

Analysis of The Challenge- Driven Innovation Programme

Final Report



Summary

CDI IS A TOOL THAT CONTRIBUTES TO SOLUTIONS TO SOCIETAL CHALLENGES

Vinnova's Challenge-Driven Innovation (CDI) programme was launched in 2011 as an investment in collaboration projects that work in the long term to solve societal challenges. Between 2011 and 2017, CDI issued calls for proposals for the funding of projects within four areas identified by Vinnova. Since 2018, the UN's Sustainable Development Goals (SDGs) represent a central point of departure for CDI. The projects must therefore meet societal challenges in a manner that contributes to Sweden's achievement of one or more of the SDGs.

CDI funds visionary projects that are based on needs formulated by the organisations submitting applications. These projects can receive funding in three stages. They can apply for and receive incremental funding from Vinnova, from SEK 500,000 in stage 1 up to a maximum of SEK 20 million in stage 3. At the same time, Vinnova's relative share of the total project budget decreases at each stage. Up to December 2021, CDI had granted funding to a total of 783 projects. Just over 500 projects have received funding for stage 1, and just over 50 projects have received funding for stage 3. More than 2,500 unique organisations have participated in CDI, and Vinnova has granted a total of almost SEK 2.5 billion in funding. Universities, private companies and research institutes are the organisations that receive the most funding. The number of project partners also increases during the projects, from an average of 5 partners in stage 1 to an average of 17 partners in stage 3.

Ramboll has performed an analysis of CDI on behalf of Vinnova. The assignment took place during the period January 2018 to December 2021. Our analysis is partly based on case studies of 44 completed projects. It is also based on a document analysis of the projects we have not studied through case studies, as well as a survey sent to the completed projects.

PROJECTS WITHIN CDI FOCUS ON COMPLEX PROBLEMS AND ARE CARRIED OUT IN BROAD COLLABORATION

The types of grand societal challenges that are related to the SDGs have a number of underlying causes with complex interrelationships. The projects have attempted, in various ways, to reduce this complexity in order to be able to be effective, achieve their goals and create manageable projects, and have therefore often focused on a specific part of the societal challenge in question. Most of the projects then focus on developing technical solutions for this specific sub-challenge. However, in order to be able to implement these solutions on a widespread scale, it is necessary to do more than simply prove the technical potential of the solution. The projects need to ensure that there is a functional business model for the solution, and that there is an infrastructure that facilitates dissemination of the solution. In this context, the projects also need to ensure that the technical solution complies with applicable regulations and is designed with the intended users in mind. Few projects explore all of these aspects at an early stage of the project. When the solution is tested during the implementation of the project, the participants involved in the project often discover how important such a system perspective is

CDI HAS CONTRIBUTED TO NEW WAYS OF MANAGING SUB-CAUSES OF GRAND SOCIETAL CHALLENGES

Almost all projects within CDI have succeeded in demonstrating the potential of solutions relating to some part of a grand societal challenge. In doing so, the projects have created more in-depth or renewed understanding of the challenge and how it can be dealt with in the future. A majority of the CDI projects have led to new projects which have been able to be designed based on insights from CDI. The projects themselves feel that their activities have impacted, to a high degree, how society now addresses the challenge in question, compared to how society has traditionally worked with the challenge.



The projects have enhanced both the participants' and other contributors' capacity to develop new innovations in the long term, in two main ways. Firstly, the projects have developed new knowledge, which has led to a large number of patents and scientific publications. Secondly, the projects have built up new networks among the more than 2,500 contributors that have participated in CDI. A number of these contributors are organisations from the public sector that have not previously participated in Vinnova-funded collaboration projects.

Although the projects have resulted in new products, services and processes, their impact is still limited to date. Few projects have scaled up or implemented widespread solutions of a system-impacting nature during or directly after the project period. As a rule, there is a need for more work after the end of the project in order to be able to utilise the technical solutions, maintain tempo and truly implement the solutions in society. This is in line with the programme logic for CDI. The greatest obstacle to system impact is that there is seldom a relevant participant who is willing to drive the process of implementing and disseminating the solution on a widespread scale after the end of the project. This is often due to a lack of sufficient incentives for an individual organisation to do this, even if society needs the solution. In this context, policies and regulations can act as both a crucial driver and barrier. Often, the projects do not identify the regulations that affect them until a later stage of the implementation of the project, at which point, in certain cases, it may be too late to adapt or modify the solution during the project period.

CDI SHOWS THAT IT IS IMPORTANT TO HAVE A SYSTEM PERSPECTIVE IN ORDER TO BE ABLE TO DEVELOP RELEVANT AND FUNCTIONAL SOLUTIONS TO CONTEMPORARY GRAND SOCIETAL CHALLENGES

Vinnova has long emphasised that it is important to test new solutions under realistic conditions. CDI has clearly shown that this approach does not just apply to the technical conditions but also to the systems of regulations, user behaviours and business models surrounding the solution. We are able to clearly observe that CDI as a concept creates good opportunities to test solutions with focus on these system aspects. This is made particularly apparent by the fact that projects within CDI often encounter the same types of obstacles, even though they focus on different types of challenges and solutions. Vinnova's ideas concerning and investments in system demonstrators and policy labs are important components of the development of this work. At the same time, our analysis shows that there is potential for improvement in relation to how CDI ensures more relevant learning. CDI would likely have benefited from a clearer mission-based governance of the programme aimed at ensuring that new solutions are tested for societal challenges which are more demarcated than the SDGs. When multiple projects adopt different approaches to dealing with the same problem, opportunities are created for learning and system impact.

CDI also provides insights into what innovation-supporting activities can lead to, and how they can best be monitored and followed up. Effects such as more new companies, more patented solutions or improved financial KPIs don't say anything about how the activities actually contribute to new ways of dealing with a societal challenge. For example, more profitable companies or a more efficient public sector cannot be equated with a better society from a social or environmental perspective. It is therefore likely that each individual activity needs to be evaluated on its own merits based on the context in which it intends to achieve impact. In other words, a system perspective is required, not only at Vinnova and in the projects, but also among those who evaluate and analyse challenge-driven innovation programmes.

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Chapter 1.

CDI is a tool that contributes to solutions to societal challenges

This chapter describes our assignment and CDI's aim, primary dimensions and changes over time.



1. CDI is a tool that contributes to solutions to societal challenges

Ramboll Management Consulting AB (hereinafter referred to as Ramboll) has analysed Vinnova's Challenge-Driven Innovation (CDI) programme on behalf of Vinnova. The assignment took place during the period January 2018 to December 2021.

1.1 Ramboll has analysed the CDI programme for four years

Ramboll has analysed CDI's projects and the programme's steering documents. The aim of the analysis has been to understand the projects' innovation journeys and the impact achieved by the projects and the programme, in other words, whether and how the overall project portfolio and the programme have contributed to change at system level. Ramboll's assignment has included the performance of an overall analysis of the case studies carried out by Ramboll within the framework for the assignment. Ramboll has reported the findings of the overall analysis to Vinnova on an annual basis. This report is the last of a total of four reports during the period 2019-2021.

This report is based on the 44 case studies of completed projects that Ramboll has carried out up to and including November 2021. The analysis is also based on a document analysis of the projects not included in the case studies, as well as a survey sent to all completed projects that have carried out stage 2 and stage 3, and the projects that have participated in the Go Global call for proposals regarding internationalisation of their solution.

The assignment has been led by Johannes Henriksson and has been carried out together with Katarina Steijer, Martin Bodensten, Clara Leandersson, Anna Järneteg, Erica Iseborn, Isabella Björling and Emilia Eldh, all from Ramboll. The assignment has been performed in collaboration with sub-consultants from Stockholm School of Economics (Mats Tyrstrup and Mattias Axelsson), KTH Royal Institute of Technology (Karin Larsson) and Länka Consulting (Anna Zingmark).

Figure 1. The annual process for analysing CDI







1.2 CDI funds collaboration projects that aim to contribute to the Sustainable Development Goals

Vinnova's Challenge-Driven Innovation (CDI) programme was launched in 2011 as an investment in collaboration projects that work in the long term to solve societal challenges. Between 2011-2017, CDI issued calls for proposals for funding of projects that aim to meet societal challenges within four challenge areas identified by Vinnova.¹ Since 2018, CDI is based on the UN's Sustainable Development Goals (SDGs). The projects must therefore meet societal challenges in a manner that contributes to Sweden's achievement of one or more of the SDGs.

CDI funds visionary projects that are based on needs formulated by the organisations submitting applications. Through a cross-sectoral and interdisciplinary approach, the projects aim to find scalable solutions of a system nature. CDI projects can receive funding in three stages: 1) initiation, 2) collaboration and 3) implementation. Before applying for funding for the next stage, the project must have completed and received approval for the current stage. Since 2018, projects that complete stage 2 and stage 3 can also apply for funding, via the Go Global call for proposals, to disseminate the solutions developed by the project internationally.

Table 1. Each stage within CDI has different focus areas and funding limits

Project stage	Focus area	Maximum funding	Approx. project period
 Stage 1 Initiation	Develop the innovation-oriented idea and plan for how it is to be developed and utilised. Develop the needs analysis at a more in-depth level and seek collaboration with more participants.	SEK 500,000 80% of costs eligible for support	9 months
 Stage 2 Collaboration	Develop the collaboration between participants at a more in-depth level and begin developing and testing innovative solutions.	SEK 10,000,000 50% of costs eligible for support	2 years
 Stage 3 Implementation	Test and implement results on a larger scale and in reality. Lay the foundation for the design of the business model and how dissemination and upscaling is to occur in order to ensure utilisation of the solution.	SEK 20,000,000 40% of costs eligible for support	2 years
 Go Global	Carry out a pilot study or implementation project aimed at exploring opportunities for internationalisation or, alternatively, carry out an internationalisation project.	SEK 500,000 (80% support) SEK 5,000,000 (50% support)	9 months 2 years

¹ The challenges were Sustainable attractive cities, Information society 3.0, Future health and healthcare and Competitive production. The latter existed until 2015/2016 before it was changed to Sustainable Industrial Development.

1.3 CDI entails a new way of working for Vinnova

In connection with Sweden's EU Presidency in 2009, the Lund Declaration was adopted with the message that European research must focus on contemporary grand societal challenges. At this time there weren't any significant research programmes in Sweden with clear focus on societal challenges. Consequently, around 2010, Vinnova commenced an initiative which resulted that same year in a decision that Vinnova would henceforth fund projects focused on one of four broad challenge areas. These four challenge areas were identified as: Future health and wellbeing, Sustainable attractive cities, Sustainable industrial development and the Information society. At the same time, Vinnova realised that this new direction did not affect how various government agency programmes were designed or implemented in practice. Vinnova therefore arranged a number of well-attended workshops within each challenge area, with participants from government agencies, universities, research institutes, companies and the Swedish Government Offices. The participants developed a number of principles with regard to what a challenge-driven approach actually entails: 1) the projects submitting applications must themselves formulate, within specified frameworks, the challenges they aim to help to solve, 2) the implementation of the project must be divided up into separate stages, and 3) the projects must focus on societal challenges based on a system perspective, in other words, the range of factors that maintain the challenge and prevent new solutions from developing. Inspiration for the programme was obtained in part from measures undertaken for a long time by the U.S. Small Business Administration (SBA), an American federal agency focused on supporting the development of small businesses.

