Smart Built Environment

Processes and information management in construction and facility management

Index

Introduction

Attractive sustainable cities, a robust and reliable infrastructure and more housing are some of Sweden's policy objectives. These are considered essential prerequisites for growth, employment and competitiveness, hence built environment is a central political issue.

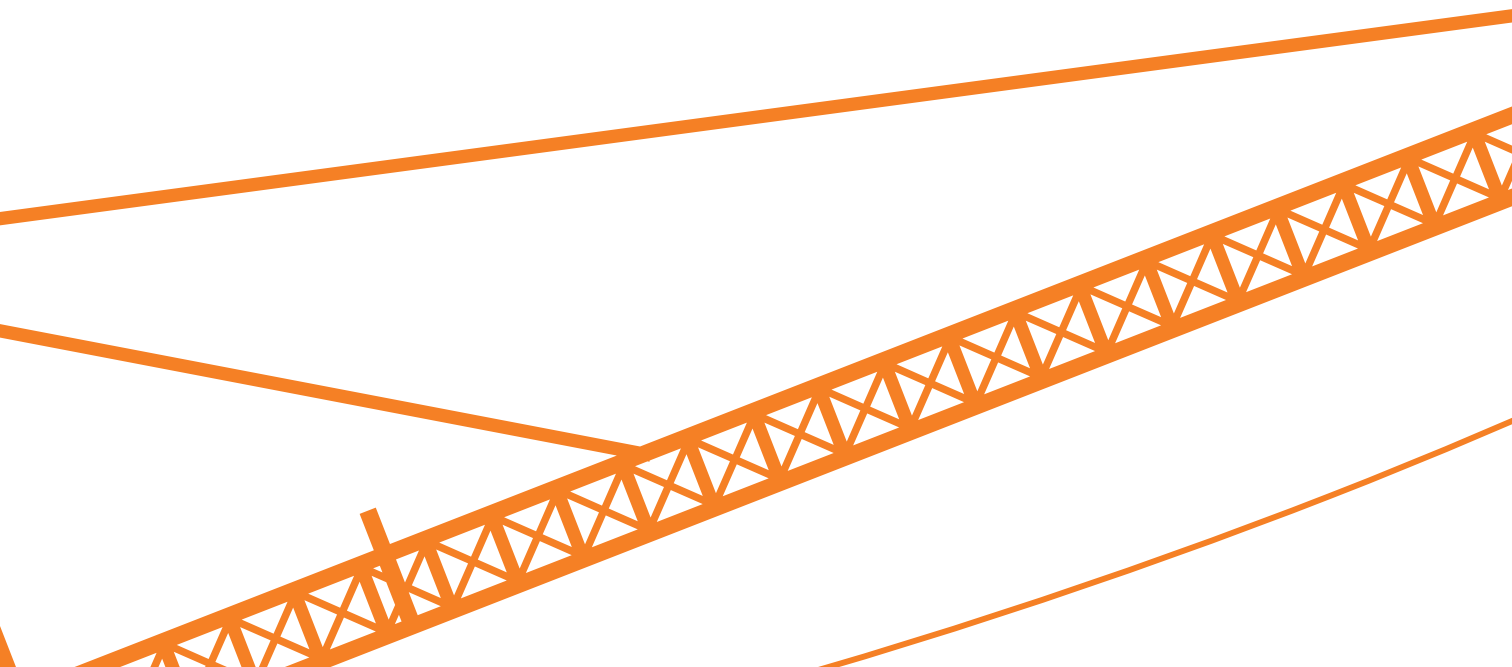
Exactly what will be built – or renovated and rebuilt – is obviously the critical question; city squares, residential housing, schools, hospitals, offices, shops, roads, railways, bridges, industrial premises, playgrounds, cycle paths, parks – their form, design and placement in the surrounding environment are all crucial to how well they can function. There is enormous potential in the extensive field of built environment to consolidate Swedish strengths while meeting the challenges of society and the needs of the public.

However, there is also clearly a need for strategic initiatives that concern both what will be built and how this takes place, in other words both products and processes. In order to release sufficient resources to develop the products, it is essential to streamline and modernize the processes as well. This applies to processes in the state, municipal and private sectors, which are mutually interdependent.

This Strategic Research Agenda (SRA), Smart Built Environment, has been developed through broad and deep collaboration between stakeholders in the built environment sector, and focuses on some of the central issues concerning how processes and tools in the built environment sector need to be developed. It proposes a comprehensive approach to these changes and to the modernization of mindset, procedures and the application of digital, structured and intelligent information. Consensus on this issue is unprecedented in Sweden. Among other things, its aim is to increase productivity while providing better endproducts in the form of the facilities and environments mentioned above.

The Smart Built Environment agenda comprises initiatives in the planning, design, construction and management phases. These complement the wide range of ongoing government activities to streamline planning and construction processes at state and municipal level. The actions contained in this agenda at corporate and industry level is part of a paradigm shift in the sector and represent one of several prerequisites for achieving targets in housing, infrastructure and urban development. The government is investing SEK 45 billion in infrastructure, which places very high demands on the efficiency of the processes applied to accomplish the desired results. However, there are needs for several other areas of development in the wide Built Envioronment sector, and we welcome more initiatives for strategic agendas to complement the important area that is covered of this agenda.

Major synergies exist with 1) the government's investments in sustainable built environment as a new investment of particular importance in the Research and



Innovation Bill; 2) Bygginnovationen; 3) the fledgling collaboration programme between the Swedish Energy Agency (Energimyndigheten) and the industry to promote research and innovation in energy efficiency in construction and housing; 4) academic collaboration at the Swedish Universities of the Built Environment (Sveriges Bygguniversitet), and 5) the industry association BIM Alliance (former OpenBIM).

IQ Samhällsbyggnad, the Swedish Centre for Innovation and Quality in the Built Environment, is the sector organization responsible for overall R&I work and has co-ordinated the development and national consensus for this Strategic Research Agenda.

About this Strategic Research Agenda

This SRA is a nationally established strategic research and innovation agenda in the field of structured information management and industrial processes in the construction and property sector. It encompasses both buildings and infrastructure, in the document entitled "Built-Environment Sector". The term "structured information management" has been used as a catch-all for building information modelling (BIM) and geographic information systems (GIS).

The agenda is the result of a merger of several agenda initiatives that have been integrated because they were shown to have general synergies and numerous are cases interdependent. It is primarily based on the two agendas entitled "ICT BIM for Sustainability in the Built Environment", which includes the agenda work on geodata by the National Land Survey, (Lantmäteriet), and "Industrial Processes for Construction and Facility Management". Both have already been presented to VINNOVA.

The Smart Built Environment was developed on the initiative of IQ Samhällsbyggnad and Sveriges Bygguniversitet, in close collaboration with Lantmäteriet, as well as the OpenBIM and Bygginnovationen organizations. IQ Samhällsbyggnad is a cross-sectoral organization with approximately 120 members from companies, organizations, authorities and academia. Sveriges Bygguniversitet is a virtual collaboration between the four universities of technology in Sweden, KTH, LTH, LTU and Chalmers, the aim of which is to co-ordinate and strengthen research and education in built environment issues.

1. Built Environment – an engine in Swedish trade and industry

According to the Swedish Construction Federation (Sveriges Byggindustrier), in recent years the construction industry in Sweden has had an annual turnover of SEK 500 billion and the value of the property stock is estimated at over SEK 6,000 billion. In addition, the value of infrastructure such as roads, bridges, railways, ports and airports etc. can be added to this figure. In total, built environment accounts for about half of the national wealth of Sweden. In 2012, the construction industry employed approximately 312,000 people and construction investments amounted to SEK 309 billion, equivalent to nine percent of the Swedish GDP. The entire built-environment sector employs about 500,000 people, eleven percent of the total workforce. The sector includes companies operating in the construction industry, facility management and the building materials industry, as well architectural firms and engineering consultancies.

The cornerstone of this agenda has been the efficiency and success of Sweden's built-environment sector from an international perspective, but it could be much better! The Agenda describes a Swedish area of strength where we are currently in the top ten countries in the world. By developing and implementing more efficient information management systems and efficient processes, we can create new international business models for growth.

"Closer collaboration with customers, project clients and facility managers"

From fragmentation to an overall focus

There are numerous strengths in the sector – a highly skilled workforce, internationally competitive companies, technically advanced, sustainable materials and products, leading-edge methods, and an understanding and utilization of information technology and industrial processes. The new technologies and procedures are already in use to certain extent, and new construction processes have been partly applied, but the potential is frequently only exploited in individual sub-processes with sub-optimized benefits. The built environment sector is fragmented with all stakeholders operating inside their traditional comfort zone with limited deliveries. A holistic approach is frequently lacking.

With information management and industrial processes as cornerstones, the sector can realign the focus of its projects. This is currently taking place through minor daily changes and developments, but the use of the new technology with its new processes, tools and approaches will require jointly targeted actions to bring about major changes. Closer collaboration with customers, project clients and facility managers needs to be emphasized. In order to achieve structural changes, short-term development projects related to innovation and implementation in small steps are necessary, as well as long-term initiatives and implementation on a major scale. Accordingly we can create the prerequisites that will enable us to abandon ingrained habits and embrace learning organizations. With this agenda, we are aiming to adopt a holistic approach that will ensure seamless information chains and enable the full potential of an industrial approach through active collaboration with the lessons learned in other sectors.

Major advances have taken place in recent years both in BIM-GIS and by exploiting new processes in companies within the sector. Cross-sectoral consensus on shared issues has been achieved with, for example, the establishment of IQ Samhällsbyggnad, OpenBIM and Lean Forum Bygg. Sector stakeholders have good experience of individual investments in major R&D programmes such as "Väg, Bro, Tunnel" (Road Bridge Tunnel), indoor construction environments, LWE (Lean Wood Engineering) and Bygginnovationen. Based on the lessons learned from these programmes, the time is right and the sector is ripe for a joint initiative, with a holistic approach.

More value and better use of public money

The built environment sector is the single largest industry in the country and it impacts the lives of the entire population. An efficient built-environment sector is the

backbone of prosperity and sustainable development for individual housing, work, travel and leisure. We already have a transport infrastructure that facilitates exports, we enjoy a high standard of housing and occupational environment, we have effective facilities for education and health care, and we have an efficient infrastructure for the supply of energy and water. Moreover – by international standards – the impact of our emissions on the environment is relatively small. But we can increase the benefits!

