cement with carbon capture and storage technology. Our findings show that public buyers actively influence GPP and that it is possible to effect change in the ecosystem from the supplier side. There is a high potential for an EUS in the construction industry to influence (downstream) public purchasers' current practice. The study demonstrates the opportunities for an EUS to directly and indirectly influence the degree of GPP. It also highlights the challenges related to GPP and innovation in the construction industry.

1. Introduction

The record high concentration of greenhouse gases in the atmosphere is a result of human and industrial activities. Some industries have more significant emissions than others. A pertinent example is the construction industry (European Commission, 2016; Huang et al., 2018; Testa et al., 2016; Varnäs et al., 2009; World Green Building Council (WGBC), 2019). This industry's CO_2 emissions can be divided into direct and indirect categories throughout the life cycle. Direct emissions result from the operational use in energy consumption and associated emissions, and indirect or "inherent" emissions result from the manufacture and transport of materials, the construction phase, maintenance work, and possibly demolition. In total, the direct and indirect emissions from the construction industry account for 23% of the world's total emissions, 94% of which originate from indirect sources (Huang et al., 2018). The emissions from cement production belong to the indirect emission category and account for 15% of the construction industry's total emissions globally. Traditionally, there has been a strong focus on direct emissions, such as more energy-efficient insulation materials and heating technology. However, in recent years, indirect emissions and the importance of limiting these to reach the 2-degree target have also received increasing attention (Huang et al., 2018).

Public procurement accounts for approximately 17% of the gross domestic product in OECD countries (Testa et al., 2016). Hence, the public sector must handle many stakeholders and ensure that their decisions are the best for society. The public sector has a responsibility to safeguard sustainability (Walker and Brammer, 2009) by, for example, procuring solutions with a reduced environmental footprint. Given the public sector's enormous purchasing power, it is exceptionally equipped to contribute to achieving local, national, and international innovation and sustainability goals (European Commission, 2016; Kundu et al., 2020; Uyarra et al., 2020). Public demand for solutions that contribute to goal achievement can be a strong driver for innovation and facilitate the development of green products and services (Aschhoff and Sofka, 2009; Edler and Georghiou, 2007; Edquist and Zabala-Iturriagagoitia, 2012). The problem with current practices, however, is that green

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public procurement (GPP) does not necessarily reach far upstream, which requires a better understanding of the supplier side. To date, there is limited research that sheds light on the role of suppliers in public procurement projects (Obwegeser and Müller, 2018). The literature on public procurement typically emphasizes the role of public procurers in the adoption of new technologies, but the role of suppliers themselves is less discussed. Addressing the supplier side is important to understand the needs of the market and to uncover the actual dynamics between buyers, suppliers, and other actors, such as intermediaries (Obwegeser and Müller, 2018). Additionally, we not only aim to contribute to this research gap, but also to challenge the assumption that suppliers do not take the initiative themselves.

This study focuses on early upstream suppliers (EUS) in the construction industry and their opportunities to succeed in green process innovation by influencing GPP. Our study takes an innovation ecosystem perspective. The case organization is seen as part of a larger business ecosystem (Moore, 1993; Overholm, 2015), where several industries are often linked together. We argue that an ecosystem perspective can help us understand how firms develop their capabilities through interaction with each other and that underpinning this are public-private partnerships and innovative procurement practices (Bleda and Chicot, 2020; Carbonara and Pellegrino, 2020). A platform-based ecosystem means that the value created by each ecosystem actor will affect the other ecosystem actors' value creation (Gawer and Cusumano, 2002; Gomes et al., 2018; Jenssen and de Boer, 2019). We aim to contribute to the extant literature by focusing on the strategic side of the business ecosystem. When discussing the platform role, our study focuses on the ecosystem and on the role of key firms and ecosystem risk and benefits.

The purpose of this study is to investigate what opportunities EUSs in the Norwegian construction industry have to succeed in their green process innovation by influencing the degree of GPP. Specifically, we sought to answer the following research question (RQ):

What is the potential of an early upstream supplier in the Norwegian construction industry, through the innovation ecosystem's influence, to increase the degree of green public procurement and succeed with its green product innovation?

2. Literature review

2.1. Green public procurement

Compared with traditional public procurement, including environmental requirements in the procurement process is a key tenet in GPP (Appolloni et al., 2012; Cheng et al., 2018; Varnäs et al., 2009). The European Commission (2008) defines GPP activity as: "A process in which public entities want to procure goods, services, and labor with a reduced environmental footprint throughout the life cycle compared to those goods, services, and labor with the same primary function as they would otherwise purchase" (p. 4). In other words, the purpose of GPP is for public actors to procure environmentally friendly goods and services, common goods (off-the-shelf), and innovative solutions without sacrificing functions or performance (Ma et al., 2021; Rainville, 2017; Sparrevik et al., 2018). Using greener procurement routines, public actors can improve their environmental performance while encouraging their suppliers to improve theirs (Varnäs et al., 2009).

GPP also serves other purposes. First, the public sector can create a market for green products by designing appropriate policies and benefiting from its size as a customer. Through this, they also set a good example for the private sector (Cheng et al., 2018; Igarashi et al., 2015; Varnäs et al., 2009). Second, successful GPP projects can provide credibility to national environmental strategies and thus illustrate good government leadership (Varnäs et al., 2009). At the same time, some people question the effectiveness of GPP and how targeted this tool is. For example, Lundberg et al. (2016) contend that GPP gives non-green suppliers a choice to either use resources to meet the green requirements or refrain from participating in the tender process. GPP's efficiency is assumed to depend on the extent to which the non-green suppliers remain competitive, which is affected by the size of the public sector as a customer in the market and the price sensitivity of private customers (Lundberg et al., 2016).

The inclusion of environmental requirements distinguishes GPP from traditional public procurement practices. Environmental requirements and criteria can be expressed in different ways and included in several steps of the GPP process (Cheng et al., 2018; European Commission, 2016; Igarashi et al., 2015; Varnäs et al., 2009). Specific qualification requirements must be met to be considered a supplier in a tender process, and in a GPP process, these requirements can be environmentally oriented (Cheng et al., 2018). Similarly, environmental requirements can be included in the specifications of the product or service to be delivered. The requirements specifications may apply to the product's properties or conditions associated with its production; for example, only renewable energy should be used in production (European Commission, 2016; Palmujoki et al., 2010). Qualification requirements and the requirements specifications must be specified when the tender is submitted.

In addition, this study focuses on innovative procurement, so not all of the GPP principles are relevant. We focus on the characteristics of innovative green procurement and identify what opportunities and market measures currently exist. As an example, in the PP directives, measures such as innovation partnerships and market dialogues are relatively new ways to promote innovative green procurement (Alhola et al., 2017). The GPP literature often focuses on predetermined standards that do not promote innovation in all cases, but require elements of innovative procurement and in turn innovation ecosystem perspectives. There are cases where requiring environmental requirements in the procurement process alone is not sufficient to achieve the desired benefits. Buyers and suppliers may need to interact at different levels to seek and discuss new solutions. Such interaction opens new doors for innovation. Effective green procurement must therefore also consider the elements or factors of innovation.

2.2. Innovative and green public procurement: an ecosystem perspective

The process of innovation and GPP is complex and heavily influenced by the ecosystem. Suppose an innovative procurement is classified as *green*. In that case, the procurement will generally be classified as a GPP, and the inclusion of environmental requirements and criteria in the process will still apply. At the same time, the process for *innovative* public procurement is characterized by two features. First, an innovative procurement process will most likely have a higher degree of *collaboration* between suppliers and customers than a procurement process of standard products (Edquist and Zabala-Iturriagagoitia, 2012). Such collaboration is justified because innovation is complex and uncertain; consequently, actors will rarely innovate alone (Wei et al., 2014). Rather, actors will interact to acquire, develop and share knowledge, information, and other resources related to the product being developed (Edler and Georghiou, 2007; Edquist and Zabala-Iturriagagoitia, 2012; Liu et al., 2021; Ma et al., 2021). Torvatn and de Boer (2017) conceptually investigate how the recent reform of the EU public procurement regulative framework may further impact the potential for innovation through public procurement, for example by using pre-tender dialogue and/or adopting more recently introduced new procedures such as competitive dialogue and especially innovation partnership. Holma et al. (2020) provide an empirical study of how pre-tender dialogue may facilitate co-development processes between the public buyer and the supplier market. In a recent empirical study of Danish municipalities and their efforts to use GPP as a driver of circular economy (CE) initiatives, Kristensen et al. (2021) find that municipalities use a range of GPP practices, including market dialogue with suppliers, albeit still to a limited extent.