Based on the principles developed during the workshops, Vinnova launched the Challenge-Driven Innovation (CDI) programme in 2011. Vinnova received almost 800 applications in response to the first call for proposals, which is a large number in comparison with other programmes. The CDI-funded projects were also different in a number of ways to the typical Vinnova project at this time, for example with regard to the project period, the number of project partners and the direction of the projects (table 2).

Table 2. Differences between CDI-funded projects and Vinnova projects at the time when CDI was launched

Typical project funded by Vinnova	Typical project funded within CDI
Individual project of 3-5 years	Three stages, shorter project of two years per stage
Few project partners (around 3 project partners per project)	Broad and in-depth collaboration (12 project partners per project on average)
Focus on technological challenges	Focus on societal challenges
R&D project that develops strategically important knowledge	R&I project that also works with system barriers and results
Typically involves male researchers	New target groups and improved gender equality in the project organisation

1.4 CDI is an example of third-generation innovation policy

In the past 50 years, countries have attempted to promote innovation on the basis of the principle that all innovation and growth always leads to positive social development in the long term. However, in the last ten years an opinion has emerged in the research community that not all forms of growth and not all forms of innovation necessarily generate positive social effects. It is not the growth itself that is the most important factor, but rather the social direction in which the growth takes us, as the leading researcher Mariana Mazzucato puts it.²

Figure 2. Three phases of innovation-promoting programmes and policy



The emerging phase in which innovation policy currently exists is usually referred to as the third-generation innovation policy. The policy now focuses on dealing with grand societal challenges through system-wide transformation. This imposes completely new demands on how innovation policy is formulated, as it needs to manage complex system contexts. CDI's structure can be viewed as an example of third-generation innovation policy, even though the programme was not based on this framework when it was formulated.

² See e.g. Mazzucato, Mariana (2017). *Mission-Oriented Innovation Policy. Challenges and opportunities*.

Table 3. Dimensions of third-generation innovation policy³

Attribute	Equivalent aspect within CDI
Directionality <i>Create a direction that is collectively accepted by the participants regarding the problem that is to be solved.</i>	The projects must relate to challenges that concern one of the Sustainable Development Goals (top-down), but the problem formulation and solution proposal is specified by the applicants in collaboration (bottom-up).
Experiment <i>Create scope to test new solutions in niches and build up skills and knowledge.</i>	The projects must be innovative and must be carried out in a maximum of three separate and relatively short stages. The projects build up skills and knowledge in the management of complex development processes.
Articulation of demand <i>Involve the market in the innovation process, ideally in the form of different principal users who can create legitimacy for new solutions.</i>	Requirement that the consortium of participants in the project must consist of or engage needs-owners, customers, users and other relevant specifiers of requirements.
Policy learning and coordination <i>Ensure continuous learning and coordination through other measures that relate to the challenge</i>	Implementation of project conferences, development of leadership skills, establishment of policy labs.

³ Grillitsch, et al. (2019). Innovation policy for system-wide transformation: The case of strategic innovation programmes (SIPs) in Sweden. *Research Policy* vol. 48(4), p.p. 1 048-1 061. Table from The Swedish Agency for Growth Policy Analysis (2020). *Den tredje generationens innovationspolitik. Kunskapsöversikt och problematisering*. PM 2020:12

Chapter 2.

The projects focus on complex problems and are carried out in broad collaboration

This chapter presents the societal challenges on which the projects focus and associated solutions, how the projects are organised and factors relevant to successful implementation of the projects.



OVERVIEW OF THE CDI PROGRAMME

 **783**
approved projects

 **2,458**
unique organisations
(org. number)

 **SEK**
2,408,345,000

 **2,533**
unique participants
(workplaces)

FIGURE 3. NO. OF PROJECTS AND NET FUNDING GRANTED PER STAGE



FIGURE 4. TOTAL NET FUNDING GRANTED, BROKEN DOWN BY TYPE OF PARTICIPANT

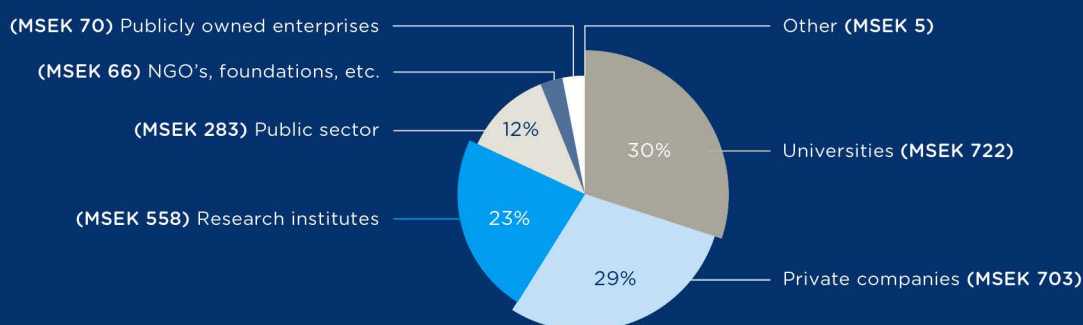
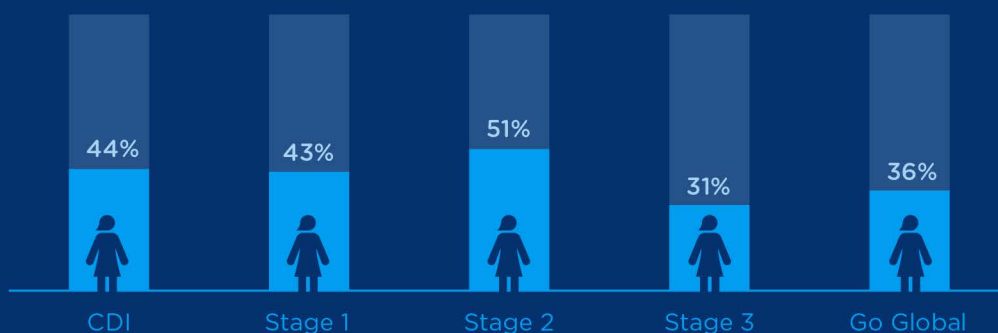


FIGURE 5. PERCENTAGE OF FEMALE PROJECT MANAGERS



2. The projects focus on complex problems and are carried out in broad collaboration

The projects within CDI must meet societal challenges in a manner that contributes to Sweden's achievement of one or more of the Sustainable Development Goals (SDGs).

2.1 Most of the projects focus on challenges relating to a few Sustainable Development Goals

Together, the projects approved to date within CDI have a connection to all 17 of the SDGs, according to Vinnova's own classification.¹ Many of the projects aim to identify solutions to sub-challenges that relate to several interconnected or closely related SDGs. But we can see that certain SDGs predominate. The SDGs to which the projects primarily relate are SDG 3 – Good Health and Wellbeing (25 percent), SDG 9 – Industry, Innovation and Infrastructure (24 percent), SDG 12 – Responsible Consumption and Production (24 percent), and SDG 11 – Sustainable Cities and Communities (20 percent). This prioritisation is in line with the Swedish Government's ambitions that Sweden particularly needs to focus on SDGs 9, 11 and 12.² At the same time, there is a very large spread with regard to the targets to which the projects intend to contribute, as well as the causes of the problems on which the projects are focused.

Among the projects that proceed to stage three, SDG 11 (Sustainable Cities and Communities) is particularly highly represented (27 percent), followed by SDG 3 (Good Health and Wellbeing – 18 percent) and SDG 12 (Responsible Consumption and Production – 18 percent). Vinnova's programmes were previously formulated within one of four challenge areas on which CDI is focused, which likely explains why a large percentage of the projects are focused on these areas. The case studies show that the projects that have been carried out since CDI introduced the SDGs better describe the challenge to which the project relates, and that these projects are needs-driven to a greater extent than earlier projects. It is likely that some of the projects which received funding during the earlier years of CDI would not have been approved today, as they lacked a clear connection to a societal challenge that is generally accepted in Sweden.

Figure 6. The CDI projects' primary focus based on the Sustainable Development Goals



1 The classification was made afterwards by Vinnova for projects approved between 2016 and 2018. Ramboll has also categorized projects when conducting the case studies.

2 The Swedish Government (2017) *Handlingsplan för Agenda 2030*

2.2 The projects demarcate their area of focus so as to be able to deal with complex and multifaceted societal challenges

Our impression is that the projects first identify a need, which they then connect to a sustainable development goal in the next step, rather than the other way round, i.e. working on the basis of an SDG and then deciding what they need to do to contribute to the achievement of that SDG. This seems to be the case even during the period when the projects were supposed to focus on one of Vinnova's four challenge areas.

There are several explanations for this. The types of grand societal challenges that are related to the SDGs have a number of underlying causes with complex interrelationships. One example is the challenge associated with increasing social exclusion, which in all likelihood has a number of underlying causes such as urban planning, labour market and education policy, demography, integration and relocation trends. In such cases it is difficult to isolate the causes behind a particular challenge, which means that it is difficult to know, in advance, which type of solution is best. New solutions also presuppose changes to established economic, social and technological structures that preserve the order which has created the challenge in question. In this context, existing companies, technologies, social norms, networks and regulations block, either knowingly or unknowingly, the emergence of new ways of working.

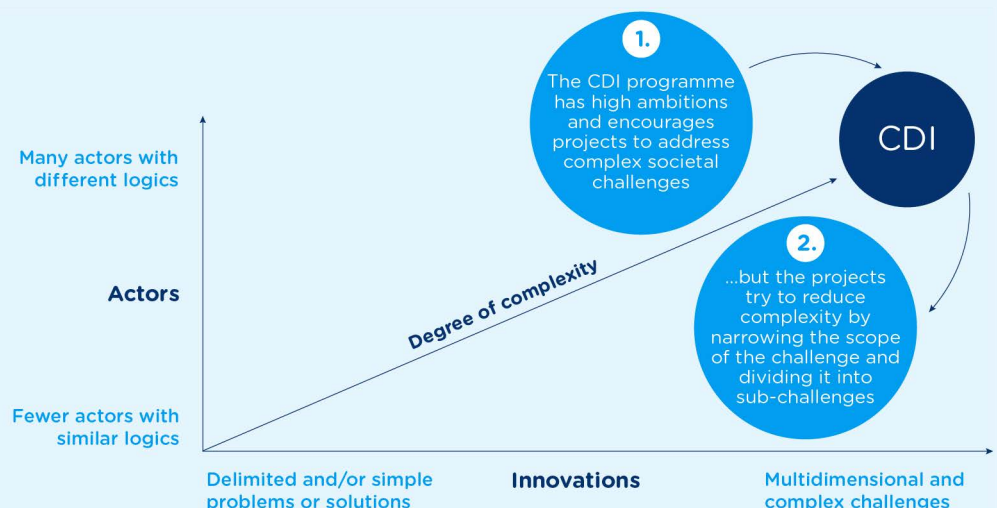
The project **Cultivation under cover** aimed to establish sites for energy-efficient cultivation of crops under cover in vulnerable residential areas, in order to manage the complex societal challenges of climate change, segregation and exclusion. The cultivation sites were intended to increase the attractiveness of and sense of security in vulnerable areas while also reducing carbon dioxide emissions thanks to fewer transports and more green areas.



