THE ULLANDHAUG INNOVATION DISTRICT

A Comprehensive Analysis of Collaborative Networks, Business Composition, and Research Infrastructure

DIVEOPP

DiveOpp Report No.2024 - 09
Tom Broekel, Rune Dahl Fitjar and Silje Haus-Reve

Keywords: innovation districts, Ullandhaug, collaboration, innovation ecosystem, clusters
UN-sustainable goals

www.diveopp.com

DIVEOPP

CONTENT

1. Introduction
2. What is an innovation ecosystem?
3. The Ullandhaug Innovation Ecosystem
4. The Economic Structure of the Ullandhaug Innovation District
5. Contribution of the Ullandhaug Innovation District to Stavanger's economy
6. Relationships between firms: Interlocking directorates
7. Research organizations at Ullandhaug
8. Research collaboration
9. Research at Ullandhaug and the UN Sustainable Development Goals
10. Research infrastructure at Ullandhaug
11. Conclusion and recommendations

PREFACE

DiveOpp has analyzed the business composition, networks, collaboration, and research infrastructure at Ullandhaug in Stavanger municipality. DiveOpp is a spin-off company from the University of Stavanger, specializing in analyses of regional transformation using research-based methods and analyses. The work is funded by the Universitetsfondet.

We would like to thank you for an exciting project and the insights we have gained throughout the process.

September, 2024

DIVEOPP

We are DiveOpp

We provide research-based assisement of regional transistion prosesses

DiveOpp is a spin-off company from the University of Stavanger and was established in 2020. DiveOpp rely on research-based approaches and analytical tools to map regional transformation opportunities, identify strategic growth areas, and promote regional development.

Silje Haus-Reve

CEO and co-founder of DiveOpp | Professor of Innovation and Regional Studies at UiS School of Business and Law, University of Stavanger.

Rune Dahl Fitjar

Co-founder of DiveOpp | Researcher
Professor of Innovation Studies at UiS School of Business and Law, University of Stavanger.

Tom Brokel

Co-founder of DiveOpp | Researcher
Professor innenfor Regional Innovation at UiS School of Business and Law, University of Stavanger.

DIVEOPP

Sammendrag på norsk

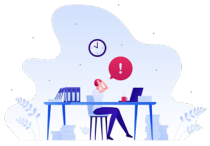
Siden 1960-tallet har Ullandhaug i Stavanger utviklet seg til å bli regionens økosystem for forskning, utdanning, innovasjon og teknologiutvikling. Her finner vi universitet, sykehus, forskningsinstitutter, offentlige institusjoner, næringsklynger og innovasjonspark. Samlingen av kunnskapsmiljøer på Ullandhaug gir gode forutsetninger for samarbeid, kreativitet og innovasjon, og derigjennom for verdiskaping og nye arbeidsplasser i regionen. Men geografisk nærhet fører ikke i seg selv til samarbeid. Det skapes gjennom at aktørene kjenner til hverandre og har gjensidig nytte av å samarbeide.

I 2023 ble Ullandhaug innovasjonsdistrikt etablert, med mål om å bidra til samarbeid mellom de sentrale aktørene på universitetsområdet. Denne rapporten analyserer hvilke aktører som finnes på Ullandhaug i dag og hvordan disse samarbeider. Dette gir et kunnskapsgrunnlag for å videreutvikle Ullandhaug som et innovasjonsøkosystem. Nedenfor oppsummeres hovedfunnene fra rapporten.

UNIVERSITETET SOM NØKKELSPILLER

Universitetet i Stavanger, UiS, spiller en sentral rolle i økosystemet, med sine 12 000 studenter og 1 800 ansatte. Universitetets forskning, utdanning og samarbeid med andre institusjoner, inkludert Stavanger universitetssjukehus og NORCE, er viktige drivkrefter for innovasjon og nyskaping. UiS har også en nøkkelrolle i å tilrettelegge for kommersialisering og kunnskapsutveksling mellom store, mellomstore og mindre bedrifter. Særlig er det mye samarbeid innen helse og energi mellom aktørene på Ullandhaug. Å styrke samarbeidet mellom Universitetet i Stavanger, forskere og bedrifter lokalisert her vil være en viktig rolle for et innovasjonsdistrikt.

DIVEOPP



SAMMENSETNING AV NÆRINGSLIVET

Analysen av næringslivet på Ullandhaug viser en stor bredde i ulike sektorer. Totalt fordeler de 251 bedriftene seg på 41 av de 88 næringskodene som finnes i klassifiseringssystemet. De fleste bedriftene er små og unge. Den typiske bedriften har færre enn 10 ansatte og er yngre enn 6 år. Dette reflekterer at Ullandhaug er et entreprenørskaps- og oppstartsmiljø. Mange bedrifter er innenfor kunnskapsbaserte næringer, med kompetanse innen rådgivning, forskning og tekniske tjenester. Det er også flere bedrifter som tilhører næringer innen IT og energi, samt at klyngene Energy Transition Norway og Norwegian Smart Care Cluster er lokalisert her.

For å analysere hvilken rolle bedriftene på Ullandhaug har i Stavanger-regionens næringsstruktur, har vi gjennomført en analyse ved hjelp av DiveOpps Diversification Opportunities Tool (DIOPTO). Dette verktøyet gir et mål på hvordan kompetansen på Ullandhaug utfyller det regionale næringslivet og hvilke aktiviteter som har gode forutsetninger for fremtidig verdiskaping.

Analysen viser at næringslivet på Ullandhaug er spesialisert innen ingeniørtjenester og teknisk rådgivning, samt støttetjenester for utvinning av petroleum og naturgass og konsulenttjenester innen informasjonsteknologi.

Disse bransjene er komplekse og nært beslektet med øvrig næringsliv i regionen, som gir gode muligheter for videre vekst. Ullandhaug har imidlertid også flere komplekse næringer av noe mindre størrelse som ikke er særlig beslektet med regionens næringsliv. Disse kan få utfordringer med å finne relevant kompetanse og utnytte synergier med annet næringsliv i regionen. Det kan derfor være behov for mer målrettede tiltak for å bygge nettverk med næringsliv utenfor regionen.

NETTVERK OG SAMARBEID

For å analysere nettverk og samarbeid mellom aktørene på Ullandhaug har vi gjort tre ulike analyser: Vi har sett på samarbeid mellom forskningsmiljøene gjennom en analyse av felles publikasjoner. For nettverk mellom bedriftene har vi analysert omfanget av felles styremedlemmer. Til sist har vi sett på forsknings- og innovasjonsinfrastruktur som kan muliggjøre samarbeid.

De fleste sampublikasjoner på Ullandhaug involverer institutter på UiS i samarbeid med Stavanger universitetssjukehus innen helse eller med NORCE innen energi. Omfanget av samarbeid på tvers av institusjoner er imidlertid nokså begrenset, og involverer i hovedsak to fakulteter og noen få fagmiljøer. Det er også lite sampublisering på tvers av fakultetene ved UiS. Det er svært få publikasjoner som involverer bedrifter på Ullandhaug.

Flere av bedriftene har felles styremedlemmer, men den totale tettheten i styrenettverket er relativt lav. Klyngen Energy Transition Norway, Havbrukskompaniet og Norsk Vind AS fungerer som sentrale knutepunkter, som binder sammen et større nettverk av bedrifter gjennom felles styremedlemmer. Styremedlemskap i bedrifter utenfor Ullandhaug knytter også sammen flere bedrifter på Ullandhaug.

Området støttes opp av forskningsinfrastruktur, blant annet ved NORCE og Universitetet i Stavanger, med spesialisering innen områder som petroleumsingeniørfag, robotikk og bærekraftig energi. Det finnes ingen fullstendig oversikt over forskningsinfrastrukturen på Ullandhaug eller i hvilken grad denne brukes på tvers av organisasjoner.

BIDRAG TIL FNS BÆREKRAFTSMÅL

For å analysere hvordan forskningen på Ullandhaug bidrar til FNs bærekraftsmål, har vi foretatt en tekstanalyse av resultatene som er rapportert i Cristin-databasen. Analysen viser at forskningen på Ullandhaug særlig bidrar til bærekraftsmålene innen helse og energi.

Universitetet i Stavanger har en variert forskningsportefølje, med betydelige bidrag til SDG 3 (God helse og livskvalitet), SDG 9 (Industri, innovasjon og infrastruktur), SDG 4 (God utdanning) og SDG 6 (Rent vann og gode sanitærforhold). Forskningsresultatene fra Stavanger universitetssjukehus er, ikke overraskende, hovedsakelig rettet mot SDG 3 (God helse og livskvalitet). Andre viktige områder er SDG 11 (Bærekraftige byer og lokalsamfunn) og SDG 5 (Likestilling mellom kjønnene). Nofimas forskning er bredt fordelt på flere SDG-er, med særlig vekt på SDG 14 (Livet i havet) og SDG 9 (Industri, innovasjon og infrastruktur). Forskningen ved NORCE retter seg også mot SDG 6, SDG 14 og SDG 9, samt mot SDG 13 (Stoppe klimaendringene) og SDG 7 (Ren energi til alle).

UTFORDRINGER OG MULIGHETER

Til tross for den sterke tilstedeværelsen av forskningsorganisasjoner og bedrifter på Ullandhaug, står økosystemet overfor flere utfordringer knyttet til integrasjon og samarbeid. Selv om det finnes flere sterke klynger på Ullandhaug, som fungerer som knutepunkter i styrenettverket, er de lite synlige i samarbeid og interaksjon med akademia. Samtidig er det begrenset forskningssamarbeid på tvers av fakultetene ved Universitetet i Stavanger (UiS). Samarbeidet mellom SUS, NORCE og UiS er i stor grad dominert av helsefag og energiteknologi. Få bedrifter på Ullandhaug bidrar aktivt til forskning og akademisk arbeid.

En annen utfordring er den fragmenterte oversikten over laboratorier ved NORCE og UiS. Det finnes ingen samlet oversikt over laboratorier på Ullandhaug, hva slags utstyr de har eller hvordan de kan brukes på tvers av organisasjoner. Dette begrenser potensialet for samarbeid og felles ressursbruk.

Næringslivet på Ullandhaug er preget av kunnskapsintensive bedrifter innenfor komplekse næringer. Dette gir stort potensial for verdiskaping. Flere bedrifter er imidlertid innen næringer som i liten grad er beslektet med regionens spesialiseringer. Det er dermed en risiko for at de i mindre grad kan bygge på kompetanse i øvrig næringsliv i regionen når de skal utvikle seg videre.

VEIEN VIDERE

Samlingen av forsknings- og innovasjonsmiljøer på Ullandhaug gir gode forutsetninger for samarbeid, vekst og verdiskaping. Analysen viser at Ullandhaug har alt som skal til for å skape et velfungerende økosystem for innovasjon: Gode forskningsmiljøer, kunnskaps- intensive bedrifter og relevant infrastruktur.

Samarbeidet mellom forskningsmiljøene, og mellom forskningsmiljøene og næringslivet, er imidlertid forholdsvis begrenset. Det er bare noen deler av forskningsmiljøene som samarbeider, og bedriftene er i liten grad aktive i forskning. Dette kan gjøre det vanskelig å utnytte mulighetene som ligger i samlokaliseringen av disse miljøene.

Selv om næringslivet på Ullandhaug er kunnskapsintensivt og i bransjer med stort potensial for vekst, er det i noen tilfeller lite beslektet med øvrig næringsliv i regionen. Det kan gjøre det vanskelig å finne kompetanse lokalt til å utvikle bedriftene videre.

Det er også få store bedrifter på Ullandhaug. For å utvikle et komplett innovasjonsøkosystem vil det derfor være viktig å knytte forskningen og oppstartsvirksomheten på Ullandhaug tett til næringslivet i andre deler av regionen.

Executive Summary: The Ullandhaug Innovation Ecosystem

The Ullandhaug Innovation Ecosystem, located just outside the city center of Stavanger, Norway, is a strategic zone that integrates research, education, and innovation activities. Originally zoned for university purposes in 1966, it now encompasses a range of organizations including the University of Stavanger (UiS), research institutes like NORCE, and numerous small and medium-sized enterprises (SMEs). The ecosystem is designed to foster collaboration between academia, industry, and public agencies, with a focus on driving regional economic development and innovation.

Key Components of the Ecosystem

1. **Role of the University of Stavanger:** The University of Stavanger plays a central role in the ecosystem, serving as an anchor institution. With over 12,000 students and 1,800 staff, the university's research output and its collaborations with other institutions, including Stavanger University Hospital and NORCE, are key drivers of innovation. UiS also plays a pivotal role in fostering relationships with SMEs and facilitating knowledge exchange. The presence of specialized departments such as health sciences and energy technology strengthens the region's expertise, especially in sectors like healthcare, energy, and digital technology.

2. **Business and Sectoral Composition:** The Ullandhaug ecosystem is home to 251 active firms, primarily focused on knowledge-based industries. The most significant sector within the district is "Architectural and Engineering Activities," which reflects the area's orientation towards consulting, research, and technical services. This is closely followed by sectors like IT services, scientific research, and energy-related activities. The sectoral diversity is essential for innovation, with 41 out of 88 sectors represented, underscoring the district's wide economic base. Importantly, the ecosystem includes clusters such as Energy Transition Norway and the Norwegian Smart Care Cluster, which promote collaboration across industries.

3. **Size and Age Composition of Firms:** Most businesses within the ecosystem are SMEs, with a large proportion (over 73 firms) having fewer than 10 employees, reflecting a highly entrepreneurial environment. The district supports both startups and mature firms, with a significant number of younger companies (0-6 years old) coexisting alongside more established enterprises. This diversity in size and age indicates a balanced innovation ecosystem that nurtures new ventures while providing stability through larger, more experienced firms. This balance is crucial for sustaining long-term growth and resilience in the face of economic changes.

Networks and Collaboration

1. **Interlocking Directorates:** A key feature of the Ullandhaug Innovation Ecosystem is the network of interlocking directorates, where board members serve on the boards of multiple companies. These networks foster close relationships between firms, enhancing strategic decision-making, resource sharing, and corporate governance. Companies like Energy Transition Norway and Norsk Vind AS act as hubs, linking numerous firms through shared board members. However, the overall network density remains relatively low, signaling opportunities for more integrated collaborations.

2. **Research Collaboration:** The University of Stavanger plays a critical bridging role in the research collaboration network, linking various entities within the ecosystem. Research outputs from UiS are extensively integrated with those from Stavanger University Hospital, NORCE, and other organizations. The university's diverse departments, particularly in health sciences and energy technology, are heavily involved in collaborative projects, contributing significantly to the region's research output. These collaborations not only advance academic knowledge but also generate practical innovations, particularly in fields such as healthcare, energy, and sustainability.

3. **Innovation Infrastructure:** The ecosystem is supported by advanced research infrastructure, including state-of-the-art labs at the University of Stavanger, with specializations in areas such as petroleum engineering, robotics, and sustainable energy. The combination of cutting-edge research facilities and the presence of SMEs fosters a vibrant environment for technology transfer and commercialization.

Challenges and Opportunities

Despite the strong presence of research organizations and businesses, the ecosystem faces some challenges in terms of integration. The network of firms and research institutions is somewhat fragmented, limiting the full potential of collaboration. Additionally, while the ecosystem hosts high-complexity industries with strong growth potential, many of these industries lack close alignment with the broader regional economy, highlighting the need for strategic support to enhance regional integration and collaboration.Moreover, while the ecosystem has made significant contributions toward the United Nations Sustainable Development Goals (SDGs), particularly in healthcare and energy, there is room for more concerted efforts in fostering interdisciplinary research that aligns with broader sustainability targets.

Conclusion

The Ullandhaug Innovation Ecosystem is a vibrant and evolving hub for research, education, and business. It successfully combines academic excellence, innovative business activity, and government support. However, to fully realize its potential, there is a need for deeper network integration and stronger alignment with regional economic strengths. By addressing these challenges and enhancing collaboration across sectors, the Ullandhaug ecosystem is well-positioned to become a leading center for innovation and sustainable growth in Norway.

1. Introduction

In 1966, the City of Stavanger established an area of 1.3 km^2 at Ullandhaug zoned for university purposes. At the time, Ullandhaug was an agricultural area outside the urban settlement, 5 km from the city centre. Stavanger would also not have a university until almost 40 years later, when the University of Stavanger was established in 2004.