The second characteristic of the process is that the specifications for the end-product should be functional, and not technical. Therefore, the public customer should only specify the product's functions to meet the identified need (Aschhoff and Sofka, 2009; Edler and Georghiou, 2007; Edquist and Zabala-Iturriagagoitia, 2012; Liu et al., 2021; Ma et al., 2021). No guidelines must be laid down for technical requirements, such as material selection. Instead, the functions of the product, for example, a building material, should be specified; this can be done by requiring that the material's greenhouse gas emissions are below a certain level (European Commission, 2016). How the product meets the identified need should therefore be irrelevant to the public customer. Lenderink et al. (2020) demonstrate how innovation may be included as an explicit selection and award criterion in the public procurement of construction projects.

Innovative public procurement covers various products (Edquist and Zabala-Iturriagagoitia, 2012; Rainville, 2017). Edquist and Zabala-Iturriagagoitia (2012) classify procurement according to the end-user of the procurement and distinguish between direct and catalytic procurement. To understand the breadth of green and innovative solutions, we explain this division.

Direct procurement refers to procurements where the public sector itself is the end-user of the procured product. In such cases, the public customer uses its demand or needs to influence or initiate supplier innovation. This category includes the procurement carried out by public actors to achieve their objectives, for example, "emission-free public construction sites."

Conversely, catalytic procurement indicates cases where a public actor (or several in cooperation) acts as a catalyst or coordinator, and make technical resources meet to solve challenges beyond their own. The purpose is to evoke innovations for the use of the public. Edler and Georghiou (2007) emphasize that it is essential to find out and understand the private supply market's needs in catalytic procurement in contrast to direct procurement. Catalytic procurements are also considered extra competence- and resource-intensive, as they require coordination of actors who can offer the requested solution and those who will use it (Edquist and Zabala-Iturriagagoitia, 2012). The private market players in the broader innovation ecosystem should provide the solution to the challenge (Aschhoff and Sofka, 2009; Edquist and Zabala-Iturriagagoitia, 2012).

The concept of innovation ecosystem stems from Moore's (1993) theory of business ecosystems. Moore (1993) argues that a company should be part of a business ecosystem linking together several industries, which is evident in the construction industry. Such a mindset provides a better understanding of how companies develop their capabilities through interaction (Moore, 1993), adhering to the open innovation principle of creating synergy between internal and external knowledge and stakeholders (Chesbrough, 2011) which could, potentially drive green procurement practices (Liu et al., 2021).

Although the innovation ecosystem concept has existed for several years, Oh et al. (2016), reproduced by Gomes et al. (2018), saw a need for a formal conceptualization. The reason for this was that the definitions proposed in various articles diverged. Aiming to design a comprehensive definition of both innovation and business ecosystems, Gomes et al. (2018) conducted a systematic review of the literature up to and including 2016 that included these two concepts. They concluded that a business ecosystem intends to realize a product's value (value capture). Conversely, an innovation ecosystem focuses on creating value for the product (value creation). Gomes et al. (2018) define the innovation ecosystem, also used in this paper, as:

An innovation ecosystem consists of interconnected and interdependent actors. The players consist of the focal company, customers, suppliers, complementary innovators, and third-party players. This implies that the network members experience cooperation and competition in addition to the innovation ecosystem having a life cycle that follows a common evolutionary process. (p. 45).

Gomes et al. (2018) criticize Adner and Kapoor (2010), Priem et al. (2013), and Ritala et al. (2013) for placing too much emphasis on value realization (the main focus of business ecosystem theory) and emphasize the importance of discovering what creates value (the main focus of innovation ecosystem theory). Innovation ecosystem theory stresses that the focal company can influence, for example, decision-makers (e.g., politicians), the media, customers, and innovative complementary actors, either directly or indirectly (Gomes et al., 2018; Kapoor and Furr, 2015). This theory differs from other relevant theories, such as that of supply chain and value chain. The ecosystem concept primarily explores the possibilities for co-specialization, bargaining power, and other possibilities in the relations between the actors (Adner and Kapoor, 2010). Therefore, these differences make it relevant to mainly use innovation ecosystem theory to address an ecosystem's collective ability to innovate and the opportunities of a focal company to activate its relationships and actors in the ecosystem.

To succeed with green innovation in the market, an EUS depends on the willingness of many actors in the ecosystem to use the solution. Based on Adner and Kapoor (2010), the actors downstream of the focal EUS in the supply chain can be considered adopters and complementary actors. Based on Sparrevik et al.'s (2018) model, a cement producer will, for example, depend on at least one concrete supplier, one contractor, and one public developer willing to adopt the innovation to reach the end customer (e.g., a public organization) through public procurement.

2.3. Risk categories in the innovation ecosystem

A functioning innovation ecosystem can add significant value to innovation as it implies that many actors can combine their capabilities (Valkokari, 2015). Adner (2006) argues that designing an innovation strategy that explicitly considers delays and challenges for a collaborative network is the key to success from the ecosystem perspective. According to Adner (2006), operating as part of an innovation ecosystem entails a great deal of risk; thus, the success of a company's growth strategy will depend on assessing the ecosystem's risks. Therefore, Adner (2006) proposes a framework to measure the different types of innovation ecosystem risks. Three different risk categories identify the focal company's total innovation risk: (1) interdependence risk, (2) initiative risk, and (3) integration risk. Fig. 1 shows the relationships between innovation strategy formulation and assessment of the three risk categories proposed by Adner.

Complementary and component actors: In innovation ecosystem theory, it is a given that the focal company is dependent on the other actors in the ecosystem, both upstream and downstream and third-party actors, to be able to succeed in its innovation. Adner and Kapoor (2010) emphasize that for a focal company to achieve success with innovation, it must follow its partners and potential adopters as closely as it follows its own development process. To distinguish more precisely among their different partners, Adner and Kapoor (2010) introduce the concepts of *components* and *complements.* Component actors produce goods or services which are used as input to the innovation, whereas complementary actors produce goods or services on which the focal company depends for their product to be used by customers downstream and the end-user. Hence, in a supply chain, upstream components are bundled by the focal firm, and downstream complements are bundled by the firm's customers and actors that are parallel to or downstream of the focal enterprise.

Interdependence risk focuses on how dependent the focal company is on the partners, complementary players, and component players to complete their products to reach the end customer on time. Thus, this risk category can be observed as the overall probability that the various ecosystem partners will live up to their obligations within a given time frame.

Initiative risk includes the uncertainty of leading an innovation project. Regardless of the product or industry, there will always be challenges associated with timing the delivery of the product or service. For initiative risk, it is crucial to assess which areas of responsibility the focal company should cover internally and which should be dealt with by their ecosystem partners.

Integration risk involves delays in the adoption chain. It is not only

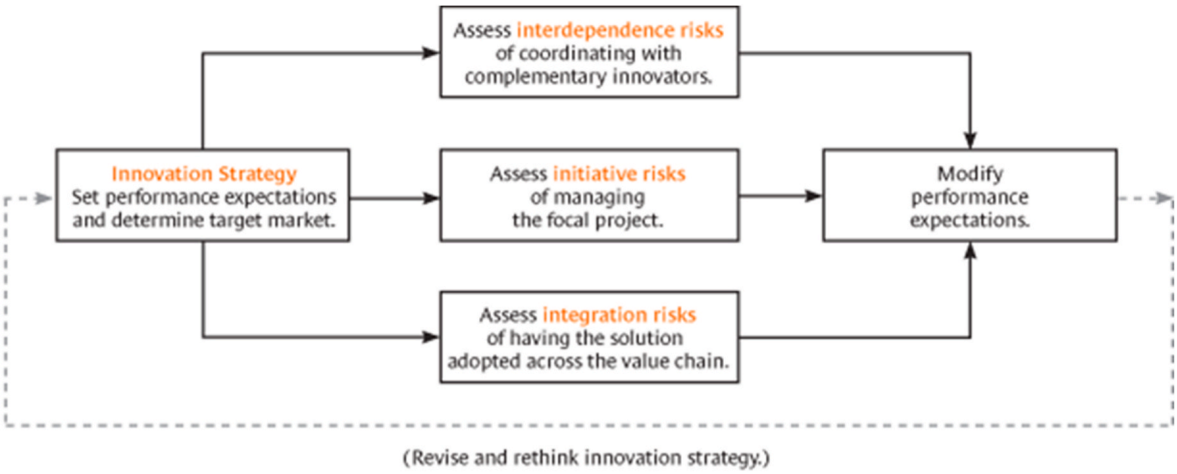

Fig. 1. Adner's innovation strategy (Adner, 2006).

affected by the development cycle where the partners, both complementary and component actors, contribute, but also in the sales cycle. The sales cycle means that the focal company also depends on each intermediary actor in a distribution channel adopting the innovation, not just the end customer. This cycle takes time as it can include several essential activities per actor. A classic sales cycle requires players to become aware of the product, agree to test it, accept the results, and upscale the order. This paper focuses on a supplier located far upstream in the supply chain, implying that many innovation intermediaries and actors must be involved before the product reaches the end customer. Adner and Kapoor (2010) point out that the benefits of adopting the product must outweigh the possible disadvantages for each of these players.