Faced with this complexity, the projects within CDI need to address two main problems. Firstly, the projects need to deal with the scope of the challenge. Secondly, they need to relate to a large number of participants who represent and are part of the system that preserves the challenge (figure 8). The case studies that we have carried out show that the projects usually manage this in the following two ways:

- **The projects break down the societal challenge into one or several sub-challenges.** It is common that the projects demarcate the societal challenge by focusing on a specific sub-cause. The projects can then work to find solutions to a relatively demarcated problem, which in itself is one of several causes of the grand societal challenge.
- **The projects are divided up into independent sub-projects.** The projects may also be divided up into independent sub-projects, whereby each sub-project gathers a manageable number of participants from different sectors of society with different assignments and conditions. Some contributors participate intensely in these projects, while others monitor the progress of the projects and participate by specifying requirements on the solution.

Figure 7. The projects' management of complex societal challenges



2.3 Few projects explore all parts of the system they want to impact from the very start

In CDI's calls for proposals it is stated that the projects must describe how they address system challenges and must account for the societal challenge at system level. This is often difficult for the projects, and consequently Vinnova has changed the texts in the calls for proposals on a number of occasions in order to provide relevant guidance to those wishing to apply to the programme. The projects have particular difficulty in describing all the factors that are behind the challenge for which the project intends to develop a solution.

In our analysis of the projects' work aimed at impacting existing systems, we have adopted an approach based on a framework that researchers have developed on behalf of the EU Commission

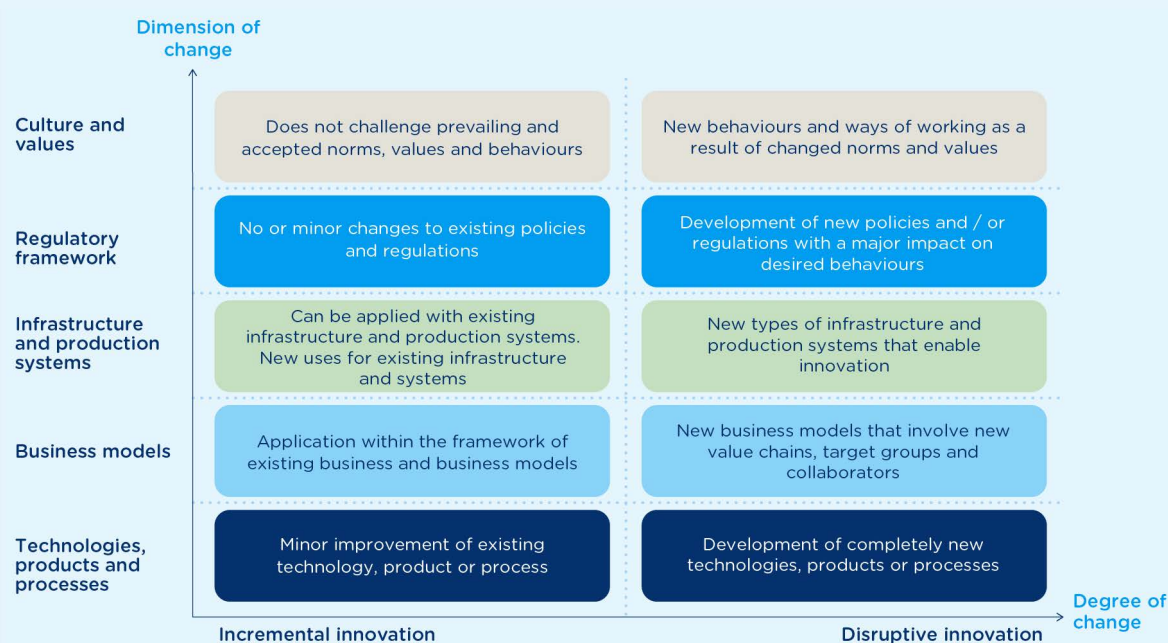
for mission-oriented innovation programmes (Figure 9). This framework clarifies that an innovation does not just cover one new product, process or service; it also covers the solution's business model and an infrastructure that makes it possible to disseminate the solution, and it must comply with or impact existing regulations and meet a need that the users actually have. System perspective within CDI means that a project explores all these dimensions surrounding an intended solution. Through such a system perspective, the projects change the system that preserves the challenge which the solution aims to address, which in turn facilitates future system innovations. The greater the impact a solution has on these dimensions, the greater the system impact achieved by the project. Based on our analysis of the projects using an approach based on the aforementioned framework, we draw two main conclusions:

The project **Innovative technology for tomorrow's emergency healthcare** aimed to develop technical solutions for the exchange of real-time images and clinical data between the home/accident site and the healthcare service. The project was too late in focusing on the identification of sustainable business models. They encountered obstacles in the regulations regarding management and processing of data. They also underestimated how sceptical the intended users were with regard to the solution.



- Even in stage 1, the projects primarily focus on the development of new technologies, products and processes, and this focus remains throughout the implementation of the project.
- As a rule, the projects omit to focus at an early stage on the dimensions of policy and regulations, culture and values, and business models. They often discover how important these dimensions are at a later stage of the project.

Figure 8. Main dimensions that need to be explored in order to facilitate system innovation³



³ Inspired by Miedzinski (2017), presented in Miedzinski, M., Mazzucato, M. and Ekins, P. (2019). *A framework for mission-oriented innovation policy roadmapping for the SDGs: The case of plastic-free oceans*. UCL Institute for Innovation and Public Purpose, Working Paper Series (IIPP WP 2019-03).

2.4 The projects primarily focus on technical solutions to complex challenges

Different societal challenges require different solutions or combinations of solutions. In our analysis of CDI, three types of solutions are prominent as solutions which the projects have focused on. These solutions mean that the overall societal challenge is addressed through one of the following (figure 10):

- Developing new technology or a new technical process (focus on technology)
- Developing an individual but socially important organisation (focus on organisation)
- That a wide range of participants need to change their behaviours or their mutual relationships (focus on coordination).

The project **Tomorrow's municipal wastewater treatment** aimed to develop a technical process for improving the treatment of pharmaceutical residues, and to explore the possibility of producing biogas from the sludge left over from the treatment process and other waste. The project had a clear focus on technology, even though widespread implementation of the technical solution requires stricter regulations and subsequent municipal investments.



The projects have typically focused on one type of solution, the most common of which has been the development of technical solutions. These projects have in turn primarily focused on the change dimensions of technology and processes as well as infrastructure and production systems, and they typically omit to focus on dimensions such as business models and regulations (see 2.3). These projects are also characterised by the fact that it is often research institutes that coordinate them. Other projects have a clear organisation-oriented focus. These projects have primarily concerned challenges in healthcare. These projects place emphasis on, for example, changing the internal processes applied by a region in relation to an existing technical solution. A third category consists of projects that are more focused on coordination. This primarily applies to projects where there is no clear, demarcated needs-owner, and where the solution entails the need for a large number of contributors to change their behaviours. These projects often concern challenges relating to urban development.

The projects have often changed focus both within and between the various stages. A project may, for example, initially focus on an intended technical solution, but gradually come to the realisation during the course of the project that the project actually needs to address the work methods used within an organisation. The project thus shifts focus and direction between stages based on increased knowledge about the actual nature of the challenge.

Table 4. Three types of solutions for addressing societal challenges in the projects that have been studied

Focus area	No. of projects	Description	Characterised by
Focus on technology	26	Addresses the societal challenge by focusing on new technical solutions.	Primarily coordinated by research institutes
Focus on organisation	12	Addresses the societal challenge through the development of an individual but socially important organisation, with focus on new work methods and approaches.	Primarily concerns challenges in healthcare
Focus on coordination	6	Addresses the societal challenge by focusing on the need for a wide range of participants to change their behaviours and start collaborating in new ways.	Primarily concerns sustainable cities and communities

2.5 Different organisations have different possibilities to participate in the projects

In our case studies we can clearly see that the projects have been driven forward by individuals with a mandate to engage in the project. However, the possibilities for obtaining such a mandate differ between individuals depending on the organisation to which they belong. In this context we observe general differences between, on the one hand, researchers at universities or institutes, and on the other hand, employees at companies and within the public administration functions of Swedish municipalities, regions or government agencies.

The dividing line exists in how organisations define a successful project and how they value the time that they invest in the project. For companies and public administration departments, new knowledge and new work methods created by a project are valuable if they are relevant and applicable to their own organisation. Researchers, on the other hand, tend to view new knowledge as valuable irrespective of who stands to benefit from the knowledge. In addition, the time invested by a researcher does not fully represent a real cost, as the remuneration received by a researcher for participating in a project is part of the funding model for the researcher’s own organisation. For companies and public administration departments, participation in CDI projects is always beyond their core assignment, and the cost of the time invested is therefore always associated with a clear in-house alternative cost.

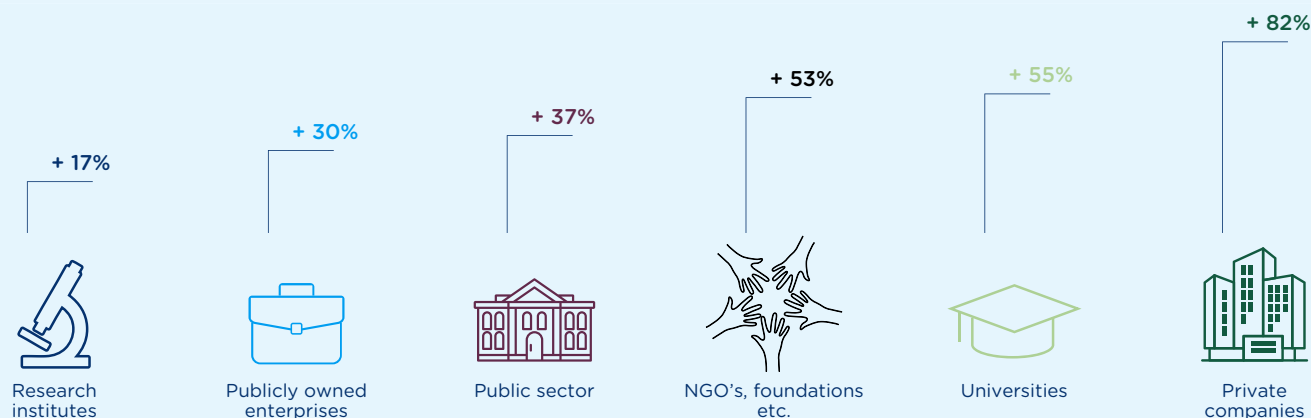
How each organisation weighs these interests and incentives in relation to each other affects the focus and direction of the projects. Projects with a “research logic” have a tendency to produce knowledge without a clear recipient, or with a lack of applicability. Projects with a “business logic” have a tendency to adopt a short-term approach and lack ambition to rectify the system defects that characterise a societal challenge. Our analysis also shows that the level of engagement on the part of the project participants can quickly increase or decrease if the project’s focus shifts from one type of logic to the other.

