

Innovation Management of Centres for Research-Based Innovation

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Abstract: Although perspectives on innovation management have changed significantly since 1900, the capability to innovate is the most important factor in value creation (Miller, 2015). This paper focus on the innovation management of one long term R&DI project – SWIPA – of eight years. The Research Council of Norwegian (RCN) established Centres for Research-based Innovation (SFI) projects in 2005 to strengthen technology transfer, internationalisation and researcher training. Close cooperation between R&D-active companies and prominent research groups is intended to develop expertise that is important for innovation and value creation. Among the defined success criteria for centres' innovation and value creation is to develop a framework for encouraging innovation and defining, mapping and following up research results that have innovation potential. Based on Damvad Analytics (2018) evaluation of long-lasting projects, RCN currently requires that proposals clarify innovation management regarding competence, integration in the centre strategy, and collaboration. The effect of the centres' contribution to innovation can be challenging to measure and make visible. One reason is that the realisation of the innovation potential from an SFI mainly takes place by user partners and in many cases in separate projects that run in parallel with or after the SFI's lifetime. This paper uses the SWIPA centre (2021 – 2028) to illustrate innovation management activities and challenges. This paper presents established management practices and actions and use theories on knowledge management to reflect on these, e.g. a dedicated work package for innovation and technology development, roles and responsibilities related to the Centre Director and the Innovation Advisory Committee (EIAC), collaboration between work packages, involvement of partners, and creation of Key Performance Indicators.

Keywords: Innovation management, Knowledge management, Key performance indicators, Inter-organizational coordination

1. Introduction

Although perspectives on innovation management have changes significantly the last century, the capability to innovate is today the most important factor in value creation (Miller, 2015). This paper focus on the innovation management of an eight-year R&D project – SWIPA – financed by The Research Council of Norway (RCN). Such long-term centres are labelled Centres for Research-based Innovation (SFI). RCN established SFI organized projects in 2005 to strengthen technology transfer, internationalisation and researcher education. Close cooperation between R&D-active companies and prominent research groups is intended to develop expertise that is important for innovation and value creation.

Based on a literature review, Leonidou et al (2020) have studied stakeholder engagement in innovation management and entrepreneurship development. A *stakeholder* is defined as any individual or group who can affect or is affected by the accomplishment of the company's objectives. Of the fourteen stakeholder categories, the most studied category is academia, followed by government and community. Academic studies emphasize that innovation management education may prepare students to engage in innovation and entrepreneurship development. (1) *Academic scientists* contribute both to social and human capital. In developing scientific strategy, human capital may contribute with a variety of scientific expertise and knowledge of laboratory techniques. Social capital of scientists may contribute to innovation management and knowledge transformation into two scientific networks: local laboratory networks and cosmopolitan networks constituting scientific peers and expertise. (2) *Government* may enhance innovation by e.g. engagement in developing an open data policy, or policies as regards to labour and business operations. (3) The *community* stakeholders cover two sub-categories: Physical community and User community.

The SWIPA centre is heterogenous, constituting stakeholders from academia, university, government, industry, suppliers, and business. Further, Leonidou et al (2020) argue that there is a lack of research on the interrelationships between the various stakeholders and their collective impact on innovation management for entrepreneurship development.

2. Theory

The literature on innovation is extensive, complex, and based on different perspectives and approaches. Furthermore, perspectives vary depending on the management level involved, the type of innovation involved, the degree of innovation/change and desired value creation.

2.1 Definition of Innovation

Several definitions of the innovation concept exist. Later classifications of innovations are influenced by Schumpeter's work from 1939 proposing a list of five main innovation types (Rocchetta, 2024): (1) Introduction of new products; (2) Introduction of new methods for production; (3) Opening of new markets; (4) Development of new sources of supply for raw materials or other inputs; (5) Creation of new market structure in an industry.

What characterize innovations in the private and the public sector deviates. Most research on innovations is based on the Oslo Manual (OECD/ Eurostat, 2005/2018), which giving guidelines for evaluation and criteria for measurement of innovation in the business sector. Four types of **innovation results** are specified: the implementation of a new or significantly improved *product* (good or service) or *process*, a new *marketing method*, or a new *organisational method* in business practices, workplace organisation or external relations. The Oslo Manual is concerning the private sector.