Today, Ullandhaug houses a university with 12,000 students and 1800 employees, alongside several other organizations that meet the zoning criteria of supporting the development of research, education, and innovation. These include the regional offices of the research institute NORCE with 130 employees, the science park Innovasjonspark Stavanger with around 150 small and medium-sized companies, the innovation company Validé and government agencies including the Norwegian Offshore Directorate and the Norwegian Ocean Industry Authority, each with around 180 employees. In 2016, the government decided on Ullandhaug as the new location for Stavanger University Hospital, which will open in November 2025. The University Hospital has around 7800 employees and will become the largest employer at Ullandhaug when opening. This includes around 200 employees with PhD degrees and 40 professors.

The establishment of Ullandhaug as an area for research and innovation has evidently resulted in the co-location of the regions' main research organizations and of an innovation-oriented business sector aiming to exploit the results of this research. Additionally, several organizations work as intermediaries to support collaboration and knowledge exchange between these actors. Besides the aforementioned Validé and Innovasjonspark Stavanger, this includes several cluster organizations (e.g., Energy Transition Norway, Norwegian Smart Care Cluster, Stiim Aquacluster), networks (e.g., HelseCampus) and public organizations such as Universitetsfondet.

Following the introduction of the Knowledge City Stavanger thematic plan in June 2022, Universitetfondet and the City of Stavanger have worked jointly to prepare the foundation for establishing Ullandhaug Innovation District. This model is also embedded in Universitetfondet's strategy 2021-2025. While the university area at Ullandhaug has developed organically for over 60 years, the idea is that a joint organization, an Innovation District, would enable stronger coordination and visibility. This would make it possible to develop synergies between the various activities and to position the region nationally and internationally. This is also in line with the ambitions of the EU's Innovation Agenda from June 2022. Ullandhaug Innovation District was established in 2023.

Against this backdrop, a natural goal for the area is to develop mutually beneficial collaborations between the research organizations at Ullandhaug, and to attract a business sector that can benefit from being co-located with these organizations. To what extent do organizations at Ullandhaug collaborate in research activities today? And which types of businesses are located in the area? These are the main questions which this report will address, with the aim of describing what characterizes the Ullandhaug innovation ecosystem.

In the report, Ullandhaug is defined as the area which is zoned for university purposes. This is also the area which makes up Ullandhaug Innovation District. We examine the area from an ecosystem perspective, and start with a discussion of the ecosystem concept. Following this, we provide an overview of the area and its historical development. We then move on to analyze first the businesses at Ullandhaug, in terms of their composition and the networks between them. Next, we analyze collaboration between the research organizations at Ullandhaug and their contributions to the UN Sustainable Development Goals. Finally, we describe the research infrastructure in the area.

In the report, we use the analysis tool DIOPTO. DIOPTO uses data and research-based insights to analyze diversification opportunities in a region or an ecosystem. The DIOPTO tool compares the opportunities of an area with those of other regions and informs our understanding of how to support further development of different industries in the region.

2. What is an innovation ecosystem?

2.1. The development of the ecosystem concept in the innovation literature

Scholars and practitioners have long since recognized that firms do not innovate in isolation. They depend on knowledge and resources outside the firm for their innovation processes. To access external knowledge, firms rely on networked or open innovation approaches, bringing in ideas and competencies from suppliers, customers, researchers, investors, and other outside sources. This can take the form of collaboration in specific projects or as part of broader alliances, or it can result from the mobility of employees between organizations or observations of what others are doing.

In the innovation literature, the concept of innovation systems emerged in the 1980s, partly to explain the innovativeness of the Japanese economy[1]. The literature on national innovation systems emphasized the role of close social interactions between suppliers and customers in developing innovation. Mutually supportive interactions between the public and private sectors and between industry and research organizations were also essential, all embedded in the national institutional framework. Later, literature applied the concept of innovation systems at other levels than that of the nation, expanding it to include regional innovation systems or technological innovation systems.

In recent years, the main question of interest in this research has been how these innovation systems change over time. Evolutionary economic geography[2] has emerged as the dominant framework for understanding this. In this approach, innovation systems develop through the recombination of knowledge from related areas. This results in path dependent development as innovation systems branch into new areas by building on existing strengths[3]. Another area of research in this field has explored how this path dependence can be broken, most notably in the field of transition studies[4].

In parallel with this development, the concept of business ecosystems emerged in the strategy and management literature[5]. Originally, the idea was to highlight that firms are not just part of industries but depend on broader ecosystems spanning multiple industries. In these ecosystems, firms co-evolve the capacity to develop new innovations through a combination of cooperation and competition. Another idea inspired by biology was the evolution of these ecosystems through different stages, such as birth, growth, maturity, and decline.

The combination of the two concepts into one – innovation ecosystems – did not catch on until around 2007[6]. It emerged mainly from the literature on business ecosystems. Indeed, given the centrality of innovation to business strategy in the contemporary economy, the two concepts have been used as synonyms in parts of the literature. The main difference between the two has been a stronger focus on value creation in the literature on innovation ecosystems, compared to value capture in the literature on business ecosystems[7].

Conversely, the literature on innovation ecosystems has not engaged much with the concept of innovation systems. The difference is partly one of perspective. The innovation ecosystems literature sees the world mainly from the standpoint of an individual business, examining how it is influenced by its context and what the implications of this are for business strategy. Conversely, the innovation systems literature takes the perspective of the economy as a whole and is mainly interested in implications for policy. These differences in perspective also feed into different understandings of the levels of control vested in actors: Whereas ecosystems naturally evolve, innovation systems can, to some extent, be designed.

Although the innovation systems literature is heavily inspired by evolutionary perspectives in the field of economics, the ecosystem concept has not been widely used within this approach[8]. However, recent work on entrepreneurial ecosystems has sought to explain from an economy-wide perspective why levels of entrepreneurial activity are higher in some regions than in others[8]. These ecosystems consist of networks of entrepreneurs, leaders, investors, skilled workers, support services, and more intangible factors such as physical infrastructure and institutions[9].

The literature on innovation districts represents yet another stream that is relevant to this discussion. This has emerged more from the field of urban planning as a concept to describe the trend for companies to move from self-contained office campuses in industrial zones to downtown urban areas. These innovation districts typically host one or more anchor institutions, start-ups, and incubators within a dense mixed-use area including housing and services[10]. Other models of innovation districts have also emerged, such as urbanized science parks and repurposed industrial districts. In all cases, the main concept is to combine a high density of innovation activity with urban qualities. Building on insights from urban economics, the idea is that this will support knowledge exchange and thus accelerate innovation[11].

2.2. Defining innovation ecosystems

As with many emerging concepts, there is no agreed-upon definition of innovation ecosystems. Indeed, the concept has been adapted by different authors to suit their circumstances, depending on the empirical context in which they want to apply it. In an attempt to address this conceptual stretch, Granstrand and Holgersson reviewed the literature on innovation ecosystems in a 2020 article. They propose a synthesized definition that combines key features of earlier approaches:

“An innovation ecosystem is the evolving set of actors, activities, and artifacts, and the institutions and relations, including complementary and substitute relations, that are important for the innovative performance of an actor or a population of actors.”[12]

Following this definition, it is important to identify the actors that make up the innovation ecosystem – i.e., the individuals and organizations composed of the ecosystem. Furthermore, we need to identify the key activities that these actors engage in, which are important for their innovative performance. The definition also refers to artifacts, which are tangible and intangible resources and other types of inputs that may affect innovative performance. The definition further encompasses the relations between the actors, activities, and artifacts. These may be either collaborative (complementary) or competitive (substitute).

Finally, the ecosystem is evolving as actors enter and exit, their activities and the artifacts they use change, and their relationships develop over time. Based on this, we will in this report examine the following components of the Ullandhaug Innovation Ecosystem:

- The actors: Organisations and employees working at Ullandhaug
- The activities: The profile of knowledge generation activities in these organizations
- The artifacts: The labs and infrastructure supporting innovation activity
- The relations: Mobility and collaboration between the organizations
- The evolution of these across time

3. The Ullandhaug Innovation Ecosystem

Ullandhaug is an area around 5 km outside the city centre of Stavanger. The area was zoned for university purposes in 1966. Therefore, activity in the area must be related to research, education and/or innovation. Over the following 58 years, new activities have gradually been introduced. The area can roughly be divided into three parts: The northern part is the campus of the University of Stavanger (UiS). The central part is a mixed-use area, primarily consisting of knowledge-intensive firms conducting research and development. These include the research institute NORCE, the science park Innovasjonspark Stavanger, which houses around 150 small and medium-sized firms. It also includes innovation support organisations such as Validé, the Norwegian Offshore Directorate and Norwegian Ocean Industry Authority, the Rogaland branch of NRK, and other firms and government organisations. Finally, the southern part will be occupied by the new University Hospital, which is currently under construction and scheduled to open in 2025. As an innovation ecosystem, Ullandhaug comprises both research organisations oriented towards generation and dissemination of new knowledge, and businesses aiming to exploit this knowledge. Additionally, innovation support organisations in the area have been set up to promote the exchange of knowledge between the sectors. This includes the innovation company Validé, as well as the science park Ipark and several cluster organisations.

The research system in Ullandhaug comprises mainly the University of Stavanger and the regional branches of the research institutes NORCE and Nofima. Stavanger University Hospital also has extensive research activities, and closer collaboration with UiS and NORCE was one of main arguments for moving the hospital to Ullandhaug.

The research organisations at Ullandhaug have created several initiatives to foster closer collaboration, between each other and with other research and higher education institutions in the region (mainly VID, BI, NMBU, Bioforsk, and HVL). These include a joint innovation company (Validé), a joint EU unit, HealthCampus, SAFER, joint research centres and clusters, and several bilateral agreements.

On the business side, most companies are located in Innovasjonspark Stavanger, which is a science park housing around 150 SMEs. It also houses the innovation company Validé, which includes functions as an incubator and TTO, as well as hosting pre-seed funds and cluster organisations. Ullandhaug hosts three clusters at the Arena Pro level of the Norwegian Innovation Clusters program: the Norwegian Smart Care Cluster, Energy Transition Norway, and Stiim Aquacluster.

3.1. Historical development of the ecosystem

The development of the area started with the establishment of Rogaland District College in 1969[13]. By 1974, it was located in new buildings at Ullandhaug, as were Stavanger Teaching College and the Norwegian School of Hotel Management. In 1994, these institutions merged to form the College of Stavanger. The merger also included Stavanger Nursing College and the Social College, which moved to Ullandhaug the following year, as well as Rogaland Music Conservatory, which stayed in its premises in Bjergsted. The College of Stavanger achieved accreditation as the University of Stavanger in 2004.

Rogaland Research was established by Rogaland County Council in 1973 as a foundation with the purpose of conducting, promoting and coordinating research in Rogaland. At the outset, it was based in the District College buildings and relied mainly on the college's staff. However, it soon developed into a research institute with several branches and an independent staff. In 1985, it open Ullrigg, a full-scale drilling rig. In 2005, Rogaland Research and the University established the International Research Institute of Stavanger (IRIS), which took over all research and lab activity in Rogaland Research, as well as contract research at UiS. IRIS merged with four other research institutes across Norway in 2018 to form NORCE.

Rogaland Knowledge Park was established by the Cities of Stavanger and Sandnes, Rogaland County Council, Rogaland Research and Forus Industry Park in 1993 to contribute to economic development based on research. In 2000, it formed Innovasjonspark Stavanger as a joint venture with Smedvig. It constructed office buildings and brought in tenants which could benefit from collaboration with the research groups at UiS and Rogaland Research. In 1998, it also opened the region's first incubator[14]. From the research side, Prekubator TTO was established in 2002 as a technology transfer office for UiS, NORCE and Stavanger University Hospital, with responsibility for commercialisation of research. In 2016, it merged with Ipark to form an integrated innovation company, Validé.

4. The economic structure of the Ullandhaug Innovation District

Following from the general overview above, we now move on to examining the composition of actors at Ullandhaug today, starting with the business sector. This is done by geolocating firms based on their official addresses. In this analysis, we include all private sector firms located in the Ullandhaug area. As the discussion above shows, many of the large employers in Ullandhaug are public-sector entities, which will not be included in this analysis. However, we will return to examine the composition of the research sector at Ullandhaug later in this report.

To understand the composition and geographical distribution of firms within this district, we conducted a detailed study using data from the Proff business register (https://www.proff.no). We focused on all firm entries between the years 2020 and 2023. The business register provides essential information that will be used in the following. This includes organizations' addresses, their board members, their industry classification, and information on their revenues and turnovers. All in all, the analysis covers 251 firms with a business interest.

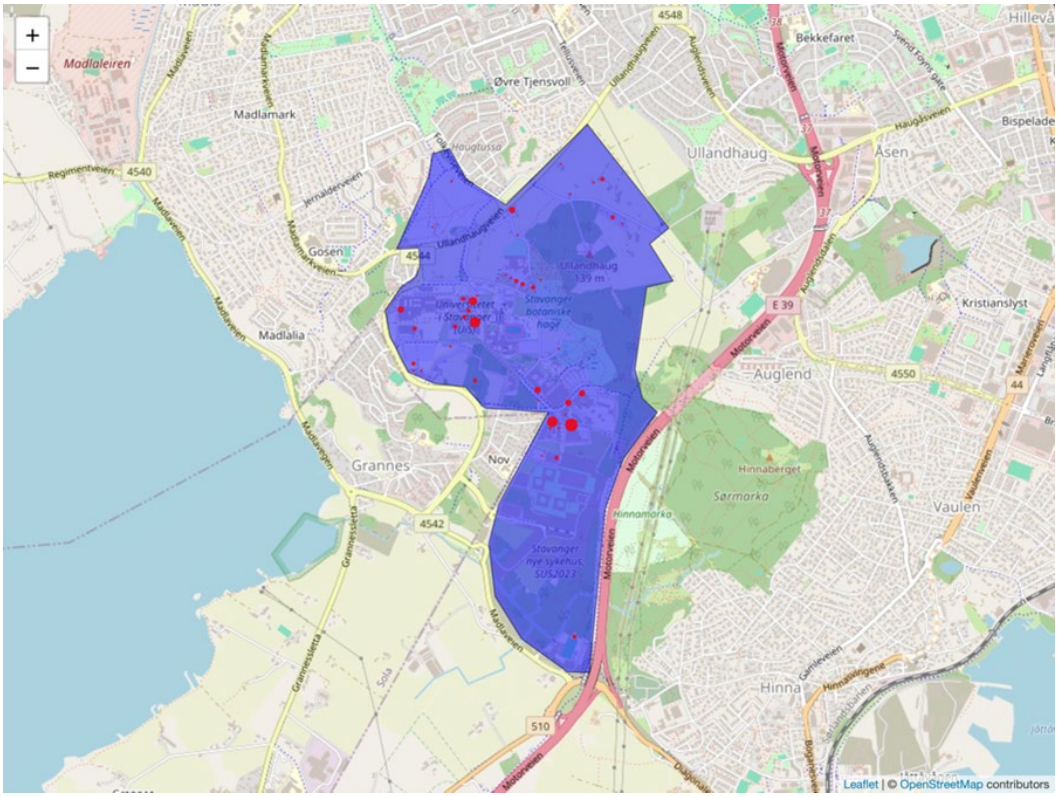


Figure 1: Firms in the Ullandhaug Innovation District

Method

In the first step, we automatically matched all firms in the register to geo-coordinates to locate each business precisely. The basis is the provided address information. In some cases, firms have the same address because they are located within the same building. Sometimes, locations are geographically very proximate, implying that identifying distinct geo-coordinates has proved impossible. If firms are associated with the same geo-coordinates, their number is aggregated in the visualization.

In the second step, we delineated the boundaries of the Ullandhaug Innovation District based on expert knowledge and feedback from a stakeholders' meeting on January 9, 2024. On this basis, we've created a custom shapefile, a digital file that accurately represents the area's geographical borders. The blue-shaded area in Figure 1 represents the outcome and delineates the spatial borders of the district.

Firms whose registered addresses fall within the district's borders were considered for our analysis. This approach ensures that our focus remains on businesses that are truly part of the innovation district. From the register data, we've identified a total of 349 entities to be located within the district. However, not all of these are directly relevant to its economic activities. More specifically, we excluded 98 entities categorized under NACE code 94. NACE code 94 specifically refers to the activities of membership organizations, which include trade unions, professional associations, and other interest groups. At Ullandhaug, this group is predominantly composed of student organizations.