An analysis of the projects’ accrued budgets, broken down by type of participant, shows that the participating companies have primarily become engaged when the project is approaching implementation or commercialisation of a solution, which is supposed to happen in stage 3. Private companies are the participants that increase their participation (accrued cost) to the greatest extent between stages 2 and 3, which is in line with Vinnova’s intentions (figure 9).

The **I-tex** project aimed to reduce the spread of infection and the growth of bacteria in sensitive hospital environments through the development and application of new knowledge and new textile materials, in order to reduce the number of healthcare-related infections. The project encountered varying incentives and conditions among the participating parties. I-tex was de-prioritised in favour of more pressing activities for each party. The choice of material for the development of clothing in antibacterial textiles was to a large extent driven by a business logic and one participant’s existing production, rather than being based on the needs of hospital staff.



Figure 9. Change in average accrued budget between stage 2 and stage 3, per type of organisation



2.6 More participants participate in each new project stage, but the coordinator is often the same

Projects within CDI are carried out in three separate stages. Prior to each stage, the project consortium needs to compete with other project proposals for funding within CDI via an open calls-for-proposals process. However, if a project does not apply for continued funding after stage 2, this does not necessarily mean that the project has been a failure. A number of projects find other paths for development outside of CDI after stage 2. For example, individual project partners may choose to continue working with an issue on their own. In our portfolio analysis and our case studies, three main observations are apparent with regard to how the projects have chosen to change the project organisation between the different project stages.

- The consortium of participants in a project often changes between the different project stages.** The case studies show that the projects are pragmatic when it comes to changing the consortium of participants based on the project’s development and needs. Most often, the consortium of participants has changed in conjunction with the project moving from one stage to the next. The gradual (stage-based) funding model makes it easier for the projects to make changes to the consortium of participants.

The **INNOKOMP** project aimed to further develop existing value chains for new powder-based component technology by bringing together participants along the entire innovation chain. Chalmers University of Technology was the coordinator during all three stages. The number of participants increased between stage 1 (8 participants) and stage 2 (18 participants) but then decreased in stage 3 (15 participants). During stage 2, the project came to the realisation that certain technologies worked better than others, which led to a narrowing down of the project from a broader approach to a more specific focus on additive manufacturing.



- More participants participate for each new project stage.** On average, ten additional participants joined the projects between stage 1 and stage 2, while the corresponding figure between stage 2 and stage 3 was two additional participants on average. This can be explained by the fact that the projects identify new needs in relation to the solution they are developing, and these needs require more (and new) perspectives from other participants. However, this phenomenon can also be explained by the fact that the design of the funding model drives developments towards the creation of larger consortiums. As the percentage of funding from Vinnova decreases per stage, the projects need to attract more partners in order to satisfy co-funding requirements.
- The coordinator is rarely replaced.** Each project is managed by an organisation in the role of coordinator. The portfolio analysis of the case studies carried out by Ramboll shows that it is most common for a research institute to adopt the role of coordinator. This applies in all three stages. In the projects where a research institute is the coordinator, there are no examples of projects where another type of actor has taken over the role of coordinator during the three stages. In our assessment there are several reasons why the percentage of projects coordinated by a research institute is so high. They possess knowledge of the availability of funding and have a business model and logic that is based on external project funding. They also have the financial conditions to participate based on full cost coverage. There is also a general perception that research institutes provide an element of independence that is appropriate for major collaboration projects.

Taking all stages into consideration, public administration departments hold the role of coordinator to the least extent. Private companies are the second least common type of coordinator, although it does become more common for them to assume the role of coordinator during stage 3. This can be explained by the fact that, in stage 3, the projects focus more on commercialising their results.

Figure 10. Change in average accrued budget between stage 2 and stage 3, per type of organisation



2.7 Most of the projects state that they work actively with gender equality, but few can provide concrete examples of what this entails

CDI was one of the first programmes within Vinnova to integrate the aspect of gender equality. Since 2016, Vinnova has included gender equality aspects in their assessment criteria, and every project is followed up in the final report for stage 2 and stage 3 with regard to gender distribution in relation to the number of project participants, hours worked and decision-making positions. In a survey sent to each project at the end of the project, the projects have also answered the question of whether or not they have worked actively with gender equality in the project. A majority of the projects state in these surveys that they have worked actively with gender equality, but few are able to provide concrete examples of what they have done in this regard. This observation is in line with the results of our case studies, where it appears that the projects have primarily considered the issue of gender equality in relation to the gender distribution of the project group.

The projects within CDI have succeeded in engaging both women and men to a relatively equal extent. However, representation in the project team is not enough to satisfy a gender equality perspective. The projects state that it is difficult to take the gender equality perspective into account

in relation to the specific challenge and intended solution on which they have focused. We can note that a challenge may seem to be gender-neutral, but a more in-depth analysis can show it to entail differences of expression in relation to women and men. Furthermore, the solutions developed by the projects can result in different consequences for women and men. In some cases this is a conscious effect, while in others it is not. We feel that the projects need to give consideration to representation of different perspectives in the team and when they develop solutions together with users. They also need to consider this in the analysis of how challenges and solutions affect different groups.

The most important thing is that the projects analyse the actual challenge and the intended solution on the basis of a gender perspective. This would reduce the risk of developing skewed solutions from a gender equality perspective. The results of our case studies indicate that the projects are lacking in relation to this analysis. At the same time, we do not perceive this to be due to an unwillingness on the part of the projects, but rather that this is a complex issue and the projects are unsure how they should perform the analysis. There is not a single template that suits all challenges or solutions which the projects can use as the basis for this work. In all likelihood, the projects need more support and guidance in terms of how to perform this analysis, both when the project starts and on an ongoing basis as part of the project work.

The project **Digital and physical play environments** aimed to contribute to the integration of children's perspectives in urban development through the use of digital tools in the physical play environment, with positive health effects as a result. The project felt that the gender equality perspective needed to be integrated into the project in a better manner. The project included a gender equality analysis in play habit studies, which influenced the continued direction of the project. This also resulted in the project partners initiating a new Vinnova-funded project with particular focus on the gender equality aspect of children's play.



Figure 11. Gender distribution of project participants in decision-making positions and hours worked, CDI (18 stage 3 projects, 44 stage 2 projects)



Decision-making positions:

47% women in stage 2
42% women in stage 3



Project participants:

43% women in stage 2
46% women in stage 3



Hours worked:

43% women in stage 2
46% women in stage 3

2.8 New regulations, strong opinion in favour of new solutions and obvious needs-owners are important success factors

In the projects we have studied there are a number of recurring factors that have acted as drivers for successful project implementation. In this context we deem successful projects to be projects which have broadly succeeded in involving and engaging relevant participants, and which have an exploratory and system-oriented focus that has made it possible to adjust the direction of the project based on identified social needs. We primarily see the existence of the following success factors:

- **Strong public opinion in favour of solving the societal challenge:** For some projects, a strong level of public opinion, and subsequent pressure on the public sector to change, or business opportunities for companies, are factors that drive the implementation of the project. However, if there is no public perception that change is necessary, this will lead to a lack of engagement in the project and difficulties in recruiting project participants.

The project **SAMCITY** aimed to create a model for sustainable goods distribution and groupage solutions that meet needs for efficient transportation with low environmental impact. In the city of Malmö there wasn't any strong public opinion against the use of heavy vehicles for transport in the inner city area, which meant that there were not sufficient drivers for the establishment of the project's intended logistics solutions, for example groupage of goods. However, the participating organisations were able to continue with a similar project in Stockholm, where public opinion on this issue was stronger.



- **New regulations and requirements are drivers for change:** Just as regulations can represent an obstacle to projects, new requirements can drive organisations from different societal sectors to take the initiative and seek collaboration with other participants. New directives and regulations from the EU, or new statutory requirements, create predictable needs around which the participating contributors can collaborate.
- **The system which the project aims to impact is clearly defined and demarcated.** A societal challenge has a number of sub-causes. For some projects it is easy to define the needs-owners in relation to whom the project must impact in order to address a specific sub-cause of a larger challenge. One such example is that of Swedish regions, which represent an important target group when it comes to new solutions within healthcare. For other solutions, however, there may be a lack of obvious needs-owners and a lack of clear demarcation in relation to the participants that are intended to deliver/provide the solution. This characterises all projects that deal with challenges where the responsibility is spread among several participants, or where the challenge is, in practice, a result of several other challenges. One such example is that of projects relating to social sustainability, which stretch over several policy areas at municipal, regional and national level.

Figure 12. Primary drivers for successful project implementation



Strong opinion contributes to engagement and makes it easier to recruit the right participants



New regulations and requirements are drivers for change



A well-defined and demarcated system makes it easier to identify, in advance, the "right" participants who can drive system change

Chapter 3.

CDI has contributed to new ways of managing sub-causes of grand societal challenges at system level

This chapter describes the impact of the projects and the drivers and barriers for system impact which we have observed.



3. CDI has contributed to new ways of managing sub-causes of grand societal challenges at system level

Individual projects within CDI cannot solve complex, grand societal challenges on their own, but they can make vital contributions. In simplified terms we can describe these desirable contributions as follows:

Mobilisation:

Broad and cross-sectoral groupings must come together and reach consensus regarding potential solutions for sub-problems relating to a grand societal challenge. In this way the projects help to **mobilise relevant participants and create acceptance** of the need for new types of solutions.

Innovative capacity:

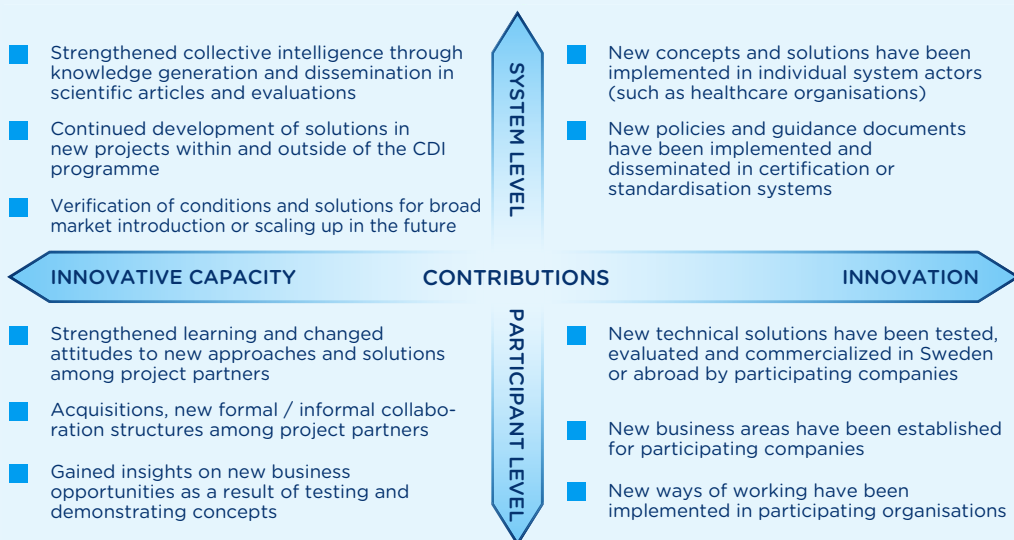
Proposed solutions must be developed and tested in collaboration projects consisting of participants such as suppliers and service providers, target groups, users and researchers. In this way the projects help to achieve **enhanced capacity** for development of the desired solution in the long term, for example through new networks and knowledge, or the demonstration of new technical applications.