Finding the balance between prioritizing the size of the market opportunities and the overall risk of being part of an ecosystem is the essence of an innovation strategy (Adner, 2006). Thus, we adopted innovation ecosystem mapping based on Adner's (2012) Value Blueprint (VB) method. The purpose of the VB is to give the focal player an overview of their ecosystem and the associated dependencies and make the company's innovation strategy more robust.

3. Method and data

3.1. Introducing the case: Norcem and CCS

Norcem is the only Norwegian cement producer and a subsidiary of HeidelbergCement Group. Heidelberg has a goal of producing carbon-neutral concrete by 2050 (HeidelbergCement, 2019). One measure to ensure this is introducing carbon capture and storage (CCS) at its production facilities (HeidelbergCement, 2019). In 2013, a pilot project was established at Norcem's plant in Brevik, Norway. Norcem is also a partner at The Research Centre on Zero-Emission Neighbourhoods (ZEN) in Smart Cities, which also serves as an innovation intermediary in this context. As a cement supplier, there are several links between Norcem and an end-user of a construction project. Therefore, it is possible to refer to Norcem as an EUS.

The cement industry has always had one of the largest contributions to the total indirect CO_2 emissions in construction projects (Benhelal et al., 2013; Huang et al., 2018). Cement is the main ingredient in concrete, the world's second most used resource, surpassed only by water (Lehne and Preston, 2018). With increasing attention and resources allocated to reducing greenhouse gas emissions, many strategies indicate how the cement industry could adapt. As an example, HeidelbergCement, as mentioned, has committed to producing carbon-neutral products by 2050, and Dalmia Baharat Cement, one of India's largest cement producers, is determined to be climate adverse by 2040 (WGBC, 2019). However, no comprehensive, groundbreaking measures have been implemented across the industry (Huang et al., 2018). Many challenges, especially economic and technical, remain before the proposed measures can be implemented in the cement plants (Benhelal et al., 2013; Huang et al., 2018).

CCS is one of the few measures that make it possible to significantly reduce CO_2 emissions, including from the cement industry (Benhelal et al., 2013; Pardo et al., 2011). In short, CCS is a technology that prevents CO_2 from being released into the air (e.g., from production facilities). The process consists of three steps; first, CO_2 is captured and compressed, then the CO_2 is transported through pipelines or gas ships to a suitable storage site where it is injected into empty oil or gas reservoirs (Benhelal et al., 2013; Gassnova, 2020). Currently, no full-scale CCS plants operate in the world's cement industry (Huang et al., 2018). In addition to technical and economic challenges associated with commercialization of CCS "operations", political and legislative factors are considered limiting (Benhelal et al., 2013; Lipponen et al., 2017). Regarding financial challenges, not only are large investment required for carrying out the necessary plans to capture CO_2, operational costs are expected to be higher (Lipponen et al., 2017). For example, it is estimated that the presently considered technologies for CCS may double the cement price (Mikulcic et al., 2013). Therefore, it is imperative to find a fair approach to burden-sharing coupled with GPP measures to facilitate the transition (Krupnick, 2020; Sparrevik et al., 2018; Stokke and Kvellheim, 2020). Further, a recent ZEN survey shows that 75% of end-users are willing to pay more for materials with lower climate footprints (Stokke and Kvellheim, 2020), illustrating the potential in the market for implementing greener products. Regarding political factors, Lipponen et al. (2017) claim that global CCS operations will not accelerate sufficiently without significant investment from the government or custom legislation. The Norwegian Government recently allocated NOK 16.8 billion for CCS investment. Norcem is the first cement company in the world to implement full-scale CCS deployment, capturing 400,000 tons CO_2 per year at its Brevik plant.

3.2. Data collection and analysis

This case study triangulated data through interviews, a structured literature review, and document analysis. The investigation used the theoretical framework as the primary tool for data analysis. Yin (2018) points out that the analysis of case study material is one of the least developed aspects of research, making the analysis itself a challenging task. Despite this, the empirical data must be analyzed to develop a theory (Eisenhardt, 1989). Therefore, it is essential to define a general analysis strategy for the implementation. Yin (2018) argues that this strategy largely depends on the researcher's empirical thoughts, evidence, and thoughtful considerations of alternative interpretations. The aim is for the strategy to contribute to the analysis of the case study, by connecting theoretical concepts with empirical concepts and provide direction in the analysis.

The data collection for this study began in the fall of 2019 when the researchers, in cooperation with Norcem, arranged a focus group workshop with actors in the innovation ecosystem. The goal of the workshop was to map key actors in Norcem's innovation ecosystem, glean insights into practical market measures, and recruit participants for in-depth interviews. Preliminary data from this workshop, and a survey probing various market measures, was presented in a ZEN-report (Stokke and Kvellheim, 2020). Following the workshop, we conducted interviews with managerial staff in these entities: Norcem, Statsbygg, Trøndelag County Municipality (TRFK), Trondheim Municipality, Skanska, and the National Programme for Supplier Development (NPSD). The interviews were conducted in two phases with each entity, in the spring and fall of 2020, respectively. In our sampling strategy we determined that saturation is more important than size. The respective sample size and selection supported the qualitative progression of successive approximations for the in-depth descriptions and interpretations of the emergent factors in the data (Antos and Ventola, 2008; Carson, 2001; Miles and Huberman, 1994). Moreover, the data subjects (key actors in the innovation ecosystem) were more significant than the sample size, since they could afford detailed knowledge relevant to the examined factors, and has not been included in preceding empirical research in this particular subject-area.

In this study, an analysis strategy was developed and applied to uncover how an EUS, through an innovation ecosystem perspective, can influence the use of public actors' instruments to support its green business process innovation. The analysis, based on Adner's (2012) VB method, consisted of two parts. The theoretical framework illustrates the implementation of the analysis and the merging of concepts from the literature review. The study's analysis strategy is explained by showing how the framework also functions as an analysis tool. Since the analysis consists of two parts, the explanation follows the same format. Finally, we delineate where and how the tool corresponds to and deviates from Adner's (2012) procedure.

3.2.1. Overview of analysis part 1

The first part of the analysis entailed mapping, according to the blue bracket in Fig. 2, the actors belonging to the categories of actors in the framework and the relationship they may have to the other categories of actors in the ecosystem. Therefore, part 1 covers steps 3, 4, and 6 in Adner's (2012) method. Both component actors and actors that complements the adoption are identified and seen in the innovation ecosystem context. Furthermore, the section captures whether and possibly how each public actor in the ecosystem uses the instruments mentioned in the theoretical framework. Hence, the analysis technique is called pattern matching; which by Yin (2018) is described as a method in which the findings of the empirical study are compared and analyzed against the conceptual framework. For example, how the public actors practice the instrument of "contract follow-ups" is examined.

3.2.2. Overview analysis part 2

The second part of the analysis was based on findings from the first—illustrated by the transition from the blue to the red bracket in Fig. 2. Answering the study's problem required uncovering the opportunities for the focal EUS to influence public actors' use of the identified instruments. Based on the innovation ecosystem literature, the theoretical framework shows that the impact can occur either directly (arrow X to the right in the framework) or indirectly via other actors in the supply chain or third-party actors (respectively arrow 3 + 4 and arrow 1 + 2 in the framework). However, the possibility of influencing depends on the existence of a relationship which can act as a channel or path for exerting influence. Hence, the connection between the two parts of the analysis is as follows; an uncovered relationship in part 1 (blue arrow in the framework) indicates a possible impact along the same path (red arrow in the framework) in part 2.