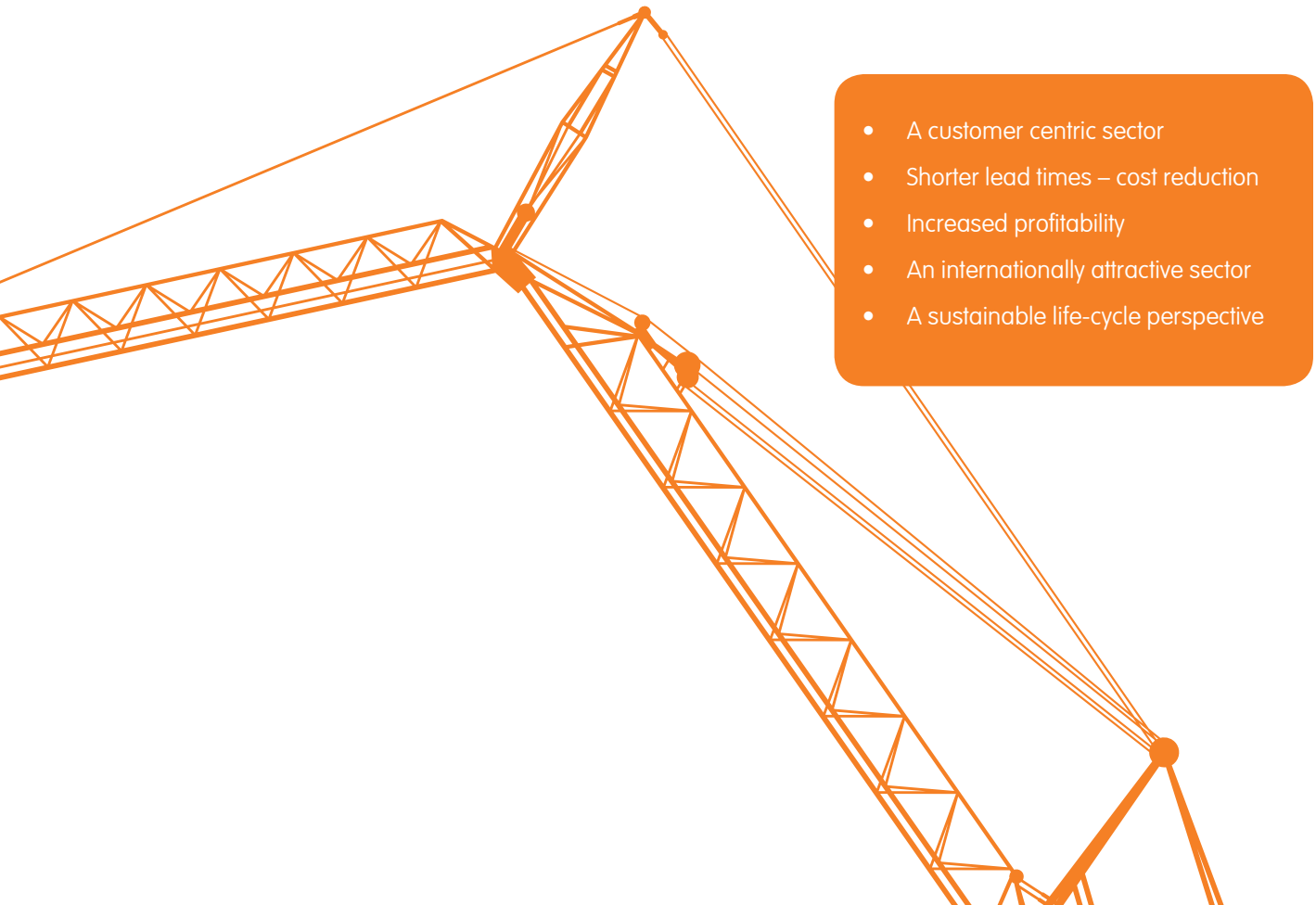
Shorter lead times – lower housing and infrastructure costs

"We can cut lead times in half!"

The average duration of a residential construction project from concept to occupancy is currently estimated at eight years, and it takes an average of nine years to plan a major infrastructure project. These lead times need to be reduced! This can be achieved by simultaneously increasing the quality of democratic processes by greater transparency and the involvement of neighbours and other interested parties. We can cut lead times in half! This will result in cost reductions, more housing for young people and a robust infrastructure for transportation and travel.

Enhanced productivity – strong growth and demand

In comparison with every other sector both nationally and internationally, productivity in the built-environment sector has long been neglected. The reasons are numerous, but many of them can be attributed to disjointed project processes with partial deliveries and a lack of accountability, as well as the lack of customer focus. By exposing the finished product to competition rather than the process sub-steps, we can optimize at the product level rather than at the project level. Through structured information models and an industrial approach to processes, in addition to continuous



- A customer centric sector
- Shorter lead times – cost reduction
- Increased profitability
- An internationally attractive sector
- A sustainable life-cycle perspective

measurements and benchmarking against other industries, we can create instructive and efficient organizations that will boost productivity in the sector. This will lead to an increase in investment and construction that is in balance with demand, as well as a much higher level of competition and exports of both products and skills.

An attractive sector – in which to work and invest

We can create a platform for international and Swedish companies looking to invest in Sweden. The prerequisites already exist among contractors, consultans and materials industry in a number of international companies that operate in Sweden. Within the scope of this agenda, there will also be a basis for entirely new activities that challenge traditional roles, and thereby provide significant opportunities for investors.

> "We can create a platform for international and Swedish companies looking to invest in Sweden"

In addition, there is also an interest base in the agenda for new investors through its links to geographical data, measurements and laser scanning, the Internet of Things, to name a few areas in which major international companies operate.

The children of today can handle smart phones and tablets in a way that barely seemed possible just a few years ago. No later than ten years from now, we need to have engaged young people to such an extent that they will consider a career in the built-environment sector. To attract the best talent, we must already show at primary school level that we are an attractive sector to aim for and work in. In order for our companies to attract the best people going forward, we need to offer approaches that are already standard practice in many industries. The built-environment sector needs to catch up and often take the lead.

2. Future construction and facility management

The built environment sector is facing major restructuring. Internationalization is increasing and previous project-based processes are changing. In terms of expertise, Sweden has unique opportunities to take a leading role in creating sustainable built environment and to export business models based on user-driven processes with customer focus. Currently, we have common structures for construction and property management, and we understand how digital information management (BIM and GIS) and industrial processes interact. Thanks to corporate initiatives and the unique ability of academia to integrate areas of knowledge from a research perspective, we also have the experience upon which to build.

"The potential to make this sector more efficient is huge"

The potential to make this sector more efficient is huge. Visualizations and modern technology are a strong support in highlighting shared visions. Risk analysis through simulations and the optimization of various scenarios are a valuable aid to long-term sustainability. This industrial strategy can create resource efficiency while maintaining and increasing the diversity of solutions.

A holistic approach through structured information management and industrial processes

The built-environment sector is characterized by sub-optimization with a large number of stakeholders whose work is primarily conducted on a project basis. Both the operational and facility management phases are information intensive, which requires a seamless flow of information. A fragmented construction process hampers the development of robust products and consensus among stakeholders on common long-term goals. A more sustainable built environment requires effective collaboration between stakeholders to achieve integrated system solutions in which the focus on individual construction projects is switched to investments that can be spread across multiple projects.

We are currently facing a range of social challenges such as sustainable growth, adapting to climate change, increasing urbanization and an ageing population. In combination with low construction activity and a growing housing shortage, there is a strong demand for increased produc-

The built environment sector

Total turnover annually: > sek 500 billion

Total workforce: > 500 000 employees

Total numbers of companies: > 75 000

Sources:
Swedish Construction federation
Statistics Sweden

tivity. The housing shortage is rapidly approaching the situation that existed before the investments of the record years. Facility managers and end users are also demanding lower costs and flexible, efficient products for intelligent facility management, such as housing and facilities equipped with sensors for life-cycle assessment and IT integration in domestic environments. Through structured information management and industrial processes, the industry can adopt the necessary holistic approach.

What is BIM?

Structured digital information management, known by the catch-all term BIM, can be defined both as a technology and as a method applied to create, communicate and analyse building information models. These models are composed of digital objects that represent facilities and infrastructure units as well as adjacent spaces, structural elements and components. The digital objects incorporate data that details all the relevant characteristics necessary to perform extensive monitoring, analysis and simulations of functions and processes during the facility's life cycle.

BIM involves analysis of factors such as material strength, power consumption, noise, indoor air quality, constructability, occupational health and safety, accessibility, architectural design, cost, time and resource planning, supply chain management, operational optimization and use of space. In other words, it concerns all the information that will be used at different stages in a facility's life cycle and above all it involves simulating and optimizing many of these factors simultaneously from a long-term perspective.

BIM entails the utilization of information in a systematic manner, with consistent three-dimensional designs and explicit classification of information concerning the facilities, thereby facilitating all the possibilities that the technology provides in relation to the above examples. BIM applications are usually divided into three main stages; 1) Three-dimensional models for visualization and interaction; 2) Integrated analysis; 3) Automation linked to industrial processes.

What are industrial processes?

By industrial processes we mean that the processes are standardized and that platforms, products and information support are disconnected from construction projects and property management, and are developed independently from a life-cycle, sustainability and customer perspective, then applied during construction and facility management. The recurring activities of construction and facility management are standardized, and the best overall solutions, such as inputs, subsystems and complete modules, are developed as separate platforms. Platforms and products are then offered in specific market niches. Development is conducted between construction projects and outside current facility management, which provides lessons learned for further optimization with a focus on user values, as well as a focus on the operation and maintenance of structures. The structured lessons-learned process involves the gradual elimination of resource wastage, while business benefits are maintained. This enables the creation of learning organizations.

"This enables the creation of learning organizations"

How do BIM and industrial processes interact?

BIM and industrial processes represent two inter-connected resolution mechanisms that address structural problems within the industry. BIM support is a prerequisite for successful business models in construction and facility management. During the past decade, construction firms have increasingly switched from traditional project management to platforms with standardized products and processes facilitated by BIM and PLM-systems (Product Lifecycle Management Systems), but with consistently high flexibility (mass customization). In order to achieve full implementation and profitable industrial platforms, BIM must simultaneously be advanced to a level in which full automation with configuration and parameterization seamlessly manages information for facility managers that has been acquired during earlier stages.

"We need to create incentives for new business models"

The business models must progress from the current focus on standard contracts, in which suppliers and consultants are procured for individual projects, to business models based on platforms such as service agreements and long-term collaboration in product development. Developing industrial platforms and basing these on current business models will not lead to innovation and development. In the same way, the third development phase in BIM (automation) is based upon the existence of product platforms and continuous improvements rather than individual projects as is the case in construction today. Fully implemented BIM requires structured construction processes in which the interfaces are standardized, not the final product.

The industrial thinking in the construction industry regarding modularization and operational optimization goes hand in hand with the configuration and parameterization in BIM. However, restructuring requires leadership, new skills as well as procedural and organizational changes throughout the sys-

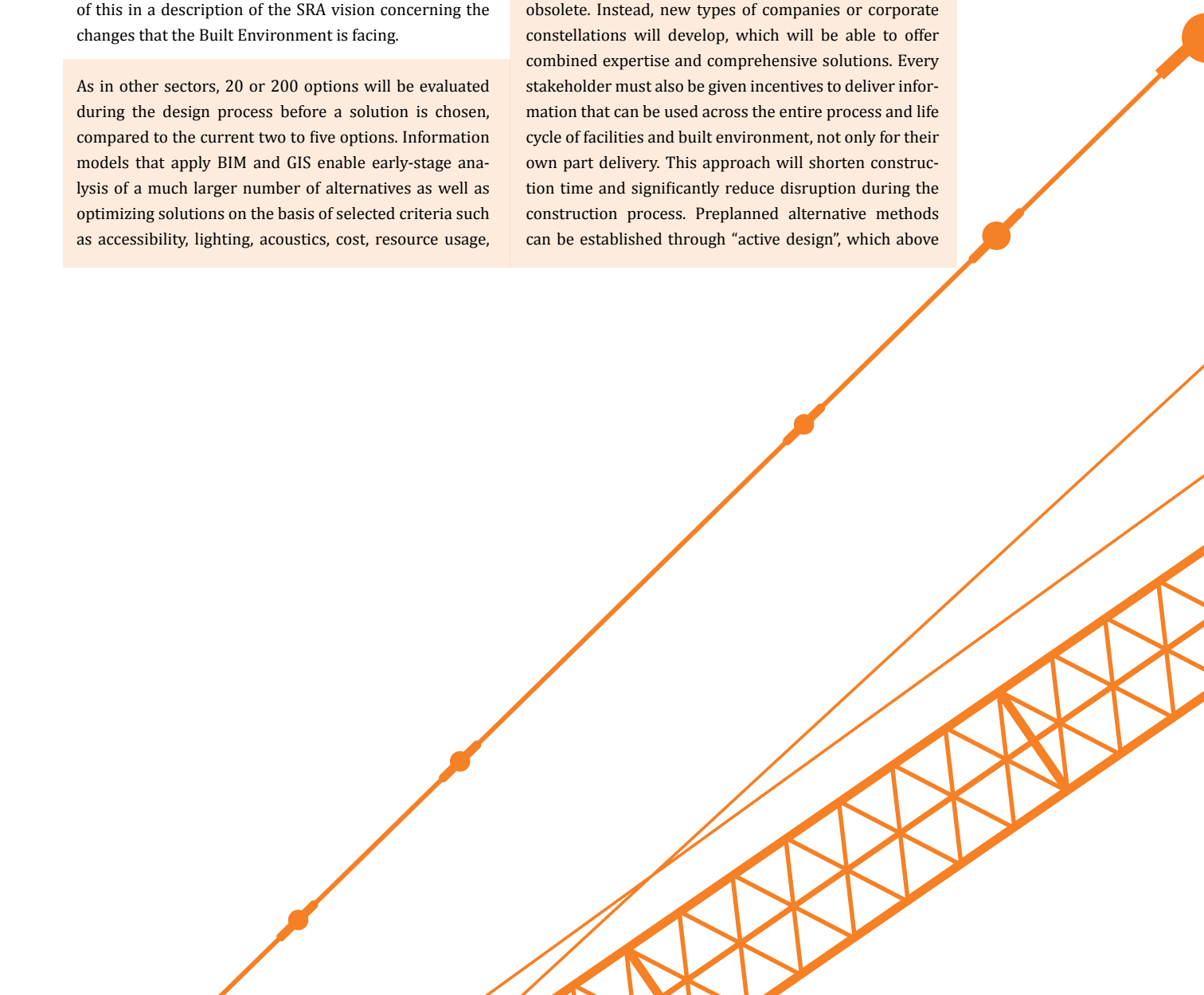
tem, from the politics to the construction. We must have access to accurate and available information across all phases through seamless information flows, while applying a serial approach instead of considering individual building and construction projects. We need to create incentives for new business models and production systems and take lessons learned and inspiration from other industries.

