

Investments in Innovations in Finnish R&D-functions in Real Estate and Construction

Suvi Nenonen¹, Miimu Airaksinen², Terttu Vainio³,

Finnish R&D-functions in Real Estate and Construction

The roadmap for built environment 2050 indicated the significance of holistic r&d-projects as future success factor for construction and real estate industry in Finland. The research and development activities in Finnish construction and real estate sector are supported by different funding organizations, e.g. by a Finnish funding agency for technology and innovation (Tekes) and Strategic Centre for Science, Technology and Innovation (SCSTI) of built environment in Finland. This paper aims to describe the national innovation system, its focus areas and activities in the field of construction and real estate sector and provide an overview of the successful projects. The methodology is literature review and analysis of variety of evaluations.

Based on the international evaluation conducted in 2012 Tekes has performed well and is among the world's leading innovation agencies. With its activities Tekes has contributed to increasing research intensity, increased cooperation between companies and knowledge infrastructure in for Finland important areas and in this way helped build knowledge and competences to increase the international competitiveness of Finnish enterprise. Especially the activities in public sector and reduction of energy consumption of the buildings were mentioned as an achievement in public sector innovations, which are a specific form of user driven innovations. The results indicate that the construction and real estate industry have traditionally been a disjointed industry. However, joining resources through different initiatives have promoted new collaboration.

Keywords: research and development, innovation policy, construction and real estate sector

1. Introduction

The built environment is constructed and shaped to respond to the social, cultural and economic needs of people; so we can reside, work, worship, move, consume, and enjoy. The number of new building developments depends to a large extent on the social and economic circumstances, following the needs of the economy and the occupants.

¹ Research Manager; Department of Civil and Structural Engineering; Aalto University; P.O. Box 13300 FIN-00076 Aalto, Finland; suvi.nenonen@aalto.fi

² Research Professor; VTT Technical Research Centre of Finland; P.O. BOX 1000 FI-02044 VTT, Finland; miimu.airaksinen@vtt.fi

³ Senior Research Scientist; VTT Technical Research Centre of Finland; P.O. BOX 1000 FI-02044 VTT, Finland; terttu.vainio@vtt.fi

Technologies to produce and operate the built environment are mainly cross-sectorial implementations of the achievements of all sectors of the economy; this technological diffusion depends on socio-economic conditions. The development of the future building stock will vary depending on social and economic scenarios. However, one characteristic of the future built environment already in development is the increase use of embedded sensor and monitoring technologies, which will allow smart technologies to help everyday living.

Generally, construction and the real estate industry pay far too little attention to research and development, and reserve only limited funds for development projects. This is partly due to the business structure and partly due to company conservatism. Additionally, many companies are too small and do not have access to funds for research and development. More important is the fact that allocation of research projects in a company might be less effective to produce tangible outcomes than if the same effort would be put on addressing the issue of how companies can work together and share data for good results and practices.

2. Innovation Policy in Finland

Companies seek competitive success through new products or by renewing their current line – by way of innovations. The innovations are usually based on group of people having different competence areas. Innovations help companies to succeed in business, build up their competitiveness and enhance productivity. This facilitates high wages and new job creation. Innovations boost productivity in the national economy and make a high standard of living and wellbeing possible. Finland has a particularly innovation-driven economy.

Innovations do not always succeed as expected in the markets, thus there is always an economic risk associated to these activities. For this reason, companies do not invest in innovation activities as much as society would wish. Therefore, the public sector tries to motivate the private sector to engage in innovation activities through various measures such as public research funding and other incentives for private research and development activities.

In addition to financing, many factors within the business environment influence the willingness of enterprises to innovate. In Finland, these include legislation, access to international markets, and the functioning of the internal market of the European Union (EU). Such incentive schemes, and the institutions planning and implementing them, constitute the national innovation system. Finland's innovation system has been ranked among the best in the world (European Union, The Innovation Union Scoreboard, 2011).

In Finland, the Ministry of Employment and the Economy is responsible for most decisions on innovation policy, which forms the base on which the innovation system develops. The development of the innovation system itself is coordinated by the Research and Innovation Council, led by the Prime Minister. In the public sector, a number of measures are in place to encourage engagement in innovation activity. Since the public sector does not produce commercial goods, the goals of its innovation activities differ from those of the private sector.

For example, among other tasks, the public sector seeks to provide citizens with more-useful public services. However, public sector innovation activities also aim to improve productivity.