The outcome of a possible impact and the resulting use of instruments may affect the three risk categories in an EUS's innovation project. The analysis in this section is comparable to Adner's (2012) seventh step. However, unlike the VB method, this step does not address how the EUS affects each actor to mitigate innovation risk. Rather, the focus is on how the EUS can reduce this risk by using the innovation ecosystem's identified channels of influence to influence the public actors' use of instruments. Each instrument was graded *low*, *medium*, or *high*, based on how effectively the instrument works in practice for the

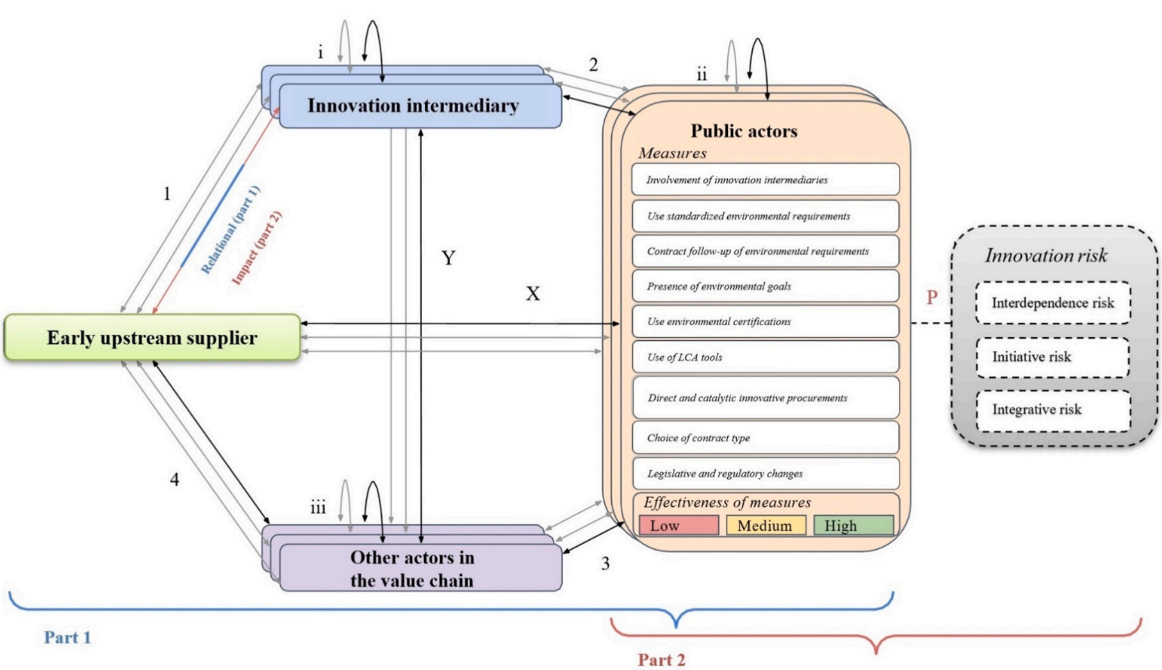

Fig. 2. Analytical framework.

potential identified in the literature.

The dotted line P in Fig. 2 shows the effect of the public actors' use of instruments on the innovation's ecosystem risk. A review of the literature suggests that in order to contribute to the green shift, the public sector should use the following instruments (see Fig. 2) several of which involve the crucial practice of marked dialogues (marked with an *):

- involvement of innovation intermediaries*
- use standardized environmental requirements
- contract follow-up of environmental requirements
- presence of environmental goals
- use environmental certifications
- use of life cycle assessment (LCA) tools
- direct and catalytic innovative procurements*
- choice of contract type*
- legislative and regulatory changes.

The arrows in the analytical framework in Fig. 2 illustrate several inherent characteristics of an innovation ecosystem. Table 1 explains the arrows in Fig. 2. The arrows structure part 1 of the analysis. The arrows show that there may be a relationship between two actors and that the actors can influence each other in the relationship. This relationship applies to all arrows but is only exemplified by arrow 1 in the following way: part 1 (red) reveals the relation, and part 2 (blue) is a possible effect given that the relation exists. However, the arrows indicate that a relationship may exist, not that it must. Therefore, two actors can belong to the same innovation ecosystem without necessarily having a relationship with each other.

4. Analysis

4.1. Part 1: relational

The main purpose of the analysis was to identify how Norcem, as the focal EUS, can influence the actors in its innovation ecosystem (see Fig. 3) in order to increase the degree of GPP so that their CCS cement can be integrated into the construction industry's supply chain. The analysis indicated if the empirical findings correspond to the literature that informed the development of the analytical framework and the extent to which the framework is an effective analysis tool. The analysis pays particular attention to the following actors: Norcem (the focal EUS), Statsbygg, Trøndelag County Municipality (TRFK), Trondheim Municipality, Skanska, and the National Programme for Supplier Development (NPSD).

4.1.1. Focal EUS

Norcem is an early upstream supplier that mainly operates in the construction industry. Norcem's first-line customers are manufacturers of ready-mixed concrete, concrete elements, and smaller concrete goods. This section addresses Norcem's relationships with innovation intermediaries, public actors, and other actors in the supply chain (see Fig. 4).

Table 1
Explanation of arrows in Fig. 2.

Arrow	Explanation
X	The focal EUS to a public actor
Y	Innovation intermediaries and other actors in the wider supply chain
1	The focal EUS and innovation intermediaries
2	Innovation intermediaries and public actors
3	Public actors and other actors in the supply chain
4	Other actors in the supply chain and the focal EUS
i	From one innovation intermediary to another
ii	From one public actor to another
iii	From one supply chain actor to another
P	How public measures impact the focal EUS innovation risks

Relationships to innovation intermediaries (see Fig. 4, arrow 1): Norcem is involved with many innovation intermediaries (also see Fig. 10). Norcem's participation in activities organized by intermediaries is primarily described as rewarding, but prioritization is essential as the use of resources can quickly become too large compared to the gain.

For example, Norcem has benefitted from its collaboration with the ZEN by improving their communication with stakeholders: "ZEN as a program has contributed to us getting more communication toward an entity that we have not had before. Statsbygg is a player we have had much better communication with through the ZEN program" (IO1).

The perceived importance of this communication is justified by the conviction that the ZEN activity will influence future construction industry regulations. Less formal communication is also highlighted: "there you can have some informal conversations that allow one to understand things that can be addressed without a formal meeting and agenda" (IO1). Thus, innovation intermediaries can facilitate open innovation between the actors who are members.

Relationships with public actors (see Fig. 4, arrow X): The data suggests that Norcem has regular contact with the large state builders. One example is several years of regular meetings with the Norwegian Public Roads Administration (SVV). A less established dialogue-based relationship, which grew through ZEN, is ascribed to Statsbygg. Similar activity occurs to a small degree with smaller public developers, such as counties and municipalities. Collaboration with such developers is more often linked to specific construction projects where Norcem can contribute with expertise in technology and sustainability.

Relationships to supply chain actors (see Fig. 4, arrow 4): Norcem has relationships with its direct customers in the supply chain and "engage in continuous dialogues with them". Norcem often contributes to finding solutions with its direct customers to challenges regarding technology or sustainability. In such project-specific dialogues, they may meet the project's main contractor. Norcem also states that they have regular dialogue meetings with the largest contractors in the market.

4.1.2. Public builders

Statsbygg is subordinate to the Ministry of Local Government and Modernization; it receives an allocation letter each year that acts as the ministry's central management instrument. The letter outlines the financial framework and describes priorities, performance targets, and reporting requirements for companies. As the ministry orders and allocates money for the assignments Statsbygg carries out, Statsbygg considers both the individual ordering ministries and the end users (i.e., Norway's citizens) as its customers. In this paper, Statsbygg exemplifies the role of state developers in Norcem's innovation ecosystem (see Fig. 5). Other actors with similar roles are the SVV and Nye Veier AS (a government-owned company).

Relationships to Norcem, the focal EUS (see Fig. 5, arrow X): Statsbygg reports rarely having direct contact with material suppliers. Through ZEN, however, they established a dialogue-based relationship with Norcem. One outcome connected to Norcem's CCS project is that they have met to update each other on the project's status and the prospects from both sides.

In this study, Trøndelag County municipality (TRFK) exemplifies the significant role of Norwegian county municipalities in an innovation ecosystem (see Fig. 6). Compared with state builders such as Statsbygg, the county municipality is considered a smaller public developer. As a public client, TRFK receives a letter of assignment from its responsible ministry, the Ministry of Local Government and Modernization (Regjeringen, 2019). Letters of assignment to municipalities and county municipalities describe objectives, goal achievement criteria and award criteria, and stipulate provisions on follow-up and control (Regjeringen, 2019). Thus, the Ministry of Local Government and Modernization is considered the TRFK's "client". The ministry, together with the end users of their buildings, that is, the county's inhabitants, constitute TRFK's customer.