4.1. Sectoral composition

The sectoral composition of the firm population within the Ullandhaug Innovation District is presented in Figure 2. Herein, firms are classified according to NACE sectoral classification. The NACE classification (Nomenclature statistique des Activités économiques dans la Communauté Européenne) is a statistical system used in the European Union to categorize economic activities. This system is essential for collecting and analyzing comparable statistical data across various economic sectors. The NACE classification is hierarchical and organized into four levels: sections, divisions, groups, and classes, with the two-digit level representing the divisions. At the two-digit level used in this report, the NACE classification includes a more granular categorization of economic activities within broader sections. Each two-digit code corresponds to a specific industry or sector. The NACE system is widely used for economic analysis, policy making, and business development, ensuring consistency and comparability across the European Union.

Another significant sector is 'Computer programming, consultancy and related activities' (NACE code 62), which includes IT services, telecommunications, and software development firms. The presence of a robust IT sector is vital for fostering a digital economy and supporting other industries through technological advancements. This sector's growth can be attributed to the increasing importance of digital transformation across all economic activities[16].

The 'Electricity, gas, steam, and air conditioning supply' sectors (NACE codes 35 and 47) also show some representation, reflecting the presence of energy-related activities in the district. These sectors provide essential goods and services, supporting consumers and businesses within the innovation district. The diversity of businesses in these sectors indicates a well-rounded economic base that can cater to various needs[17].

Less represented sectors, such as 'Mining and Quarrying' (NACE code 09), have a minimal presence. This distribution is typical for an urban innovation district focused on high-tech and service industries. The limited presence of these sectors aligns with the district's emphasis on service-oriented businesses and reflects broader trends of urban economic development where industrial activities are less prominent[18]. Some firms in 'Agriculture, Forestry, and Fishing' (NACE code 01) reflect the presence of some farmland in the district despite its urban location.

Service-oriented sectors such as 'Administrative and Support Service Activities' (NACE code 82), 'Financial and Insurance Activities' (NACE code 64), and 'Human Health and Social Work Activities' (NACE code 86) are also represented. These sectors play a critical role in supporting the district's broader business ecosystem, providing necessary services that facilitate business operations and contribute to the overall quality of life in the area. The strong presence of these sectors underscores the importance of a supportive infrastructure for fostering a conducive environment for innovation and growth[19].

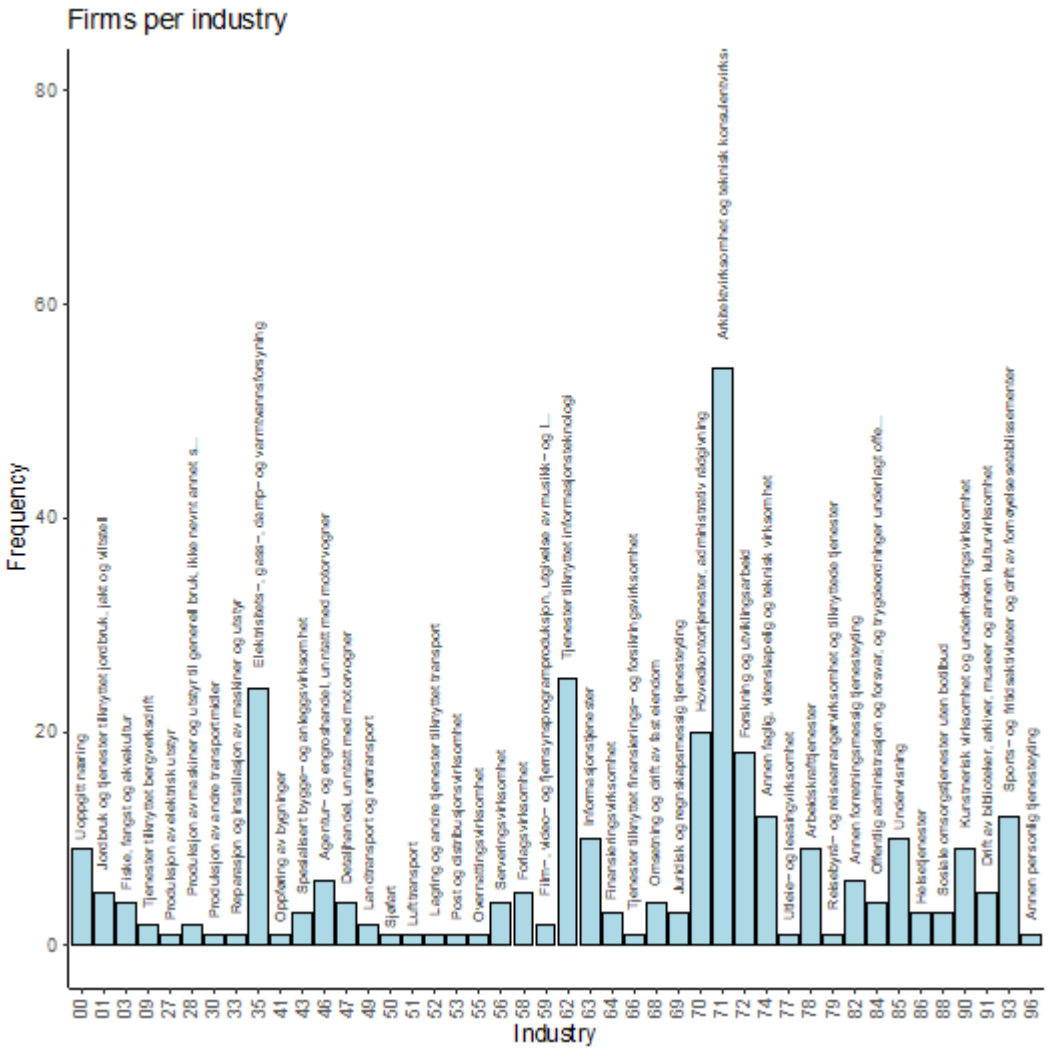


Figure 2: Sectoral composition of the district

Ullandhaug has a large share of firms in the 'Architectural and engineering activities; technical testing and analysis' sector (NACE code 71). This sector's prominence indicates a strong presence of businesses involved in consulting, research, and technical services, which are crucial for driving innovation and supporting the district's development. The concentration of firms in this sector suggests that the district is an active location for knowledge-based industries essential for economic growth and competitiveness[15], which is in line with the district's zoning for these types of activities. The significant presence of the related sectors, NACE 70 'Activities of head offices; management consultancy activities' and 72 'Scientific research and development' further underline the strong research focus of the district.

4.2. Age distribution

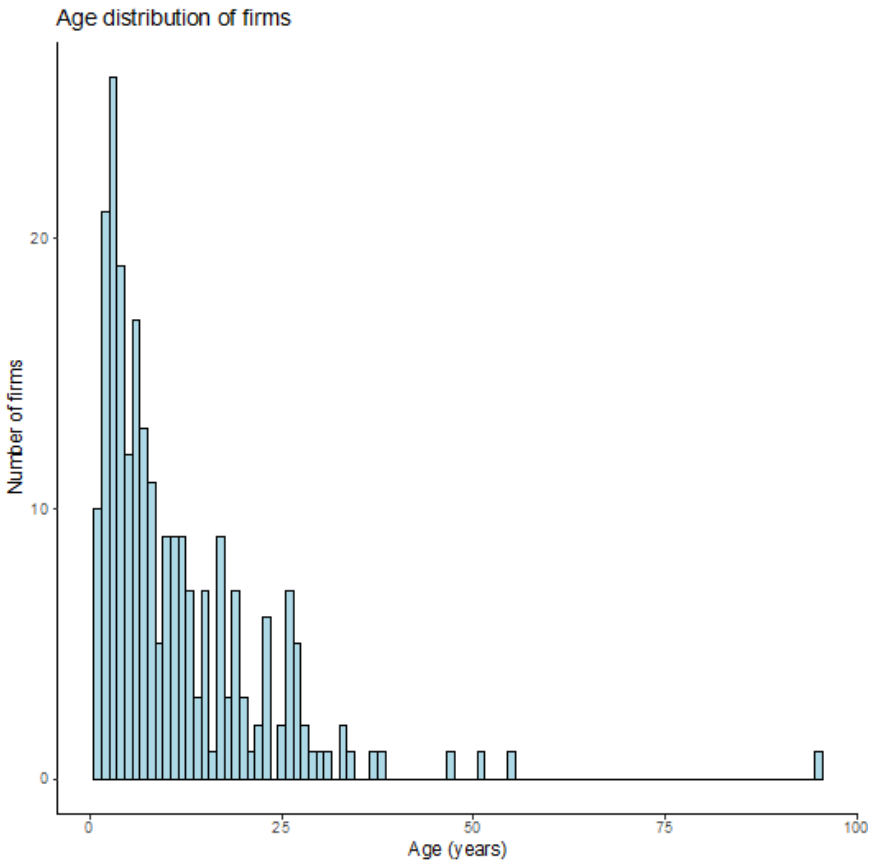


Figure 3: Distribution of firms' age

Figure 3 illustrates the firm age distribution within the Ullandhaug Innovation District. The x-axis represents the age of firms in years, while the y-axis shows the number of firms. Considering the presence of incubators and office space oriented towards start-ups, it is not surprising that Ullandhaug contains a large share of young firms, with the highest shares being in the 0–6-year categories. Nonetheless, the area also contains several more mature firms, with a fair share being older than 20 years. This diverse age profile indicates a healthy economic environment supporting both startups and well-established enterprises. The age of a firm can significantly influence its performance and role within an innovation district. Younger firms, typically startups, are often associated with high levels of innovation and risk-taking. They are crucial for introducing new ideas and technologies, which can drive economic growth and attract further investment into the district. Studies have shown that young firms are often more adaptable and can quickly respond to market changes, which is vital in fast-evolving sectors such as technology and innovation[20].

On the other hand, older firms bring stability and experience. These firms have typically overcome initial growth hurdles and have established their market presence. They often have more resources and developed networks, which can provide support and mentorship to younger firms. Moreover, mature firms contribute to economic stability and can help anchor the district's economic base[21]. The presence of young and old firms suggests a balanced ecosystem where innovation and stability coexist, fostering a dynamic and sustainable economic environment.

In the Ullandhaug Innovation District, the presence of young and mature firms highlights the district's ability to attract and retain various businesses. This diversity in firm age can enhance the district's resilience and adaptability, ensuring that it can thrive in a competitive and rapidly changing economic landscape. Combining innovative startups and established firms creates a synergistic environment supporting continuous growth and development.

4.3. Size distribution

Next, we look at the distribution across firm sizes, visualized in Figure 4. It categorizes businesses based on the number of employees, offering a detailed overview of the workforce distribution among firms. The x-axis represents the number of employees, using a logarithmic scale to display the data. The y-axis indicates the number of firms.

The distribution is largely composed of firms with only one employee. Notably, this includes 73 firms for which no employment data has been reported in the past three years. However, since these firms are still operational, they have been assigned one employee in this visualization to ensure their inclusion. In any case, most firms in the district are small and medium-sized enterprises (SMEs), with most having fewer than 10 employees.

This prevalence of smaller firms is characteristic of innovation districts, where startups and small businesses are vital. These smaller firms tend to be more flexible and responsive to market changes, making them crucial for fostering innovation and entrepreneurship. The high number of small firms suggests a vibrant, dynamic, and entrepreneurial environment within the district, conducive to rapid innovation and growth[22] .

However, the figure also indicates the presence of larger firms, although they are fewer in number. These larger firms, typically with over 250 employees, provide a stable economic base and can act as anchor institutions within the district. They often possess significant resources for research and development, contributing to sustained innovation and providing essential support and infrastructure to smaller firms[23]. At Ullandhaug, the university is the main anchor institution, along with other research organizations such as NORCE and – in the future – the University Hospital. Private sector firms typically leave the area when they reach a certain size.

Looking at firm size based on turnover supports these insights. Figure 5 presents the turnover distribution of firms within the Ullandhaug Innovation District. It gives insight into the economic performance of businesses in terms of their average turnover from 2020 to 2022. The x-axis represents the average turnover, while the y-axis shows the number of firms, with the data displayed on a linear scale. These numbers must be interpreted carefully, as the employed database is inconsistent in reporting concerning currencies. We have converted all values to NOK based on the relevant exchange rates; however, in many cases, no currency information was provided, implying that we took the values at face value.

The distribution reveals that most firms have relatively modest turnover, with the vast majority businesses falling below 100 million NOK and the modal value being in the 0-10 million NOK category. This pattern is typical in districts with a high concentration of small and medium-sized enterprises (SMEs), which often have lower turnovers than larger corporations. The prevalence of firms with lower turnover aligns with the previously discussed firm size distribution, where many businesses were identified as SMEs. While agile and innovative, these smaller firms typically generate less revenue than larger, more established ones[24].

However, the figure also indicates the presence of firms with significantly higher turnovers, with some firms exceeding 400 million NOK. These firms, although fewer in number, contribute substantially to the district's overall economic output. High-turnover firms are likely to be the larger businesses within the district, leveraging their resources and market reach to achieve higher revenues. Low- and high-turnover firms highlight a diverse economic landscape within the Ullandhaug Innovation District, encompassing a range of business sizes and economic capabilities.

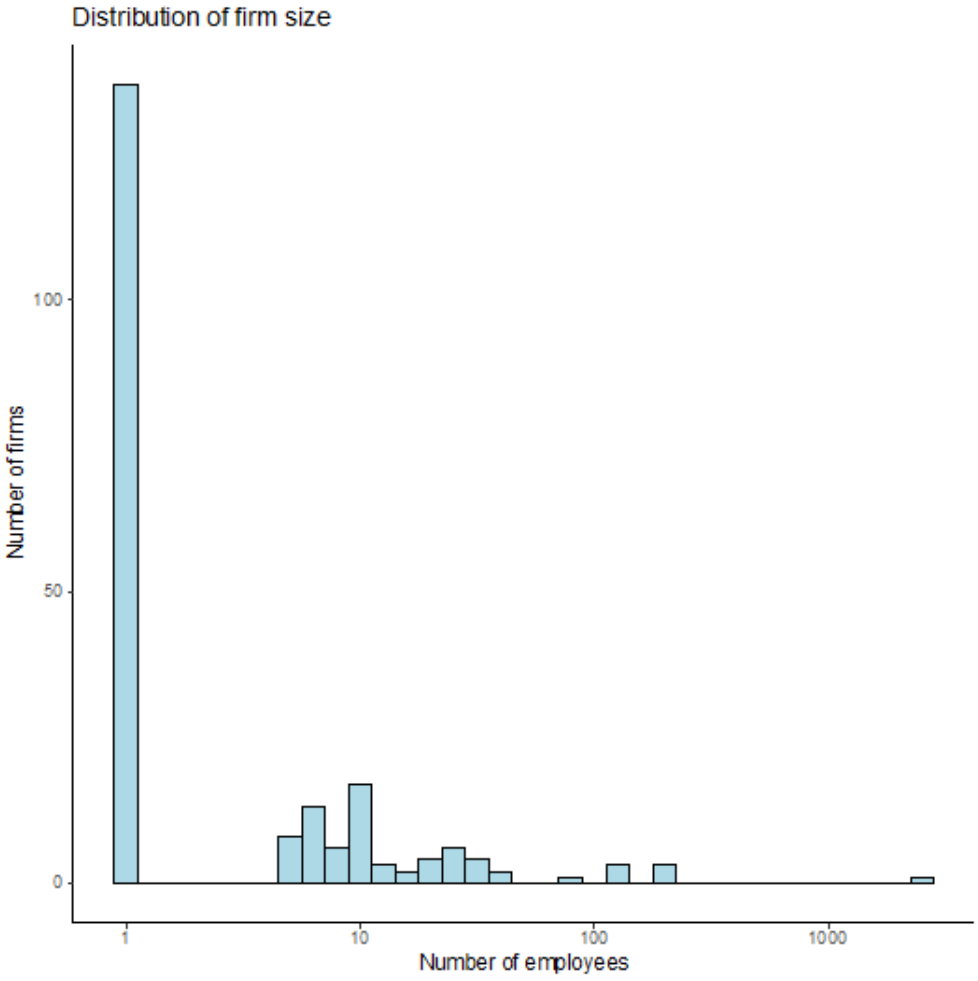


Figure 4: Firm size distribution (number of employees)