New value chains and future added value

Our vision involves dismantling the currently extremely fragmented processes, with suboptimal partial deliveries, and creating new roles and new value chains with other services and products. The following are some examples of this in a description of the SRA vision concerning the changes that the Built Environment is facing.

As in other sectors, 20 or 200 options will be evaluated during the design process before a solution is chosen, compared to the current two to five options. Information models that apply BIM and GIS enable early-stage analysis of a much larger number of alternatives as well as optimizing solutions on the basis of selected criteria such as accessibility, lighting, acoustics, cost, resource usage, energy efficiency, logistics, operational aspects and occupational environment. The correct criteria must also be established through structured awareness of user needs and requirements across the life cycle. This also enables considerable opportunities to create a decision support for better end products. At the same time, it means that many more specialists will be involved at an early stage and participate in the new iterative processes during which product development takes place. Moreover, the design process will also take place on platforms, separately from the projects, with effective solutions that can be adapted and configured for individual projects.

The relay race process, in which one specialist hands over to another, who continues the work with a resulting loss of information and holistic perspective, will become obsolete. Instead, new types of companies or corporate constellations will develop, which will be able to offer combined expertise and comprehensive solutions. Every stakeholder must also be given incentives to deliver information that can be used across the entire process and life cycle of facilities and built environment, not only for their own part delivery. This approach will shorten construction time and significantly reduce disruption during the construction process. Preplanned alternative methods can be established through “active design”, which above



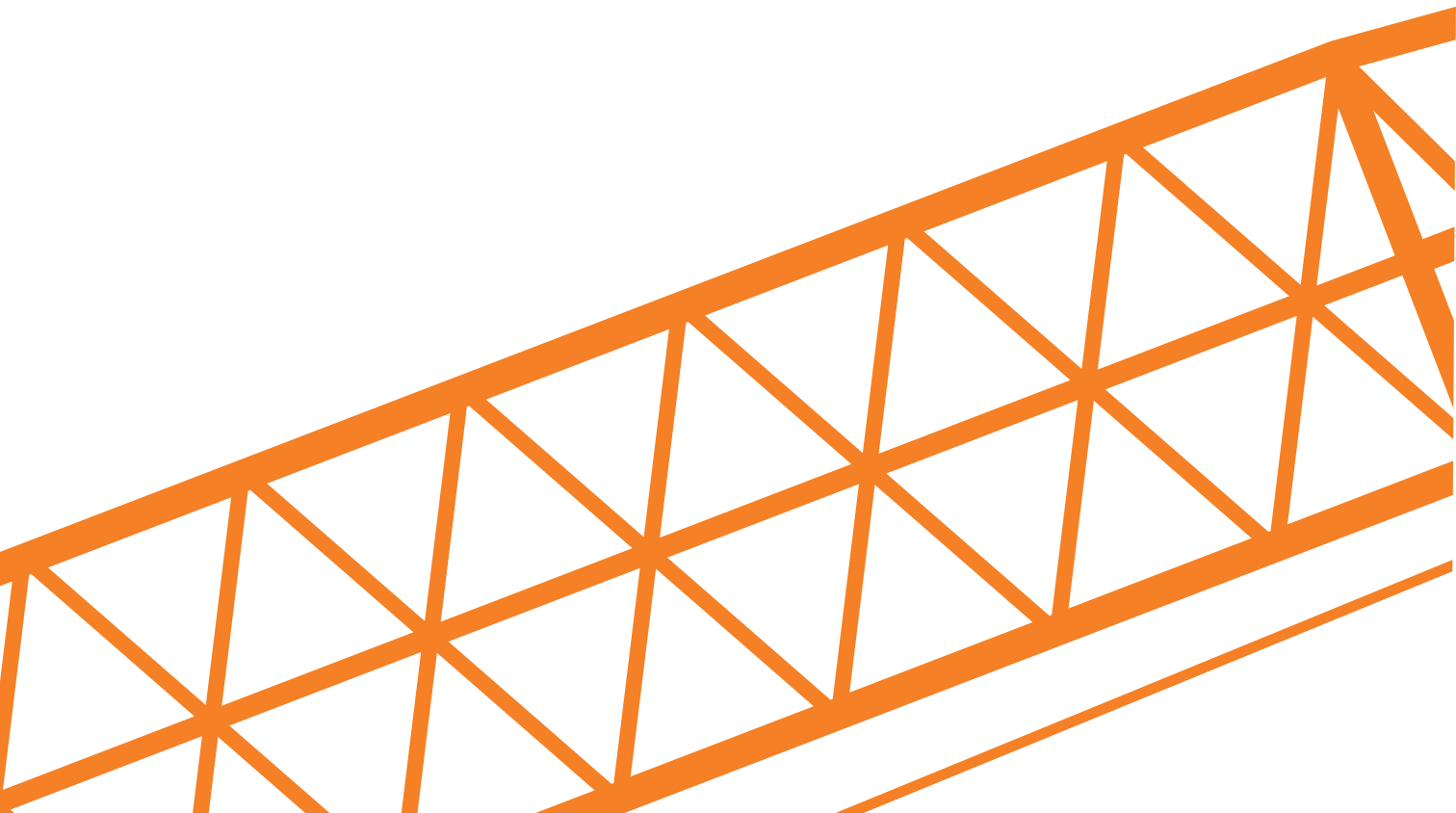
all will create more efficient buildings and structures with correct information for long-term facility management. The division between design and construction, which is unusual in other industries, will radically change to a situation with focus on product development and customer needs. As a result, new roles and services will emerge with a tighter integration between current roles.

Entire material and supply chains will also be impacted and changed, partly because platforms and information models make it possible to order the right quantities with the right dimensions and the right shipment time, partly because purchasing and logistics management is shifting from project-related processes to businessrelated processes, where a single deal may involve 20 projects instead of just one. The product platforms that can be established and stored with the help of BIM will enable the materials industry to develop new roles and provide products and services related to these platforms, products which can then be configured and tailored to individual projects. Traditional roles will conflate, and consultants, contractors and material manufacturers will begin competing with each other for who will assume management and process ownership responsibility.

"As a result, new roles and services will emerge"

Currently, the process-owner role is frequently lacking due to the fragmentation and sub-optimization of the value chains that exist. Nobody takes an integrated approach to the process. The stakeholder who most frequently acts as the overall process owner is the construction client, which is feasible for a few major recurring construction clients, but also in these cases it is conducted with optimization for individual projects and reduced experience feedback as a result. The many small construction clients who order construction projects on an infrequent basis obviously lack this skill-set, because the project itself disrupts the business processes of facility management for a property or facility owner. The transition to new processes will enable other stakeholders to assume the important role of process owner.

Information management with BIM and GIS will create significant opportunities to manage the life-cycle perspective for everything from embedded materials and products to the carbon footprint of buildings and facilities across the chain of planning, construction, facility management and demolition. Once again, early-stage analysis will be carried out in order to optimize solutions from a resource and cost perspective across entire facility life cycles, during which relevant information that adds value



to the property or facility is incorporated. Information delivery will become an important and valuable service during property ownership transfers.

The IT industry has hitherto only been seen as a supplier of hardware and software to the sector, but with the advent of technologies such as the "Internet of Things", fresh opportunities have emerged for these stakeholders. Sensors embedded into materials and products that can collect, analyse and disseminate data related to humidity, temperature, motion, pressure, light and sound etc. have enabled the IT industry to offer services and products for both the construction and the facility management processes and to users and decision-makers.

How can desired goals be achieved?

Achieving change requires a great deal of commitment on a number of levels. Many of the changes impact the traditional working methods of the stakeholders, both internally and in relation to each other. The division of responsibilities and deliveries that is currently applied calls for changes to be made jointly, but opportunities for individual stakeholders to affect joint processes is limited.

BIM adoption at companies is currently taking place at a fast pace, with perceived benefits such as shorter lead times, fewer errors, a reduction in unnecessary duplication, and an increase in profits. However, as long as it is being adopted in existing processes and long-standing business models, no benefits will be achieved for entire processes, only sub-optimized benefits at stakeholder level, or – in a worst-case scenario – on an individual level. The development still takes place almost exclusively in individual projects. Likewise, adoption and development of industrial thinking has taken place at several stakeholders with good results, but this is also happening within the framework of traditional roles whereby, for example, builders are only able to influence the production process itself. All too infrequently is it taking place integrally in the facility management phase, or in structures to which architects, engineers and material suppliers can relate and develop their business models. Coherent digital information management with BIM and GIS also requires – regardless of the processes used – common standards which ensure that the information is an accurate digital representation, traceable and widely accessible across different stakeholders over time.

Joint initiatives and concentrated efforts are therefore required in a number of areas affecting the business community, public sector and academia so as to create the common structures that will enable the prerequisites that will boost the sector's competitiveness.

A great deal of knowledge and expertise related to this field currently exists in many business enterprises and in academia. However, this knowledge needs to be deepened and, above all, broadened in scope to include more companies and more individuals. Undergraduate education in university colleges and universities is essential for the future provision of skills, but there is also a need for major initiatives in upgrading skills among corporate employees at all levels. These skills are required to meet the challenges that we are facing, but also to broaden and expedite the implementation of all current activities in this field, activities which could be conducted on a much larger scale.

3. Global trends

Swedish built environment lies at the forefront in the development and use of BIM and industrial processes. Sweden and its Nordic neighbours are often cited amongst the five strongest regions in the world regarding BIM implementation. The UK, the US and Singapore are other leading countries. In addition, Sweden has a world-class position in the field of systematics and classifications in construction and facility management, and it is also among the six leading countries in industrial processes in the built-environment sector, for which knowledge is otherwise available in Japan, Korea, the US, Germany and Denmark.

As regards the combination of BIM and industrial processes, along with our national experience in the telecom and engineering industries, Sweden is unique in the world! Expertise in integrating structured information management processes with industrial processes and creating business models based on this integration is a Swedish area of strength with considerable export potential.

"Swedish built environment lies at the forefront in the development and use of BIM and industrial processes."

During the last decade, practical applications for both BIM and industrial processes have been created by sector companies in a large number of actual construction projects. Knowledge and maturity has increased, primarily among architects, technical consultants and contractors, but a realization of the great merits that exist in the facility management phase has contributed to a variety of initiatives in this area too. Developments have taken place due to an awareness of the great potential for enhanced efficiency and productivity, not as a result of the demands of public construction client organizations, which have been the main driving forces in Norway and Finland. The same demands are now beginning to reach Sweden and the Swedish built-environment sector stands ready to meet these.

Both among our Nordic neighbours and from an international perspective, there is a general lack of focus on process changes and the connection with industrialized processes. In Sweden, we have a unique opportunity to create competitive advantages.

The Nordic countries

In Denmark, a programme is in progress that is focusing on structures and classifications. In total, approximately EUR 9 million will be invested over a four-year period to 2014. The government is also pursuing this issue through the Danish National Property Agency, Bygningsstyrelsen, and is requiring the use of 3D models of objects and properties, as well as the adoption of international open standards for BIM modelling. In Denmark, development of industrial processes has been continuous; hence the general degree of prefabrication, precision and quality is significantly higher than in Sweden.