Relationship to Norcem, the focal EUS (see Fig. 6, arrow X): TRFK states

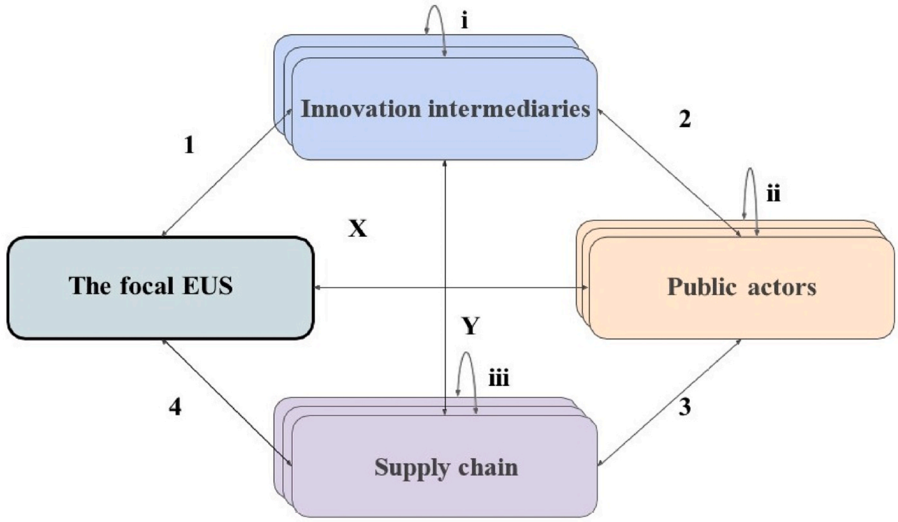

Fig. 3. Simplified analytical framework adapted to analysis: Part 1.

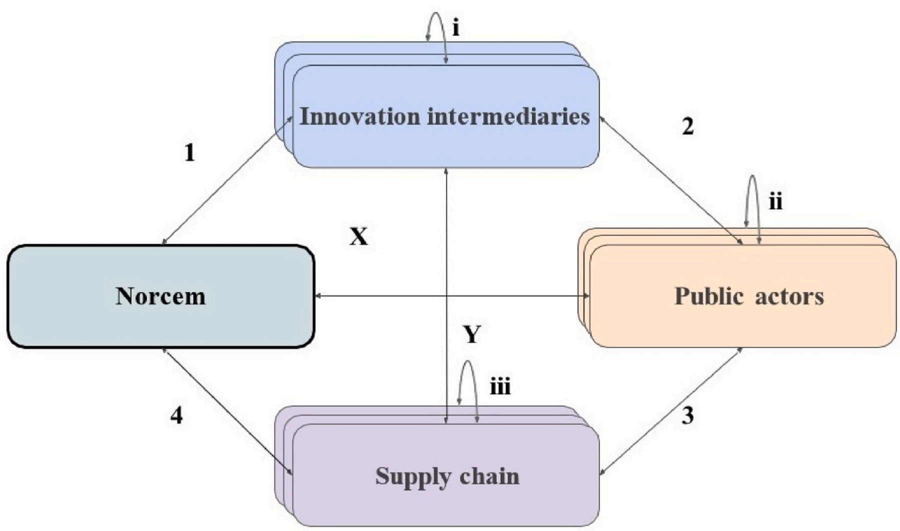

Fig. 4. Norcem's location in the innovation ecosystem and relationships to be identified.

that material suppliers often visit to provide updates on new solutions. Communication mostly concerns new technologies and solutions offered by players in the upstream supply chain (i.e., the contractor or consulting engineers).

Our study also shows the role of Norwegian municipalities in the innovation ecosystem. Trondheim Municipality is a public developer. Compared with Statsbygg, Trondheim is a smaller public developer (like the county municipality). However, as Norway's third-largest municipality, Trondheim is uniquely positioned to prioritize investment in the environment. In the study, Trondheim Municipality's relationships with innovation intermediaries, other public actors, Norcem, and other actors in the supply chain are central (see Fig. 7).

Relation to Norcem, the focal EUS (see Fig. 7, arrow X): The data indicates that there is no direct relationship between Norcem and Trondheim municipality. However, both are members of ZEN and partake in joint activities.

4.1.3. Other actors in the supply chain

The category *other actors* include several actors, for example, concrete suppliers and subcontractors of concrete elements. This study found that presently only Skanska belongs to this category. However, Veidekke is an example of another actor with a similar role.

Skanska's role in the innovation ecosystem: Skanska, one of Norway's largest contractors, has a broad portfolio of projects that includes public and private clients. Skanska's projects include traditional execution contracts, turnkey contracts, and interaction contracts. Sometimes they are the project developers. In this study, Skanska exemplifies the role of main contractor in the innovation ecosystem (see Fig. 8).

Relation to Norcem, the focal EUS (see Fig. 8, arrow 4): For several years, Skanska and Norcem have had a dialogue-based relationship associated with work towards more environmentally friendly cement. The relationship is characterized as independent with regard to green development, as both actors have developed their own sustainability practices which indirectly overlap.

4.1.4. Innovation intermediaries

The actors belonging to the *innovation intermediaries* category acted as knowledge producers or intermediaries. The NPSD was the only actor belonging to this category interviewed in this study. However, several others, such as ZEN, were mentioned. The NPSD is considered an

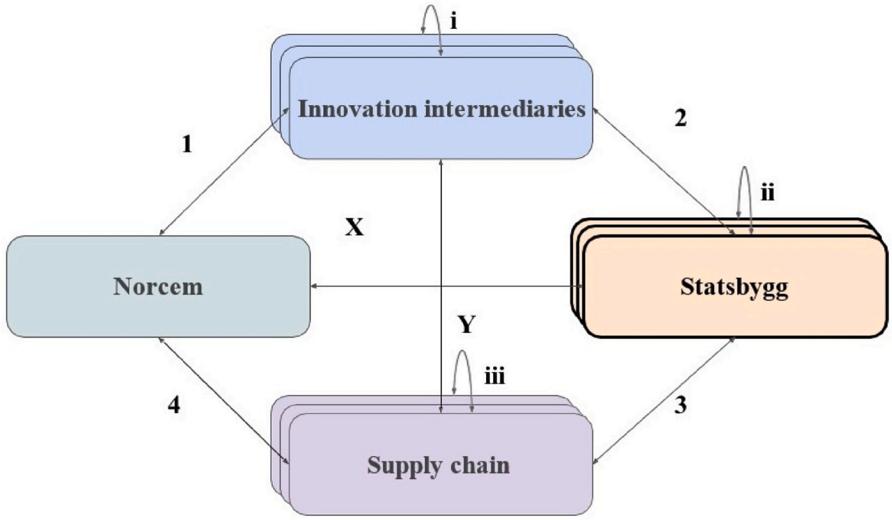

Fig. 5. Statsbygg's location in the innovation ecosystem and relationships to be identified.

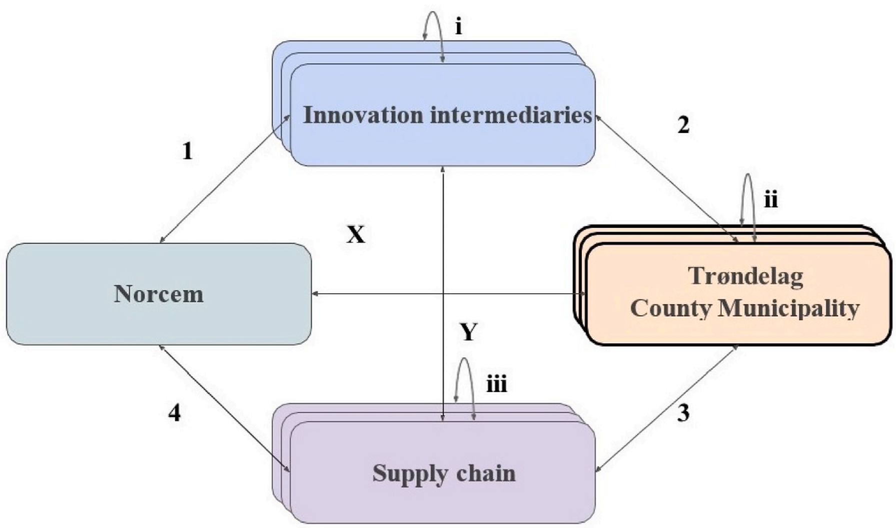

Fig. 6. TRFK's location in the innovation ecosystem and relationships to be identified.

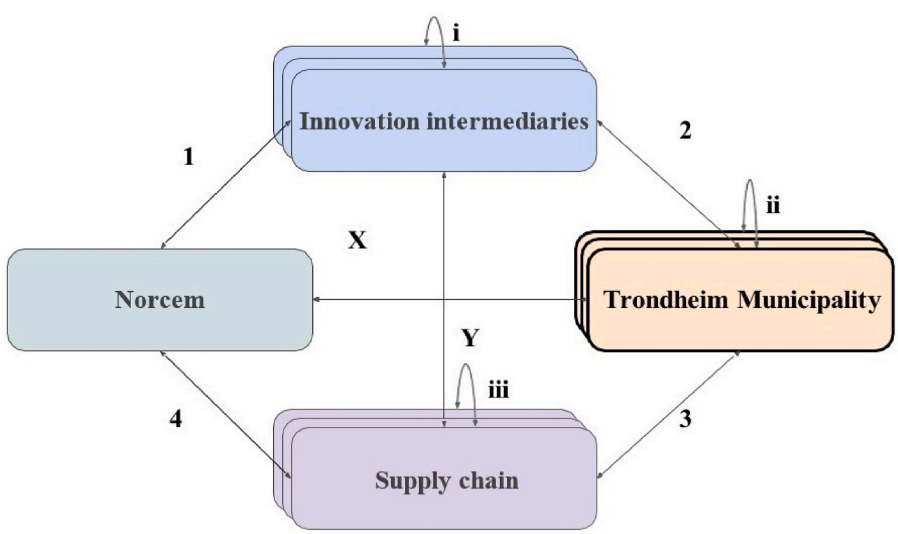

Fig. 7. Trondheim Municipality's location in the innovation ecosystem and relationships to be identified.