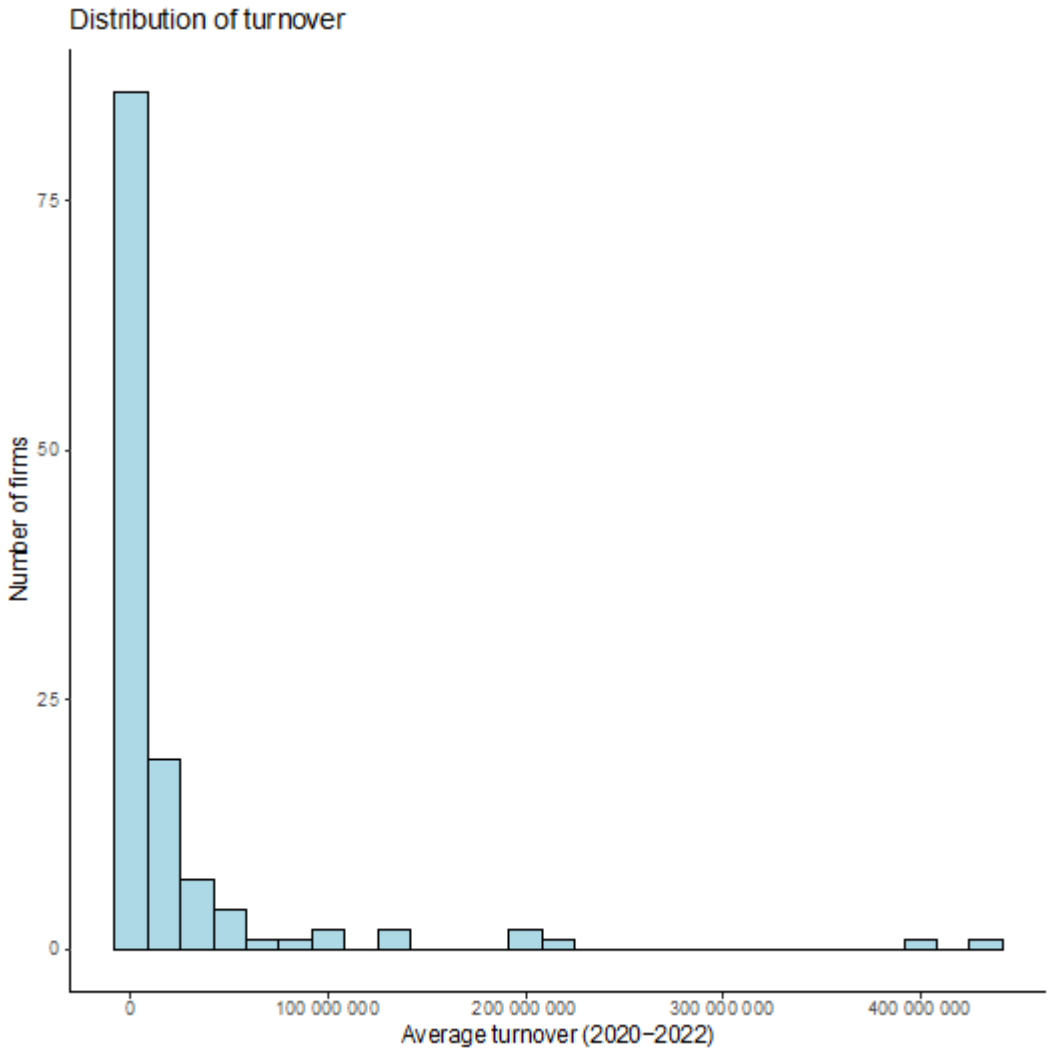


Figure 5: Firm size distribution (turnover in NOK)

In summary, the turnover distribution figure complements the firm size distribution data, painting a comprehensive picture of the economic landscape within the Ullandhaug Innovation District. It underscores the importance of combining small and large firms to support a robust and innovative economic ecosystem.

The coexistence of small and large firms within the Ullandhaug Innovation District points to a balanced and resilient economic ecosystem. Small firms benefit from the infrastructure, market opportunities, and collaborative potential provided by larger firms, while larger firms gain from the innovation and niche specializations of smaller, agile companies. This symbiotic relationship enhances the district's overall capacity for innovation and economic stability, fostering a conducive environment for continuous growth and development[25].

4.4. Profit distribution

Interesting insights can also be obtained from the profit distribution of firms within the Ullandhaug Innovation District. The corresponding Figure 6 gives a detailed look at the financial performance of businesses based on their average profit from 2020 to 2022. The x-axis represents the average profit in NOK, while the y-axis shows the number of firms.

The distribution indicates many firms clustered around lower profit levels, with many businesses showing average profits between -20 million and 20 million NOK. This suggests that while a substantial portion of firms operate at modest profit levels, some businesses are also experiencing slight losses. This is common in innovation districts, where many small and medium-sized enterprises (SMEs) face tight profit margins, particularly in their early stages or during challenging economic periods. Research has shown that SMEs often struggle with profitability due to limited resources and market reach[26].

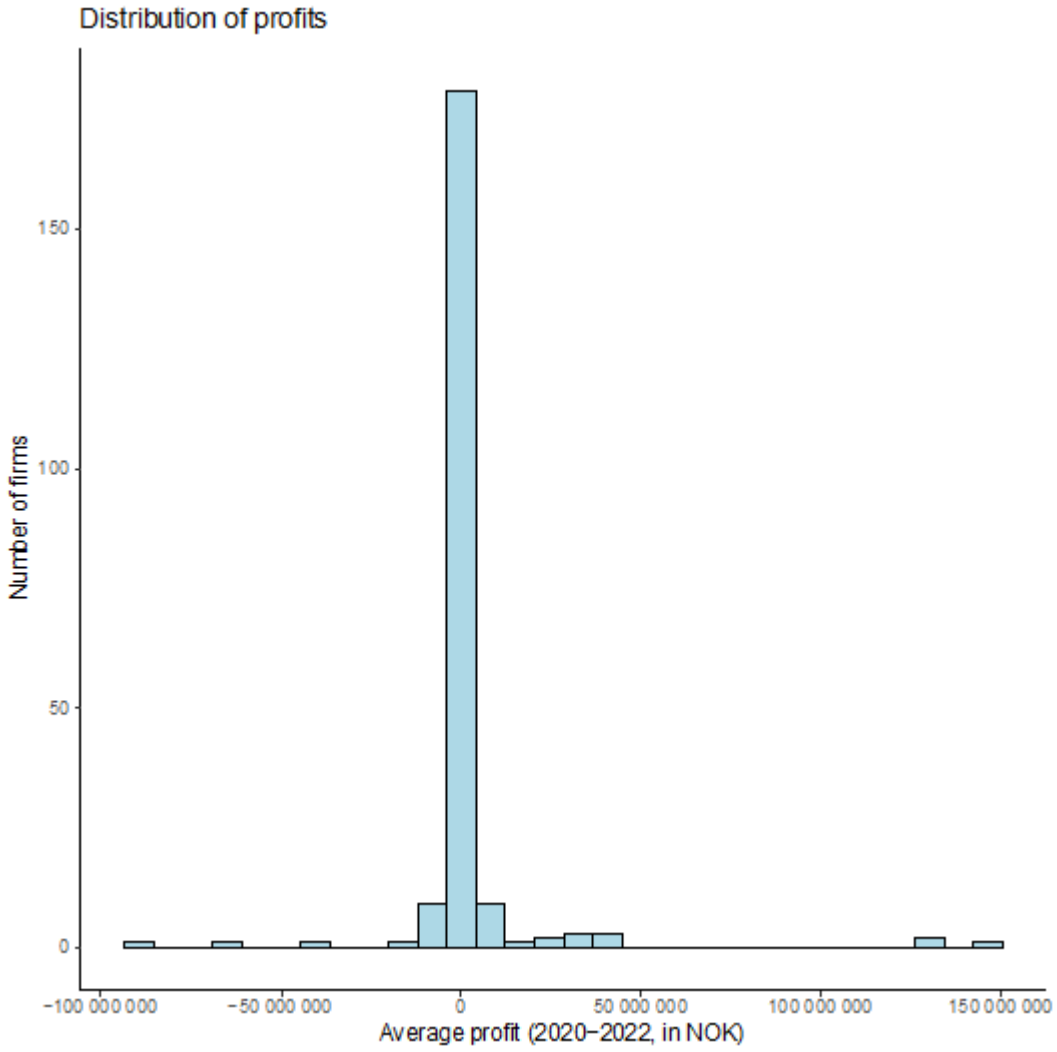


Figure 6: Distribution of profits across firms

Additionally, the figure shows the presence of firms with higher profit levels exceeding 100 million NOK. These more profitable firms, although fewer in number, contribute significantly to the district's overall financial health. Larger, more established firms typically achieve higher profitability by leveraging their extensive resources, established market presence, and operational efficiencies. These firms are crucial in stabilizing the district's economy and supporting smaller enterprises[27].

Loss-making and profitable firms highlight the diverse economic landscape within the Ullandhaug Innovation District, encompassing various business sizes and financial outcomes. The diversity in profit distribution within the Ullandhaug Innovation District reflects the different phases in which companies are. Many firms are start-ups and spin-offs in their growth phase, typically not associated with high-profit margins. During this phase, companies often reinvest earnings into the business to fuel growth and expansion, leading to lower short-term profitability. This phenomenon is well-documented in the literature, highlighting that early-stage companies prioritize growth over immediate profits to establish market presence and competitive advantage[28].

5. Contribution of the Ullandhaug Innovation District to Stavanger's economy

In addition to the internal structure of the district, it is important to consider its embeddedness in Stavanger's economy and its contribution to the broader region's economic growth potential. DiveOpp's own Diversification Opportunities Tool (DIOPTO) allows the assessment of the districts' contribution in an easy-to-understand and yet scientifically based manner. More precisely, the tool helps evaluate how well the district's activities align with the region's existing economic strengths and if they constitute promising growth opportunities. DIOPTO uses two key dimensions to understand this embeddedness: relatedness and complexity.

Relatedness reflects how closely an activity is connected to the region's current industries and capabilities. For example, a district embedded in Stavanger's oil and gas industry may also have strengths that align with emerging sectors like renewable energy. By examining the relatedness of economic activities, DIOPTO helps assess how well the district's current activities complement the broader region's strengths, supporting sustainable integration into the larger regional economy. This dimension captures the extent to which the district's economic activities build on the region's existing knowledge and competencies. It indicates how well the regional economy facilitates its further growth by providing a fertile set of resources, infrastructure, knowledge, and supportive activities. In the empirical assessment, economic strengths are approximated by normalized employment shares of industries (4-digit industry classes in the NACE classification) that are weighted by normalized labor flow intensities between all industries in Norway. In this context, an industry is considered highly related to its region when employees in that industry (across all of Norway) often transition into jobs within industries that are already strong in the region and vice versa[30].

Complexity measures the economic value and competitive potential of a district's activities. Activities with higher complexity are harder to replicate and typically generate more value. By assessing this dimension, DIOPTO identifies which activities are most likely to drive future growth and provide long-term competitive advantages for the region. High-complexity activities are crucial for boosting the region's overall economic potential because they enable the creation of unique products and services that are in demand but difficult to imitate.

Empirically, the complexity of an activity (at the 4-digit NACE industry class) is approximated using an index. This index quantifies the complexity of tasks typically associated with specific occupations, weighted according to the share of those occupations in an industry's workforce. High index values indicate that industries depend heavily on employees in occupations requiring more complex tasks.

DIOPTO combines these two dimensions into a matrix, plotting the position of each industry according to its relatedness to the broader regional economy and its level of complexity. Industries that find themselves with above average levels of relatedness and complexity are generally seen as benefiting from a supportive regional economy, growth chances, and attractive economic value generation.

For this report, we define the relevant regional economy as the Stavanger/Sandnes urban area and evaluate each industry (at the 4-digit industry class level) based on its relatedness to other industries in the region and its level of complexity using the DIOPTO tool. Using this framework, we map the Ullandhaug Innovation District's industry portfolio (see Figure 7) in the matrix, highlighting how the district's industrial strengths contribute to the region's growth potential. Specifically, we focus on the extent to which the district's specializations are related to other industries in the region and on how complex they are, indicating their potential to drive regional economic growth.

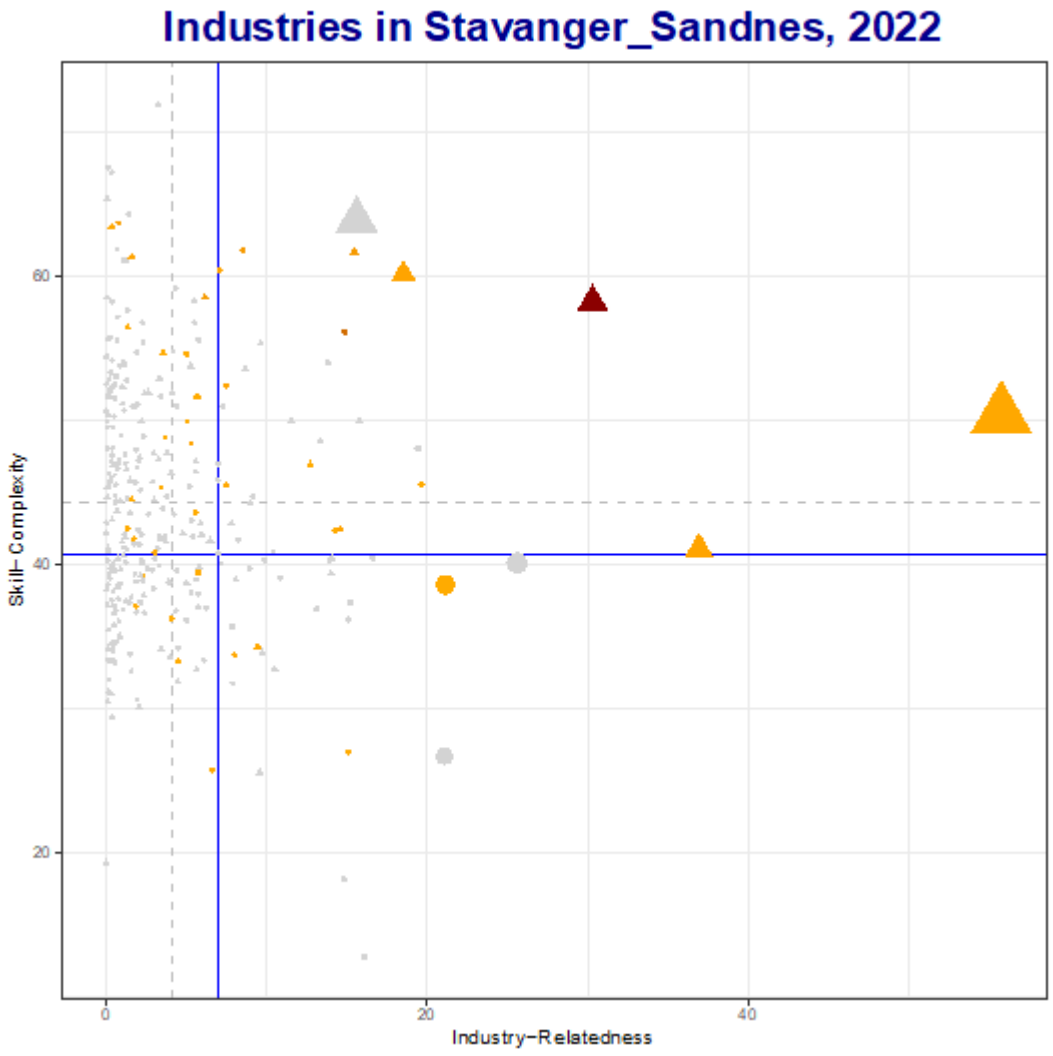


Figure 7: DIOPTO Matrix Stavanger/Sandnes and Ullandhaug's strength

Figure 7 presents the mapping of industries (dots and triangles) in the broader Stavanger/ Sandnes region with respect to their relatedness and complexity values. The x-axis represents industry relatedness, showing how closely each industry aligns with the region's existing strengths, while the y-axis indicates skill complexity, reflecting the industry's long-term economic value and technological sophistication.

Dashed blue and grey lines represent national and regional averages for relatedness and complexity, dividing the matrix into four quadrants. This helps distinguish industries that are easier to enter but may offer lower returns (lower right), and those that are more complex but less aligned with the region's current capabilities (upper left). Industries in the upper right quadrant are characterized by both high relatedness and complexity, marking key opportunities for regional growth. These industries are well-integrated with the region's strengths and hold strong potential for long-term competitive advantages.

Symbol size corresponds to the industry's share of regional employment, with larger symbols indicating stronger specialization. Triangles represent industries where the region is more specialized than the national average, while dots indicate industries where other regions in Norway are more specialized.The color gradient, from yellow to dark red, reflects the share of all firms in Ullandhaug active in the respective industry, with darker red indicating higher shares.