Innovation:

The projects must prepare for and facilitate **widespread implementation and dissemination** of the solutions that have been developed. The solutions must contribute to the management of individual problems and challenges through the use of methods that are different to those used in the past.

The CDI projects require a system perspective, which means that the projects must involve and engage important participants who are relevant in relation to the challenge which the project aims to solve. The ambition is that the projects will contribute to system impact in contexts where changes need to be made by various participants. This is reflected in the programme logic for CDI, whereby the projects must achieve impact both in relation to the organisations that participate in the individual project (participants level), and in the system to which the project relates (system level). This impact is, in turn, divided into innovations (commercialisation or implementation of new products, services or processes) and innovative capacity (the capacity of the participants or the systems to achieve innovation in the long term) (figure 13).

Figure 13. Examples of expected types of impact from CDI projects

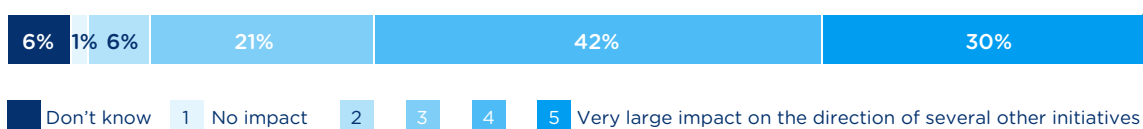


3.1 The projects succeed in mobilising participants and setting the agenda for new solutions, but the conditions are different depending on the type of societal challenge involved

Through CDI, Vinnova wants the projects to mobilise participants in relation to a societal challenge. One goal in this context is to mobilise a wide range of participants with different perspectives, who may not have collaborated with each other in the past. Another goal is to create more in-depth understanding and increased acceptance of ways in which the societal challenge can be addressed in the future. In the section below we present our perception of the programme’s contribution to the achievement of this aim.

- The projects have succeeded in creating acceptance of the need for new types of solutions to a societal challenge.** Almost all projects within CDI have succeeded in demonstrating the potential of a certain solution relating to some part of a grand societal challenge. This work takes place through broad cross-sectoral collaboration, which contributes to a more in-depth understanding of the challenge and how it can be dealt with in the future. In our follow-up survey in the autumn of 2021, 72 percent of the respondents state that their projects have to a large degree contributed to impact on the focus and design of other projects and initiatives in the area concerned.

Figure 14. Has the project contributed to impact on the focus and design of other projects and initiatives in the area concerned? (n=71)



- Many of the projects have already resulted in spin-off projects before the projects have ended.** Of the stage 3 projects, 85 percent have led to spin-off projects for the participating organisations (a total of 118 spin-off projects). Among the stage 2 projects, 64 percent have led to at least one spin-off project (a total of 64 spin-off projects). As not all projects have responded to the survey, it is likely that the total number of spin-off projects is even higher. CDI thus contributes to a large extent to the achievement of impact on the design of new initiatives concerning the societal challenges on which the projects have focused.
- The projects set the agenda for new solutions by disseminating knowledge and establishing new collaboration consortiums.** A number of projects within CDI have worked to contribute to the process of knowledge development among the actors affected by the solutions on which the projects have focused. There are a number of examples of how networks and other collaboration bodies have been established to facilitate continued joint work with the solution. In Ramboll’s follow-up survey in the autumn of 2021, the responses show that 59 percent of the projects feel that they have contributed to system impact by having an impact, to a large extent, on how society addresses the societal challenge concerned, so that the work methods now employed by participants are different to those that have traditionally been used in relation to the issue.

Figure 15. Has the project had an impact on how society now addresses the challenge compared to the work methods that have traditionally been used? (n=71)



Examples of how CDI projects have mobilised and impacted the view of the need for new solutions to a societal challenge



The project **Lead Patients** aimed to examine how the healthcare service can better and more systematically utilise and benefit from the drivers and competences that exist among active, engaged and informed patients and close relatives of patients (known as lead patients). During stage 2, the project's focus changed from establishing a competence centre for active lead patients to establishing the Lead Patient Forum – a diagnosis-independent collaboration platform for issues relating to patients and their close relatives. This change occurred after the project had carried out stakeholder mappings which showed that the project needed to elevate its goal to a higher level in order for the project to be able to generate system effects. Today, the Lead Patient Forum (Swedish name: "Forum Spetspatient") is a non-profit association that works to achieve system change within healthcare, with the perspective of patients and their close relatives in focus

The project **C/O City** aimed to develop solutions for the use of ecosystem services in urban planning and urban development. The project involved public and private actors from the community building sector in exploring the challenge and developing solutions. In order to mobilise municipalities, companies and academia in relation to the challenge, and to create interest in ecosystem services, the project linked their project to the work in the area of climate change adaptation, which at the time was highly prioritised within Sweden municipalities. The project gathered together actors with different input values and different types and levels of knowledge, which meant that a lot of time was spent on establishing a common understanding, breaking down existing perspectives and developing a common language in relation to ecosystem services.



The project **DigiPat** involved suppliers and users to develop digitalised work methods within pathology, with the aim of shortening the queues and waiting times for healthcare and improving the work involving the making of diagnoses. The project was based on a current and prioritised challenge and succeeded in increasing the level of consensus regarding the need for digital pathology among Swedish care providers and other pathology actors. The project has also contributed to the establishment of a common view that digital pathology represents the right path in order to make the field of pathology more efficient and effective. However, the actual root causes of the project, in the form of an inefficient healthcare system and long queues and waiting times in healthcare, depend on a number of other factors which exist beyond the scope of the project's focus on digital solutions.



The project **Climate-proof system solutions for urban surfaces** worked to develop solutions that would enable hard surfaces in cities to handle stormwater in the event of a cloudburst for example. From the very beginning, the project was careful to mobilise a wide range of participants from different disciplines. Through this project, new solutions have been developed that derive benefit from knowledge relating to concrete, natural stone and landscape architecture. By involving major, influential participants such as the Swedish Transport Administration and Swedish municipalities with environmental profiles, the results have achieved a high level of legitimacy. This has facilitated the continued work and mobilisation process after the project.

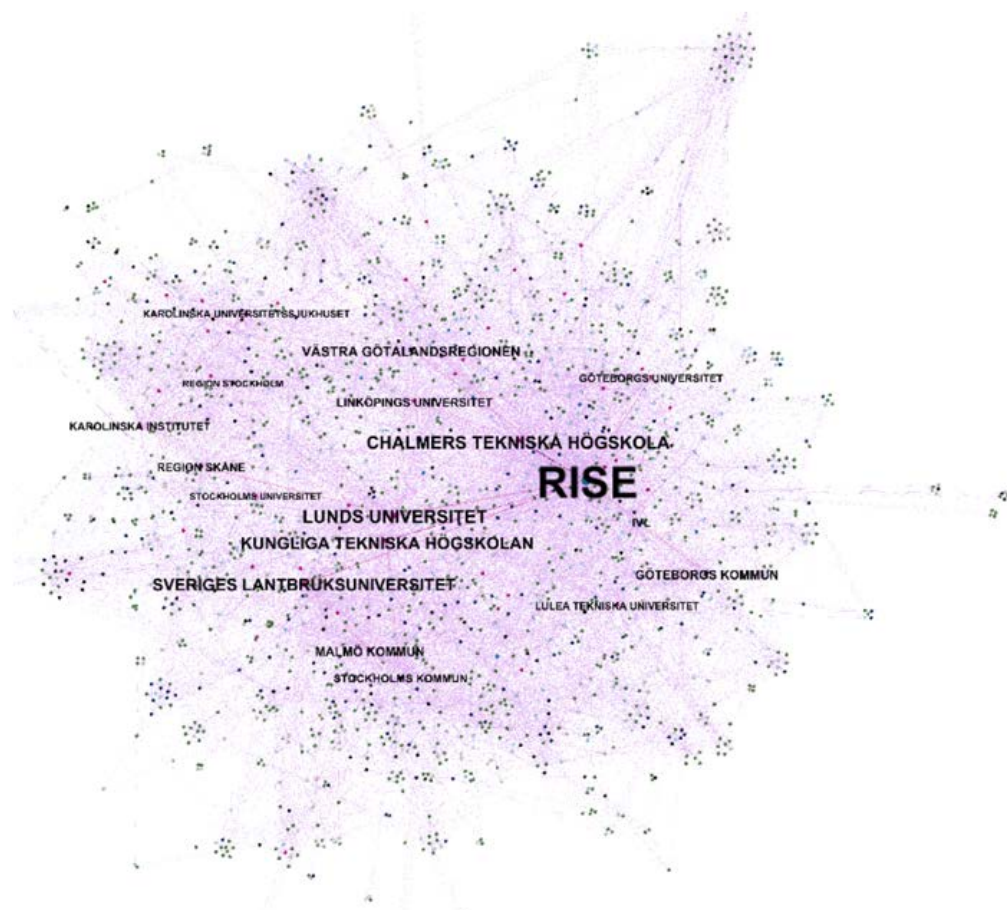


3.2 The projects have improved conditions for the implementation of future innovations by enhancing the participants' innovative capacity

In order to manage societal challenges, it is necessary to develop new solutions that replace the work methods that have contributed to the emergence and continued existence of the challenge. This requires enhanced innovative capacity in the form of new knowledge, new networks and new work methods. Based on final reports, our case studies and the survey we sent to completed projects, we see that CDI has contributed to the enhancement of the following aspects of innovative capacity.

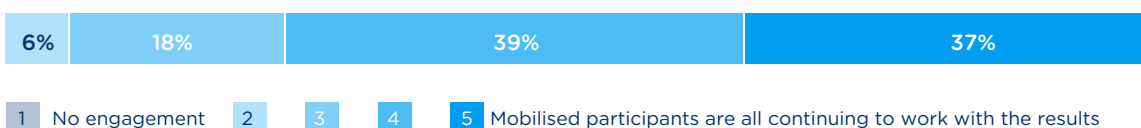
- The collaboration in the projects has contributed to an innovation system that mobilises more than 2,400 participants.** In total, 2,458 unique participants have been mobilised in the CDI projects. In their final reports, almost all stage 2 and stage 3 projects (96 percent) state that the projects have resulted in new and important forms of collaboration for the R&D and innovation activities of the organisations involved. The network of participants is characterised by different clusters of universities, public administration departments, private companies and other contributors who collaborate with each other in a number of projects within several distinct nodes. CDI has contributed to the establishment of completely new collaboration consortiums and networks, primarily for Swedish municipalities and regions (figure 18). The lines between the participants represent unique collaborations. The dots represent unique participants, and the size of the dots is determined by the number of collaborations an individual participants has had. The nature of the networks differs between different societal challenges. In terms of the number of collaborations, major companies are the most important collaboration partners when it comes to industry-related projects. Swedish regions are important key actors in projects concerning healthcare and health. Swedish municipalities are important nodes for projects relating to community building. RISE (Research Institutes of Sweden) is the participants with the greatest number of collaborations and represents an important knowledge node in CDI's overall innovation system.

