

# Twin Green & Digital Innovation in the construction sector

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**TWIN**

# Executive summary

**This report seeks to assist SMEs to start with Twin Green and Digital innovation to strengthen the sustainability and competitiveness.**

**Relevance:** The report confirms the increasing need and opportunities for SMEs active in the European construction sector to engage in the twin green and digital transition process which seeks to achieve long term transformation of business and the society at large towards a more competitive and sustainable future.

Yet, SMEs and general and particular in the construction sector are lagging in the adoption of the Twin as they are not aware of the relevant Twin options and business owners see Twin innovation measures as costly without providing tangible impact. Finally, SME owners indicate that there is no roadmap for planning and implementing the Twin transition.

**Relevant Twin options:** The report identifies a set of relevant combinations of green and digital innovations that can be applied by SMEs in the construction sector value chain at the level of suppliers, business operations and to develop their products and markets.

Relevant green and digital innovations in the supply chain include the use and local sourcing of low carbon and nature-based materials and digital tools to compare materials and transport costs.

At business operations level, construction companies are to seek greener, less use and recycling of materials, energy, water and waste products with support of enterprise resource planning tools, data analysis and smart meters.

Looking at products and markets, the construction sector can benefit from innovations in efficient building processes, maintenance and energy sourcing and renovation and service based real estate services empowered by product digital tracking and tracing technologies, big data analysis and machine learning.

**Impact of Twin innovations:** The study shows that the expected impact of Twin innovations is strong in terms of social and environmental impact.

However, the opinions of subject matter experts diverge from the literature where the economic impact of twin innovations is concerned.

While twin innovation will support competitiveness and enables companies to comply with environmental reporting demands from customers and regulators, the innovations are associated with important investment cost increases that will not be compensated by higher market prices.

Therefore, successful twin innovations will only be realized if suppliers, contractors and clients work together and share knowledge and investments to identify effective twin innovation in the sector that combine lower environmental impact and lower operational costs on longer term.

**Roadmap for implementation:** As for timing of the Twin innovation, in the short term SMEs can expect the most positive impact from the Twin innovations in business operations.

In the mid term, SMEs will benefit from the sourcing of sustainable materials in the supply chain.

In the longer term, construction companies can explore more sustainable building methods that can lower operational costs of construction projects and new construction as a service which can enhance their long term revenues and competitiveness in the market.



This research is published on behalf of [Haarlem Campus](#) and [SRH Higher Education](#). The topic Twin Green and Digital Innovation is chosen to enhance the understanding of this topic, its impact and the application to small and medium companies. We hope that our research can assist both larger and in particular smaller companies to start with their transition towards and more green and digital way of doing business.

We will also use the knowledge and experiences gained as input into the study programs offered by Haarlem Campus and SRH including the Bachelor Digital Transformation Management and the Masters Applied Sustainability Management and Leadership for Digital Transformation.

The research is conducted by Arjan Rensma and Prof. Dr. Stijn van der Krogt in close collaboration with experts from construction companies Dura Vermeer and Stamhuis.



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During the interviews we found that both companies have developed a clear vision on twin green and digital transition, with both aspects being key elements of successful innovation. Their experiences can provide other companies, and in particular SMEs in the construction sector, to start with their quest for Twin Innovation

Among other strategies, retail construction company Stamhuis seeks in their retail projects maximum circularity of their materials by developing detailed material passports, reuse of materials and use of renewable energy.



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## SUSTAINABILITY

### BUILD WITH AN EYE FOR TOMORROW

"You must not only say what you do, but also do what you say!"

We keep a close eye on the consequences for people and the environment in everything we do. Sustainability is central to us.

#### CLOSED CYCLE OF MATERIALS

- Insight into material flows
- Return guarantee
- Collaboration with partners

Measuring is knowing. Insight into the impact in order to make our projects more sustainable is essential. With this we help provide input for SCOPE 3 of the CSRD legislation. Our material flow shows which materials are used within a project, aiming for maximum circularity. Taking back materials and taking responsibility is an important part of this to make the transition to the circular economy. We facilitate this through our own Revision Center (RCN) together with producers and partners from our construction team.

## SUSTAINABILITY HIGH ON THE AGENDA

Director and major shareholder Henk Stamhuis is chairman of the Energy Collective Lage Weide (ECLW): a joint initiative of a number of Utrecht companies that are doing everything they can to reduce energy consumption at the Lage Weide industrial estate. In addition, as a board member of the local industry association, Henk has the policy subject of sustainability in his portfolio. It therefore needs no further explanation that sustainability is high on the agenda at Stamhuis.

Construction company Dura Vermeer seeks to have a net zero carbon emission in 2050, and for this they have a clear roadmap and operate ahead of their clients seeking shared responsibility to find Twin solutions with customers, suppliers and other stakeholders. Examples are electrification of construction equipment, 3D concrete printing, the reuse of asphalt, the construction of bridges with used materials and life-cycle analysis of building and utility projects.