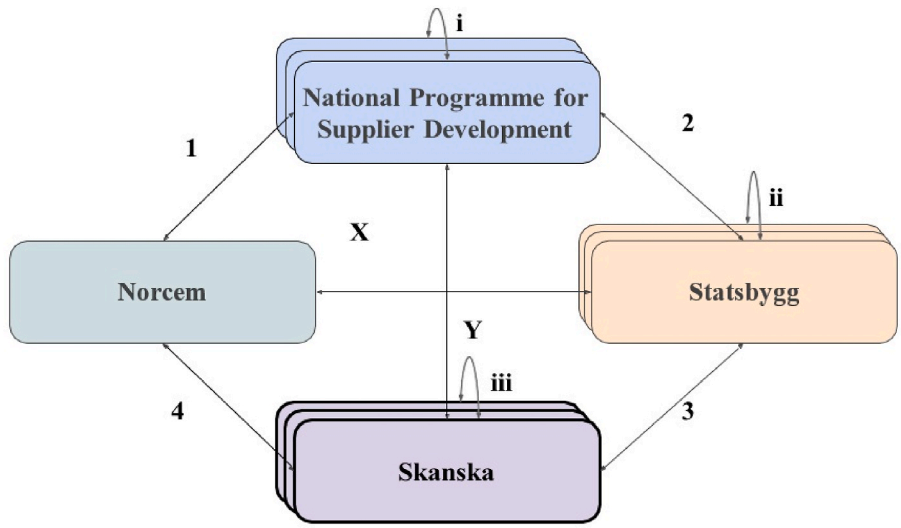

Fig. 8. Skanska's location in the innovation ecosystem and relationships to be identified.

innovation intermediary in Norcem's innovation ecosystem (see Fig. 9). They describe themselves as a driving force, facilitator, and knowledge builder who ensures that procurements are as innovative as possible. The NPSD operates in the "space" between the actors in the traditional supply chain; therefore, it is part of the instrument apparatus to promote innovation in public procurement.

Relation to Norcem, the focal EUS (see Fig. 9, arrow 1): The NPSD did not state an explicit relationship with Norcem. However, the program collaborates with other material suppliers toward making them more attractive actors (e.g., in the construction industry). The NPSD has close, ongoing collaboration with the national wood suppliers who want more focus on the use of wood in the construction industry.

4.1.5. Mapping the innovation ecosystem

The analysis of the actors and relationships in the innovation ecosystem shows that Norcem have relationships with some public developers (e.g., Statsbygg and SVV). Such relationships enable direct influence from the public actors. Further, supply chain actors, such as Skanska, have closer relationships with some public builders than Norcem. However, the strength of these relationship reportedly depends on the specific project's contract structure. Since Norcem has a relationship with contractors like Skanska, the relationships between the contractor and public actors enable Norcem to exert indirect influence on the public actors. Alternatively, Norcem can indirectly influence the innovation ecosystem actors via its relationships with its direct customers.

Fig. 10 summarizes the mapped innovation ecosystem and includes a broader selection of actors than discussed. These additional actors are the ministries and innovation intermediaries involved with the mentioned actors. There is also a direct relationship between Ministry of Petrolum and Energy and Norcem, resulting in the Brevik-plant project being financed on the national budget; as well as a direct relationship to the energy company Equinor who is a component supplier to Norcem, but which also forms a path of indirect influence to the Ministry. This notwithstanding, the mapped ecosystem is necessarily a simplification of reality, based on limited data. Part 2 identifies how Norcem can use the innovation ecosystem (actors and relationships identified in part 1) to influence the public actors' use of tools and instruments.

4.2. Part 2: impact

The second part of the analysis addressed the observed use of public sector instruments and their significance for Norcem. Subsequently, we explain Norcem's opportunities for directly and indirectly influencing the use of instruments. Tables A1–A.3 summarize the public instruments

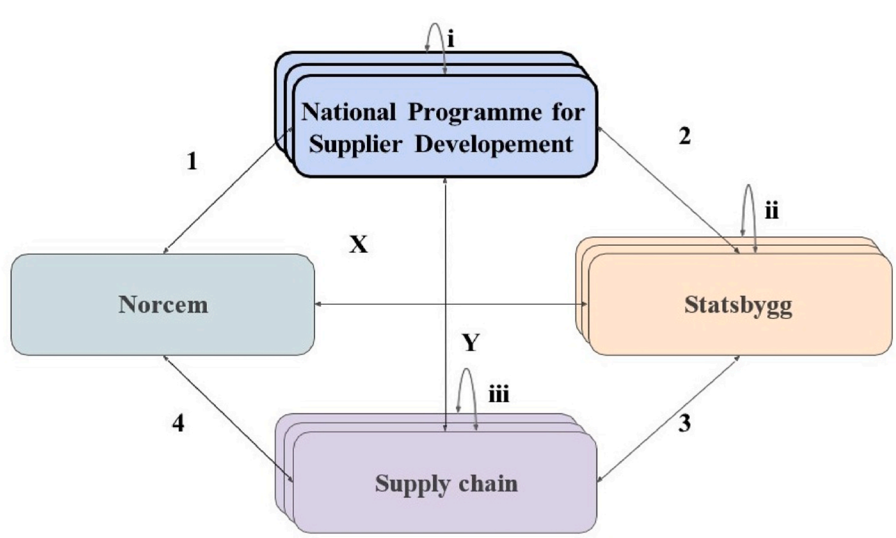

Fig. 9. National Programme for Supplier Development's location in the innovation ecosystem and relationships to be identified.

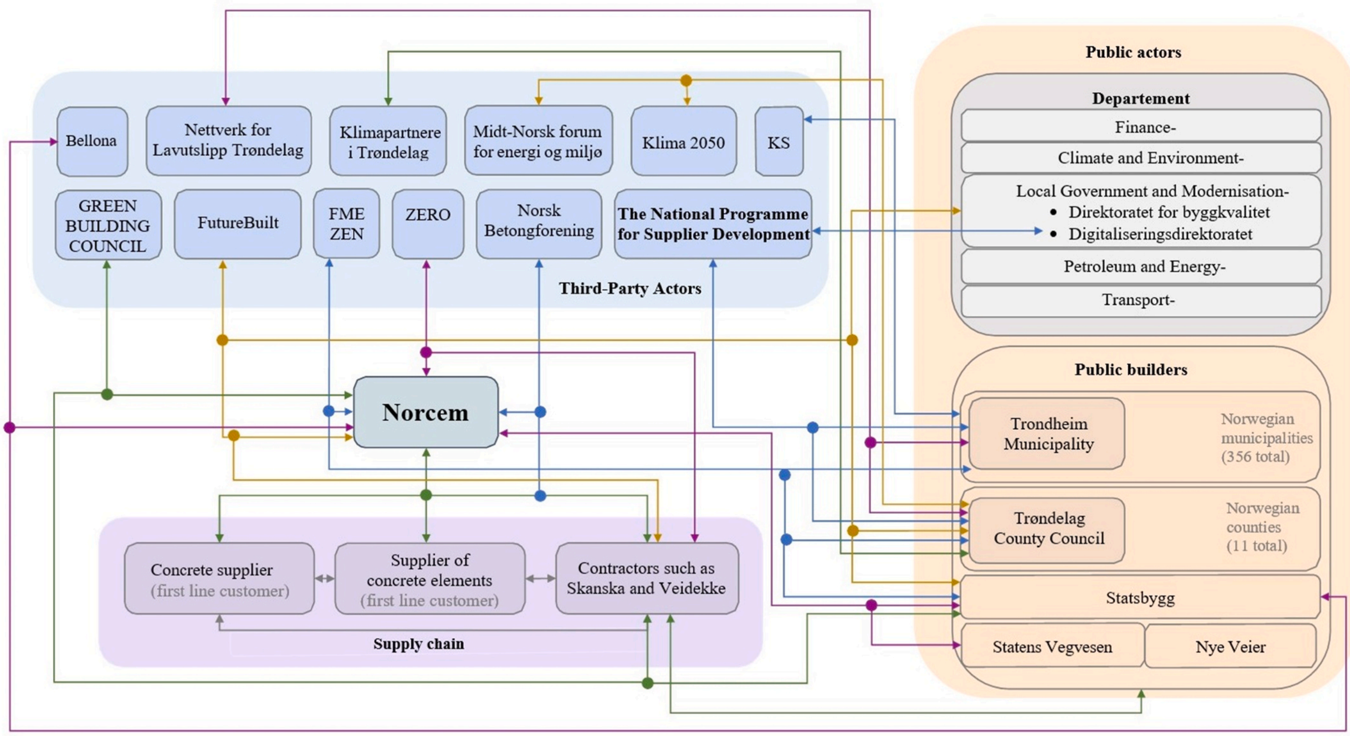

Fig. 10. Norcem's mapped innovation ecosystem.

identified and the associated risk categories they are assumed to influence.