In Norway, BIM implementation has mostly been managed by two public construction client organizations, which have established uniform requirements for BIM in their projects with a focus on international standards. Their effects can mainly be observed in the design phase and partly in the construction phase, but so far not in the facility management phase.

In Finland, the Finnish government has successfully managed to preserve the tradition of open construction systems for prefabrication. It is also important to note that Finland widely applies contracts negotiated by tender in contrast to the directed turnkey contracts that are common in Sweden. The result is that in Sweden there are very few industrial builders but value oriented component manufacturers, whilst in Finland the component manufactures are efficient but massproducers. Senatfastigheter, the major public construction and property developer, has for a number of years required information delivery in a prepared BIM manual, which has served as the basis for a new national BIM manual. A major national development programme has been managed by Built Environment Innovations (RYM) for several years.

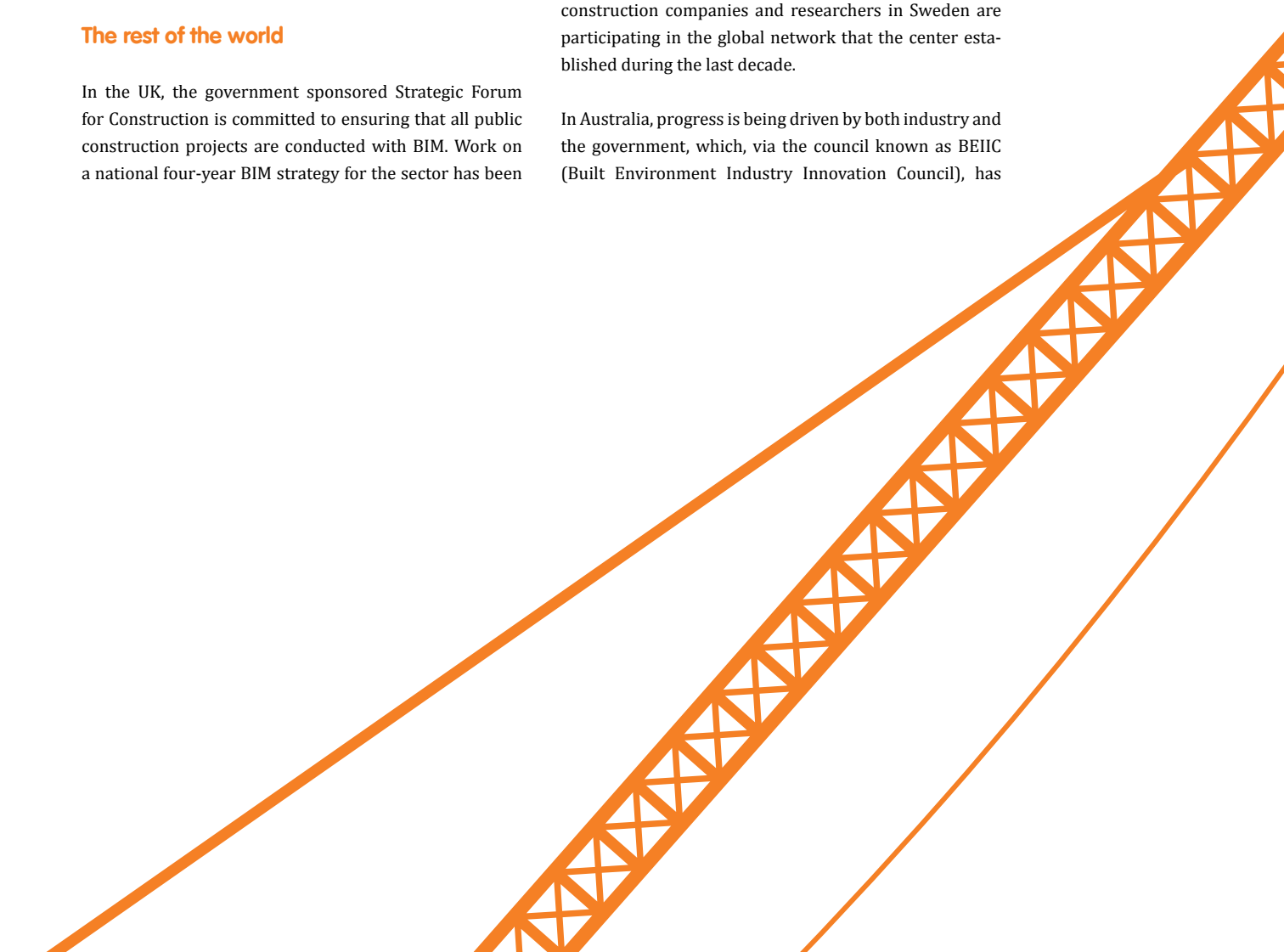
"As regards the combination of BIM and industrial processes Sweden is unique in the world"

The rest of the world

In the UK, the government sponsored Strategic Forum for Construction is committed to ensuring that all public construction projects are conducted with BIM. Work on a national four-year BIM strategy for the sector has been initiated, in which the government, the private sector, the public sector, research institutes and academia are collaborating. The general aim of the strategy is to simplify and expedite BIM adoption throughout the sector and establish uniform requirements for BIM implementation in government-funded projects. Furthermore, the British government intends to invite international participation in this development, including the development of standards. An investment of SEK 50 million annually for five years has been earmarked for this project.

Since 1988, CIFE (Center for Integrated Facility Engineering) at Stanford University in the US has been working with BIM and the connection with construction industrialization through the concept of Virtual Design and Construction. CIFE is now a world-class centre for the development of methods and processes. Several major construction companies and researchers in Sweden are participating in the global network that the center established during the last decade.

In Australia, progress is being driven by both industry and the government, which, via the council known as BEIIC (Built Environment Industry Innovation Council), has



established a strategic plan for the construction sector in which BIM is an important element and through which the council also supports development projects in BIM. However, Australia clearly lags behind Sweden in respect to industrial processes.

Singapore is the leading country in Asia in the field, and the government has initiated a strategic programme aimed at providing the necessary IT infrastructure for information exchange, regarding example for building permits management that incorporates all stakeholders in the construction process, including supervisors.

Japan has a long tradition of process and product thinking. The Japanese market is very large, which means that each company has its own concept, which are primarily based on life cycle thinking and customer requirements. Digital information management, advanced industrial processes based on automotive industry models and niche business models are well developed and exemplary.

In the current Chinese five-year plan, BIM has been identified as an important aspect in the progress of Chinese built environment. Adoption is still low, but their goals are very high and include their own standards, in addition to full-scale early adoption in the country's millions of "low income housing" units. Opportunities for collaboration are considerable, especially if China is considered a potential export market.

South Korea is now progressing rapidly with open standards and so-called "model checking", i.e. inspecting and testing the content of BIM models against agreed rules, and this has become a significant major trend. The authorities will be initiating new research projects from 2013 onwards. The goal is to strengthen the competitiveness of the South Korean construction sector. International co-operation with regard to the development of BIM standards and guidelines is desired.

International competitiveness

The investments that have been made by our Nordic neighbours have been limited by the lack of flexible process and product thinking as well as the dearth of new busi-

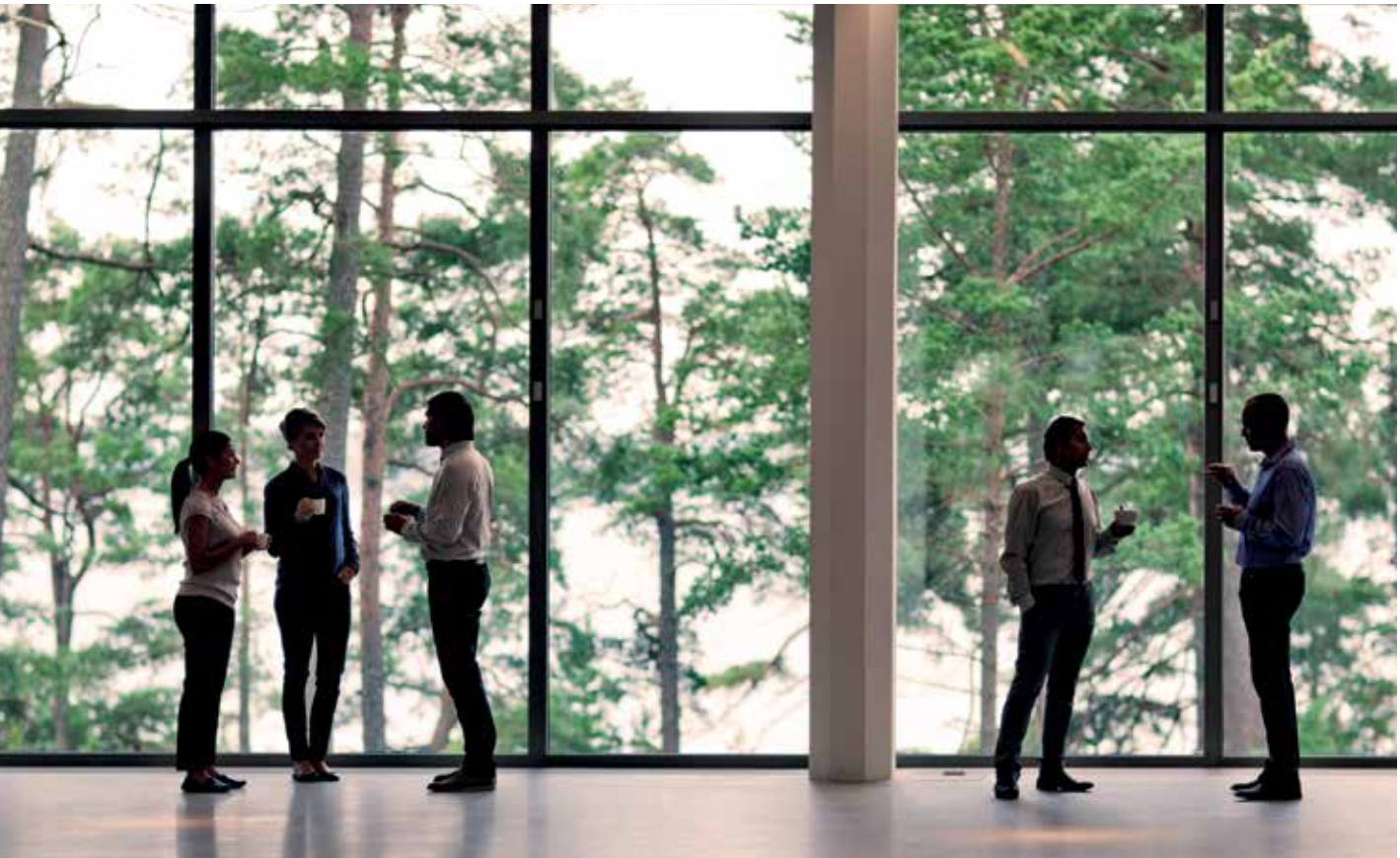


Photo: Henrik Trygg / mediabank.visitstockholm.com

ness models. However, there is in Sweden exchange taking place through ICT BIM in industrial processes due to our tradition of collaboration and openness. These large, state-supported projects will enhance the competitiveness of our Nordic neighbours. An increasingly international outlook has revealed major investments in BIM and a movement towards industrial processes, many clearly addressed to domestic construction industries in a globalized world. Sweden boasts leading expertise in ICT BIM and industrial processes, particularly in terms of classification, implementation and the connection between BIM and industrial processes. Consolidating the current Swedish position into a position of global leadership requires new commitments based on Swedish capabilities in systematic thinking, structure and a culture of collaboration.

In a national market, growth in the built-environment sector provides better conditions for other domestic industries. Studies in Australia have shown that the transition to BIM in itself results in a GDP increase. In Swedish terms, this would amount to a GDP increase of over SEK 13 billion in the period from 2011 to 2025. Even higher growth can be achieved if a country can increase its exports with the availability and implementation of BIM. In our priorities we have based our forecast on areas that will generate growth both for Sweden itself and for Swedish industry in an international context.