This paper aims to describe the national innovation system, its focus areas and activities in the construction and real estate sector, and to provide an overview of successful projects. The methodology is literature review and analysis of variety of evaluations of innovation policies.

3. Real Estate and Construction Sector in Finland

The total value of the Finnish national wealth was EUR675 billion (Euro (EUR), in 2011. 75 per cent is tied to the infrastructure of economic activity, housing and leisure pursuits, namely buildings, roads and networks. The infrastructure is maintained, repaired and renovated annually by a sum equivalent to about 6 per cent of its value (reference). In 2011, a total of EUR44 billion was invested in the built environment; 60 per cent in maintenance of existing buildings, constructions, traffic arteries and networks. Investment due to new construction and replacement, which is sensitive to economic fluctuations, represented only 40 per cent.

The ratio of the stable to sensitive production of the real-estate and construction sector changes with the national economy. The entire sector employs more than 500,000 people, which is more than one fifth of the Finnish workforce and accounts for a quarter of the national GDP. Its significance varies according to particular sectors of the national economy. The majority of total housing costs are in one way or another related to all sectors; construction, repair and maintenance of spaces are a significant item of expenditure in the education sector.

The volume of real estate and construction R&D is about €350 million, 70 per cent financed by private sector and 30 per cent by public sector. The most active R&D actor has been building product industry, mainly the building services industry. Recently, the planning sector has also invested in IT application development such as BIM.

The greatest challenge for the industrial society is to adapt its production and economic activities to what nature can sustain. By joining the Kyoto Protocol, Finland has committed to limiting hazardous emissions into the atmosphere. The real estate and construction sector must also take this goal seriously, as it affects over 40 per cent of the consumption of primary energy in Finland and it produces a third of the national CO₂ emissions (EU 2008).

The real estate and construction sector can use tools such as energy efficient heating, production and transportation, use of renewable energy sources, and cogeneration systems. In 2012, the new energy regulations for buildings took into force by the Ministry of the Environment. The new regulations aim to reduce 20 per cent of the energy consumption of new buildings and created a demand for renovation activities during 2013 (Finnish Ministry of Environment 2013).

The environmental impact of a building is the sum of the production process of construction materials, the land use related to the building as well as the energy needed for heating, air conditioning, supplying water and running the equipment. The public sector has invested in the reduction of detrimental environmental impacts of construction through programmes such as the Finnish Government Programme for Ecologically Sustainable Construction, approved in 1998 which was among the first of its kind in Europe (Anon, 2001).

A good living environment is healthy, safe, pleasant, stimulating, aesthetic and nature-oriented. Communities must also be competitive in order to serve as bases supporting business and industry. A living environment that meets the needs of its residents should be linked to an eco-efficient community structure with short distances for people to carry out their daily activities and is also pleasant to live in. To this end, the often dispersed community structure of Finnish urban areas can be integrated by small scale complementary building, creating additional benefits through a more independent elder population. Furthermore, the eco-awareness of consumers has increased significantly, creating a demanding client group also in the real estate and construction sector. Eco-efficiency is becoming one criterion for quality construction alongside safety, healthiness, pleasantness and durability.

The ageing gross area of approximately 550 million square metres building stock, 78,000 km of roads, 28,000 km of streets, 100,000 km of fresh water pipes, 45,000 km sewers, and other infrastructure require care and certain technical repairs become timely as a building ages. In fact, the critical age of most structures ranges between 30 (buildings) and 50 years (infrastructure sections). A large number of buildings and infrastructure parts have already reached or are about to reach this point.

The impact of the cyclical nature of new construction investments can be alleviated by timing needed repairs with periods of slow new construction. Currently, the implemented renovations do not meet the repair needs, instead, are delayed and only carried out when the damage is evident, increasing the cost of renovation activities. Pre-emptive repair work and repairs carried out at an earlier phase of the life of infrastructure would improve living conditions and work productivity.

The generalised development of information and communication technology (ICT) has made it as one of the key factors in the construction process. Information networking of projects also networks enterprises into closer co-operation excluding those companies that do not adopt the new technology as part of their business concept. Today, organisations are able to change information on a product model basis. In Finland, a key development in this area was the Vera Technology Programme that has allowed the continued translation of research outputs into practice through an open access model. Future areas of research are the utilisation of design and production information in both infrastructure, and real estate and maintenance management. The focus of the programme is currently shifting from information exchange between design and construction to information utilisation over the entire life cycle.