The DIOPTO matrix reveals that many district firms are active in the most attractive industries in the regions. Most of them are above-average complex (above the solid blue line). However, many of them lack relatedness to the rest of the regional economy (left of the grey dashed vertical line). Consequently, Ullandhaug's industrial portfolio features many high-value, growth- promising industries. Unfortunately, a substantial number of them lack a supportive regional economy. However, industries in the upper left quadrant may also be starting points for new development paths, indicating attempts to move beyond the dominant local (petroleum-related) industries.

The fact that Ullandhaug Innovation District specializes in highly attractive industries like Engineering activities, technical consultancy (A), Support activities for petroleum and natural gas extraction (B), and Consultancy in information technology (C) has important implications for the district's future development. With their high relatedness and complexity, these industries provide a solid foundation for the district's long-term growth and competitiveness within the broader regional economy. However, the finding that many high-complexity industries in the district have lower relatedness to the region's existing economic structure suggests a need for strategic support to foster stronger linkages with the surrounding economy.

This lack of relatedness implies that the district may face challenges in leveraging regional synergies, potentially requiring more targeted policies or collaboration initiatives to integrate these high-value industries more effectively into the regional ecosystem. Additionally, the industries in the upper left quadrant could represent opportunities for diversifying the region's economy, helping it move beyond its dependence on petroleum-related industries. For future development, nurturing these emerging sectors and improving their alignment with regional strengths will be crucial for creating new growth pathways and ensuring the district's continued contribution to the region's economic evolution.

6. Relationships between firms: Interlocking directorates

As discussed above, an innovation ecosystem consists not only of actors and their activities but also of relations between these actors. With this in mind, we now examine the relationships between the firms at Ullandhaug. A common way to examine relationships between firms is to look at the composition of their board, or what is often referred to as interlocking directorates. Interlocking directorates refer to the phenomenon where a person serves on the board of directors for two or more companies simultaneously.

This creates a network of inter-firm relationships through shared board members, also known as board interlocks. These networks are significant in the context of corporate governance, strategic decision-making, and resource sharing. The academic literature provides extensive insights into the relevance and implications of these networks, particularly in innovation ecosystems like the Ullandhaug Innovation District.

Interlocking directorates are crucial in enhancing corporate governance by facilitating better decision-making and oversight. Board members who serve on multiple boards bring diverse perspectives and experiences, which can improve strategic decisions and corporate policies. This cross-pollination of ideas is essential in innovation districts, where rapid decision-making and adaptability are crucial for maintaining competitive advantage[32].

These networks also enable resource sharing among firms. Board members with positions in multiple companies can help share valuable resources such as knowledge, technology, and even financial capital. This is particularly beneficial in innovation districts, where access to the latest technologies and research is vital. Such resource flows can enhance innovation capabilities and drive collaborative projects that might be too large or complex for a single firm to undertake independently[33].

Interlocking directorates can facilitate the formation of strategic alliances. Companies with shared board members are likelier to trust each other and collaborate on joint ventures or strategic partnerships. This is significant in innovation districts, where firms often need to pool their strengths to explore new markets or develop new products. These alliances can lead to significant competitive advantages and foster an environment of mutual growth[34].

Empirical studies suggest that interlocking directorates can positively influence firm performance. Firms within these networks can leverage shared board members' strategic insights and networks to improve their performance metrics. This is particularly true for small and medium-sized enterprises (SMEs) that may lack extensive resources. Access to the networks of larger firms through shared board members can provide critical support and open up new growth opportunities[35].

The network plot of the Ullandhaug Innovation District is based on shared board memberships as registered in the proff.no database. However, we restrict the links to interlocks via joint memberships in firms located in the Ullandhaug Innovation District. That is, if a board member of one company is also part of the board of another company located in the Ullandhaug district. We also consider whether firms are linked by their board members being jointly active on company boards outside of the district.

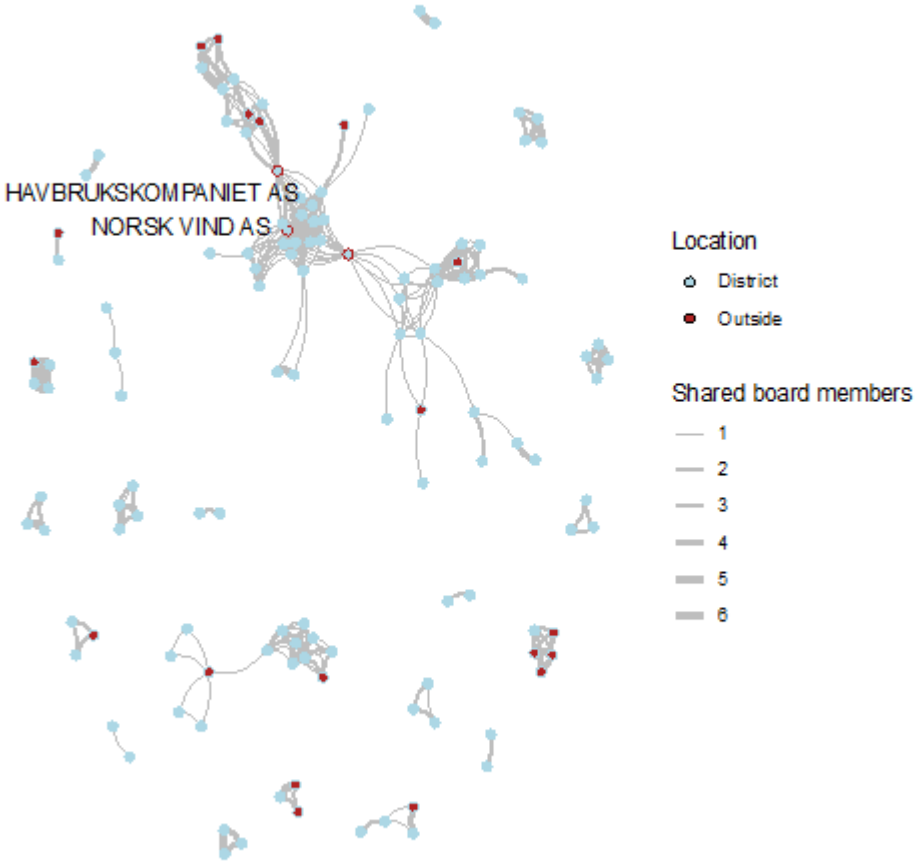


Figure 8: Network of interlocking directorates at Ullandhaug

Figure 8 visualizes the identified relationships. Each node represents one firm and each link means that at least one person is active on both firms' boards. Links are thicker when multiple people are active on the same boards. Nodes in red are firms not located in the district but which link two firms at Ullandhaug through having joint board members with at least two different firms in the district.

The plot reveals several interconnected firms. Overall, the density is relatively low. The network density is defined as the number of connections among firms in relation to the theoretical maximum. A dense network structure is advantageous for rapidly disseminating information and coordinating joint efforts. The relatively low density of the Ullandhaug's networks makes such processes less likely. However, bear in mind that the theoretical maximum would imply that all firms share at least one board member with every other firm at Ullandhaug, which would be a highly unlikely scenario.

It is therefore more interesting to look at specific nodes to identify firms that connect several others within the ecosystem. It is notable that the network is subdivided into several components consisting of firms which are interconnected with each other but not with other firms in the network. One large such component can be identified at the top of the graph, connecting a large share of firms at Ullandhaug. However, there are also several smaller components, including one just below the middle of the graph and several around its outer limit. Firms like Havbrukskompaniet AS, Energy Transition Norway SA, and Norsk Vind AS have the largest number of connections within the network. They are also part of the largest and most integrated network component. Companies like these play a pivotal role in the district, serving as information and resource exchange hubs. Their central position suggests they might influence the district's strategic direction.

It also becomes visible that several companies not located in the district provide integrative roles in the network (red dots). While this points toward some gaps in the district's internal network, it also means that there is no clear separation between the internal and external networks.

In conclusion, the interlocking directorates within the Ullandhaug Innovation District are critical in enhancing corporate governance, facilitating resource sharing, and fostering strategic alliances. These networks contribute significantly to the innovation capabilities and overall performance of the firms within the district, highlighting the importance of collaborative structures in modern business ecosystems. However, the district's network seems rather thin and may benefit from stronger integration initiatives.

7. Research organizations at Ullandhaug

We now look at the other main component of the Ullandhaug Innovation Ecosystem – its research system. As discussed above, the research organizations form the anchor tenants at Ullandhaug. Note that in the following analysis, we also consider the Stavanger University Hospital, which is still located at Våland, but will move much of its operations to Ullandhaug in 2025.

A challenge in analyzing the research activities at Ullandhaug is the localization of research activities of multi-location organizations such as NORCE. This research organization and others have several branches outside Ullandhaug, making it difficult to pinpoint which activities are conducted in the district and which are conducted elsewhere. For the University of Stavanger, which has two smaller campuses downtown, this represents a lesser challenge because most of its activities occur at Ullandhaug. For research institutes such as NORCE and Nofima, the branches at Ullandhaug house a small share of their overall employment. However, we identified those employees from both organizations located at Ullandhaug. Accordingly, only the research output attributed to these individuals will be considered in the following. Unfortunately, this information was impossible to collect for firms, implying that their activities are likely overexaggerated in the following. However, as we will see, there are few research outputs associated with firms.

Insights into the research activities and collaboration structures in the Ullandhaug are gained by looking at organizations' research output registered in the Cristin database. The Current Research Information System in Norway (Cristin) is a centralized platform designed to collect, manage, and disseminate information about Norwegian research activities. Established to streamline the research administration process, Cristin serves as a comprehensive repository where academic publications and research outputs from various Norwegian institutions are systematically registered and made accessible. This system facilitates the reuse of research information and aids in monitoring and reporting scientific publications to relevant governmental bodies such as the Norwegian Ministry of Education and Research and the Ministry of Health and Care Services.

The Cristin database encompasses various research outputs, including books, articles, lectures, presentations, interviews, opinion pieces, reports, and posters. Data is integrated into the system through two primary methods: manual registration by individual researchers and automated collection by the organization SIKT, which retrieves data from other platforms and makes it available within Cristin. The database was previously used in an in-depth study of the University of Stavanger's research and collaboration activities[36].

Under the system for results-based redistribution of funding, Norwegian universities, research institutes and hospitals are rewarded financially for scientific publications based on their registration in Cristin . The database is, therefore, a comprehensive register of scientific publications (journal articles, scientific book chapters, and monographs). For non-scientific publications (e.g. lectures, newspaper articles, reports), registration in Cristin is done voluntarily by individual researchers, and the database does not include all publications. However, UiS has an internal funding system in which dissemination is included, and faculty members, therefore, have incentives to register such publications. There is no financial incentive or other obligation for firms and government agencies to register in Cristin. Consequently, we expect the registration of publications to be incomplete and perhaps mainly done in cases with co-authors from universities, research institutes, or hospitals.

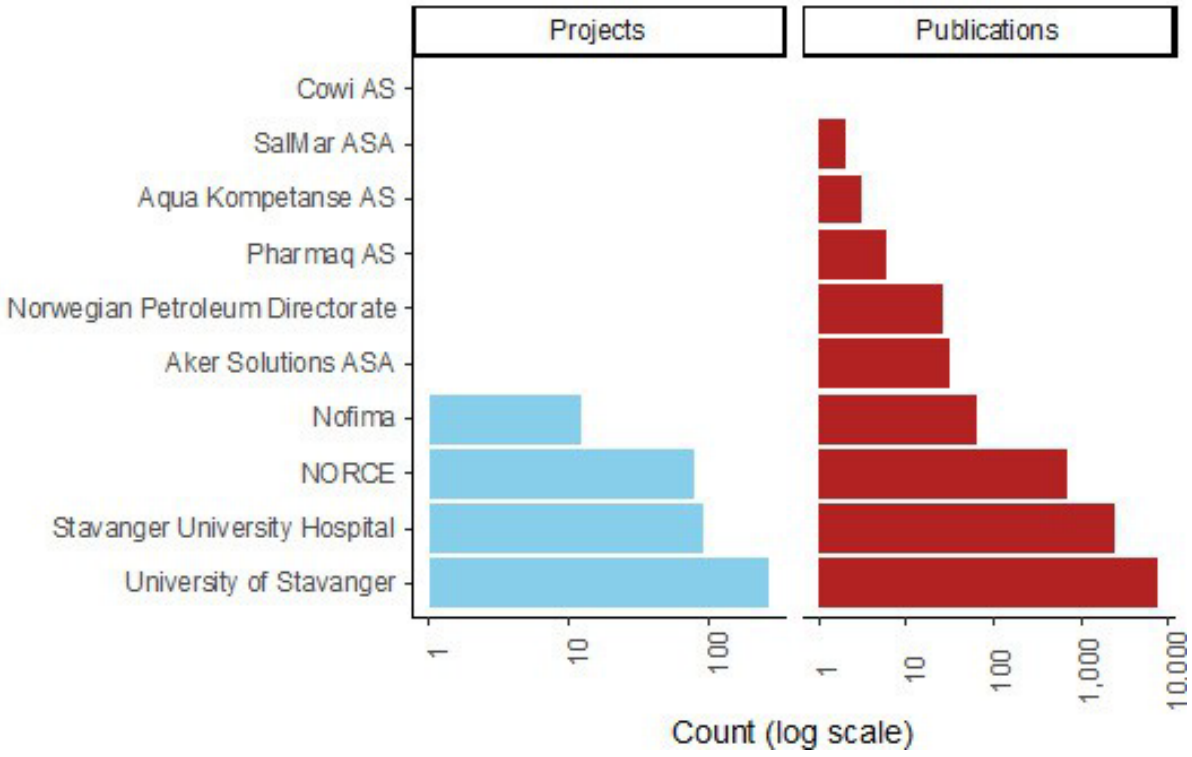


Figure 9: Cristin Items by Organization

For all organizations located at Ullandhaug, we collected information on their research output from the Cristin database over the past 10 years, from 2013 to the present. This dataset includes a total of 5,517 items. Overall, 10 organizations at Ullandhaug have registered output in Cristin. Of these, the four research organizations, UiS, Stavanger University Hospital, NORCE, and Nofima, represent the lion's share of publications. However, some firms and public sector organizations have also registered a small number of publications in Cristin. The potentially incomplete data from organisations outside the research sector itself currently available hampers our ability to draw robust conclusions about the research landscape and collaborative efforts in Ullandhaug, especially when it comes to interactions between the research system and other parts of the innovation ecosystem. We risk overlooking significant contributions and potential synergies that could drive innovation and progress without a complete picture. Therefore, it is imperative to enhance the efforts to register systematically and catalog research outputs from all organizations in the district.

Improving the comprehensiveness and accuracy of these databases may provide a more detailed and representative understanding of the research dynamics at play. This could, in turn, facilitate better strategic planning, resource allocation, and policy-making to foster collaboration and innovation within the district. Enhanced data collection efforts will benefit individual organizations by increasing their visibility and impact and strengthening the overall research ecosystem in Ullandhaug, driving it towards greater sustainability and excellence.

Figure 99 ranks the 10 organizations with research output by their numbers of registered research items in the Cristin database. Note that we use a logarithmic scale on the x-axis as the inter-organizational differences in registered research output are massive. The differences are, therefore, much larger than they may appear at first glance. The Figure also highlights that the database features research output in the form of publications and projects for which the organizations have received public support. While the number of projects is substantially smaller than that of publications, their information will still be relevant to enriching insights into research-based collaboration. Not surprisingly, the University of Stavanger is the largest contributor, followed by the University Hospital, NORCE, and Nofima, each by an order of magnitude, as visualized in Figure 9. At first glance, it might be surprising to find NORCE only in third place, given its prominent role in the Norwegian research landscape.

However, note again that the analysis only considers employees' research output and project involvement at its Ullandhaug offices. Although this required substantial manual effort, it increased the precision and reliability of the analysis. The same is true for Nofima, in fourth place, which also has a much larger research output nationwide. Unfortunately, it was impossible to filter the research output in this way for other organizations. For Aker Solutions and SalMar, most of the research output is likely from branches other than their small Ullandhaug offices. Conversely, the Norwegian Petroleum Directorate (now Norwegian Offshore Directorate) conducts most of its activity at Ullandhaug. In any case, we proceed by including all projects, collaborations, publications, and collaborations of these organizations with other organizations at Ullandhaug as part of the Ullandhaug innovation ecosystem.