However, how can innovation management facilitate achievement of results? The **innovation process** is highly variable according to industrial sector and the level of abstraction of the innovation itself (Robertson, 1974). The complexity of the new product and its technological level will determine how the innovating organisation handles the innovation. The degree of change or novelty are often used to classify three **innovation categories**: (1) *Disruptive* (ground-breaking change, brand new), (2) *Radical* (significant change) and (3) *Incremental* (gradual change).

The innovation definition used as the basis for describing the management and facilitation of innovation within Norwegian ministries are (Defi, 2018): "*New or significant changes in the organisation to improve activities and results*". Innovation results can be new or significantly changed services, products, processes or ways of organizing work, or ways to communicate with the outside world, such as service recipients, citizens and businesses. Our study is based on RCN's **definition of innovation**, which specifies potential innovation results:

Innovations are new or significantly improved goods, services, processes, organisational and governing forms or concepts that are implemented to promote value creation and/or yield benefits to society.

2.2 Innovation Management

The capability to innovate is the most important factor in value creation of an individual, an organization, a community, a region, an industry, a society and an economy (Miller, 2015). Miller argues that innovation management perspectives may be described by *four generations* with significant changes, i.e. perspectives on best practice to enable radical innovations. In the first generation (1900 – 1940) basic functional business disciplines (as marketing, finance, operations) and hierarchical business units were created. The second generation (1940 – 1975) added e.g. project management, teams, linear stage gate product development processes, and HR performance management. New information technologies (as ITC and TV) created new possibilities and enabled new management tools. In the third generation (1975 – 2000) radical innovations was thought to be radically new products, services or processes. Strategic planning developed as a new approach including e.g. scenarios, competitive strategy, technology roadmaps, lean, knowledge management, and globalization. The fourth generation (2000 -) adds more to radical innovations than prior generations, and where characteristics that transform industries and markets are new capabilities, business models and industry structures. Linear processes are replaced with nonlinear, iterative processes for creating radical innovation. While prior models presented rational and simple phases of product innovations, current theorists perceive innovation as a dynamic design and decision process, including irrational knowledge as intuition and emotional knowledge (Bratianu, 2022).

The field of innovation is multi-disciplined (economics, finance, organisational behaviour, etc.). Hence, numerous perspectives and research are related to innovation. Global trends like increased digitalization leads to increased complexity, interrelations, collaboration and communication. Innovation studies may benefit from knowledge management perspectives (Asimakou, 2009). Creation of innovations and processes that deal with coordination, dissemination, and specialization can be facilitated by socio-technical theoretical approaches (Lim, 2000). In a complex and interconnected world, it will be even more important in the future to study how networks of organisations and actors together may contribute to successful innovation processes (Stene, 2021). New business models for cooperation are developed in several innovation projects based on partnership.

Communities of Practice (CoP) are arenas for collaboration, experience sharing, learning and planning. Based on situated learning theory, CoPs emphasise that individuals learn through participating in social activities. They provide social contexts for learning and co-creating shared practices. Wenger (1998) defines CoPs as groups that

share practices, frequently communicate, and develop shared values and identities. Motivation may vary between members depending on values and sense of belonging. While CoPs traditionally met face-to-face, most interactions now occur online (Bratianu, 2022). He argues that CoPs are social practices aiming for cooperation, not competition, and where trust is the key concept of success.

Terry et al (2019) distinguish between three CoP types: (a) *Informal* groups seek to provide a forum for discussion among individuals who are interested in a topic. (b) *Supported* groups are sponsored by management and seek to build knowledge and skills for a given competency area. (c) *Structured* groups are developed and managed by an organisation to advance business strategies or goals.

2.3 Value Creation

The innovation objectives describe intended achievement or goals. A society in continuous change makes measurements challenging. For example, technological development may redefine the rules for value creation for both governance, business management, and citizens. Examples of value creation are:

- *Social impacts* – reduced poverty, security, equality, welfare distribution, increased health, etc.
- *Service* – through efficiency, quality, user satisfaction, increased usage, greater choice, etc.
- *Trust and legitimacy* – affect user satisfaction with service and the ability to achieve larger societal goals.

Value creation can be defined as successful at different levels based on goal achievement (Samset, 2003):

- *Strategically* – The total measure (actually, a package of measures) is socio-economically effective – contributes to a socially desired development over time.
- *Tactically* – The measure is purpose effective – gives rise to the greatest possible benefit for users and side effects are optimized.
- *Operationally* – The delivery is as agreed and produced in the most cost-effective way.