Figure 16. New networks have been established to address various societal challenges



- Established networks last over time.** Ramboll’s follow-up survey of project managers from the autumn of 2021 shows that the mobilisation of participants, as described above, is something that lasts over time. Three quarters of the projects state that the project participants still have a level of engagement in continuing to work with the results after the project. This often occurs through different forms of spin-off projects.

Figure 17. Is there a continued level of engagement among those who participated in the project to continue working with the results from the project after the end of the project? (n=71)



- The projects contribute to the development and dissemination of knowledge through publications and other types of knowledge-related documents.** A large majority of the projects result in various types of publications that others can use and build on in their development work. This applies to both stage 2 projects (84 percent) and stage 3 projects (92 percent). A number of projects have resulted in different types of guides and education/training materials that are used within various organisations for training purposes as well as in education programmes at universities.
- The project participants’ innovative capacity has primarily been enhanced by giving them the opportunity to test and demonstrate new technical solutions.** The work performed in the projects is often strongly connected to a technical solution to a societal challenge. The projects primarily contribute knowledge that verifies the technical potential of the solution. At the same time, this is not sufficient for the creation and widespread implementation and dissemination of an innovation. There is also a need for knowledge regarding other aspects, such as suitable business models for the technical solution, systems for producing the solution, and the intended users’ preferences regarding the design of the solution. Over time, the projects have generally become better at exploring such aspects and thus increasingly contribute to the enhancement of the actors’ innovative capacity from a system perspective. The work has also resulted in a number of participating companies establishing new business areas, developing their business model or recruiting individuals with completely new skills and knowledge, in order to continue working with the project’s results.
- One in four projects leads to patent applications.** Around one in four stage 2 and stage 3 projects lead to applications for patents or other forms of protection of intellectual property rights. The most common type of coordinator for these projects is a university or research institute. There are also a couple of examples where the project results have contributed to the establishment of spin-off companies.



Examples of how CDI projects have contributed to the enhancement of innovative capacity

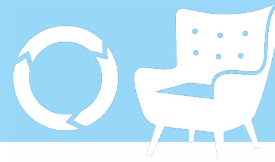
The project **DECODE** was based on the challenge of current planning processes not being sufficiently inclusive, and the risk that they could lead to urban districts with low social values and locations that aren't used or are perceived to be unsafe. In order to achieve sustainable development, the project aimed to develop an inclusive urban development process where actors with different competences, interests and time perspectives participate in the planning process. The project resulted, among other things, in several spin-off projects, a large number of research articles, a new certification system for social sustainability in the planning process, and a network for local housing markets with price levels that also suit low-income households. This network is run by private and public participants and manages, among other things, the research project Testbed SOU 2018:35, which aims to develop a calculation model for reasonably priced housing.

The project **Shared energy is double energy** aimed to create a model for a resource-efficient and circular economy. The project has, among other things, implemented a symbiosis function in city of Malmö, which provides businesses and operations with a clearer path into the municipality and acts as an arena for constructive dialogue regarding the opportunities and obstacles associated with symbiotic solutions. There is also potential to spread the concept of industrial urban symbiosis to more Swedish municipalities. After the project, a number of project participants have continued, in various contexts, to create awareness and understanding of the concept and the project's solutions.



The project **From waste to gold** focused on being able to utilise materials for value-creating production to a greater extent, instead of allowing the material to become landfill, or sending it through energy-intensive recycling/recovery processes. The project has generated new projects, assignments and initiatives. This is particularly apparent within the textile area, where RISE has created a testbed for recycling/recovery and is performing several new projects for e.g. Formas, Vinnova and Re:source. The project has involved a mixture of different industries and sectors in a common project regarding recycling, which has inspired the organisation of the CDI project Popfree, which is run by RISE and concerns highly fluorinated substances. The project has also contributed to policy development by sharing the experiences of the participating companies with the Swedish Chemicals Group, the Swedish Environmental Protection Agency and the Swedish Powder Coating Association.

The project **Innovative powder-based component technology (INNOKOMP)** has proceeded, together with three international actors, with the Vinnova-funded Go Global project INNOGLOBE. INNOGLOBE aims to enhance the capacity to offer additive manufacturing through international connection to a common open testbed. Parts of the consortium have also received funding via Horizon 2020. The project aims to develop and commission an open pilot facility that covers the entire value chain for industrial metal additive manufacturing. Parallel to INNOKOMP, a Centre for Additive Manufacture - Metal (CAM2) was also established with five research organisations and more than twenty industry partners. This competence centre uses results from INNOKOMP in various continuation projects.



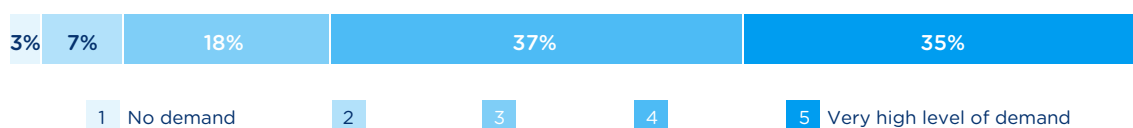
The project **Business model innovation for circular furniture flows** aimed to contribute to the transition of the furniture industry towards circularity through changed business models. Even though the project has primarily focused on business models, the project also identified at an early stage the need for the project to work with attitudes and policy in order to succeed. The project has increased the level of acceptance, interest and maturity among the participants that have participated in the project with regard to circularity as a solution for achieving sustainable consumption. Through this project, major companies and public organisations have carried out investigations and tests that have increased their knowledge of how they can procure circular furniture flows and how the Swedish Public Procurement Act (LOU) may need to be developed in order to promote circular economy. This new knowledge has resulted in procurement processes relating to recycling and reuse and new purchasing patterns, which in turn have led to a number of smaller companies being prepared to invest in the transformation of their production chain.

3.3 The projects lead to innovations to a large extent, but their impact is limited to date

In their final reports, almost all completed stage 3 projects state that the project has resulted in significantly improved products or services. More than half of the projects state that the project has resulted in new or significantly improved processes or ways of organising their own activities or the activities of others. This is a positive result, but in this context the projects do not take into account whether the innovations help to address the societal challenge in new ways, or how complex the system that surrounds the innovation is, and how difficult it is to change that system. In the section below we present our perception of the CDI projects' contribution to system innovation aimed at solving parts of a grand societal challenge.

- It is the project participants themselves who implement most of the innovations that originate from the projects, but this does not contradict the assertion that they have achieved system impact.** Overall, the projects within CDI are successful in involving system actors. A system actor is an organisation that ultimately preserves the solutions, conditions and approaches that are currently rewarded. They may be government agencies, regions, municipalities or leading/influential companies. Innovations from the CDI projects are often implemented in such organisations and therefore generate system impact, even though the solution is rarely implemented and disseminated on a widespread basis during the project period.
- The projects' system impact primarily occurs through impact on policy and not through widespread implementation and dissemination of new technology.** Our case studies indicate that the technical solutions developed in the projects are generally incremental in nature and that they have not yet achieved any system impact, even though the stage 3 projects have, on the whole, come further in terms of preparing for widespread implementation and dissemination of the solutions. Yet a majority of the projects perceive that there is currently a high or very high level of demand for the solution that has been developed (Figure 20). However, the case studies indicate that the clearest system impact actually comes from the projects' impact on policy and regulations. This may concern impact in relation to guidance documents, collaboration methods or certification and standardisation systems. New and verified technical solutions may also have an impact on the requirements included in the current regulations. For example, legislators may work on the basis of cost/benefit calculations in relation to new regulations or guidelines based on a solution that has been tested within CDI. Around half of the CDI projects state that they have impacted policy in some way.
- CDI's system impact may both increase and decrease in the long term.** Our analysis shows that the projects have developed a large number of solutions for widely differing types of challenges. In a number of cases the solutions have been patented and/or established in the market, and the projects state that there is a high level of demand for the solutions. At the same time, system change is a dynamic process, and in this context we cannot isolate individual measures or initiatives within CDI from the outside world. Insights from individual projects are carried into other development initiatives, and external events may both increase and decrease the need for the solutions that the projects have developed. At the same time, CDI shows that individual projects can make important contributions to how we view the need for new solutions and to the dissemination of the solutions.

Figure 18. Is there currently a demand for any of the solutions developed by the project? (sale/use of the product/service/work method that was developed) (n=71)



Examples of innovations to which CDI projects have contributed

The project **The Södertörn model** aimed to create models for collaboration between the business community, Swedish municipalities and academia, as well as tools for knowledge-driven and co-creative urban development, in order to create equitable, prosperous and resource-efficient urban development in the area of Södertörn. After the end of the project, the analysis tool that the project developed, The Södertörn Analysis, is being used in a number of locations in Sweden, and other Swedish municipalities have developed their own variations of the tool.



The project **Improved cancer diagnosis and pharmaceutical development** resulted, among other things, in a new company that holds a patent for new technology relating to the recreation of tumour tissue. The tool is used during evaluation of cancer diagnoses and prognoses, and as a tool for evaluating new pharmaceuticals. The project also resulted in new R&D investments by the coordinator, a large number of research articles and several spin-off projects. Several of the solutions that were developed during stage 2 have been carried forward, both in new CDI projects and as research projects with other sources of funding.



The project **Wireless coverage indoors in modern, energy-efficient buildings** focused on developing a technical solution that rectifies a lack of wireless coverage indoors in energy-efficient buildings, by creating conditions for smart homes, digital healthcare services in the home, and other important social services. The project involved collaboration between, among others, research institutes, construction and property companies, Public Housing Sweden and internet service providers, in order to develop a digital infrastructure and a business model named KO 2.0. The new business model is now being developed further by Public Housing Sweden and solves earlier problems relating to a lack of financial incentive to rectify wireless coverage issues indoors. At least one procurement process that is similar to KO 2.0 has been carried out by a municipal property company.

The project **Implementation of a solution for care of chronically ill patients in the home (the KOL Project)** aimed to develop a scalable solution for care of chronically ill patients in the home, in order to improve the efficiency of healthcare and contribute to a more equitable system of healthcare. With the diagnosis chronic obstructive pulmonary disease (abbreviated KOL in Swedish) as an example diagnosis, the project developed a technical solution for care in the home. The patient received, among other things, sensors installed in their home for the registration of health data on an ongoing basis. The patient also received the possibility of connecting to a care operator, with the operator acting as a link to the healthcare service. The solution has also been validated in a clinical trial involving around 80 patients. The solution has contributed to improved quality of life and fewer readmissions for the patients. The project has created new business opportunities for companies that undertake procurement processes regarding the provision of patient supervision (care operators) as well as companies that undertake procurement processes for the maintenance of technology that facilitates such supervision (technology operators).



The project **Tomorrow's municipal wastewater treatment** in the municipality of Simrishamn developed a technical process for improving the treatment of pharmaceutical residues in wastewater. The project succeeded in demonstrating a technical process that produced very low limit values for pharmaceutical residues, which has raised the bar for the regulations regarding treatment of pharmaceutical residues. The project has shown legislators what it is possible to do, which has the potential to impact the regulations. However, until statutory requirements on the treatment of pharmaceutical residues are introduced, it is not likely that other Swedish municipalities will follow suit, due to the high investment costs involved.