8. Research Collaboration

A core part of the research system is interactions between its members, which fuel the exchange of knowledge, ideas, and resources. Using the Cristin data, exploring collaborations that have translated into joint publications and projects is possible. This allows for looking into the patterns of interactions and the network of actors within the district.

Empirically, we treat every publication and project to which at least two organizations of the Ullandhaug innovation ecosystem have contributed since 2013 as an indication of a collaboration. To assess which actors engage most frequently with each other in this type of collaboration, we count the number of joint projects and publications they are associated with in the Cristin database. Table 1 summarizes this information in the form of the number of collaborative links established in this way (Number of Collaborations) and the share of these, which are joint externally funded projects (Share of Projects). Most interactions involve the University of Stavanger collaborating with either Stavanger University Hospital or NORCE. The third and fourth most frequent interactions also involve the University of Stavanger, with Nofima and Aker Solutions, respectively. Fifth is the link between NORCE and the Stavanger University Hospital, manifesting in eleven joint publications and two subsidized projects.

Partner	Partner	Number of Collaborations	Share of Projects
University of Stavanger	Stavanger University Hospital	1,856	0.039
NORCE	University of Stavanger	709	0.035
Nofima	University of Stavanger	63	0.031
Aker Solutions ASA	University of Stavanger	32	0
NORCE	Stavanger University Hospital	27	0
NORCE	Nofima	13	0.154
Aqua Kompetanse AS	Pharmaq AS	3	1
Norwegian Petroleum Directorate	University of Stavanger	3	0
SalMar ASA	Pharmaq AS	2	0
Pharmaq AS	University of Stavanger	2	0
Cowi AS	University of Stavanger	2	0
Norwegian Petroleum Directorate	NORCE	1	0

Table 1: Collaboration between Ullandhaug Organizations

The number of interactions underlines the importance of the university as a central player. To learn more about these interactions, we divide the university into its constituent departments and faculties, examining how these sub-units collaborate both among each other and with other actors within the ecosystem. Unfortunately, similar information is unavailable for the other large and heterogeneous actors – the Stavanger University Hospital.

Partner	Partner	Number of Collaboration	Share of Projects
Faculty of Health Sciences	Stavanger University Hospital	399	0.03
NORCE	Department of Energy and Petroleum Engineering	390	0.02
Department of Quality and Health Technology	Stavanger University Hospital	375	0.01
Department of Energy and Petroleum Engineering	University of Stavanger	373	0.01
Department of Public Health	Stavanger University Hospital	327	0.01
Department of Mechanical and Structural Engineering and Materials Science	University of Stavanger	240	0.00
Department of Mathematics and Physics	Stavanger University Hospital	232	0.00
Department of Electrical Engineering and Computer Science	Stavanger University Hospital	200	0.01
Department of Mathematics and Physics	University of Stavanger	194	0.02
Department of Chemistry, Bioscience and Environmental Engineering	Stavanger University Hospital	167	0.02
Department of Early Childhood Education	National Centre for Reading Education and Research	153	0.03

UiS Business School	University of Stavanger	130	0.03
Department of Electrical Engineering and Computer Science	University of Stavanger	130	0.02
National Centre for Reading Education and Research	University of Stavanger	129	0.07
Faculty of Social Sciences	Department of Media and Social Sciences	127	0.01
Department of Cultural Studies and Languages	University of Stavanger	124	0.06
Norwegian Centre for Learning Environment and Behavioral Research in Education	Stavanger University Hospital	119	0.00
Department of Early Childhood Education	Department of Education and Sports Science	108	0.10
Department of Public Health	Department of Quality and Health Technology	108	0.04
Department of Electrical Engineering and Computer Science	Department of Mathematics and Physics	104	0.00

Table 2: Collaboration between Ullandhaug Organizations and UiS Units

Table 2 lists the 20 most frequent pairs of organizations and UiS units that interact in joint publications or projects. Note that faculties have different organizational structures, implying that departments and subunits can differ considerably in size. Moreover, in many instances, faculties are registered as project and publication contributors. It is unclear if these instances reflect incomplete records or if the faculties are the true contributors and not any of their departments. The faculty structure at UiS has also changed over the period. For instance, the Faculty of Health Sciences and the UiS Business School were established as faculties in 2017 and were departments within the Faculty of Social Sciences. Publications between 2013 and 2017 would therefore be attributed to what is now the Faculty of Health Sciences and UiS Business School, respectively. Publications from 2018 onwards would more likely be attributed to the Departments within the Faculty of Health Sciences (i.e. the Department of Quality and Health Technology, the Department of Public Health or the Department of Caring and Ethics). The same true for the UiS Business School, although its departments were not established until 2019 and therefore do not appear in the list. In addition, for many publications and projects, only the University of Stavanger is reported as an affiliation, implying that these cannot be allocated to a specific department or faculty.

In any case, the most frequent collaboration occurred between the Faculty of Health Sciences and the Stavanger University Hospital underlining the importance of health-related topics in joint research activities in the district. Collaboration between Stavanger University Hospital and two of the departments at the Faculty of Health Sciences – the Department of Quality and Health Technology and the Department of Public Health – follow in third and fifth place, respectively. Also in the top ten are collaborations between Stavanger University Hospital and three departments at the Faculty of Technology and Natural Sciences: The Department of Mathematics and Physics, the Department of Electrical Engineering and Computer Science, and the Department of Chemistry, Bioscience and Environmental Engineering.

The second most frequent interaction takes place between NORCE and the Department of Energy and Petroleum Engineering, which accounts for well over half of the collaborations between UiS and NORCE. This is the only pair in the top 20 involving NORCE, underlying that NORCE's research collaboration within Ullandhaug, while quite frequent, is mostly specific to one UiS department. It highlights the importance of energy and petroleum activities in the Ullandhaug research system. This focus reflects the district's ongoing commitment to addressing energy challenges and underscores the University of Stavanger's specialized departments' central role in fostering inter-organizational collaborations. These collaborations aim to advance academic knowledge and practical solutions within the energy sector by integrating various perspectives and expertise.

Another notable collaboration involves the National Centre for Reading Education and Research and the Department of Early Childhood Education. This is the most frequent collaboration involving two different departments with UiS, although it is less frequent than the external collaborations of six UiS departments with Stavanger University Hospital or NORCE. This partnership emphasizes the district's focus on educational research, particularly in the early stages of childhood development.

The high number of joint collaborations indicates a strong synergy between these departments, likely driven by shared goals of improving literacy and educational outcomes for young children. The implications of this collaboration are significant, as it highlights the district's commitment to addressing foundational educational challenges, potentially influencing educational policies and practices regionally and nationally.

Another notable collaboration involves the National Centre for Reading Education and Research and the Department of Early Childhood Education. This is the most frequent collaboration involving two different departments with UiS, although it is less frequent than the external collaborations of six UiS departments with Stavanger University Hospital or NORCE. This partnership emphasizes the district's focus on educational research, particularly in the early stages of childhood development. The high number of joint collaborations indicates a strong synergy between these departments, likely driven by shared goals of improving literacy and educational outcomes for young children. The implications of this collaboration are significant, as it highlights the district's commitment to addressing foundational educational challenges, potentially influencing educational policies and practices regionally and nationally.

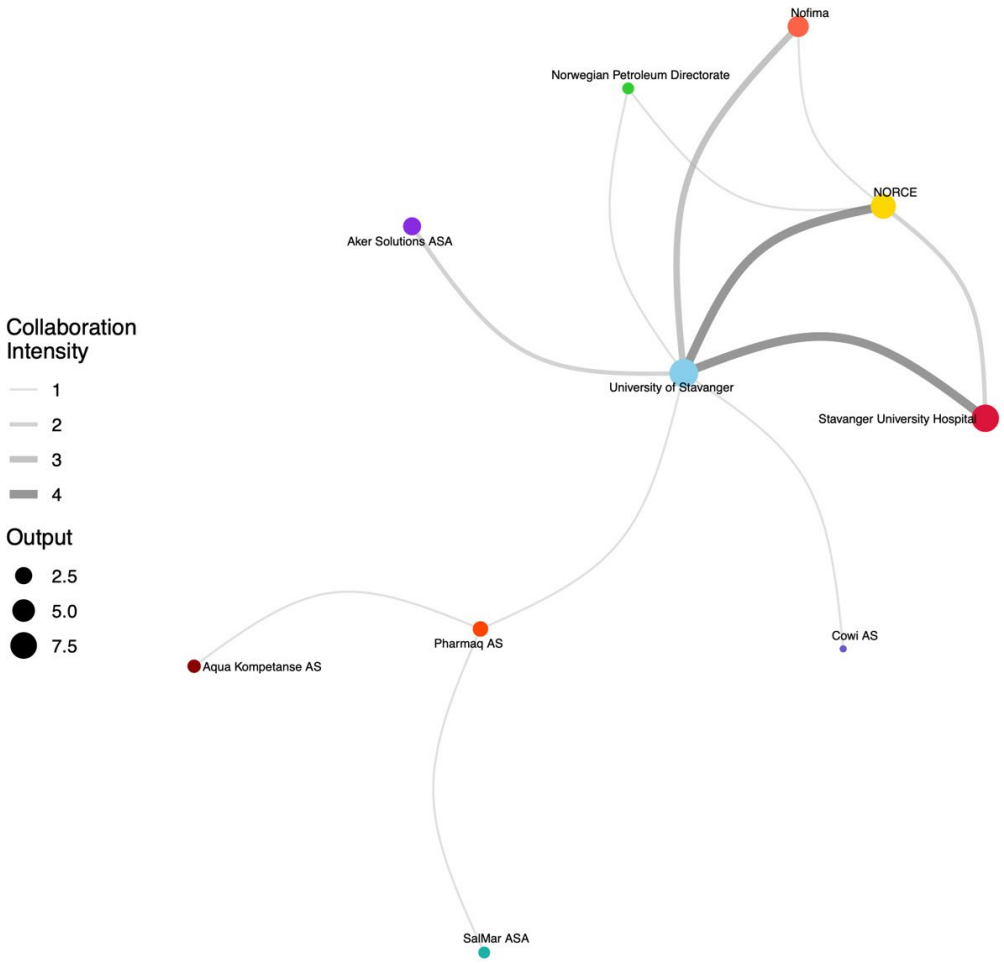


Figure 10: Network of Research Collaboration at Ullandhaug

Another example of a notable collaboration is between the Department of Quality and Health Technology and the Department of Public Health, two of the departments in the Faculty of Health Sciences. This partnership underscores the district's emphasis on health sciences and the integration of technological innovations to enhance public health outcomes. The higher share of projects within this collaboration reflects an active pursuit of funded research initiatives to improve healthcare quality and accessibility. The implications include potential advancements in public health interventions, new health technologies, and contributions to the broader healthcare ecosystem.

In general, it is worth noting that all cross-department collaborations within UiS in the top 20 are either between two departments in the same faculty, or between a department and its parent faculty or the university level.

The varied nature of these top collaborations within the Ullandhaug Innovation District highlights the district's multidisciplinary approach to research and innovation. At the same time, it showcases a lot of untapped potential for more interdisciplinary collaboration.

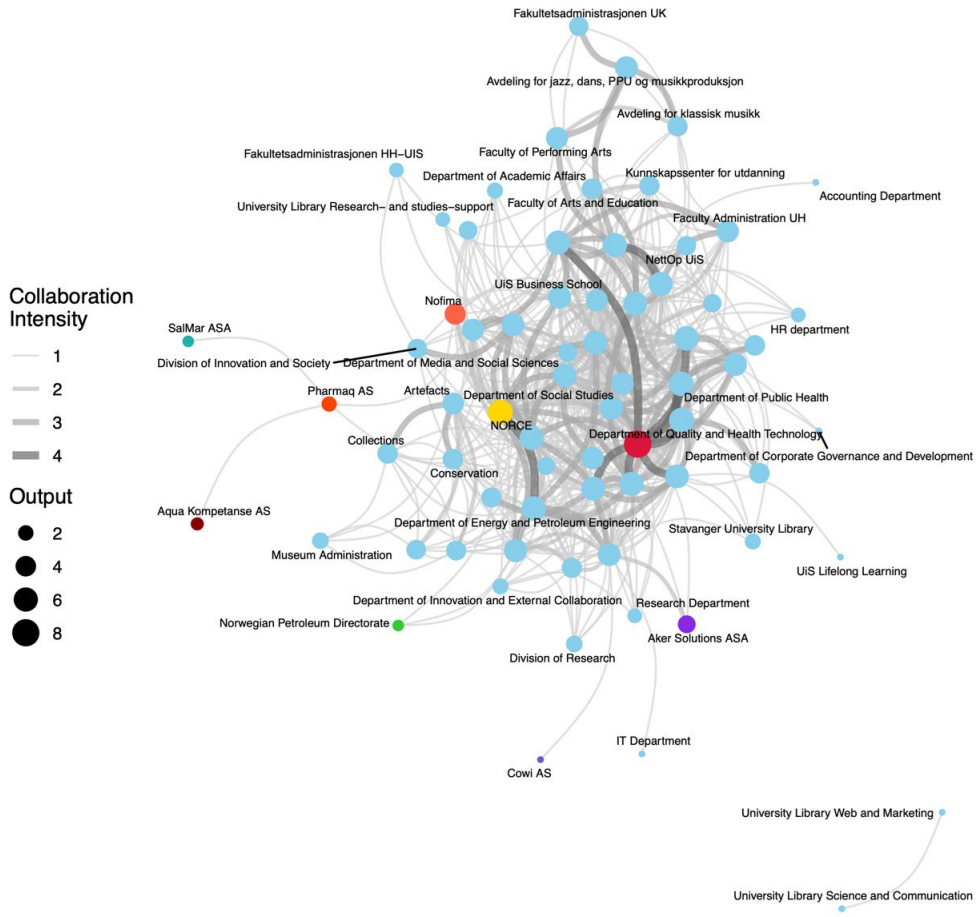


Figure 11: Network of Research Collaboration at Ullandhaug with UiS entities

Examining the entire research collaboration network further exemplifies the perception of substantial unexplored potential. Figure 10 visualizes this network at the level of organizations, while Figure 11 disaggregates the university into its individual units. These network plots underscore the university's central role in integrating interactions among organizations at Ullandhaug. Without NORCE, the university would be the only link between two distinct clusters of firms: Aqua Kompetanse AS, SalMar ASA, Nofima, and Pharmaq AS on one side, and Aker Solutions AS, the Norwegian Petroleum Directorate, and Cowi AS on the other. This bridging function of the university is primarily due to its heterogeneous nature.

The network becomes much more complex when the university is disentangled into its subunits, as shown in Figure 11. This complexity highlights that companies collaborate with specific departments rather than the university as a whole. This reveals two important insights:

1. **Unequal Engagement:** Not all subunits of the university engage equally with companies in the Ullandhaug district. Certain departments are more active in fostering collaborations, indicating varying levels of interaction and outreach across the university.
2. **Fragmented Research Landscape:** No strongly integrated, interconnected cluster of organizations and university entities exists. Instead, the network comprises multiple smaller groups of linked units, suggesting a fragmented research landscape with multiple thematic foci. This fragmentation is concealed when considering the university as a single entity and not accounting for its internal interaction patterns.

The university’s role as a central connector highlights its strategic importance in fostering collaborations across diverse fields. By bridging various clusters, the university facilitates interdisciplinary research and innovation, promoting knowledge exchange and the integration of different research domains. In addition, a couple of implications can be derived.

1. **Targeted Support for Subunits:** Identifying which departments are more actively engaged in collaborations can help provide targeted support and resources to enhance their outreach and impact. Encouraging less active subunits to engage more with external partners can also help balance the collaborative efforts across the university.
2. **Enhancing Network Cohesion:** The fragmented nature of the research landscape suggests opportunities to enhance network cohesion. Initiatives that foster interdisciplinary projects and collaborations between different university departments and external organizations can help build a more integrated research environment. This could involve creating thematic research clusters or centers of excellence that bring together diverse expertise to address specific challenges
3. **Maximizing Unexplored Potential**: The identified potential for further integration and collaboration indicates untapped opportunities for innovation. By strategically leveraging its bridging role, the university can initiate new partnerships and projects that exploit synergies between different sectors and disciplines. This can lead to more comprehensive and impactful research outcomes.

In conclusion, the detailed analysis of the research collaboration network in the Ullandhaug innovation ecosystem highlights the pivotal role of the university in bridging various clusters of firms and research entities. If the actors recognize and address the fragmented nature of these interactions, there is significant potential to foster a more cohesive and integrated research environment that can drive innovation and societal progress.