"Opportunities for Sweden to achieve strategic advantages in BIM and industrial processes are considerable"

Opportunities for Sweden to achieve strategic advantages in BIM and industrial processes are considerable. The product-platform approach rather than a focus on projects provides excellent opportunities for increased profitability, greater customization, new business models and international growth. From a global perspective, recent decades of advanced Swedish skills in the built-environment sector, combined with lessons learned from other Swedish industries such as the telecom and commercial vehicle industries[1], represent unique expertise.

A coherent and forward-looking investment in information management and industrial processes in the construction and facility management sector could greatly enhance Swedish growth and exports in three different ways:

1. Exporting expertise

Internationally speaking, BIM adoption is increasing rapidly in most countries, and the commercial tools that are used are widespread. Generally speaking, there are large gaps in the expertise required to build applications and processes related to these tools, partly due to the lack of national culture driving issues of standardization, regulation, structure and classification. In Sweden, knowledge is available in how to combine structured information management with industrial processes. Business models related to this are an area of Swedish strength with high export potential.

2. A catalyst for Swedish industry

In a sustainable society, facilities and infrastructure are optimized on the basis of user benefits and reliability. Infrastructure and production facilities are characterized by robustness, even under extreme conditions. This is beneficial to the competitiveness of Swedish industry because exports can be provided and designed with a high level of quality and reliability.

3. Strong domestic market

The domestic market provides the primary base for development in the construction, facilities and real estate sector. Competition becomes fiercer with increasing globalization and Swedish companies are now facing new competition from foreign players in the domestic market. Bearing this in mind, it is also necessary to develop processes that will enable the attainment of a world-class position. Strong companies can then be developed for increased growth both within the country's borders and abroad.

1For example Ericsson AXE, Scania, etc.

4. Vision and goals

The built-environment sector is facing a paradigm shift and a structural transition that will require all existing stakeholders to rethink their roles, practices, processes and business models. These are changes that have already taken place in other sectors with positive results. The built-environment sector has now begun a similar process, but much of the development still remains. One important difference is that in other sectors major companies already existed that could act as process owners and drive the changes. In the built-environment sector, the situation is fragmented and only the Swedish Transport Administration is influential enough to manage even parts of these changes. However, not even the Transport Administration will succeed without help from other stakeholders. Hence a common vision and mutual commitment are needed. We have summarized this vision of a new and sustainable built-environment sector in the following statement:

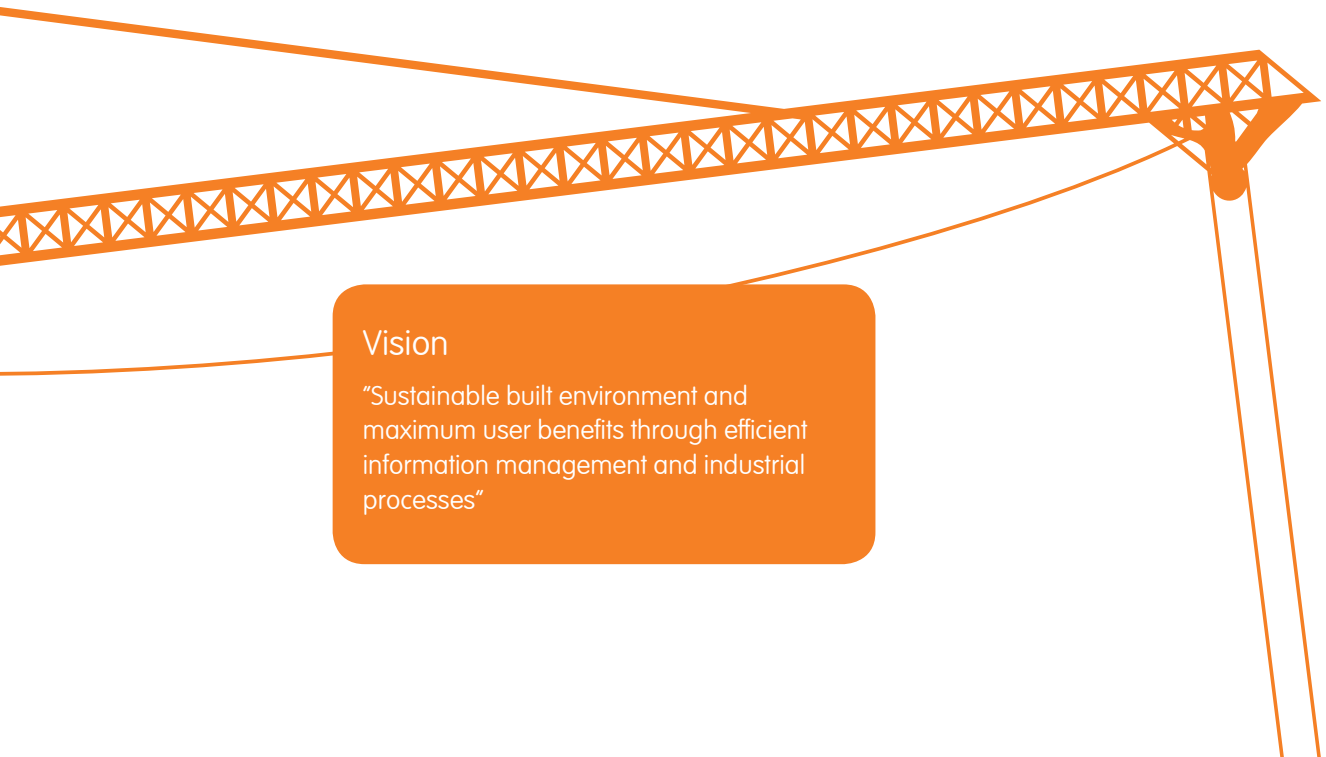
"Sustainable built environment and maximum user benefits through efficient information management and industrial processes"

The proposed development initiatives will lead to five goals:

1. Customer-centric sector – from fragmentation to an overall focus!
2. Shorter lead times – cost reductions for housing and infrastructure
3. Increased profitability and exports –increased productivity, strong demand and sustainable growth
4. An internationally attractive sector – in which to invest and work
5. Planning, design, construction and facility management are managed from a sustainable life-cycle perspective

Structural changes require the development of structured information management in combination with industrial processes. Exploiting the potential of BIM and industrial processes requires the following:

- Ingrained habits and patterns need to be broken. The bulk of the changes do not concern technological issues but involve behaviours and broad implementation through small steps. In order to create learning organizations, long-established patterns need to be abandoned at individual and corporate level. We also need to learn more about these behaviours, and prioritize leadership and organizational issues.



Vision

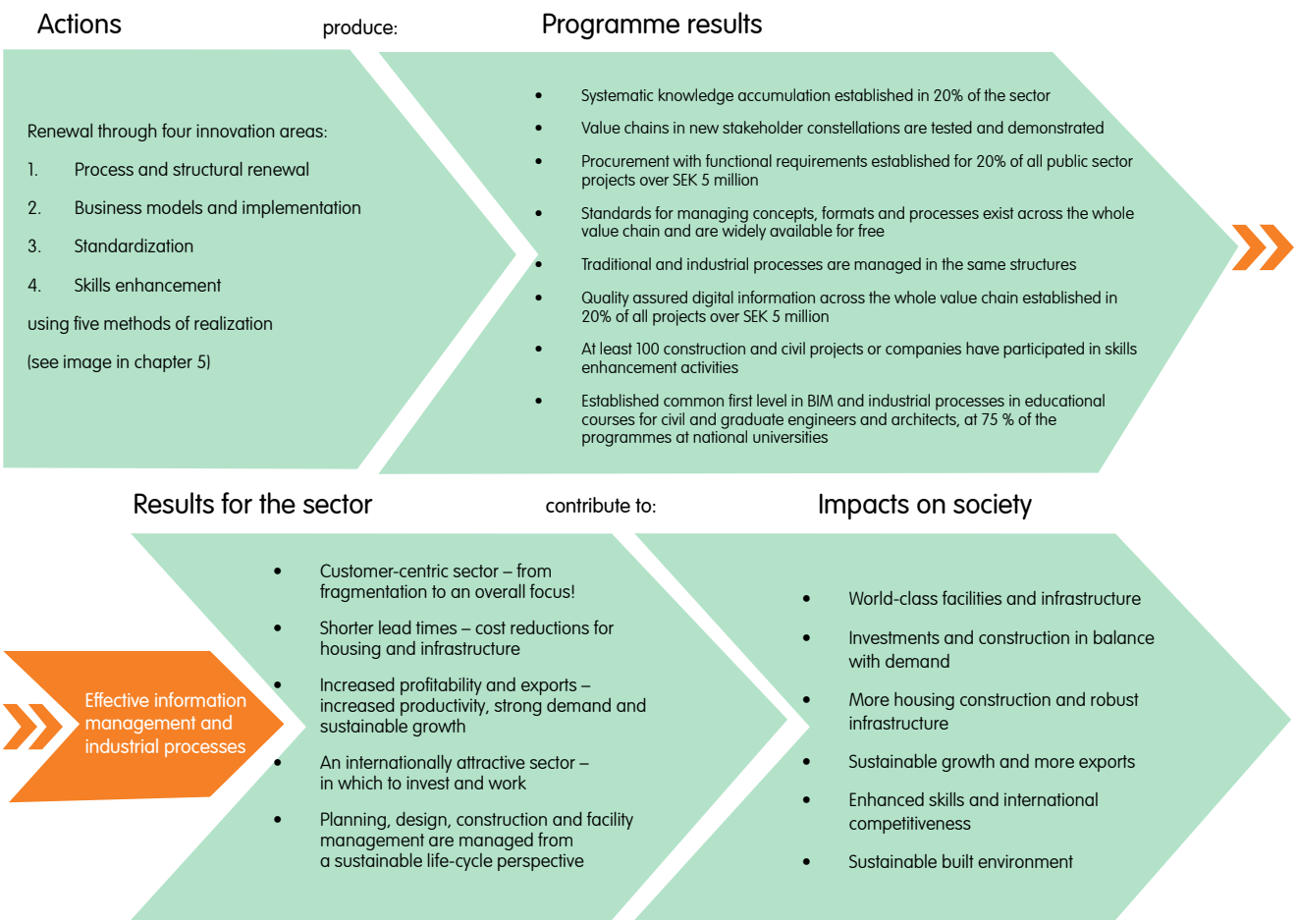
"Sustainable built environment and maximum user benefits through efficient information management and industrial processes"

- BIM applications: Good applications are currently available in the design and construction phases. These must be advanced and expanded as they have been in other industries. The facility management process, with its long-term perspectives, requires an even greater focus on development, one with an emphasis on finding the balance between technological level, flexibility, sustainability, requirements in the project process, and costs in comparison to benefits. The transition also requires major adjustments in procurement, contractual and organizational forms that will impact all stakeholders in the value chain.

- A larger number of more competitive, rational construction methods are needed, both as regards site constructions and prefabrications, in order to execute unique projects using standardized methods. This encompasses marketing strategies for industrial processes and new business models in addition to expertise and inspiration from other industries in product development, tailored solutions and the architecture of the platforms.

- Value stream optimization of industrial processes: The facilities management phase must be integrated during new constructions, during the development of product and platform-tailored production systems and supply chains (construction processes tailored for specified products) and during the development of planning issues and procurement. This applies, for example, to the issue of fixed requirements rather than functional requirements.

- Standardization and regulations: The sector needs to apply common information structures and methods in order to collaborate, for example to set requirements or to verify during the information ex-



change between the various parties in planning and in dialogue with the authorities.

- Enhance construction client competency in how to specify and verify functions, and how to benefit from industrial processes in their own organizations, both for actual construction projects and for operations and facility management.