4. Finnish Public Innovation Investors Real Estate and Construction Sector in Finland

4.1 Tekes, Finnish Funding Agency for Technology and Innovation

Tekes supports high-quality research that generates significant commercial potential for businesses development while also promoting better competitiveness and welfare for society at large. Tekes funding is allocated to individual projects, many of them with global impact through leading research. In practice, this criterion for funding allocation translates into the need for collaboration between research institutions and the private industry. The funded research projects use the construction sector as a source for data as well as wisdom and steering for the research process, so the research outputs are relevant to the academic community and have practical implementation.

Based on the priorities outlined in its strategy, Tekes uses technology programmes to allocate funding, networking efforts and expert services to areas that are important to both business and society. Approximately half of the total funding allocated is granted to companies, universities and research institutes through technology programmes that consist of research projects and services that support business operations, such as shared visions, seminars, training programmes and international visits. (Hyytiäinen et al., 2012)

Based on an international evaluation conducted in 2012 by van der Meen et al. Tekes is among the world's leading innovation agencies, contributing to increasing research intensity, cooperation between companies, and creating new infrastructure knowledge in Finland. These activities have helped build a strong knowledge base and competences that have led to increase the international competitiveness of Finnish enterprises, particularly in building energy consumption reduction technology as a form of user driven innovations. (van der Meen et al., 2012)

The main goal of previous real estate and construction business technology programmes funded by Tekes was to identify Finnish real estate and construction cluster and to initiate a proper technology programme for each sub-cluster. The objective was to launch and reinforce R&D and innovation (R&D&I) activities in these fields, to increase the size of the technology programmes and to promote company-driven R&D&I-activities. The cluster strategy was carried out through five technology programmes during the period of 1997–2007 (Table 1) (Rajakallio et al. 2009).

Table 1. The first Tekes's R&D programmes of real estate and construction sector (Rajakallio et al. 2009).

ProBuild	1997–2001	Developing construction process
Rembrand	1999–2003	User-oriented real estate business
Infra	2001–2005	Civil engineering - construction and services
Cube	2002–2006	Technology program for building services)

Sara	2003–2007	Value-network oriented construction
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As a result, the number of new foreign investors in property markets almost quadrupled between 2002 and 2007 (moving from 7 new foreign investors to 26), although this number decreased again in 2008. This fact shows to what degree the markets develop with the support of R&D activities (Steinbock 2009).

According to the evaluation by van der Meen (2012) the R&D&I know-how and vision of the industry has increased through Tekes' programmes, by creating prerequisites for a market-led product development in the industry. The programmes have generated a new, more holistic mindset of business operations, in which value networks are taken into consideration rather than the value chain. Tekes' activities have led to a significant shift in R&D in the Finish construction industry from initiative oriented to target-oriented.

Tekes' cluster programme has also had positives effects on other development areas of the industry business environment, such as the creation of the industry glossary and concepts, and development of procurement practices and network management frameworks. As Rajakallio et al. 2009 showed, international co-operation in R&D projects has also increased due to Tekes' programmes. However, the development of industry trade practices and research culture had as a precondition the creation of a code of conduct for this line of business (Rajakallio et al., 2009). Although the strategy of Tekes included the creation of an end-user-oriented culture, the development of the housing sector and the creation of a competitive advantage through life-cycle expertise, the cluster programme had a less significant effect on these areas.

Tekes published a new strategy in 2011 which includes intelligent and smart environments among the areas of focus. This refers to the development of housing, work and leisure environments into functional, comfortable and energy-efficient entities. Priorities on this area are: Smart energy systems and sustainable material economy, safety and security of the living environment which makes good use of digital systems as well as user-oriented products, services and processes (Saarnivaara, 2011).

The latest programmes are in line with Tekes' strategy and are summarised in Table 2.

Table 2. R&D&I programs of real estate and construction cluster in Tekes in 2000's.

Name	Years	Goal
The Built Environment programme	2009-2014	The programme increases the usability and serviceability of the built environment by developing the practices of real estate and construction field. The programme focuses on renovation and refurbishment.

The Spaces and Places programme	2008-2012	The target group of the programme includes service sector players, information and communication technology companies and the construction and real estate industry. The programme encourages the participants to cooperate across sector boundaries. The user of the space is on focus, when developing new business models for developing, producing and maintaining the relevant environments.
The Sustainable community programme	2007-2012	Aims to generate renewable business activities in designing, constructing and maintaining sustainable and energy efficient areas and buildings. One core theme of the programme is a noticeable improvement in the energy efficiency of buildings and communities as well as the promotion of adopting renewable energy sources.