3. Methodology

RCN centres are dedicated, long-term initiatives designed to strengthen excellent, creative research and innovation groups or to build research groups in strategically important areas. Document analyses are used to present SWIPA structure, management and objectives, including the project description, Collaboration Agreement, work plans, MOMs, in addition to internal and external evaluations. In addition, observations and active participation in the centre have been an important basis.

The innovation measures and evaluations are developed in collaboration with centre partners and other SFIs and are based on RCN evaluations of long-term projects.

4. The SWIPA centre

SWIPA (Subsurface Well Integrity, Plugging and Abandonment) is a centre for research-based innovation (SFI) financed by The Research Council of Norway (RCN) for 2021-2028.

4.1 Objectives

The *overall objective* is to obtain a scientific understanding of permanent well barriers and allocate for improved well barrier design methodologies. The *primary objectives* are to:

- Reduce plugging and abandonment (P&A) costs by facilitating rapid deployment of well barrier establishment and P&A technologies and system solutions
- Increase value creation in the Norwegian O&G industry by implementing solutions for new P&A and sidetracks
- Create new solutions and products for storage of CO₂ and nuclear storage, and reconversion of petroleum wells

4.2 Organisation

The 35 partners represent three research institutes, two universities and industrial end users (operating petroleum companies, service companies, authorities, and international academic partners).

The Board is responsible for the scientific quality, progress of work, overall plans, address conflict resolutions, and admits new partners. It is led by industry. In addition to R&D partners and RCN, the three operational companies are represented.

The Centre management team consists of the Centre Director (employed at SINTEF), four work package (WP) leaders and two university representatives. The WP leaders work at research institutions (SINTEF, NORCE, IFE) and the universities are represented by the Norwegian universities UiS (University of Stavanger) and NTNU (Norwegian University of Science and Technology). The Centre Director is responsible for administrative, financial and legal tasks, and serves as main contact for WP leaders, educational program and SWIPA committees.

Scientific Advisory Committee shall safeguard the scientific quality and is represented by all academical partners. The committee is led by a financial industry partner.

Exploitation and Innovation Advisory Committee (EIAC) shall advise the Board on new research directions, evaluate commercial potential and identify spin-off projects. EIAC constitutes all SWIPA partners and is led by a financial industry partner. Administrative support is given by work package 4 (see Figure 1).

Technical Advisory Committees are established for and managed by each WP. The purpose is to present specific R&D topics to ensure knowledge transfer between partners and to get feedback on partner priorities. Technical Review meetings are held twice a year.

4.3 Innovation Management

A work package (WP4 “Innovations and technology management”) is dedicated to innovation management. *WP4 objectives* are to:

- Review and prioritize results and innovations toward further technology qualification, in addition to identify potential test campaigns at high technology readiness level (TRL)
- Evaluate how a potential risk-based approach to technical barriers affects the holistic risk picture including non-technical aspects such as organizational barriers
- Have close communication with national authorities as HAVTIL (Norwegian Ocean Industry Authority) and international consortiums such as Net Zero in UK
- Perform business case studies

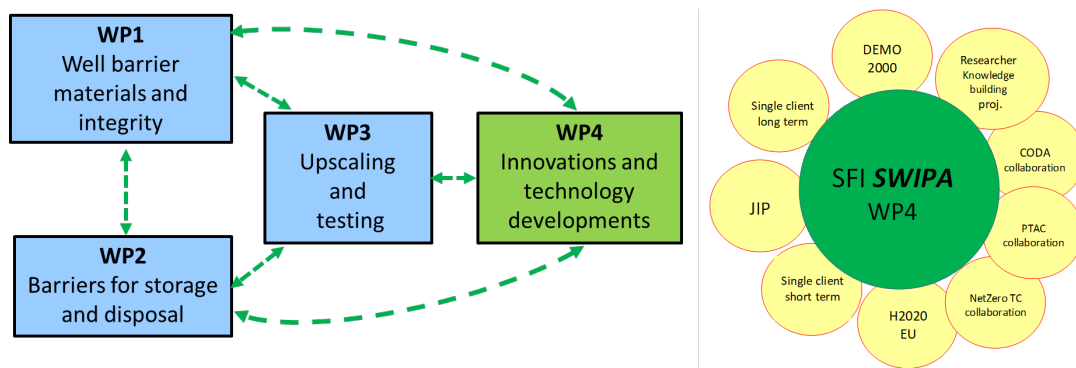


Figure 1: Collaboration between SWIPA work packages to create spin-offs

Figure 1 illustrates the collaboration between the four work packages. All contribute to create spin-offs as demos, pilots, national/international research projects or knowledge building programs.