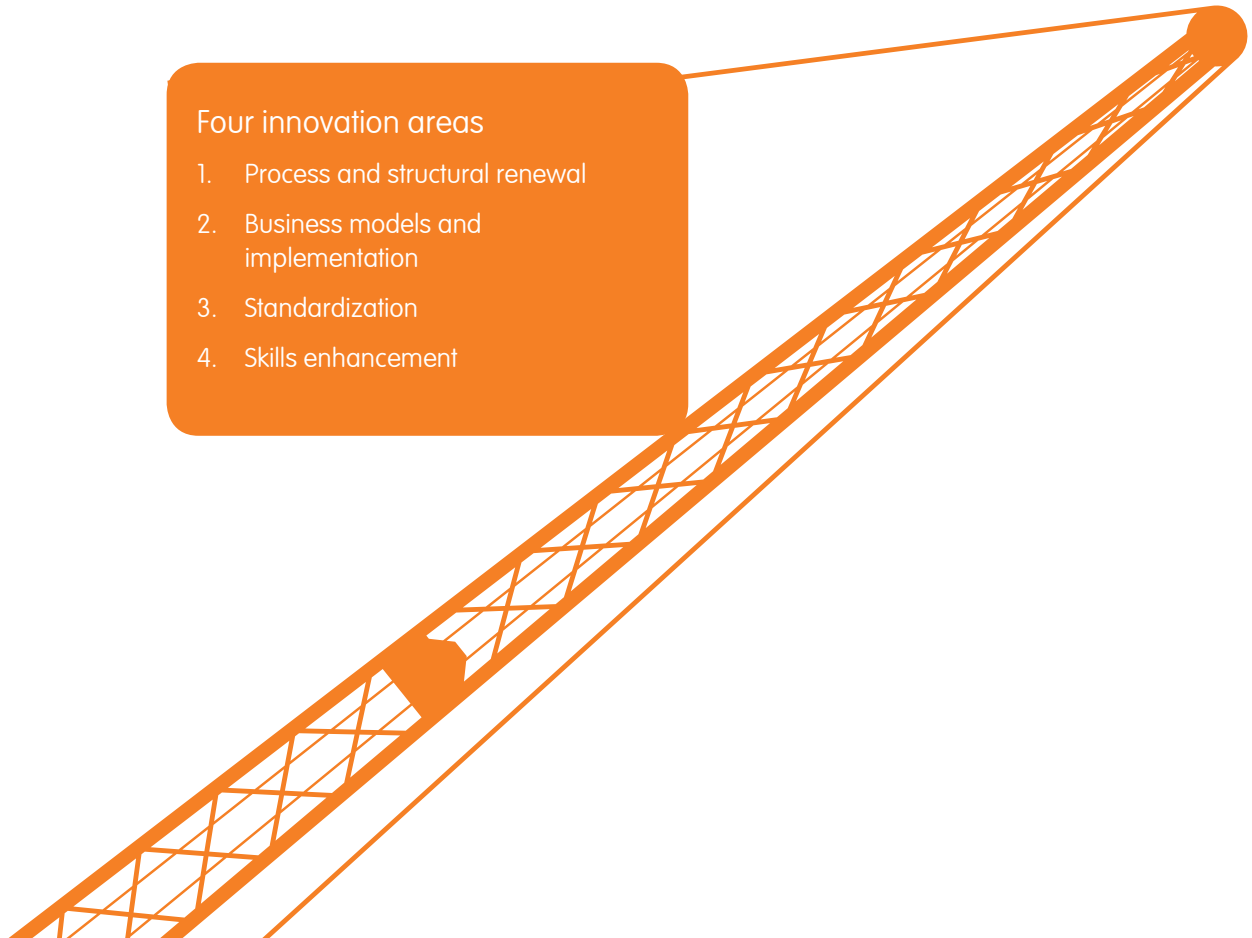
- Knowledge supply: We need to supply the market with the right knowledge and skills to enable the potential of BIM and industrial processes. The changes will mean that certain roles will be strengthened and that new roles will be established, while others will be weakened or even disappear. Increased knowledge regarding information management and underlying informatics is an important area both for the design methodology in traditional processes and for determining product in an industrial process. Increased knowledge in change and implementation processes, as well as new forms of collaboration, are other critical factors.

In order to achieve the above, we have summarized proposed projects and activities into four innovation areas:

1. Process and structural renewal
2. Business models and implementation
3. Standardization
4. Skills enhancement

Results and impacts

The purpose of this SRA is to meet both the challenges of the sector and the major challenges of society. This will be achieved with a chain of activities that generates results and impacts at different levels. By means of the four innovation areas above, described in more detail in Chapter 5, development and implementation actions will be carried out that will increase and diversify the application of "Effective information management and industrial processes". Indicators for this are stated as programme results. This in turn will lead to results for the sector that makes impacts on society.



5. Innovation areas and methods of realization

The four innovation areas will require different methods of realization – from concrete business-driven innovation projects, via implementation in companies, demonstration projects or pilots, and cross-industry development projects, to applied research as well as basic and additional training.

Agenda actions will be carried out in six work packages (WP), during which a mixture of stakeholders (society, industry and academia) will plan and conduct the actions in accordance with the Board's guidelines.

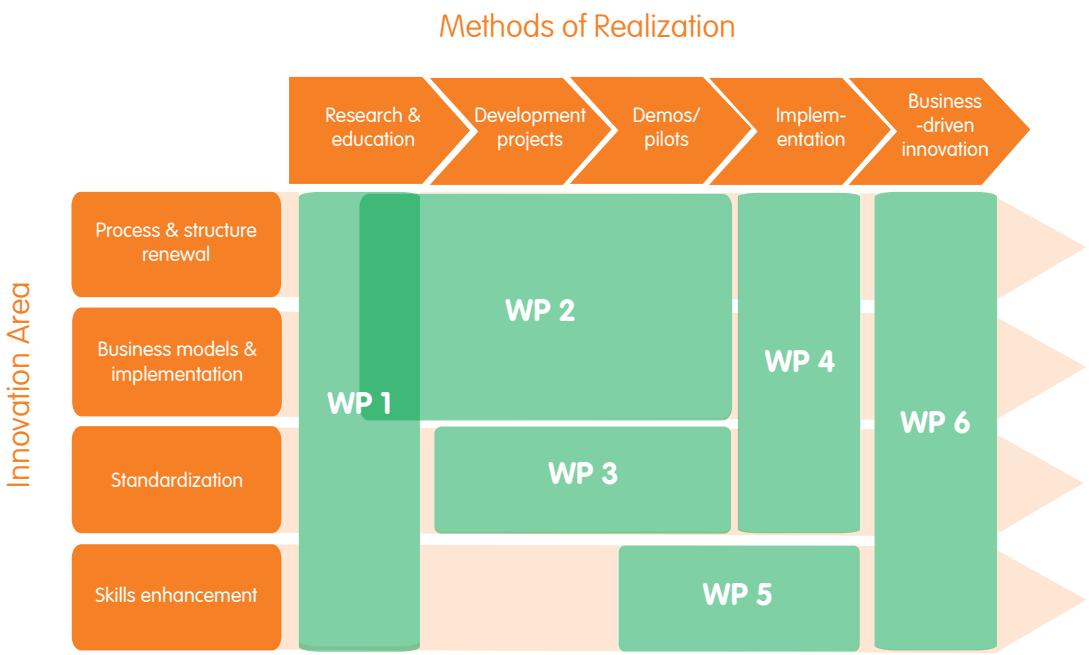
A coordination function called Innovation coordinator is suggested in the organization schema in chapter 6, and is described further below in this chapter. This function will ensure that the agenda always maintains its focus on small and medium-sized enterprises, internationalization and cross-sectoral collaboration in all the innovation areas. This is a essential elements to bringing about change and innovation in the built-environment sector.

"This is a cornerstone for bringing about change and innovation"

The projects described in WP1, WP2 and WP3, and other known initiatives, are summary descriptions from the two previously published SRAs. In some cases, the work of the agenda has resulted in close dialogue regarding future joint activities, in other cases closer contacts will need to be established. Project proposals and collaborations will be specified within the framework of a Strategic Research Programme.

WP 1 – Centre of Excellence

WP 1 consists of a long-term national research environment in this field, aimed at achieving a strong international reputation for excellence. The centre will feature a wide range of active participants from the industry, from construction clients to the materials industry, who will define requirements and bridge the gap between applied needs-related research, and practice-based implementation.



There will be close cooperation between WP 1 and WP 2. There will be a loose boundary between the applied research in WP 1 and the development oriented projects in WP 2. The main difference is how projects are initiated in respect to time to results (industry focus) and in the level of academic research.

The centre will be built in a "distributed" way, where different research environments will create a shared virtual centre to gather expertise from across the country. The purpose is to:

- Achieve a healthy and well-distributed research environment. Through co-production between different research groups and stakeholders, generic and industry-related research related to needs, can take place, and the quality and relevance of civil engineering programmes ensured.
- Establish research partnerships with leading international research environments and prioritized potential export buyers to increase strategic and curiosity-driven R&D collaboration with environments outside the built environment sector.

"Research work will be converted into practical results and innovations"

The goal of the excellence centre is to create a forum through which researchers and the industry will jointly conduct open research on high academic level, with a strong applied character, but also research of a knowledge-building nature, with long-term applications and innovations of more than five years.

Research work will be converted into practical results and innovations, defined on the basis of user needs, and theoretical relevance. Industrial PhD students will be used. The distributed research environment will initiate research projects in which competitors, suppliers and customers from the built-environment sector and from other sectors (for example the engineering industry) join forces around open issues.

Priority areas of research and education

- Marketing strategies for new processes.
- Forms of collaboration and value flows in new processes.
- Informatics and PLM systems.
- Innovation and implementation processes in project-based organizations.
- Follow-up research with measurement, monitoring and validation.
- National base in basic education.

Current initiatives and collaborative partners

The work with the Excellence Centre will be developed within the framework of the existing organization, Swedish Universities of the Built Environment (Sveriges Bygguniversitet). Contacts will also be established with the corresponding architectural organization – Swedish Schools of Architecture (Arkitekturakademien). Constructive relationships already exist with the University of Reading (UK) School of Construction Management and Engineering, and Stanford University's CIFE (Center for Integrated Facility Engineering). These are two of the leading research environments in the world in this field. An international research council will be formed by establishing contacts with strategic universities and promoting the recruitment of leading international research leaders.

WP 2 – Development and demonstrations in collaboration

There is a need for development, demonstration and testing in a variety of areas. Development projects will be conducted in collaboration between industry and academia in short-term areas of common interest to existing stakeholders. Projects should have an impact in the short term, less than three years. Project specific goals will be stated for each project.

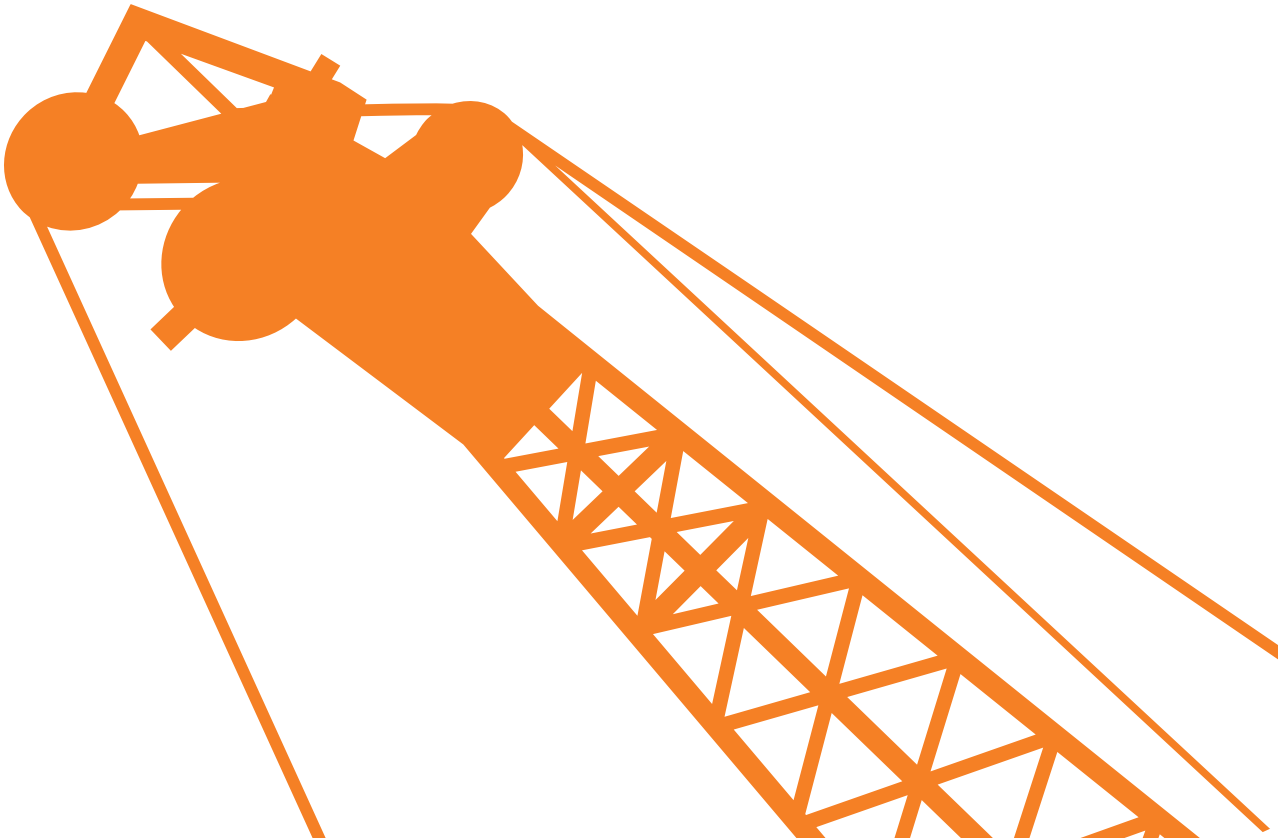
Development projects and demonstrations will also be conducted to enable the necessary changes, for example in relation to stakeholder roles, processes, commitments and value chains. Projects must take up issues that are of common interest to several stakeholders, in other words individual companies must not be allowed to drive development. Project results will be made available to the public.