The analytical framework illustrates a conceptual innovation ecosystem for an EUS in the construction industry. The innovation ecosystem has four categories of players: the focal early upstream supplier, innovation intermediaries, public actors, and other actors in the supply chain. The framework also illustrates the possibility of interactions and relationships between actors in the innovation ecosystem and how these relationships impact one or more actors. Hence, the framework sheds light on a focal EUS's direct and indirect influence on public actors' GPP practices and is considered an essential contribution.

All innovations involve risk, which can be influenced positively or negatively by the innovating actors. That is, innovation risk depends on all actors in the innovation ecosystem. However, based on the study's RQ, the theoretical framework only covers how the public actors influence the EUS's innovation risks. For a more in-depth answer to the RQ, it is relevant to detail the public actors' role in the innovation ecosystem. The literature review highlighted several instruments that may impact a public actor's ability to practice GPP.

The use of these instruments influenced one or more of the three risk categories associated with the innovation project (interdependence, initiative, integration risk). By linking public actors' use of policy instruments with the innovation risks, it became clear that two of the innovation risks theoretically have a greater potential for reduction than the third. Most of the instruments seem to influence the EUS's initiative and integration risks. Only the use of LCA tools seemed to influence interdependence risk. Few instruments seemed to influence the capacity of the component and complementary actors, given these actors' ability to deliver to the focal EUS's innovation project.

The study showed that the focal EUS could coordinate with a wide range of actors in its innovation ecosystem to influence the use of instruments. Innovation intermediaries and main contractors emerged as possible channels and allies for influence. Furthermore, the use of innovation intermediaries is considered a particularly relevant finding as they can limit the challenges associated with the mature and risk-averse nature of the construction industry. Innovation intermediaries function as facilitators for relationship building and information exchange. Together, the findings indicate how an EUS can affect its innovation ecosystem.

The innovation ecosystem perspective was used to assess direct and indirect methods for the focal EUS to influence public actors. Indirect methods of influence can be as effective as direct ones. This is assumed to apply, for example, if the focal EUS has a close relationship with a contractor with overlapping interests and a relatively weak relationship with public builders. The indirect impact methods are considered one of the major contributions from the innovation ecosystem perspective (and this study's). Overall, an innovation ecosystem perspective is a useful method for uncovering an EUS's opportunities to influence the activity of public actors to integrate greener solutions, such as low-carbon cement, into the market.

We observed that a lack of willingness among public buyers to prioritize climate-friendly solutions poses a challenge and increases an EUS's innovation risk. When assessing whether available purchasing competence and resources determine a public purchaser's ability to practice green procurement, the actors in the supply chain primarily focus on the public builders as the decision-maker. However, other actors may also exert influence, in particular public actors (ministries and user organizations such as universities) but also indirect customers such as main contractors who can provide input that affects a project's environmental ambition or component suppliers who may influence ministries with industry development responsibilities.

5. Discussion

The analyses show the potential for a focal EUS to influence its innovation ecosystem, aiming to increase the degree of GPP to succeed with its business process innovation. Innovation ecosystem theory stresses that the focal company can influence a range of different actors, either directly or indirectly (Gomes et al., 2018; Kapoor and Furr, 2015). This theory differs from other relevant theories, such as that of value chain or technology innovation system (TIS). It is relevant as an analysis framework for our study as the ecosystem concept primarily explores the possibilities for co-specialization, bargaining power, and other possibilities in the relations between the actors (Adner and Kapoor, 2010). The TIS framework, as an example, was deemed not applicable as our case study focuses on a focal company in relation to the upstream supply of a green product, and not the system and components pertaining to CCS technology. Therefore, its relevant to use innovation ecosystem theory to address an ecosystem's collective ability to innovate and the opportunities of a focal company to activate its relationships and actors in the ecosystem. The focal EUS's potential for direct and indirect influence may be strengthened by relations between actors in the innovation ecosystem. Further, the potential depends on the extent to which the focal EUS can map the public actors' use of instruments and the EUS's understanding of the overriding factors that affect their innovation ecosystem.

The role of innovation intermediaries seems crucial for increasing the actors' insight and competence in promoting innovation. The construction industry can be considered a mature industry, contributing to a low perceived need for external expertise. The industry is risk-averse, primarily due to its high demands, especially concerning quality, safety, costs, and time use. At the same time, the industry must comply with industry regulations. Therefore, it is reasonable to assume that the willingness to adopt (green) innovative solutions is, in principle, low. Despite these industry characteristics, it can be argued that increased information and revised regulations can contribute to moving the industry in a greener direction.

Our empirical data indicates that many companies in the construction industry consider pilot projects crucial for testing environmentally friendly, innovative solutions. To enable such pilot projects, Norcem's initial CCS deployment is necessary to drive the industry in a more innovative and greener direction. For an innovative EUS, this attitude seems positive, as it can help lower the adoption threshold for green, innovative products. However, the projects must not remain pilots. Successful practices must be integrated, standardized, and scaled. Only integration into the companies' daily practices makes the industry greener through the scaling of the practice. However, such integration processes, especially across actors, seem particularly challenging for the construction industry as the learning capacity and degree of information flow are low.

Innovation ecosystems are expected to evolve; they cannot live on pilot projects. There are multiple channels of communication between suppliers and other actors, such as public actors, intermediaries, and other suppliers. The distinction between these channels is important because it determines future interaction and information flow. For example, if a ready-mix concrete supplier plans to introduce new low-carbon concrete, it may want to reuse (reactivate) the same communication channel that the cement supplier uses. The extent to which the innovation ecosystem is relevant to future suppliers seeking green innovations depends on their position in the ecosystem. Therefore, the scaling degree and recombination effect of pilot projects depend on the position of new suppliers in the innovation ecosystem.

Moreover, open innovation is a practice that can help increase the flow of information between the actors in the construction industry. However, in a project-based industry, this often implies that the links between the actors are loose. Loose links may indicate that the actors do not have a high level of trust in each other and, thus, open innovation may be unattractive. However, innovation intermediaries can be a viable alternative to help build this trust; an actor can create an arena where new and long-lasting relationships are developed with relevant experiences and knowledge exchanged. Open innovation and the involvement of intermediaries can contribute to an increased willingness to adopt GPP in the construction industry and reduce the integration risk for the EUS.

6. Conclusion

An innovation ecosystem perspective provides a basic framework for an EUS to explore opportunities to influence public actors' use of instruments. The perspective enables risk assessment and contributes to a comprehensive overview of opportunities and barriers in a firm's innovation ecosystem. This study directly links the public sector's use of instruments for GPP and the innovation risks in an EUS's green innovation project. However, the instruments in our study is limited to the findings of literature review, and this may have affected our list of instruments. A more comprehensive literature review could provide accurate descriptions of these instruments or reveal new ones. This warrants further investigation and research on the instruments necessary for use by the public sector to contribute to the green shift, such as market dialogues and innovation partnerships. These are emergent factors in the PP field and should be given ample focus in future research.

Based on our findings, mapping the innovation ecosystem is a necessary first step in identifying the opportunities for a focal EUS in this context. However, no clear system boundary delineates which actors to include when mapping an innovation ecosystem. Ecosystems are not industry-specific but linked to a focal actor; therefore, mapping the innovation ecosystem is complex. The focal company may acquire an unmanageable amount of ecosystem information. Hence, the ability to manage and allocate resources to collecting ecosystem information in the mapping phase can be decisive for green process innovation. Having mapped the ecosystem and the relationships between different actors therein, a focal EUS can consider which mix of direct and indirect relational paths and channels to activate or develop, in order to influence the use public actors use of GPP.