WP4 collaborates with the innovation committee (i.e. EIAC) to review and prioritize results and innovations towards further technology qualification. WP4 acts as a secretary for the EIAC, which is led by a financial industry partner.

5. Framework Encouraging Innovation

5.1 Innovation Strategy

The first year of the centre, developing an innovation strategy was emphasized. The WP4 manager contacted another newly started long-time centre. The innovation manager of SFI Autoship had experience from prior projects, and invited innovation managers of three other centres hosted by SINTEF and NTNU. Together the five

centres created a general document “Best practice innovation strategy for a research centre”. Based on this each of the centres modified it to needs and demands of each specific centre.

The SWIPA Innovation strategy is based on the contract, project description and consortium agreement. The strategy document is dynamic, i.e. is regularly updated. The content includes definitions of key concepts, SWIPA goals and objectives, innovation management structure and processes, utilization of results, IP management and technology transfer, tools and procedures, in addition to competence building and innovation culture. Appendixes are added if necessary and includes templates for Key Performance Areas (KPA), innovation potentials of deliveries and results, and Maturity scales.

5.2 Collaboration Arenas

Some innovation management arenas include internal, academical partners collaboration, while other arena also incorporate end users. Further, most arenas are digital web meetings, and some are physical face-to-face meetings.

R&D collaboration – The Centre management team has short administrative *on-line* web meetings each month. The Centre Director defines the schedule at monthly meetings for academical partner, including WP managers and university PhD/ Postdoc supervisors.

However, *face-to-face WP4 workshops* are the most significant arena for experience transfer and reflections on value creation and potential improvements. These two-day physical internal workshops are held twice a year and involve all academical partners. Dialogue and reflections are related to specified topics. In addition, laboratories visits are arranged to get insight in research settings, artefacts, methods and results.

Collaboration with external partners – Separate Technical Review meetings for each WP are arranged twice a year. Digital EIAC (*innovation committee*) meetings are synonym with WP4 Technical review meetings, held twice a year and last 1,5 – 2 hours. The WP4 scientific team administers these meetings.

Likewise, the *scientific advisory committee meetings* are arranged twice a year as digital events. In addition, annual conferences are arranged as physical 1,5-day events. The first half day is limited to SWIPA partners, followed by lunch-to-lunch open for external organisations. Board meetings have a schedule at twice a year as physical meeting.

5.3 Topics and Processes

EIAC (Exploitation and Innovation Advisory Committee) meeting topics are related to:

- Innovation potential of deliverables and results, i.e.:
- *Single-page evaluation sheets: Academical paper evaluation of innovation potentials: (a) commercial utilisation, (b) patentability, (c) spin-offs, and (d) academic impact*
- Evaluation of achievements
- *Status SWIPA objectives*
- *Progress indicators: KPA/KPI*
- *Verification of well barrier elements*
- *Qualification process of new technology*
- *Standards and regulation – Qualification using new technology and methods*
- Learning and experience transfer from relevant centres and projects
- *How can collaboration lead to successful innovation?*
- Exploitation of results
- *How to succeed in generating spin-off projects*

Physical WP4 workshops emphasize a combination of prepared presentations and documents by each WP, discussions and reflections, and agreements on further actions and strategies. Topics include:

- Innovation strategy
- Lab and facility visits
- Communication plan
- Involvement of partners
- Regulations and standards
- Evaluation of results and deliverables

Physical Annual conferences topics are e.g.:

- Status objectives and WPs
- Innovation strategy
- Standards, regulations and verification processes
- Future P&A operation practices
- Spin-offs
- International collaboration

The day before the conference, a *networking workshop for the students* is arranged. The students present status of work, get feedback and get insight in each other's subjects, methods, results and progress plans.