9. Research at Ullandhaug and the UN Sustainable Development Goals

We also explore the degree to which research in the Ullandhaug innovation ecosystem aligns with the UN Sustainable Development Goals. To link research output to the UN Sustainable Development Goals (SDGs), we utilized the text2sdg package in R, a robust tool designed for detecting SDG references in textual data[38]. The package's core strength lies in its meticulously crafted dictionary, based on official UN documentation and detailed descriptions of each SDG, including its specific targets and indicators.

The development of this dictionary involved a comprehensive review of these UN documents, extracting keywords, phrases, and terms that encapsulate the essence of each goal. This initial extraction was just the beginning. The dictionary underwent extensive validation by testing its performance on datasets and texts that explicitly reference the SDGs. This iterative process ensured the dictionary's high sensitivity (capturing genuine SDG references) and specificity (minimizing false positives). Rooting the dictionary in official UN documents guarantees that detected references align accurately with the United Nations' definitions of each SDG.

Using the previously described dataset of research output from the Cristin database, we automatically translated all non-English project and publication titles into English. Subsequently, the text2sdg procedure checked for matches between each research item's (translated) title and the SDG dictionary. The corresponding SDG was assigned to the research item if a match was found. Importantly, the method allowed a single item to be associated with multiple SDGs.

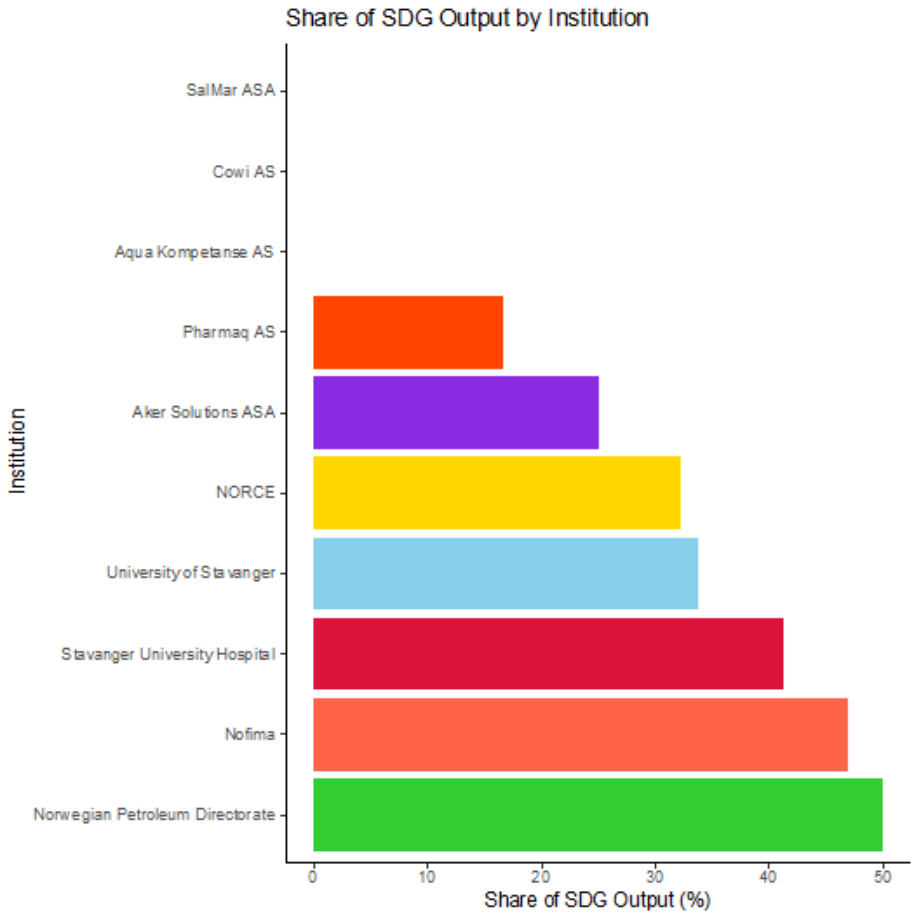
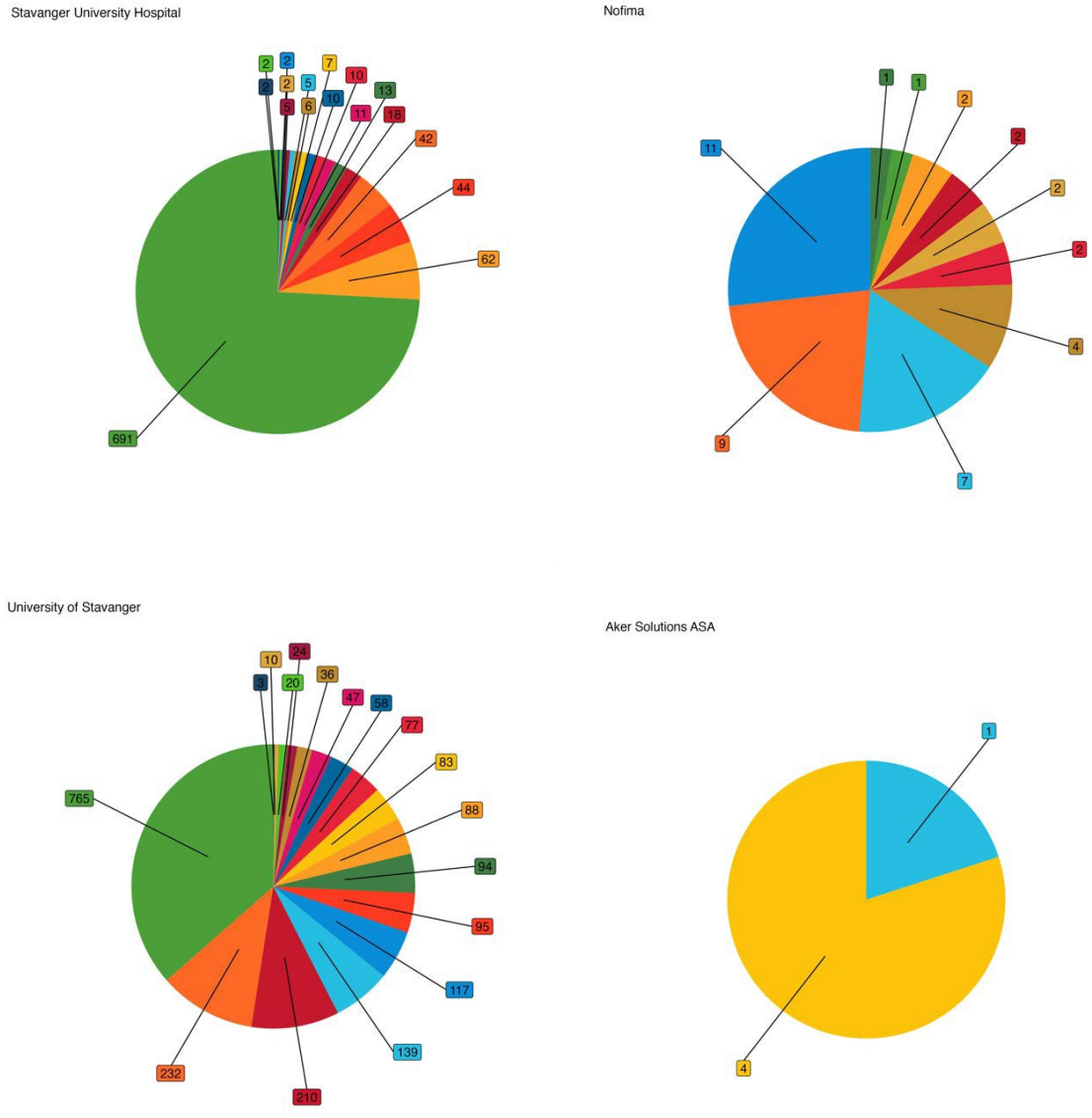


Figure 12: Ullandhaug Organisations and Share of SDG Research

Approximately 34% (1,907 out of 5,517) of all items were linked to at least one Sustainable Development Goal (SDG). Figure 12 highlights the variation in the proportion of research items associated with at least one SDG across different organizations. Note that the Norwegian Petroleum Directorate has only two outputs in total, one associated with one SDG. Similarly, SalMar, Cowi and Aqua Kompetanse have very few publications. Not only because of this, it is important to interpret this ranking with caution. The Cristin data may not fully represent the research output of organizations with smaller contributions. We also do not know which share of SDG output one could expect until similar studies have been conducted in other universities and research organizations. In any case, looking at the research output of the university and NORCE, there seems to be potential for stronger contributions to SDG-related research. Given the interdisciplinary nature of such research, these insights fortify the impression of the substantial untapped potential of joint and SDG-related research by organizations at Ullandhaug.

This variability can partly be attributed to the substantial heterogeneity in the research focuses of different organizations. To capture this diversity, we examine the relative importance of the 17 SDGs in each organization's research output in Figure 12. Figure 13 lists the 17 SDGs along with their respective colors and labels. Below, pie charts illustrate the relative shares of selected organizations' research outputs (those for which a sufficiently large number of research outputs are registered) associated with specific SDGs, providing a clearer picture of how each organization's research aligns with these global goals. The numbers on the pie charts refer to the SDGs, visually representing the distribution of research focus across these global goals.

Stavanger University Hospital's research output predominantly and non-surprisingly focuses on SDG 3 (Good Health and Well-Being), constituting the pie chart's largest segment. Other significant areas include SDG 11 (Sustainable Cities and Communities) and SDG 5 (Gender Equality).



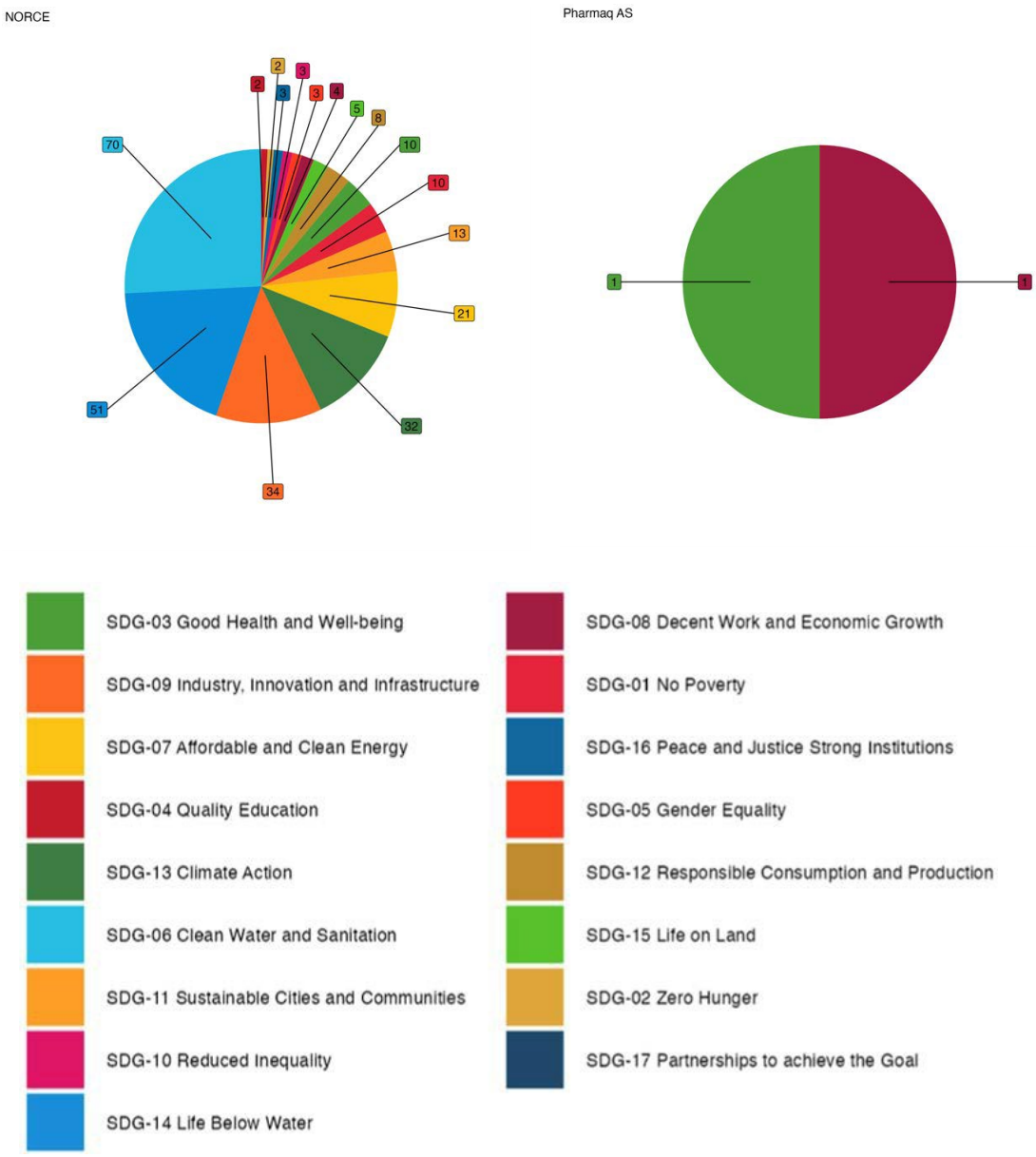


Figure 13: Colors and Labels of UN-SDGs

Nofima's research is widely distributed across multiple SDGs, emphasizing SDG 14 (Life Below Water) and SDG 9 (Industry, Innovation, and Infrastructure). Many small segments indicate a broad research portfolio addressing various sustainability goals. This diverse focus reflects Nofima's commitment to a broad research spectrum.The University of Stavanger exhibits a broad and varied research portfolio, with significant contributions to SDG 3 (Good Health and Well-Being), SDG 9 (Industry, Innovation, and Infrastructure), SDG 4 (Quality Education), and SDG 6 (Clean Water and Sanitation). The diversity in their research output highlights the university's interdisciplinary approach and efforts to address various sustainability challenges.NORCE's research output significantly emphasizes SDG 6 (Clean Water and Sanitation), SDG 14 (Life below water), SDG 9 (Industry, Innovation, and Infrastructure), SDG 13 (Climate Action), and SDG 7 (Affordable and Clean Energy). The prominence of these goals suggests NORCE's strong commitment to addressing climate change and promoting sustainable energy practices.

10. Research infrastructure at Ullandhaug

The Ullandhaug Innovation District hosts diverse specialized labs across multiple scientific and technological fields. While there is no official overview of these labs, the University of Stavanger does provide a list of its labs. We have classified these by field and provide an overview below of the labs which are available through the university.

The largest concentration of labs is in Geology and Reservoir Technology (approximately 23%), including facilities focused on core analysis, geophysics, and oil recovery techniques. These labs reflect the region's historical strength in the petroleum sector but are also well- positioned for transition into sustainable energy solutions.

The Chemistry and Environmental Engineering labs (about 11%) offer advanced analysis capabilities, including mass spectrometry and nuclear magnetic resonance spectroscopy, which are crucial for environmental monitoring and industrial chemistry processes. The Microscopy labs (roughly 14%) support both material and biological sciences with high-end equipment like scanning and transmission electron microscopes.

In Biology and Molecular Biology (9%), labs such as tissue culture, flow cytometry, and sequencing play a vital role in biotechnological research, positioning the district for health and life sciences breakthroughs. The presence of Sustainable Energy labs (8%), focusing on emerging technologies like battery storage, hydrogen, and heat pumps, indicates a clear push toward future-oriented energy solutions.

Additionally, Automation and Computer Technology labs (12%) demonstrate the district's investment in robotics, electronics, and advanced digital systems, which are crucial for developing smart technologies and industrial automation. Overall, this balanced mix of labs is valuable for the future development of the Ullandhaug Innovation District. While the strong presence of petroleum-related labs reflects the region's legacy, the increasing number of labs dedicated to sustainable energy, automation, and biotechnology shows the district's strategic shift toward future industries. This diverse infrastructure positions the district as a key player in advancing innovative technologies critical for regional and global growth.