Roadmap of Built Environment was part of the programme activities in one of the programmes with the emphasis and future prospects of renovation, infrastructure and well-being construction in Finland. The main future challenges of the real estate and construction sector are summarised in the following list:

1. Understanding properties and buildings as service platforms
2. Need for new business models and earnings logics
3. Public sector innovation challenge
4. Urban living and emphasis on public and shared spaces
5. Multipurpose use of facilities
6. Emphasis on local services, local production and telecommuting
7. Adaptability, flexibility and individuality
8. Emphasis on lifestyles, leisure times and well-being
9. Real-time infrastructural monitoring
10. Use of wood in new constructions
11. Energy-efficiency, renovation (e.g. the life cycles of short-term suburbs) and the development of new services are important

12. Export as an important goal for the construction sector
13. Change management in construction

The Roadmap and recommendations for the Built Environment Programme in 2010–2014 are:

1. Turning the real estate and construction sector into a driver for Finnish energy and climate policy
2. Developing cross-departmental cooperation in public administration and legislative reform
3. Innovating new services for housing and combining parallel sectors
4. Increasing participation and creating open innovation platforms
5. Conducting larger projects

The roadmap highlights the need to understand properties and buildings as service platforms. This statement is a relevant guideline not only for traditional technically orientated business but also new possible actors. The role of change management is also emphasised. The vision towards 2020 is to exploit the user perspective as the main driver for businesses development. (Nenonen ed., 2011)

4.2 Strategic Center for Science, Technology and Innovation in Construction sector (RYM Ltd)

RYM Ltd was founded in 2009 as the Strategic Centre for Science, Technology and Innovation (SCSTI) of built environment in Finland. RYM Ltd is a completely new business concept in the Finnish innovation system. We define it as "Venture for Intellectual Capital". The knowledge venture company RYM Ltd. collects financing agreements during the first phase. The second phase marks the start of research programmes as "funds". Finally, the third phase presents the programmes as work packages and tasks as "spin-offs".

RYM Ltd is engaged in the production of forecasting information, acquisition and development of research funding, research programmes in selected spearhead areas, and Living Labs as test platforms for research results. In addition the aim is a networked international operation, close co-operation with other sectors Strategic Centers for Science, Technology and Innovation, as well as open, multichannel communication. The creation of a SCSTI in the real estate and construction sector (RYM Ltd) is a unique undertaking. The RYM Ltd's research strategy identifies four areas of thematic focus that will initially dominate the research agenda, these are: energy efficiency; processes and frameworks of practice; competitive social infrastructure; and user-oriented spaces Table 3 presents the on-going programmes starting after 2010.

Table 3. The programmes of Strategic Centre for Science, Technology and Innovation in the real estate and construction sector.

Program	Time	Goal	Participants and Volume
Built Environment Process Re-engineering	2010-2013	Goal is to create totally new user centred procedures and business models for the real estate, construction and infra sectors by product model-based data management over the entire life cycle.	43 participants: 37 companies and 6 research institutes, Budget of 21 million euros.
Indoor Environment program	2011-2014	The aim of the Indoor Environment research program is to find solutions that promote productivity, pleasantness and health of space users in an ecologically sustainable manner.	36 participants: 26 companies and 10 research institutes. Budget of 20 million euros.
The Energizing Urban Ecosystems program	2012-2015	Goal is to create an internationally recognized and multidisciplinary hub of excellence for urban development in Finland.	11 participants: 9 companies and 2 research institutes Budget of 20 million euros.

In December 2012, RYM Ltd had 53 shareholders. RYM Ltd directs funds and expertise from both private companies and public financiers of innovation in areas of research that are deemed as most significant for international competitiveness. Joint strategic leading-edge research will generate superior world-class expertise over the entire life span of the built environment. This offers real estate and construction sector companies, research institutes and universities a novel way of engaging in close, well planned and ambitious co-operation to develop and bolster cutting-edge expertise. The evaluation of the Strategic Centers for Science, Technology and Innovation was conducted in 2012. Investigations (Lähteenmäki-Smith, 2013) indicated that RYM programmes enable true company-research cooperation that goes beyond meeting discussion and seminar talks. It also forces companies to make long-term commitment and to introduce long-term actions. Requirement for significant resources and efforts by companies is seen as positive and it has enforced companies strategic role.