The project **Alkosensor** focused on reducing society's costs for injuries in traffic through a new form of technology for sobriety tests. The project has designed user-friendly, safe and contactless measurement methods through the use of gas sensor technology. Potential areas of application include breathalysers in vehicles and at workplaces, as well as applications regarding environmentally hazardous gases and within healthcare for example. An Alkosensor system has been marketed and is currently being used by train and bus operators in Sweden.

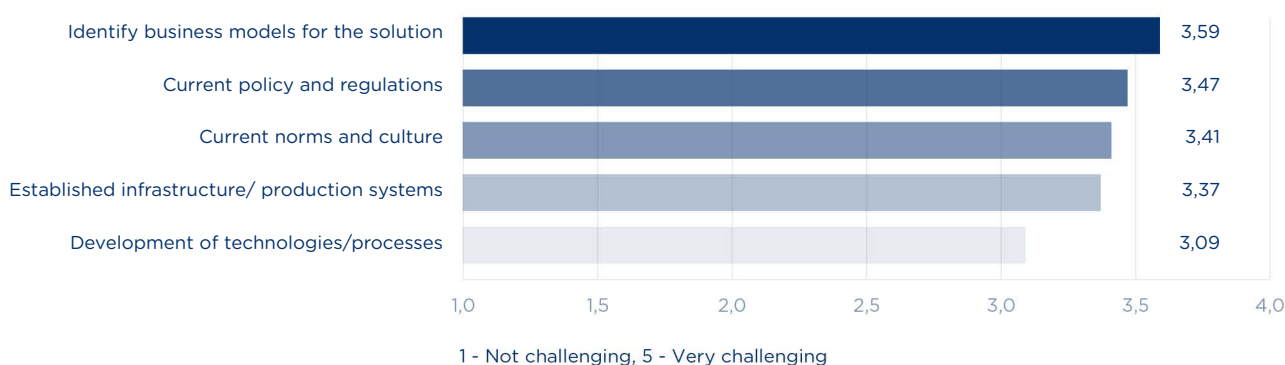
3.4 A lack of supporting business models is the greatest obstacle to the realisation of system impact

Few projects scale up or implement widespread solutions of a system-impacting nature during or directly after the project period. As a rule there is a need for more work after the end of the project in order to be able to utilise the project's solutions, maintain tempo and truly implement the solutions in society. This is in line with the programme logic for CDI and the goals set by Vinnova. At the same time, there are a number of recurring drivers and barriers which affect the conditions for achieving system impact and widespread implementation and dissemination of solutions after the end of the projects.

- A lack of business models is the greatest obstacle to widespread implementation and dissemination of the solutions that have been developed.** A common obstacle is the lack of a relevant participant who is willing to drive the process of widespread implementation and dissemination after the end of the project. This is often due to a lack of sufficient incentives for an individual organisation to do this, even if the societal need exists. When referring to business models in this context we also include internal incentive structures for the implementation of a new process in a public organisation. The lack of incentives has several causes. The solution may be complex to realise, surrounded by a great degree of uncertainty or beyond the boundaries of a company's strategic direction or a government agency's fundamental assignment and instructions. Companies may also be unwilling to develop business models in a project consortium that includes competitors. Consequently, a number of the innovations from the CDI projects that now exist in the market are related to new service offers which are based on existing business models rather than new ones.
- Policy and regulations act as both a crucial driver and barrier for widespread implementation.** Insights into the regulations that surround the proposed solution may represent such a major obstacle that the project decides to discontinue the solution. In other cases it turns out that the solution that has been developed will meet new requirements in the form of e.g. future EU directives, in which case the solution acts as a driver for widespread implementation. Often, however, the projects only identify the regulations that affect them once the projects begin to perform activities in practice and test a solution under real conditions.
- It is easier for the projects to influence the perception of the solutions that are required within clearly demarcated or changeable systems.** There are major differences in the size of the systems that need to change in order to find sub-solutions to a grand societal challenge. For some projects it only requires a few actors to change their behaviour in order for a solution to have an impact, while for other projects it is difficult to even gain an overview of how the system is structured. In certain cases the solutions require major system changes in relation to infrastructure for example, in which case major and long-term investments are needed in order to be able to develop the solution.

Our description above is reflected in the responses to the survey we sent to completed projects. Those who have responded to the survey highlight the fact that business models and policy and regulations are particularly challenging aspects in relation to the continued work. At the same time, our perception from the case studies is that the differences between the named challenges in the figure below are even greater than what the coordinators' survey responses suggest.

Figure 19. What has been/is particularly challenging in relation to the continued work aimed at solving the challenge you focused on in the project? (n=70)




Examples of external drivers and barriers for widespread implementation of the solutions developed


The project **Innovative technology for tomorrow's emergency healthcare** aimed to develop technical solutions for the exchange of real-time images and clinical data between the home or accident site and the healthcare service. The solution was intended to facilitate early assessments and reduce the strain on ambulance resources and emergency wards. However, the hardware developed by the project encountered a number of regulatory obstacles. For example, the technical infrastructure was located in Denmark, and patient data was not permitted to leave the boundaries of healthcare provider Region Skåne's firewalls. The original idea of placing a camera on the outside of ambulances was complicated by Swedish data protection regulation and the strong privacy protection that applies at the site of accidents. The project got started too late with the work of influencing the users' attitudes to the solution. The hardware that was developed in the project was discontinued after the end of the project and is no longer in use.

The project **Sustainable open solutions for the smart home** had difficulty in finding a supplier that could develop and drive the implementation of an IT platform for providing other companies with data on which they could base their services. The reason for this was a lack of a business model for the organisation that would be providing the data. The business models for these types of solutions are characterised by uncertainty and require suppliers to move away from the use of solutions provided by individual companies, and instead agree on a technical infrastructure and open up to new service providers. Also, few companies are willing to develop and manage such platform.

The project **Stadsbruk** aimed to develop a concept for cultivation close to urban areas on unused land, in order to facilitate the establishment of new companies and the creation of new jobs. The project also aimed to increase the availability of locally produced food and contribute to the development of more attractive cities. From the very beginning, the project had a clear idea regarding upscaling and dissemination of the concept. One driver for this work was to involve a consulting firm in the work relating to the municipalities' planning processes, with financial incentive to disseminate the concept to new customers. After the completion of the project, the concept is being disseminated and sold with the goal of incorporating it into the municipalities' comprehensive planning.



The project **Waste to gold** focused on creating a functional marketplace and associated business models for leftover industrial materials. However, the project identified a legislative obstacle in that companies wishing to sell leftover materials not normally included in their offer are subject to new statutory requirements that can entail higher costs. The companies also need to be able to trace the materials that have previously been used in the value chain, which also entails increased costs. It is therefore easier for the companies to simply sell the materials directly to a recycling company instead of to companies that would be able to use them immediately.



The project **BiodiverCity** developed new types of green roofing. One such example was a meadow roof, which had been tested and developed in the project and which benefits biodiversity in several ways. One challenge associated with the meadow roofs was that they lack fire classification. This entails greater risks for developers and property managers in installing meadow roofs compared to other established solutions.

The project **HASPOC** aimed to develop a standardised IT security solution for built-in systems that are based on a virtualised platform. New information security regulations represented a driver for the project, as these new regulations served to broaden the potential market for the solution developed by the project.



The project **Quiet public spaces** focused on reducing noise levels in the public environment. The project eventually arrived at the insight that there was no demand from needs-owners for the noise-reducing solutions being developed by the project. Despite existing regulations and target values regarding noise, the project felt that the issue was not prioritised by needs-owners. Lack of public opinion and a lack of knowledge about the consequences of high noise levels means that urban planning processes do not take into account the issue of noise-related problems to the extent justified by the growth of these problems.

3.5 CDI has impacted how Vinnova works with the promotion of system innovation

CDI has entailed a new way of working for Vinnova. Overall, CDI has contributed to more learning at Vinnova about how system-oriented and challenge driven innovation initiatives can and should be designed. The challenge in the future has to do with how Vinnova can best utilise and benefit from this structural capital in the agency's new organisation. Based on interviews with key individuals at Vinnova, CDI has thus far had the following types of central impact on the agency.

- **CDI has enhanced Vinnova's capacity to manage complex system perspectives.** CDI's focus on societal challenges and funding of short projects that gather together cross-sectoral consortiums and address system barriers has imposed new demands on Vinnova's project administrators. From an early stage, CDI became a form of nursery in which many new administrators were placed. As these new administrators then received responsibility for other programmes and calls for proposals, the agency's capacity to impact and work in other complex system and participant contexts was also enhanced.
- **CDI has shown the value of involving new groups of participants in order to contribute to system innovation.** Historically, most of the projects funded by Vinnova have included universities, research institutes and companies. CDI also opened up the possibility for government agencies and other parts of the public sector to apply for funding for development projects. The level of interest among these groups turned out to be high and demonstrated the added value associated with actors collaborating more broadly in projects that aim to impact established systems. This has since spread to other programmes within the agency.
- **CDI has contributed to the initiation of and has impacted a number of other programmes and initiatives.** A number of programmes and their design can be traced back to CDI. Within CDI, Vinnova observed a need to enhance the knowledge of government agencies, municipalities and parts of civil society that had not previously participated in Vinnova's programmes to any great extent. This led to the FRÖN (English: "SEED") initiative for increased innovation in publicly funded activities. CDI also contributed to the investment in Innovation platforms for sustainable and attractive cities, and its focus on challenges from a system perspective. Similar impact can be observed in relation to Vinnova's work regarding social innovations. The analysis of the stage 3 projects within CDI has also shown that factors such as regulations, rather than technology, represented barriers for widespread implementation, which led Vinnova to invest in temporary policy labs regarding various innovations. Even the work currently being undertaken in relation to the agency's mission-based focus on system demonstrators has derived lessons from the work within CDI. Furthermore, CDI has attracted a lot of attention internationally, not least within the EU. With this programme as the foundation, Vinnova has participated in international networks for the development of transformative innovation policy.
- **CDI has acted as a testbed for new work approaches at Vinnova.** CDI was the first of Vinnova's programmes to integrate aspects of gender equality, and the first in which the gender equality perspective has impacted, in a concrete manner, the formulation of the programme's calls for proposals and the programme's assessments. CDI was also the first programme that placed the SDGs in central focus. Vinnova has needed to regularly test new text formulations in its calls for proposals in order to make it easier for applicants to formulate project proposals connected to societal challenges. CDI has consistently represented an opportunity for Vinnova to experiment in relation to both major and minor aspects of the programme's design, which at a later stage has impacted the design of other initiatives.

Chapter 4.

Lessons learned regarding the design of challenge-driven innovation programmes

This chapter summarises how calls for proposals and the implementation, monitoring and follow-up of challenge-driven programmes should be designed based on lessons learned from the CDI projects included in this study.



4. Lessons learned regarding the design of challenge-driven innovation programmes

Based on our analysis of CDI, we hereby present the main lessons we have identified in relation to how challenge-driven innovation programmes should be designed. In our assessment, these lessons are relevant to the future development of CDI and other programmes and initiatives at Vinnova. These lessons should also be relevant to other organisations at municipal, regional or national level that develop challenge-driven initiatives.