The priority project areas listed below are described at an aggregate level and based on a large number of sub-projects that have been developed in outline form[2].

2 Project outlines were presented in two agendas, "ICT BIM for Sustainable Built Environment", which includes the work done by Lantmäteriet (National Land Survey) on geodata, and "Industrial Processes in Construction and Facility Management", both of which have previously been shown to VINNOVA.

Priority project areas

- Digital planning processes and licensing, digital standards and information modelling in urban planning.
- Innovation-friendly public procurement and functional procurement with level requirements.
- Development of product- process- and business models to support innovation and functional procurement
- System factors for information management and industrial processes, more collaboration and redeployment.
- Industrial design (product development) for new business models and information management.
- Automation with integrated data flow.
- Accessible databases with lessons learned from operations and facility management.
- Facility management models and processes with support for evaluation from a lifecycle perspective.

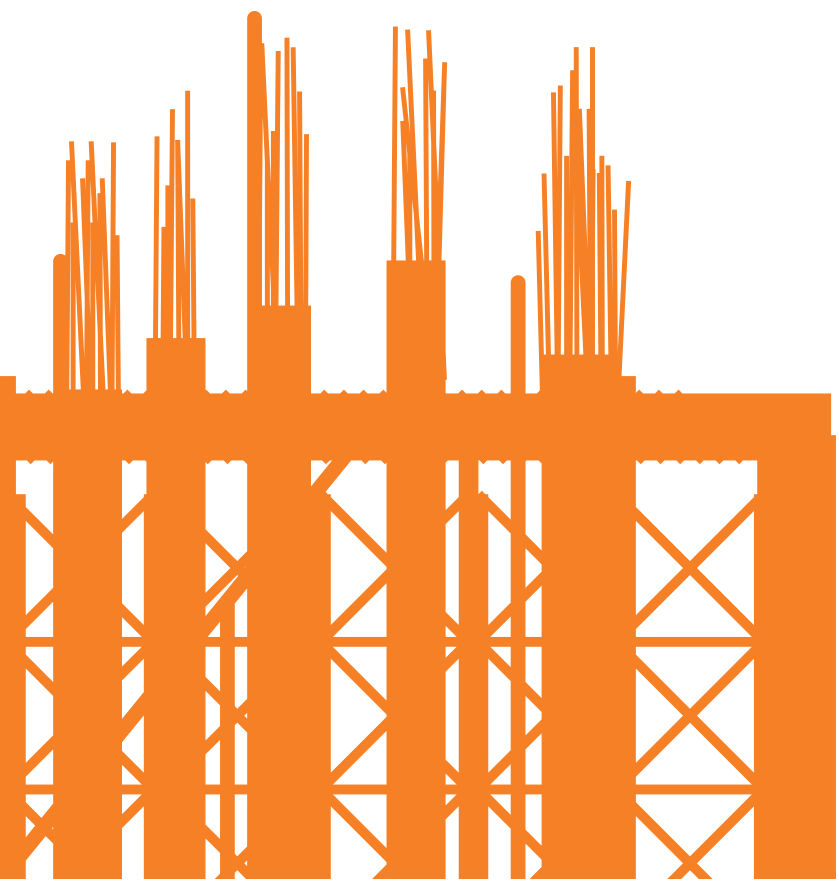


- Intelligent facilities that support customers and users.

- Modelling of existing facilities based on scanning and other measurement methods for digitizing the real world.

Current initiatives and collaborative partners

In some of these project areas there are ongoing initiatives, but according to the stakeholders there has been a lack of cohesive strategy for the various actions. The Swedish Transport Administration's investment in more efficient processes on a general level and its focus on "BIM Implementation" are important initiatives that are also impacting the sector with their specific targeted requirements. The National Land Survey (Lantmäteriet) and the National Housing Board (Boverket) are currently conducting the SPF project ("Coherent Zoning and Property Registration Process"), and the National Land Survey in partnership with the Swedish Association of Local Authorities and Regions (Sveriges Kommuner och Landsting) is conducting the collaborative project entitled Swedish Geoprocess. Both of these projects have clear connections to early-stage digital processing.



In the field of intelligent facilities, there has been close co-operation with the IoT agenda (Internet of Things) during the agenda process, and several intersection points were found. In workshop form, we succeeded in identifying a number of applications in which the built-environment sector has a need and where the IoT agenda can deliver solutions in the form of intelligent sensors for measurement and analysis. Together we have identified five priority areas with examples of joint development projects in the areas: 1) Production, 2) Logistics, 3) Facility management, 4) Users and 5) Lesson learned/ Big data.

For several years, IQ Samhällsbyggnad has collaborated with RYM, the Finnish "SHOK" (Strategic Centres for Science, Technology and Innovation) organization. Contacts are well established and there are plans for joint projects.

WP 3 – Development of common standards and structures

A prerequisite for the widespread adoption of information management with BIM and GIS are common national and international standards and guidelines, and a consistent strategy in establishing standards. These standards are divided into three main categories; 1) concepts and classifications; 2) data storage and transfer formats; 3) information delivery. In addition, the structures for contract forms must be revised since the standard contract and procurement forms that are currently in use are not compatible with information models with legal status.

In close collaboration with the work of this agenda, an extensive project has been carried out by the OpenBIM programme. This project has firstly resulted in a survey of the current situation regarding the above standards, which has revealed flaws, overlaps and omissions in the standards that are currently applied, and secondly in an action plan for the upcoming years in which priority standardization initiatives have been proposed in ten sub-projects, and where the benefits of these initiatives to various stakeholders have been described. They have been condensed into the six priority areas below.

Priority project areas

- Procurement – digital concept definitions in standard contracts and public procurements requiring the delivery of information models.
- Development of information modelling classifications.
- Co-ordination of information structures for BIM and GIS.
- Information delivery with attribute reports.
- Standardization of application interfaces (API) for shared information sources, such as model servers and product databases.
- Format standards and their application – internationally and nationally.

Current initiatives and collaborative partners

The Swedish Transport Administration will work with standardization initiatives related to infrastructure, for example as part of the European collaboration project V-CON (Virtual Construction for Roads), which includes the Netherlands, among other countries.

The five Swedish public construction client organizations – Specialfastigheter, Akademiska hus, Statens fastighetsverk, Riksdagsförvaltningen och Fortifikationsverket – are working to develop a strategy for systematic work with BIM in projects and facility management. This work concerns standards, among other issues.

The BIM Alliance association, which will be established on 1 January 2014 through a merger of the Swedish associations OpenBIM, fi2 Förvaltningsinformation and buildingSMART Sweden, will be closely involved in the standardization work. The association will become a member of the international buildingSMART alliance, which conducts international standardization for BIM.

In addition, the National Land Survey will play a central role in projects related to the connection between standards for BIM and GIS, as well as those concerning the EU Directive INSPIRE, which contains mandatory provisions for geodata within the EU. "The Proactive Land Survey" (Det proaktiva Lantmäteriet) is a project whose aim is to create a holistic view of processes, from planning through property formation and planning permission to construction. The process is currently divided between different stakeholders.

"A concrete support function for participating stakeholders"

WP 4 – Implementation support

A good knowledge in this field already exists among companies and relevant authorities, and it is already applied in live projects and to a certain extent in facility management. However, this could be done on a much larger scale. Lessons learned have demonstrated how necessary it is to allocate specific resources to managing the implementation of both the existing and the new knowledge and technology that has been created in proposed R&D projects.

WP 4 will provide a concrete support function for participating stakeholders. The task is to provide active and systematic support, and catalyze implementation through both pilot projects in specific live construction projects as well as in facility management organizations. The activities proposed in WP 4 are strongly inspired by the work performed by Produktionslyftet (The Production Leap).

The large companies need help in implementing known technology on a broad scale in their organizations. The need for implementation efforts is large, and may be exemplified by a statement from the project manager for BIM implementation on Swedish Transport Administration: "To take full advantage of BIM, we need to inspire and teach 2000 people about BIM, in the organization." Coaching activities for large companies will focus on internal change management rather than implementation in individual projects.

In turn, the large companies such as the major contractors, clients and facility managers , can act as guides by actively working with – and communicating outwardly – their implementations of new technologies and approaches. They can mentor the small and medium-sized enterprises, upon which the major companies are also dependent in the overall process. This would also contribute to providing relatively rapid results in business-oriented development and drive the required behavioural changes.

- Human resources in the form of coaches to support the pilot project – "Help with Self-Help", as well as support for internal change management.
- A hotline service for participating stakeholders to support them in actual projects and activities.
- Human resources that will support small and medium-sized enterprises directly.
- Packaging and communication of results from other WPs to ensure the availability of new knowledge.
- Support material for the planning and organization of pilot projects.
- Dissemination of monitoring and measurement results.

Current initiatives and collaborative partners

Produktionslyftet (The production Leap), a national programme initiated by the engineering industry employer's organization, Teknikföretagen, and the IF Metall union, the purpose of which is to boost the productivity, competitiveness and development capabilities in Swedish industry, has served as a model for work with corporate training and coaching. The methods applied, such as "the oblique wave", which supports small, medium-sized and large enterprises in various ways, have provided the inspiration for the approach to implementation. This existing expertise will be utilized within the program.

WP 5 – Forum for change and dissemination

WP 5 has been designed as an industry-driven network for education, knowledge transfer and communication, which will also co-ordinate activities in regard to the export of Swedish expertise and products. The forum has two tasks: Facilitation of change and Dissemination of knowledge.

Demands for change are great and increasing. Above all, energy and sustainability issues highlight the need for a wide range of skills to join forces against the systemic problems that currently exist. One prerequisite is that

every construction client has the knowledge and skills to place appropriate demands on sector stakeholders. This specifically applies to public sector clients, who have the capacity to act as pioneers and use their purchasing power in an obvious way to create favourable conditions for innovation. The basis of this is to assess facility life cycle, and base the requirements on user perspectives, cost-efficiency and sustainability.

Among the projected consultants, individual expertise in information management with BIM and GIS currently exists in many companies. However, a comprehensive broadening of skills is required to reach out to many more. There is an even greater need for advanced expertise in the necessary process changes and how design can be boosted, from unique design to product development.

"An industry-driven network for education, knowledge transfer and communication"

Among building contractors, builders and installers, there are a few large companies that already possess knowledge and experience in industrial processes and BIM. However, the four largest contractors represent a total of less than 30 percent of the market. The rest are SMEs, which need help to adopt the research and technological developments.