Table 3: Overview Ullandhaug Labs

Lab	Field
X-ray diffraction (XRD)	Geology and reservoir technology
Core lab	Geology and reservoir technology
Thin sections and milling	Geology and reservoir technology
Mineral separation	Geology and reservoir technology
Enhanced / improved oil recovery (EOR / IOR)	Geology and reservoir technology
Geotechnics	Geology and reservoir technology
Near-surface geophysics	Geology and reservoir technology
Geodesy /Lidar	Geology and reservoir technology
Data and geomodelling	Geology and reservoir technology
Nuclear magnetic resonance spectroscopy (NMR)	Chemistry and environmental engineering
Respiromitry	Chemistry and environmental engineering
Mass spectrophotometry	Chemistry and environmental engineering
Chromatography	Chemistry and environmental engineering
Spectrophotometry	Chemistry and environmental engineering
Scanning electron microscope (SEM)	Microscopy
Transmission electron microscopy (TEM)	Microscopy
Light microscopy	Microscopy
Raman spectroscopy	Microscopy
Cathodoluminescence microscopy	Microscopy
Confocal microscopy	Microscopy
Tissue culture laboratory	Biology and molecular biology
Flow cytometry	Biology and molecular biology
Sequencing	Biology and molecular biology
Zebra fish laboratory	Biology and molecular biology
NanoCatalysis Lab	Sustainable energy

Battery technology	Sustainable energy
Hydrogen	Sustainable energy
Heat pumps	Sustainable energy
Robot lab	Automation
Two-Tank	Automation
PLC lab	Automation
Electronics lab	Automation
Drone lab	Automation
Medical technology	Automation
Thermogravimetry	Materials science
Tensile, compression and bending testing	Materials science
Impact testing	Materials science
Hardness testing	Materials science
Data centre/UNIX	Computer Technology
Cisco Networking Lab (CNL)	Computer Technology
Mechanical workshop	Construction and building materials
3D-printing	Construction and building materials
Concrete	Construction and building materials
Wood workshop	Construction and building materials
Roadbuilding	Construction and building materials
SWIPA	Drilling and well technology
DrillBotics	Drilling and well technology
Rheology	Drilling and well technology
Computer-aided design and manufacturing (CAD/CAM)	Design, modelling, and simulation
Ullrigg Test Center	Drilling and well technology
Advance Subsurface Flow Laboratory	Geology and reservoir technology
Open Lab Drilling	Drilling and well technology
PNA Test Well	Drilling and well technology
Pressure and Leakage Laboratory	Drilling and well technology

11. Conclusion and Recommendations

The Ullandhaug Innovation District has laid a strong foundation for research and innovation but must address several challenges to fully realize its potential. By strengthening its connections to other regional hubs, specializing within the broader Stavanger innovation ecosystem, and promoting deeper collaboration between firms and academic institutions, Ullandhaug can enhance its role as a key driver of innovation in Norway. Additionally, shifting focus towards more basic research, fostering SDG-aligned collaborations, and improving access to research infrastructure will ensure that the district continues to contribute to both regional economic growth and global scientific advancements.

By addressing these challenges, Ullandhaug is well-positioned to become a leading center for sustainable innovation, research, and collaboration within the Stavanger region and beyond.

UNIVERISTY AS A KEYPLAYER

Collaboration within the University and Between Firms and Academia

An important opportunity for Ullandhaug lies in improving collaboration both within the University of Stavanger and between academic researchers and firms located in the district.

While there are some collaborative efforts across university departments, particularly in health sciences and energy, these collaborations often fall short when it comes to deep engagement with the business community. The lack of strong connections between firms and academia is a critical gap that limits the district's innovation potential. Strengthening these ties requires creating structured programs that encourage more active collaboration. This could include the formation of formal research clusters, collaborative innovation labs, or joint ventures that bring together university departments and businesses. It is essential to promote interdisciplinary collaboration across the university, ensuring that firms gain access to a broader range of academic expertise while researchers benefit from real-world business challenges that could drive more impactful research outcomes.

THE ECONOMIC STRUCTURE OF BUSINESSES

Lack of Larger Firms and Limited Industry Presence

One of the most prominent challenges at Ullandhaug is the limited presence of medium and large firms. The district is dominated by small and medium-sized enterprises (SMEs), with larger businesses conspicuously absent. This lack of industrial diversity and the absence of larger players reduce opportunities for large-scale innovation projects and limit the potential for substantial economic and technological breakthroughs.

The physical size and scope of Ullandhaug, being a relatively small area, make it less attractive to larger corporations. As a result, the district struggles to draw in major firms that typically act as anchor institutions in other innovation ecosystems. This highlights the importance of strengthening Ullandhaug's connections with other regional hubs, such as Forus and Jåttåvågen. By creating closer ties with these larger business districts, Ullandhaug can broaden its network and increase its relevance within the regional and national innovation landscape. Collaborative efforts with these hubs could allow Ullandhaug to serve as a complementary node, focusing on research and specialized knowledge-intensive activities.

Incomplete Ecosystem: Specialization within a Regional Innovation Network

As it stands, Ullandhaug is not a complete ecosystem. Larger firms and more complex industries that contribute to a robust innovation environment are missing. This incomplete ecosystem presents a challenge in terms of attracting the missing elements, particularly larger firms. Given Ullandhaug's limitations, it is unlikely that it will naturally evolve into a comprehensive innovation ecosystem on its own. Instead of aiming to become a standalone innovation hub, Ullandhaug should embrace a specialized role within the larger Stavanger region's innovation ecosystem. The district can focus on its strengths, such as fostering collaboration between academic institutions and smaller, innovative firms, while connecting to the broader business community in other parts of Stavanger.

By aligning itself within a larger network, Ullandhaug can leverage the region's collective strengths and remain competitive in areas where it excels, such as energy research and sustainable technologies.

NETWORK AND COLLABORATION

Limited Research Engagement with Firms: Shifting Focus to Basic Research

The firms at Ullandhaug primarily focus on incremental and application-oriented innovation. While this serves immediate business needs, it may limit the potential for breakthroughs in more fundamental areas of research. The district's focus on engineering and consultancy services, while valuable, has contributed to a narrow orientation toward short-term, practical innovations rather than deeper, long-term scientific advancements. To overcome this, there is a need for greater awareness and emphasis on basic research. Encouraging firms to engage in more fundamental research, particularly in collaboration with university departments, could lead to more significant and transformative innovations. Areas such as sustainable energy, digital transformation, and healthcare could benefit from this shift, leading to new technologies and applications that would not only benefit local businesses but also contribute to global scientific advancements. Increasing investments in basic research would also help align the district's activities with the United Nations Sustainable Development Goals (SDGs), driving meaningful contributions to global challenges such as climate action and clean energy.

The Role of Clusters: Mobilizing Firms for Research and SDG Collaboration

While Ullandhaug hosts several industry clusters, such as Energy Transition Norway and the Norwegian Smart Care Cluster, the data suggests that these clusters do not yet play a strong role in fostering scientific research or encouraging collaboration between firms. There is significant untapped potential for clusters to mobilize businesses to engage in research activities that align with the SDGs, particularly SDG 9 (Industry, Innovation, and Infrastructure) and SDG 6 (Clean Water and Sanitation).

To maximize their impact, these clusters should be used as vehicles to promote scientific research and drive innovation across the district. By encouraging firms to collaborate more actively with research institutions and public organizations, these clusters could help create a more integrated and dynamic ecosystem. Furthermore, clusters can play a key role in aligning firms' activities with the SDGs, ensuring that the innovation district contributes to solving pressing global issues while enhancing its research output and international standing.

THE WAY FORWARD

The integration of research and innovation sectors at Ullandhaug forms a strong foundation for cooperation, growth, and value creation. Ullandhaug has all the necessary components to establish a well-functioning ecosystem for innovation: robust research institutions, knowledge-intensive companies, and relevant infrastructure.

However, collaboration among research environments, as well as between these environments and the business sector, is relatively limited. Only certain segments of the research communities engage in cooperation, and businesses are generally not active participants in research. This lack of collaboration can hinder the ability to leverage the opportunities presented by the co-location of these environments. While the firms at Ullandhaug are knowledge-intensive and operate in sectors with significant growth potential, they are, in some cases, not closely related to the wider industry in the region. This disconnect can make it challenging to find local expertise to further develop these companies.

Additionally, there are few large companies at Ullandhaug. To cultivate a complete innovation ecosystem, it will be essential to closely connect the research and startup initiatives at Ullandhaug with the business community in other parts of the region.

Promising Directions for Future Collaboration and Research

The district already has a promising foundation for future collaboration, as around one-third of its research output is aligned with the SDGs, particularly SDG 9 (Industry, Innovation, and Infrastructure) and SDG 6 (Clean Water and Sanitation). This focus provides a strong starting point for future interdisciplinary research and collaborative projects.

Building on this momentum, Ullandhaug should prioritize research programs that integrate fields such as energy technology, water management, and healthcare. By doing so, the district can create opportunities for both firms and researchers to engage in high-impact projects that not only benefit the regional economy but also address global challenges. Initiating joint research programs, funding interdisciplinary projects, and creating collaborative hubs focused on sustainability will be critical in advancing Ullandhaug's role as a center for innovation and research. Such initiatives would help firms take advantage of the university's knowledge base, leading to more innovative solutions and greater economic growth for the region.

iInfrastructure and Labs: Lack of Data and Limited Accessibility

A key area of concern is the lack of detailed data on the research infrastructure at Ullandhaug, particularly with regard to the availability and usage of specialized labs. While the district boasts a number of cutting-edge facilities, such as those focused on geology, energy, and materials science, there is limited information about how these resources are used and who has access to them. This lack of data makes it difficult for firms and researchers to take full advantage of the available infrastructure. To address this issue, a comprehensive review of the district's lab facilities should be undertaken, with an emphasis on clarifying access procedures and ensuring that labs are used efficiently to support collaborative research.

References

1 Lundvall, B. (1992). National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning. London: Pinter; Freeman, C. (1987). Technology Policy and Economic Performance: Lessons from Japan. London: Pinter.

2 Boschma, R., Frenken, K. (2006). Why is Economic Geography not an Evolutionary Science? Towards an Evolutionary Economic Geography. Journal of Economic Geography 6(3): 273-302.

3 Neffke, F., Henning, M. Boschma, R. (2011). How do Regions Diversify over Time? Industry Relatedness and the Development of New Growth Paths in Regions. Economic Geography 87(3): 237-265.

4 Geels, F.W., Schot, J. (2007). Typology of Sociotechnical Transition Pathways. Research Policy 36(3): 399-417.

5 Moore, J.M. (1993). Predators and Prey: A New Ecology of Competition. Harvard Business Review, 93309.

6 Gomes, LA.V., Facin, A.LF., Salerno, M.S., Ikenami, R.K. (2018). Unpacking the innovation ecosystem construct:

7 Ibid.

8 Spigel, B. (2017). The relational organization of entrepreneurial ecosystems. Entrepreneurship Theory and Practice 41(1): 49-72.

9 Stam, E. (2015). Entrepreneurial ecosystems and regional policy: A sympathetic critique. European Planning Studies 23(9): 1759-1769.

10 Katz, B., Wagner, J. (2014). The rise of innovation districts: A new geography of innovation in America.

11 E.g. Glaeser, E. (2011). Triumph of the City: How Our Greatest Invention Makes US Richer, Smarter, Greener, Healthier, and Happier. New York: Penguin.

12 Granstrand, O., Holgersson, M. (2020). Innovation ecosystems: A conceptual review and a new definition.Technovation 90-91: 102098.

13 This historical overview is based mainly on Eriksen, E.L. (2006). Fra hugskole til universitet. Stavanger:

14 https://www.innovasionspark.no/aktuelt/innovasionsparkens-historie-oz-suksessfulle-vision

15 Audresch, D. B. (1595) Inovation and Industry Evolution. *MIT Press.

16 Bresnahan, T.F. & Traitenberg, M. (1995), General Purpose Technolgies 'Engines of Growth'2 *Journal of

17 Kara, A., Spillan, J.E., & DeShields Jr, O. W. (2005). The Effect of a Market Orientation on Business Performance: A Study of Small-Sized Service Retailers Using MARKOR Scale. *Journal of Small Busines Management*, 43(2), 105-118.

18 Glaser, E. L., Kallal, H. D., Scheinkman, J. A., & Shleifer, A. (1992). Growth in Cities. *Journal of Political Economy*, 100(6), 1126-1152.

19 Porter, M., 1998. Clusters and the new economics of competition, Harvard Business Review November - December) 77-90.

20 Coad, A., Frankish, J. S., Roberts, R. G., & Storey, D. J. (2013). Growth paths and survival chances: An application of Gambler's Ruin theory. *Journal of Business Venturing*, 28(5), 615-632.

21 Haltiwanger, J., Jarmin, R.S, Miranda, J. (2013) Who Creates Jobs? Small versus Large versus Young. Review of Economics and Statistics, 95(2), 347-361.

22 Audretsch, D. B. (1995). op.cit.

23 Coad, A. et al. op. cit.

24 Coad, A. et al. op.cit.

25 Porter, M. E. (1998). Clusters and the New Economics of Competition. *Harvard Business Review*, 76(6), 77 - 90.

26 Cressy, R. (2006). Why do Most Firms Die Young? *Small Business Economics*, 26(2),

103-116; Storey, D.J.; (1994). Understanding the Small Business Sector. *Routledge*.

27 Beck, T., Demirguc-Kunt, A., & Maksimovic, V. (2005). Financial and Legal Constraints to Firm Growth: Does Firm Size Matter? *Journal of Finance*, 60(1), 137-177.

28 Colombo, M.G., & Grilli, L. (2005). Founders' human capital and the growth of new technology-based firms: a competence-based view. *Research Policy*, 34(6), 795-816; Mason, C., & Brown, R. (2013). Creating good public policy to support high-growth firms. *Small Business Economics*, 40(2), 211-225.

29 The scientific basis of the tool rests in the literature on related diversification in general and the works of Crespo, J., Balland, P.-A., Boschma, R. A., & Rigby, D. (2017). Regional Diversification Opportunities and Smart Specialization Strategies. EU-Directorate-General for Research and Innovation; Hidalgo, C. A., Hausmann, R., Hidalgo, A., & Hausmann, R. (2009). The building blocks of economic complexity. Proceedings of the National Academy of Sciences of the United States of America, 106(26), 10570-10575.

30 For technical details see: Deegan, J., Broekel, T., Haus-Reve, S., Dahl Fitjar, R., & Haus-Reve#, S. (2024). How regions diversify into new jobs: From related industries or related occupations? Regional Studies, 0(0), 1-16.

31 For technical details see: Deegan, J., Broekel, T., Haus-Reve, S., Dahl Fitjar, R., & Haus-Reve#, S. (2024). How regions diversify into new jobs: From related industries or related occupations? Regional Studies, 0(0), 1-16.

32 1. Mizruchi, M: S. (1996). What do interlocks do? An analysis, critique, and assessment of research on interlocking directorates. Annual Review of Sociology, 22(1), 271-298.

33 Burt, R. S. (2004). Structural holes and good ideas. American Journal of Sociology, 110(2), 349-399.

34 Powell, W. W., Koput, K. W., & Smith-Doerr, L. (1996). Interorganizational collaboration and the locus of innovation: Networks of learning in biotechnology. Administrative Science Quarterly, 116-145.

35 Geletkanycz, M. A., & Hambrick, D. C. (1997). The external ties of top executives: Implications for strategic choice and performance. Administrative Science Quarterly, 654-681.

36 Brökel, Heike & Broekel, Tom, 2023. "Collaboration and SDG-related research at the University of Stavanger," MPRA Paper 120005, University Library of Munich, Germany

37 This part of the funding system for universities was phased out in 2023.

38 Meier, D. S., Mata, R., & Wulff, D. U. (2021). textsdg: An R package to Monitor Sustainable Development Goals from Text. 20, 1-10. http://arxiv.org/abs/2110.05856

Who is DiveOpp?

The world is full of business opportunities. This is equally true for individuals, organizations, regions, and countries. And all of these must make choices between alternatives: Shall our company strengthen investments in a new technology to enter additional market segments or is it better to concentrate on our core competences and solidify our current position? Will supporting this new industry open the path for future growth in our region or will it be easier to sustain our competitiveness through facilitating our current economic specialization?

Answering such questions is anything but easy and such decisions usually have long-lasting consequences. It involves the setting of long-term business / economic strategies shaping firms', regions', and countries' developments for considerable time periods. Consequently, such decisions need to be based on a solid assessment and evaluation of reliable information.

This is where DiveOpp comes into play. We provide science-based assessments of economic opportunities and deliver detailed information that forms a reliable basis for such kind of decision-making and scenario development.

DiveOpp specifically assesses diversification opportunities using context-specific mixes of patent data (firms and regions), employment and occupational statistics (regions), and web-based information (firms and regions).

www.diveopp.com