In terms of managerial implications, the study provides relevant knowledge and insights for practitioners and project-based companies in the construction industry, including innovation leaders, project managers, and procurement professionals. Firstly, focal companies can use the innovation ecosystem framework as a mapping or analytical tool to promote and leverage green innovation as part of their innovation management system. For single construction projects, it is common to conduct stakeholder studies, including stakeholder analysis and assessment (Savage et al., 1991; Olander, 2007). However, as these methods do not provide a broad overview of supply chain stakeholders in different industries, powerful or innovative stakeholders are not always captured. This becomes a problem in complex construction projects where innovation is essential and collaboration is complex (Davies and Mackenzie, 2014). Furthermore, they rarely cover the interests of stakeholders in the early phases of innovation, and across projects.

Therefore, an innovation ecosystem framework can provide the focal company with strategic information more broadly down or up the supply chain and uncover potential opportunities, and provide a basis for deciding which actors to influence directly and/or indirectly along which relational paths, and whether one or several paths of influence should be pursued simultaneously for increased effects. Second, it provides a new perspective on the uncertainty and risks associated with the introduction of new products and processes in the construction industry. Incorporating these risks (interdependence, initiative, and integration) into the risk management system will help innovation and project managers better define sources of external uncertainty and capture time-dependent issues (Davies and Mackenzie, 2014; Hamdan et al., 2021). Especially in the design and planning phases of large projects, this will help all stakeholders anticipate and influence final outcomes. Hence, an innovation ecosystem framework can provide the focal company with a strategic view that covers broader both in time (more phases in innovation and adoption processes) and space (more actors up and down the supply chain). Future research should explore how EUSs approach and influence the innovation ecosystems for their green innovations and the results of their efforts, from the perspective of the EUS as well as other involved actors.

CRediT authorship contribution statement

Raymond Stokke: Writing – original draft, preparation, Conceptualization, Writing- Reviewing, Supervision, Methodology. **Frida Strand Kristoffersen:** Writing- Reviewing, Data curation, Visualization, Investigation, Software. **Marte Stamland:** Writing- Reviewing, Methodology, Data curation, Visualization, Investigation, Software. **Elsebeth Holmen:** Supervision, Visualization, Investigation, Editing. **Hasan Hamdan:** Writing – review & editing. **Luitzen De Boer:** Supervision, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix

Table A.1
Overview of findings from the analysis Part 2 (1).

Measures (Public actors)	Risk categories assumed affected	Degree of realized potential Low Medium High	Rationale for assessment of instruments	Norcem's opportunities for influence
Involvement of innovation intermediaries (to facilitate the process and organise market dialogues)	Integration	Medium	Considered well utilized, but the public actors' awareness of the purpose of innovation intermediary involvement is questioned. Recommend that Norcem identify and become involved with super-innovation intermediaries.	Direct: Make use of existing meeting activities with public builders. Via innovation intermediaries: Raise raise public builders' awareness through other innovation intermediary engagements. Via supply chain actors: Ally with other green-focused players.
Use standardized environmental requirements	Integration	Medium	The empirical data indicates that public actors seek guidance in preparing environmental requirements, to a certain extent, which has a positive effect. The Criteria Guide is available to everyone and seems to be used by public builders, but the data does not indicate how many. However, there seems to be significant variation in awareness of such tools among public builders, which reduces the tool's effectiveness.	Direct: Make use of existing meeting activities with public builders. Via innovation intermediaries: Contribute to designing standardized tools. Via innovation intermediaries: Encourage skills development within GPP. Via both innovation intermediaries and supply chain actors: Contribute to raising awareness of tools (e.g., Criteria Guide). Via supply chain actors: Ally with other green-focused actors.
Contract follow-up of environmental requirements	Integration	Low	A higher degree of contract follow-up can help to significantly highlight the CCS cement's competitive advantages and reputation building. Despite the benefits the instrument offers, the data suggests that two of three public builders interviewed practice contract follow-up to a small degree.	Direct: Facilitate increased use by providing necessary documentation. Via innovation intermediaries: Contribute to raising awareness about and encouraging contract follow-up. Via supply chain actors: Ally with other green-focused actors.
Use environmental certifications	Integration and initiative	Medium	Well utilized, but there is no certification specifically for CCS cement and high competence requirements for using current certifications reduce the tool's effectiveness. Based on the competence requirement, it is assumed that many public developers do not use this tool.	Direct: Facilitate increased providing necessary documentation. Via innovation intermediary: Contribute to preparation of certifications and LCA tools. Via supply chain actors: Ally with other green-focused actors.

Table A.2
Overview of findings from the analysis Part Two (2).

Measures (Public actors)	Risk categories assumed affected	Degree of realized potential Low Medium High	Rationale for assessment of instruments	Norcem's opportunities for influencing
Use of LCA tools		Low	Seems to have huge potential as there are already tools adapted to the Norwegian market. Recommend client possess	Direct: Facilitate increased use by providing necessary documentation.

(continued on next page)

Table A.2 (*continued*)

Measures (Public actors)	Risk categories assumed affected	Degree of realized potential Low Medium High	Rationale for assessment of instruments	Norcem's opportunities for influencing
	Integration, mutual dependence and initiative		expertise in LCA; the empirical data indicates LCA tools are used to a small extent (indicating ineffective use of the tool).	Via innovation intermediary: Contribute to preparation of certifications and LCA tools. Via supply chain actors: Ally with other green-focused actors.
Presence of environmental goals	Integration and initiative	Medium/Low	Evenly, data shows 52% Presence of green goals in public builders' strategies. Efficiency is weakened by wood materials explicitly presented as a better choice than concrete in one of three strategies among interviewed public builders.	Direct: Make use of existing meeting activities with public builders. Via innovation intermediaries: Contribute to raising awareness about inclusion of green goals. Via innovation intermediaries: Encourage skills development within GPP. Via supply chain players: Ally with other green-focused actors.
Direct innovative procurement, with market dialogues	Integration and initiative	High	Direct PPI seems to be practiced to a relatively large extent, often as pilot projects that all interviewed public builders focus on. Such projects often focus on new, sustainable use of materials, an aspect that CCS cement fulfills. It is realistic to assume that pilot projects will receive attention both inside and outside the industry, which is positive as it contributes to increased awareness of CCS concrete use.	Direct: Few possibilities for influence. Via innovation intermediaries: Build relationships with (relevant) public builders. Via innovation intermediaries: Contribute to raising awareness about innovative procurements. Via innovation intermediaries: Encourage skills development within innovative public procurement. Via supply chain actors: Ally with other green-focused actors.
Catalytic innovative procurement, with market dialogues	Integration and initiative	Medium	Norcem has benefited from catalytic PPIs practiced to a greater extent than is done today. Implementing such procurements is resource-intensive, which may explain why it is practiced to a lesser extent than direct PPI.	Direct: Few possibilities for influence. Via innovation intermediaries: Build relationships with (relevant) public builders. Via innovation intermediaries: Contribute to raising awareness about innovative procurements. Via innovation intermediaries: Encourage skills development within innovative public procurement. Via supply chain actors: Ally with other green-focused actors.

Table A.3
Overview of findings from the analysis Part 2 (3).

Measures (Public actors)	Risk categories assumed affected	Degree of realized potential Low Medium High	Rationale for assessment of instruments	Norcem's opportunities for influence
Choice of contract type, with innovation oriented ones including market dialogues	Integration	Medium	Data shows a positive trend in integrating cooperation in contracts. On the basis of NPSD, which claims that innovative procurement competence decreases with size, it seems that this barrier can prevent small public developers from adopting such forms of contract and is, therefore, assumed in assessing this instrument.	Direct: Make use of existing meeting activities with public builders. Via innovation intermediaries: Encourage skills development within innovative public procurement. Via innovation intermediaries: Contribute to raising awareness of the form of cooperation contract. Via supply chain actors: Ally with other green-focused actors. Via supply chain actors: Facilitate framework agreements with relevant first-line customers.
Legislative and regulatory changes	Integration and initiative	High	Assessment of changes in laws and regulations is made on the basis of the opportunities public actors have to influence existing bills by contributing to hearings. Based on the study's empirical evidence, public builders have good opportunities to participate and contribute to hearings for changes in laws and	**Norcem's opportunities to influence ministries:** Direct: Involve politicians and contribute to consultation responses. Via innovation intermediaries: Contact

(*continued on next page*)

Table A.3 (*continued*)

Measures (Public actors)	Risk categories assumed affected	Degree of realized potential Low Medium High	Rationale for assessment of instruments	Norcem's opportunities for influence
			regulations. Nevertheless, proposals were made for how Norcem can use its innovation ecosystem to influence the ministries (in addition to how Norcem can influence public developers). The focus on influencing the ministries' bills is essential, as such proposals are a prerequisite for invitations to hearings.	relevant actors. Via supply chain actors: Ally with other green-focused actors. **Norcem's opportunities to influence public builders:** Direct: Make use of existing meeting activities with public builders. Via innovation intermediaries: Motivate to participate and contribute to consultation rounds. Via supply chain actors: Ally with other green-focused actors.

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