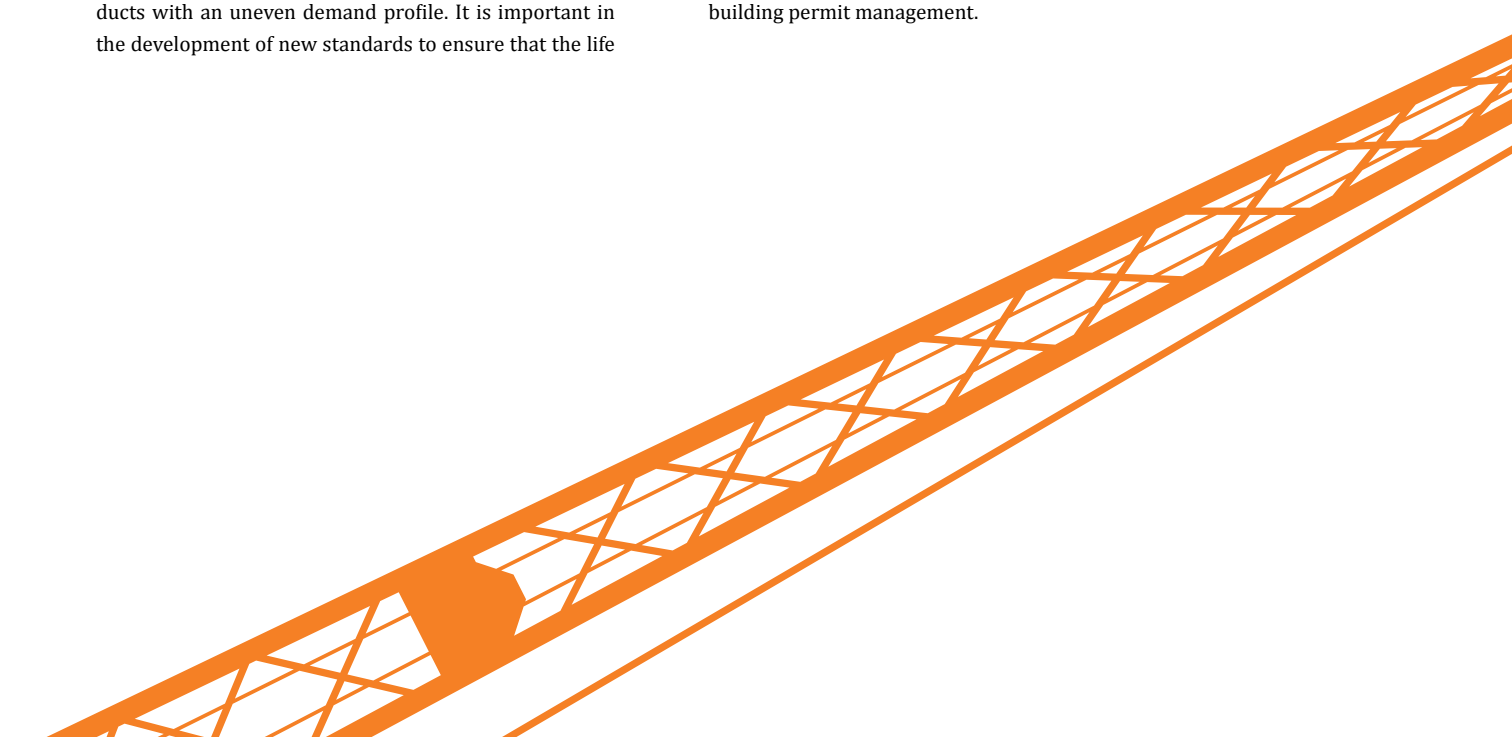
The materials industry has lengthy experience in industrial production and business models. The industry is also accustomed to developing and manufacturing products with an uneven demand profile. It is important in the development of new standards to ensure that the life cycle for the project as well as the product is included in the process.

The field of facility management requires a particular focus on up-skilling, partly because there is so much untapped potential, and partly because knowledge in BIM at facility-managing organizations is generally low, although several successful initiatives have been conducted in recent years. Knowledge of how platforms can be used in facility management is also a major shortage area. This calls for actions targeted at decision-makers at various levels, with a focus on comprehensive knowledge in processes, procedures, benefits and requirements. The forum will specifically concentrate work to:

Task 1 – Facilitation of change

A network sharing knowledge between organisations active within the programme

- Skills enhancement activities for the key actors
- Act as a catalyst for the export of Swedish know-how in information management, industrial processes and its related business models.
- Selectively monitor issues in relation to information management and new processes in discussions concerning social issues such as productivity, construction and maintenance costs, as well as zoning and building permit management.



Task 2 – Dissemination

Dissemination of knowledge from within the programme to external stakeholders

- Disseminate valuable knowledge and experience from the programme and from the surrounding world, and ensure transparency, quality and ethics in the industry-driven network. Dissemination will take place through seminars, conferences, websites, etc., but also through specific forms of directed education.

Current initiatives and collaborative partners

Produktionslyftet (The production Leap) will serve as an inspiration for methods in strategic skills enhancement. Lean Forum Bygg is a not-for-profit organization within built environment whose purpose is to become a leading inspiration and knowledge provider in Lean Thinking. The future BIM Alliance association can also play a role in change management and skills enhancement through their regular activities with interest groups, conferences and seminars, during which issues can be channelled. IQ Samhällsbyggnad has initiated a method project for the general dissemination of new knowledge throughout the sector, as well as research and development results generally, which will be put into practice.

"Opportunities will be created for business development"

WP 6 – Business-driven innovation

WP 6 is a project-based work package, to facilitate that ideas in companies can be developed into commercially viable products or services within three years. In WP 6 opportunities will be created for business development and innovativeness in individual firms or constellations of stakeholders, in which results are close to commercialization and where these are not necessarily available to everyone in the collaboration.

For change to occur, it is important to facilitate and create competitive innovative climate for companies. An evaluation of the ongoing "Bygginnovationen" (a VINNOVA program) states the great need for innovation support instruments (actions ranging from evaluation of ideas to seed-money for testing and market introduction), to support new ideas to be commercialized by companies.

However, capitalization in terms of demonstration projects in WP2 will act as a catalyst for the business-driven innovation in work package 6. WP 6 will be designed to:

- Act as an innovative instrument for individual stakeholders or groups of stakeholders.
- Be managed in conjunction with Bygginnovationen to promote ideas and development projects with immediate commercial applications within the scope of this SRA.
- Ensure projects can be conducted with a requirement that results are confidential.

Current initiatives and collaborative partners

In WP 6, the ongoing Bygginnovationen, is planned to play a role by taking charge of special calls within the field that will be aimed at ideas and innovations close to commercialization.

Innovation coordinator

The important function "Innovation coordinator" will be composed of a group led by an experienced industrialist, answerable to the programme board. The coordinator will be authorized by the board to ensure that all projects and activities conducted in the four individual innovation areas retain a focus on:

- Small and medium-sized enterprises
- International collaborative partners, such as companies or visiting international researchers or matchmaking studies, EU programmes, export initiatives
- Measuring and benchmarking other countries and other industries
- Cross-sectorial collaboration projects in which IT, telecom and manufacturing industries are especially necessary

In order to motivate renewal and change a coordinator outside Sweden, for example from Finland or Denmark, will be engaged. Dissemination of information outside those already initiated, as well as outside the sector, is important to reach the goals.

6. Implementation

Never in modern times has the built-environment sector been as unified nor consensus been so strong for a given task as it now. By virtue of this consensus, there are a large number of organizations with considerable credibility that can initiate the process quickly.

Proposal for implementation governance

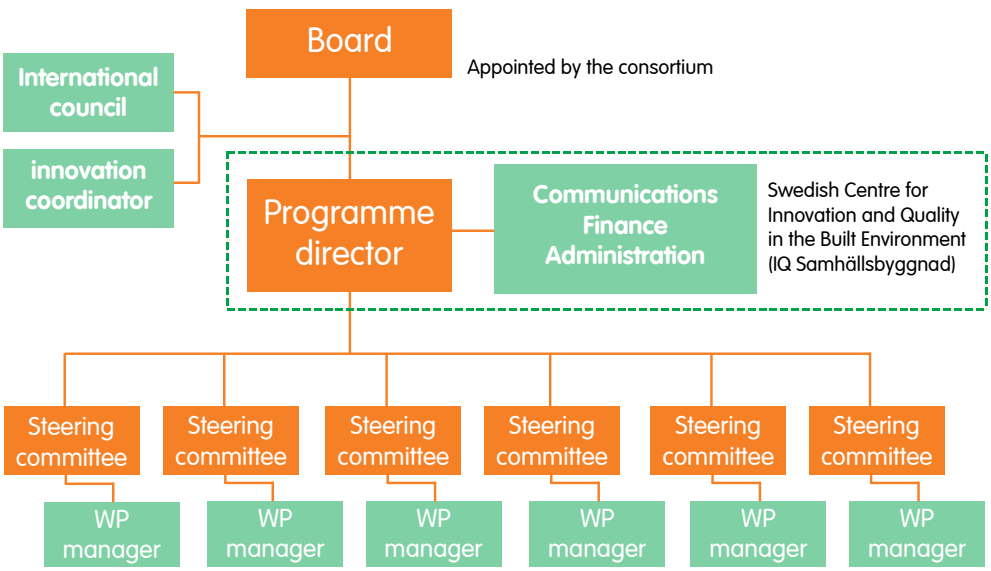
The first step will be to establish a consortium of key stakeholders from various companies in the sector, the Swedish Universities of the Built Environment and the National Transport Administration. This consortium will be the beneficiaries and also, in partnership with academia, the main implementers. The body that will govern the work will be a board appointed by the industry consortium. A programme director will be responsible for implementation on behalf of the board. The programme director will be supported by a secretariat, which will primarily ensure collaboration and good leadership in the various work packages that are planned. The secretariat will also be responsible for finance, administration and communications. Two councils will be established to support the programme director and the board: one international council and one group responsible for WP1: innovation catalyst. There has been broad agreement that the programme secretariat should be located at IQ Samhällsbyggnad, which will serve as a platform co-ordinator and partner in cross-sector projects and programmes.

For co-ordination between companies, academia and society, a steering committee for each WP will be assigned to the programme director. Operations will be managed by a WP manager for each WP, for example from SBU (Excellence Centre), BIM Alliance (Development of common standards and structures) and Bygginnovationen (Business-driven innovation).

The formation of the governance should take place within six weeks of the establishment of SIA (Strategic Innovation Area) programmes.

Consensus and funding

Based on the strong consensus for the contents of this SRA, we have identified a large number of funding opportunities. Funding will primarily be secured through the industry agency due to the commercial motivation of this SRA. In part, funding will comprise the industry's own work and means, and consist additionally of projects with partial public funding, for example in the form of SIA-programmes supported by Vinnova, the Swedish Energy Agency and Formas, by Formas' strong research environments and EU projects. Regarding Bygginnovationen we proposes an contribution of funding from the SIO program to the ordinary activities in Bygginnovationen, for specific calls within the SRA area. SBUF (the Development Fund of the Swedish Construction Industry) is also a natural source of funding for this development.



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Companies and organizations that support this agenda

The following companies and organizations have been involved in various ways in the agenda development process.

Arcona
Arkitekturakademin (Swedish Schools of Architecture)
ARKUS
BSK Arkitekter
Byggherrarna
Bygginnovationen
Byggmaterialindustrierna
Cementa
Chalmers University of Technology
Fastighetsägarna Sverige (Swedish Property Federation)
Huge Fastigheter
Imtech Nordic
IQ Samhällsbyggnad (Swedish Centre for Innovation and Quality in the Built Environment)
KTH (Royal Institute of Technology)
Lindbäcks Bygg
LiU (Linköping University of Technology)
LTU (Luleå University of Technology)
LTH (Lund University Faculty of Engineering)
NCC
OpenBIM
PEAB
Plan B
Projektengagemang
Regionfastigheter
Skanska
Specialfastigheter
SBI (Swedish Institute of Steel Construction)
Svensk Betong
Svensk Byggtjänst
STD (Swedish Federation of Consulting Engineers and Architects)
Svergies Byggindustrier (Swedish Construction Federation)
SBU (Swedish Universities of the Built Environment)
Sweco
Trafikverket (National Transport Administration)
Tyréns
VVS-företagen (Swedish Association of Plumbing and HVAC Contractors)
White
WSP
Åkej