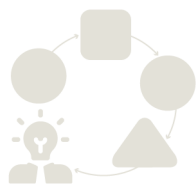


Lessons
regarding calls
for proposals

1. **Steer the direction of the projects through concrete problems (missions) that complement broad Sustainable Development Goals.** Within CDI it is difficult for the participants in the projects, and for Vinnova, to obtain an overview of the measures that are being undertaken to address a specific sub-cause of a grand societal challenge. At the same time, many of the CDI projects endeavour to change the same system. When several projects have a similar focus, it is important to ensure that they learn from each other and do not get stuck on the same types of barriers. One way of making this happen is to develop more problem-oriented and mission-based calls for proposals. This entails a process whereby concrete and targeted problems without any obvious solution are formulated as different types of measures which, together, will attempt to solve the problem during a set period of time.¹ Opportunities for the exchange of experiences and portfolio management by and between organisations that manage challenge-driven initiatives then become clearer compared to a steering of the direction of the projects that is entirely based on broad (global) sustainable development goals.²
2. **The projects should explore and describe needs before a solution is proposed.** As a rule, there is an intended recipient or purchaser of the solution developed in the projects. It could be a region, a municipal water and sewage company, a government agency or a company. The projects within CDI that succeed in creating engagement are focused on problems or challenges that are relevant to these target groups, and where there is a great need for new solutions. The projects should therefore explore their value offer and invest time, at an early stage, in understanding the need for new solutions rather than first proposing a solution and then searching for an application. This means that the programme also needs to be open to project applications in which a specific solution is not proposed in advance.
3. **Ensure engagement from several groups of participants.** CDI has clearly demonstrated that a challenge-driven approach makes it attractive for the public sector, small companies and civil society to apply to the programme. CDI also shows that there is added value associated with involving these types of participants in the development of new solutions at system level. This openness should characterise the programme when it comes to the requirements imposed by the programme in relation to the composition of the applying project consortiums as well as forms of co-funding.

1 Mazzucato, Mariana (2018). MISSIONS. *Mission-Oriented Research & Innovation in the European Union. A problemsolving approach to fuel innovation-led growth*. DG for Research and Innovation.

2 This way of thinking is also in line with the thoughts of the 2019 winner of Nobel Memorial Prize in Economic Sciences, that is about breaking down answers on how we can solve great societal challenges into manageable issues that could be answered through carefully designed experiments together with the target groups that are primarily affected. Individual experiments should in these cases be part of a larger whole where experiments create continuous learning. See for instance: Komet (2021). *Upplägg och utvärdering av regulatoriska försök. Komet kommenterar 2021:08*, published 2021-08-30.



Lessons regarding implementation

4. **The projects should focus on more than technology.** Projects that focus on how existing but unutilised technical solutions can better be utilised through changes to business models, public instruments, production systems or the attitude of different target groups to the technology, rarely exist within CDI. It is, however, likely that there is major added value to be gained from imposing a requirement on projects to explore, prior to the testing of a specific technical solution, the obstacles that may exist in relation to widespread implementation of the potential solution. There is also likely much to be gained from finding out whether other existing solutions can be implemented in new ways.
5. **Gradual funding is a clear success factor.** Our case studies of projects within CDI clearly show that the gradual (stage-based) project funding model works very well. The projects often shift focus and often change the consortium of actors between project stages. Naturally it is also possible to make such changes within the framework for a single project with a longer project period, but it is clearly easier to do so when using a model that is divided into several different stages. It is likely that this also applies to projects of smaller financial scope.
6. **Challenge-driven innovation projects do not need to cost a lot of money.** A majority of the CDI projects have a relatively large budget. At the same time, we cannot see any clear relationship between a large project budget and the social impact generated by the project. We feel that a project's costs are driven by three main factors. Firstly, it is expensive to develop new technical solutions, which is what a majority of the projects are focused on. Secondly, the project coordinator (often an institute or university) has strong incentives to maximise the project's budget, which is facilitated by putting together large consortiums to meet the funding organisation's co-funding requirement. The third factor is that costs increase when it is necessary to coordinate and administrate a project that involves many actors. We therefore feel that innovation programmes should send a signal that the implementation of the project does not necessarily need to include the development of new technology in large project consortiums.
7. **Ensure that the solutions developed can be managed after the end of the project.** One of the greatest challenges for CDI is to identify and engage the organisations that have possibilities and incentives to continue with the implementation of the solutions that have been developed in the projects. In other words, the projects must be able to answer, even at an early stage, the question of how the solution that is being developed will be managed after the end of the project.



Lessons regarding monitoring and follow-up

8. **Evaluate the activities in new ways.** The third generation innovation policy has completely different goals than earlier forms of innovation support programmes. Quantifying the number of new products, services or processes generated by these types of programmes is less relevant than before, as this does not say anything about whether or not the activities have had an impact on the factors that preserve current systems and challenges. Consequently, we cannot check whether the solution that has been developed actually contributes to changing the *status quo* and truly paves the way for new ways of dealing with a challenge. It is therefore likely that each individual activity needs to be evaluated on its own merits and viewed on the basis of the context in which it intends to achieve impact. This requires a case study-based methodology. When applying such a methodology, calculations of socio-economic effects are more interesting than effects on individual participating companies.
9. **Prioritise an active form of portfolio management.** A number of projects within CDI work with the same societal challenge. Lessons learned from these projects and from activities and initiatives outside the programme need to be compiled as a basis for targeted calls for proposals, the purpose of which is to address identified barriers or knowledge gaps. This requires an ongoing dialogue with the approved projects and with external stakeholders in order to understand needs and communicate lessons learned and impressions gained.

Chapter 5.

Conclusions

This chapter presents future-oriented conclusions from the analysis of CDI.



5. Conclusions

In this chapter we present our conclusions from our analysis of the 44 projects that we have studied during the four years we have followed CDI.

- **CDI provides unique knowledge about the potential of challenge-driven innovation programmes.** Internationally there are few programmes that fund broad collaboration projects with the aim of developing system solutions to the grand societal challenges of our time. Furthermore, few - if any - programmes have been carried out during such a long time as CDI, or to an equivalent financial extent. The analysis of CDI therefore provides a unique insight into how this type of programme works and the results that such programmes can generate.
- **CDI shows the benefit of a system perspective in relation to the development of relevant and functional solutions to societal challenges.** Vinnova has long emphasised how important it is to test new solutions under realistic conditions. CDI has clearly shown that this approach should not just be limited to the technical conditions, and that it is as least as important to explore the system of regulations, user behaviours and business models surrounding the solution. We can clearly observe that CDI creates opportunities for such learning, and that projects within CDI often arrive at this insight as the implementation of the project continues.
- **CDI has the potential to provide other types of benefits than traditional R&I programmes and should therefore be monitored and followed up with this in mind.** There is no natural connection between the pricing of an innovation and its value to society. More profitable companies or a more efficient public sector cannot be equated to a better society from a social or environmental perspective. This changes what we expect in terms of effects from a programme like CDI, compared to a traditional innovation support initiative. We therefore also need to evaluate CDI's activities in other ways than how we evaluate more traditional initiatives.
- **CDI enhances conditions for system innovation in the long term.** The projects within CDI are often based on a technical solution where intended suppliers and users participate in the development work. This work almost always increases the knowledge of barriers and opportunities for widespread implementation of the solution. The knowledge, capacity and networks that the projects help to create around a solution enhance conditions for the realisation of desired system innovations in the long term.
- **The CDI concept is fundamentally successful, but there is potential for improvement.** Although the projects within CDI focus on different challenges, they often encounter the same obstacles. Unclear or ambiguous value offers, legal barriers or the lack of an organisation that has incentives and feels a sense of ownership with regard to dissemination of the solution are all obstacles to widespread implementation which many projects have encountered. Vinnova's ideas concerning and investments in system demonstrators and policy labs are crucial components of ways to meet such obstacles, and the same applies to the specification of clearer requirements on the projects to explore these obstacles. At the same time, there is a need for clearer governance whereby new solutions are tested for concrete problems (missions) that are more demarcated than the sustainable development goals. It is our assessment that this would create better opportunities for complementary projects to address the same problems and learn from each other.

Annexe 1. Projects studied

Case studies during 2018

Completed stage 2 projects that have not applied to stage 3

- SAMCITY – Sustainable supply systems for an attractive city (2014-00726)
- Next generation test system for quicker and more reliable biological evaluation of pharmaceuticals, materials and chemicals (2014-00695)
- Data-driven Innovation Arena (2014-00807)
- The warm and clean city 2 (2014-00717)
- Elmob – electrified mobility in Gothenburg (2014-00957)
- I-Text – Intelligent use of Innovative Textiles for a healthier patient-centred hospital environment (2014-00719)

Completed stage 3 projects

- Forest methanol (2015-00416)
- ExDIN (2014-04317)
- SENSATION (2015-00451)
- Optimised flows and IT tools for digital pathology – Widespread implementation (2014-04257)
- Smedpack3 (2014-04237)
- Implementation of solution for care of chronically ill patients in the home (2015-00388)
- STREAM – The stream of information for smart, efficient automation (2014-04319)
- Facilitating sustainable production of alcohol sensors with a global decrease in alcohol-related deaths (2015-00402)
- C/O City (2015-00415)

Case studies during 2019

Completed stage 2 projects that have not applied to stage 3

- From waste to gold (2014-00904)
- FUSE – Future Industrial Services Management (2014-00814)
- HASPOC – High Assurance Security Products on COTS platforms (2014-00702)
- Cultivation under cover – Attractive and sustainable solutions for cultivation under cover (2015-00282)
- Increased participation for persons with cognitive and mental disabilities (2015-00253)
- Green IoT – an energy-efficient IoT platform for open data and sustainable development (2015-00347)
- IntegrIT – tool for patient-centred clinical research and knowledge-based care (2014-00736)

Completed stage 3 projects

- Attract (Attractive and sustainable habitats in a cold climate) (2014-04287)
- Cell Health – Implementation of structures and tools for cell therapy treatment in healthcare (2014-04280)
- Sustainable open solutions for the smart home (2014-04288)
- ItACiH – IT support for advanced cancer care in the home (2013-04876)
- Climate-proof system solutions for urban surfaces (2015-00456)
- BiodiverCity (2015-04416)
- DigiFys – Digital and physical play environments (2016-03777)
- Stadsbruk (2016-03841)
- DECODE (2016-03724)

Case studies during 2020

Completed stage 2 projects that have not applied to stage 3

- Innovative technology for tomorrow's emergency healthcare (stage 2)
- Citizen Communication Platform (2015-00305)
- ProVeg (2014-00792)
- Powder-based component technology (2017-01265)
- E-patients (2017-01221)

Completed stage 3 projects

- The Södertörn model
- Shared energy is double energy, City of Malmö
- Quiet Public Spaces
- Business model innovation for circular furniture flows
- Improved cancer diagnosis and pharmaceutical development

Case studies during 2021

Completed stage 3 projects

- Tomorrow's municipal wastewater treatment (2014-04309)
- Wireless coverage indoors (2018-00438)
- School for all from day one (2017-03740)



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