4.3 Other actors

The Academy of Finland provides funding for scientific research of the highest quality. The academy now provides funding for housing research. Due to the social significance and impact of living and housing, this sector must be understood to a greater depth than the

building construction and settlement of large communities. Changes in family and age structures, in lifestyles and the workplace as well as energy issues and the challenges of sustainable development have created new areas of focus within the living and housing sector. The multidisciplinary programme approaches housing from the resident's point of view as an entity that comprises environmental issues from sustainable development to land use, logistics and services, as well as consumer issues from cultural needs through to health issues. This research concerns a range of social and physical spaces as well as virtual environments. Requirements of accessibility, sustainability and versatility have gained increasing prominence in relation to living and housing. Further research is also needed in the field of land use, other environmental aspects of housing as well as housing renovation and repairs. However, despite their prominence and relevance, housing issues have received only modest basic research attention in Finland when compared to many other European countries.

Between 1995 and 1998, the Academy of Finland carried out the EKORA Research Programme for Ecological Construction, and, between 1998 and 2001, the Urban Studies Research Programme in a joint effort with other funding bodies. Funding was also directed towards the Spaces of Nature and Culture Research Programme from 2001 to 2004. (Anon., 2011)

Another important actor, which has been active in research activities concerning sustainable development, is Sitra, the Finnish Innovation Fund. This organisation has the duty to promote stable and balanced development in Finland, the growth of its economy and its international competitiveness and co-operation. They have e.g. carried out the Energy Programme with several practical projects that proved that the use of energy by communities and the people, as well as their greenhouse emissions, could be significantly decreased. Through good examples and influencing regulations the programme can help return Finland back to the top in energy efficiency. Energy efficiency of the built environment plays a crucial role in the reduction of emissions. In addition to energy efficiency, people's lifestyle is an important factor. Therefore, the programme aims to create the preconditions and structures that enable people to make low-carbon choices. (Anon., 2012).

5. Conclusion

The research and development in the construction sector has undergone a transformation from a single product and a single research discipline to a wider scope and cross discipline research area. The general trend in the construction sector is to act as integrators of products/services to benefit the industry and its end user. The social/people dimension at a large scale was lagging behind until the year 2000, albeit it has been hidden under many research topics. Nevertheless, the social dimension is currently seen as an essential theme in the construction sector due to the importance of users and their engagement in the process and end-product/service design.

Climate change and lack of resources have been well-known research topics since the 1970's oil crisis; including energy efficiency and energy saving. The new topics of low carbon, low energy and zero energy buildings, highlight a more holistic approach where

buildings are seen as a part of energy systems and sustainable development. The second R&D wave in wood construction is also booming today. Kajander et al. (2011) conducted a study about Challenges for Sustainability Innovations in real estate and construction Industry. Key challenges identified include: the complexity of the industry value network; team building; R&D-intensity; and commercialization management. In addition, their findings suggest that sustainability business innovation in this industry is constrained by project business orientation in REC industry, fundraising and internationalization issues, and lack of regulation and standards.

Interdisciplinary approaches in research have been increasingly acknowledged in the construction and real estate industries. However, methods of interdisciplinary collaboration have not been systematically analysed yet. An interdisciplinary field crosses traditional boundaries between academic disciplines. The investigations in interdisciplinary research in general indicate that the disciplinary boundaries are most thoroughly transcended when members of disparate fields develop a common language that facilitates a shared conceptual framework. This level of collaboration has the greatest potential for originality. However, it is seldom observed due to the challenges associated to the development of a common language. A challenge in interdisciplinary research is to manage both the collaboration within academia and with the industry. Furthermore, the interpretation of the research outcomes might hinder its impact due to the articulation and interpretation of findings from a mono disciplinary perspective by the industry. The research process varies depending on the approach taken. It is always demanding to collaborate with representatives from a variety of disciplines due to the obvious risk of being considered weak or fragmented due to lack of academic rigor. One major challenge is therefore to design the research in such a way that a common language can be found. The common goal has to be shared but the ways to achieve it can be designed differently depending on the relevance of conduct the research in a multi-, inter- or trans disciplinary way (Nenonen and Lindahl, 2012).

Infrastructure research and development in Finland is well established. The challenge is to translate this innovation into the field of practice, which traditionally is not research orientated. New initiatives that support the leading role of companies through innovation policy can create new ways to apply research into practice and to generate collaboration between academia and industry. The construction and real estate industry have traditionally been a disjointed industry. However, joining resources through different initiatives have promoted new collaboration.

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