Webinars have been arranged related to specific topics, i.e.:

- PhD and Postdoctoral research
- Collaboration with international partners

5.4 Key Performance Areas

Defined success criteria for innovation and value creation include to develop a framework for encouraging innovation and defining, mapping and following up research results that have innovation potential. However, an evaluation in 2018 of long-lasting projects financed by the RCN argues that the effect of the centres' contribution to innovation can be challenging to measure and make visible. One reason is that the realisation of the innovation potential from an SFI mainly takes place by user partners and in many cases in separate projects that run in parallel with or after the SFI's lifetime.

5.4.1 Result assessment

One type of **result-KPIs** (Key Performance Indicator) is related to the objectives described in the project description, including e.g. number of PhD candidates, academical papers, spin-off projects and news articles. These are regularly measured and presented at arenas open for all partners.

In addition, **innovation potentials** are noticed for each academic paper presented by PhDs, Postdoc students or R&D partner. Innovation indicators include: (a) commercialization utilization, (b) patentability, (c) spin-off projects, and (d) academic impact. The one-page template is created by the Centre Director and shall be commented on by the involved WP manager, and assessments are made available to all partners at the SharePoint site. This gives the partners an update of results, opportunity to consider what may be relevant, and a basis for utilizing the results further in new projects, demos or pilots. This may also encourage to take contact with the involved R&D partners, to utilize lab facilities, or to create new activities and projects together with some of the other industrial partners.

5.4.2 Process assessment

A project initiated by RCN challenged eight of the SFI Centre Directors to share experiences and best practices to increase the potential regarding innovation and value creation based on the R&D activities. A report from the working group were delivered in 2023, presenting recommendations on five Key Performance Areas (KPA):

1. Innovation
2. Involvement
3. Internationalisation
4. Communication
5. IP management

Based on these recommendations, the WP4 management team in 2024 created **process-KPIs** for each KPA to map the progress towards centre goals and to reflect on how to achieve intended results. KPIs are specified by reference to SWIPA documents as the project proposal and Consortium Agreement. The purpose of the KPI descriptions is to have a basis for reflections and discussions both in the management team and with all partners. In addition, the SWIPA partners should have knowledge of best practice for innovation and value creation.

Column three in Table 1 gives examples of KPI descriptions included in the five KPAs. Autumn 2024, the WP4 management team, Centre Director and EIAC leader reflected on the status. Column two presents the status marked with green, yellow or red. Green means that "Activity status is satisfying", yellow indicates "Improvement potential", and red informs about "No activity". Column four are comments on how the status

may be followed up for user partners. The results were presented at autumn 2024 at WP4 Technical Review Meeting.

Table 1: Process-KPA/KPIs status autumn 2024.

KPA (1) Innovation			
KPI	Status	Description	Folow up for user partners
Objectives and concept		Innovation Strategy established and is regularly updated	Understand partner's innovation expectations
Resources		WP4 responsible for innovation management	Involvement in R&D activities and initiatives
Culture and trust		Innovation on the agenda (all relevant joint meetings) Centre result report – Include innovation contributions	Challenge the partners to clarify their contributions to innovation and utilization of results.
KPA (2) Involvement			
KPI		Description	Status
Involvement strategy		Establish partner arenas for sharing expectations and experience Establish a reference group for each WP (include partners)	Several areas as technical review meetings, conferences, webinars. SharePoint for sharing information and documents.
Collaboration		Create partner ownership and relevance to R&D Facilitate joint publication	Contribution with materials and recommendations in projects.
KPA (3) Internationalization			
KPI		Description	Status
Internationalization strategy		Clarify internalisation expectations Estimate market and export potential Consider R&D mobility and stay abroad	Scientific committee
Documentation		Document centre activities (EU proposals, co-publication, requirement, market and export possibilities)	Dissemination of results at international conferences. Opportunities presented in related EU projects.
KPA (4) Communication			
KPI		Description	Status
Communication strategy		Define goals for communication Adjust communication plan if needed	Plan established.
Involvement		Involve partners and students	SharePoint, social media etc.
Resources		Establish dedicated personnel	OK
KPA (5) IP management			
KPI		Description	Status
IP principles		Legal settings of research results – Clarify ownership and right of use Effective and transparent IP management	See Collaboration Agreement.
Utilization plan		Establish a plan for utilization of research results	Template for registration of commercial potential. RCN emphasizes the importance of bringing results to commercial innovations.

6. Discussion

6.1 How to Support Innovation Processes?

An innovation strategy, collaboration arenas, innovation-focused processes and topics, as well as a framework for assessing both result and process KPIs, are key components of an effective innovation management system. The established system supports innovation processes in various ways by continuously monitoring and maintaining a strong focus on innovation within SWIPA.

In addition, a dedicated work package (WP4) focuses specifically on innovation and technology management. Its purpose is to follow up on the innovation strategy, evaluate outcomes and potential innovations, and identify relevant test campaigns. WP4 plays a crucial role in the research centre, as it addresses the need for expertise in innovation management and ensures that resources are allocated to maintain and develop the innovation management system. For most partners and researchers in the centre, this represents complementary expertise that enhances their scientific and technological competencies.

Coordination and collaboration are key functions in SWIPA's innovation management. From a knowledge management perspective, dialogue is essential for learning, and several arenas have been established to support this. The centre can be seen as a structured group or Community of Practice (CoP) aimed at advancing strategic goals. It is led by the Centre Director at SINTEF, in collaboration with three research institutes and two universities.

The Innovation Advisory Committee meets online twice a year. A challenge is that communication tends to be formal and one-directional, with most participants keeping their cameras off. This makes it difficult to observe reactions, gauge engagement, or invite spontaneous feedback. As a result, open reflection and discussion are hard to foster. In contrast, physical workshops enable richer communication and shared reflections on innovation opportunities and management.

The relevance of the KPI framework depends on how it is applied for assessment and continuous learning. In SWIPA, both KPIs and evaluation sheets can support innovation processes, though engaging all stakeholders remains a challenge.

6.2 Drivers and Barriers for Innovation Practice

After four years, SWIPA has been evaluated by RCN and external experts based on documents, interviews, and a partner survey. The midway evaluation highlights that success in innovation and value creation largely depends on add-on projects and partnerships. A solid framework and tools to promote innovation and track research outcomes are essential. Key measures include the dedicated innovation work package, the External Innovation Advisory Committee (EIAC), technical review meetings, conferences, and PhD development. Digital platforms like social media, webinars, and podcasts also support innovation. Additionally, risk-based R&A solutions developed in collaboration with HAVTIL may help improve regulatory frameworks. For SWIPA this means that the centre management must continue building on the established innovation management system, which supports structured work with research-based innovations.

A key challenge is that the motivation among members may vary, depending on factors such as values and sense of belonging. The centre consists of a network of heterogeneous organisations, including stakeholders from academia, industry, government and suppliers, each with different goals and reasons for participating. One barrier to collaboration is competition among in-kind partners, particularly those delivering specific service or technology to the three operating oil and gas partners. These partners may, to some extent, compete for similar contracts, which can limit collaboration.

Trust between partners is a key driver for collaboration and Mora et.al (2023) emphasise the importance of building partnership through knowledge sharing networks. Based on the arguments presented above, trust may also represent a significant barrier to collaboration. They further highlight the value of digital platforms – for example involving partners and using dashboards and visualizations to support decision making. However, it is essential that front-end interfaces are user-friendly and allow for easy interaction with the system. Drawing on experiences from SWIPA, we argue that digital platforms cannot replace physical interaction and communication, but they serve as valuable tools for dissemination and information sharing.

Furthermore, we see potential in leveraging regulations to establish clear strategic plans and vision statements that align project goals with available resources. In this context, the collaboration with HAVTIL within SWIPA

represents a valuable opportunity to stimulate innovation processes, and function as a driving force for the implementation and commercialization of new solutions in the oil and gas industry.

6.3 Evolution of Innovation Management Perspectives

Value creation by implementing solutions is one of the primary objectives of SWIPA. The focus is mainly on technological aspects of new materials and verification methods of plugging and abandonment (P&A) of subsea offshore wells. Likewise, Mora et al (2023) argue that innovation approaches solely have focused on technological aspects and linear models. Barbieri and Álvares (2016) describe the evolution of innovation management generations, where the two first models are characterised by technology-push and market demand pull. Later generations have moved to nonlinear models, characterized by dynamic interactions and feedback between R&D and market. The authors argue that the models cover management of radical innovations but should also include incremental innovations and small improvements. Further, the sixth-generation emphasizes network interaction and the innovative milieu, where important features are ease of contact and trust between partners and social, cultural and natural conditions. The last SWIPA period must face challenges related to identifying potential spin-offs and test campaigns between the many partners with deviant motivation, business models and opportunity to gain directly utility of centre results.

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