# Introduction



**The Twin Green and Digital innovation seeks to achieve long term transformation of business and the society at large towards a more competitive and sustainable future.**

Hitherto, green and digital innovation represent two leading but still separated trends that eventually affect all business. The combination of digital and green innovation of business is a more recent approach introduced by the European Commission and has been marked as a priority for European business in the next decades. Increasingly, Twin innovation is adopted by larger corporations as an answer to the pressure from internal and external stakeholders.

Yet, Small and Medium Sized Enterprises (SMEs) are lagging behind. They will have to catch up with the Twin green and digital innovation due to a combination of increasing pressure from different stakeholders including government, corporate clients and increasingly their customers.

SMEs are facing a number of challenges to invest in twin innovation including a lack of general knowledge about relevant twin innovations and high costs and perceived lack of benefits of these innovations for their business performance.

This report provides some of the answers to the challenges of SMEs in the particular case of the construction sector:

- An overview of relevant options for Twin green and digital innovation;
- An insight in the Impact of Twin innovation on business performance; and
- A basic roadmap for the implementation of the Twin innovation transition.

# Green innovation



**The green transition seeks to assist companies in their combat of climate change and environmental degradation by innovations in supply, production and sales processes.**

SMEs play a central part in the environmental challenges that Europe is facing given their large contribution to production and employment. SMEs are defined as companies with 10 to 250 employees and represent over 99% of all companies in the European Union, generate 57% of value added and generate 67% of employment (European Commission, 2020).

SMEs play a large role in their region at community level and can thereby have an important contribution to a greener and more digital Europe. Yet, they have limited capacity to implement and use digital technologies to support the green transition and are slow to implement innovations as a result of its highly decentralised nature and a lack of collaboration in the value chain (Goh, 2020).

SMEs have a significant share in the deteriorating of most environmental processes. Their emission of carbon dioxide alone represents 63% of all emissions by companies in Europe (European Union, 2022). SMEs are main actors in the European road transport sector and still dependent on fossil fuels.

Yet SMEs are widely-neglected actors in the Net Zero transition. A recent survey has looked at environmental action by SMEs.

A recent survey indicates that in Europe 89% of SMEs do take limited and isolated actions to reduce resource usage, including lower waste, savings on energy and materials, recycling and water savings. Around one third of SMEs offer green products or services, but these products represent mostly less than 10% of total turnover and are mostly sold at national level.

Finally, only one quarter of SMEs in Europe have a strategy to reduce their carbon dioxide emissions and 4% indicate that they are carbon neutral. Despite the increased attention for resource efficiency, investment by SMEs in green measures and technology is still limited (European Union, 2022).

SME business owners are mostly reactive as they see environmental measures as costly and affecting competitiveness without providing tangible benefits. (Studer, Welford and Hill, 2006). Also, most SMEs lack the expertise to undertake green innovation. They also remark that there are limited tools to help with planning, implementation and evaluation to guide green transition processes in SMEs (Martins, 2022).



# Digital innovation

**Digital innovation refers to the adoption of digital technologies and data by companies to improve business performance.**

Research indicates that they can provide broad benefits for SMEs in terms of better access to skills and talent, productivity and competitiveness, finance, product development and markets (Ramdami, 2022). Digitalization also has strategic value to market expansion and internationalization and is highly instrumental in new product development and customer satisfaction (Bala, 2019).

Despite the overall potential impact of digitalisation, there is still a clear gap between the level of digitalisation of both basic and emerging digital technologies among SMEs and larger companies.

A recent study of PWC shows that SMEs have a significant gap in digital transformation even in basic technologies such as E-commerce, cloud computing, ERP or big data analysis (PWC, 2022).

SMEs have a significant share in the deteriorating of most environmental processes. Their emission of carbon dioxide alone represents 63% of all emissions by companies in Europe (European Union, 2022). SMEs are also main actors in the European road transport sector and still dependent on fossil fuels.

Key obstacles to digital transformation SMEs are to overcome include are financial limitations linked to a lack of awareness about the potential revenues for SMEs. Other factors include the fear of data security and the required organisational culture and changes necessary to secure effective digital transformation. Another obstacle is found in the lack of internal digital expertise.

As a result, company owners of SMEs often choose not to invest as they do not know whether the investment will affect their business performance. If they decide to undertake digital transformation, they make less informed decisions on where to focus investments and efforts in their business processes. This directly affects the effectiveness of overall digital innovation but also limits the chances of SMEs to provide the necessary data to support a green transition process.

# Twin innovation

**Twin green and digital innovation allows companies to develop their digital strategy together with green business solutions to optimize the efficiency and sustainability of supply chains, business processes and products and markets.**

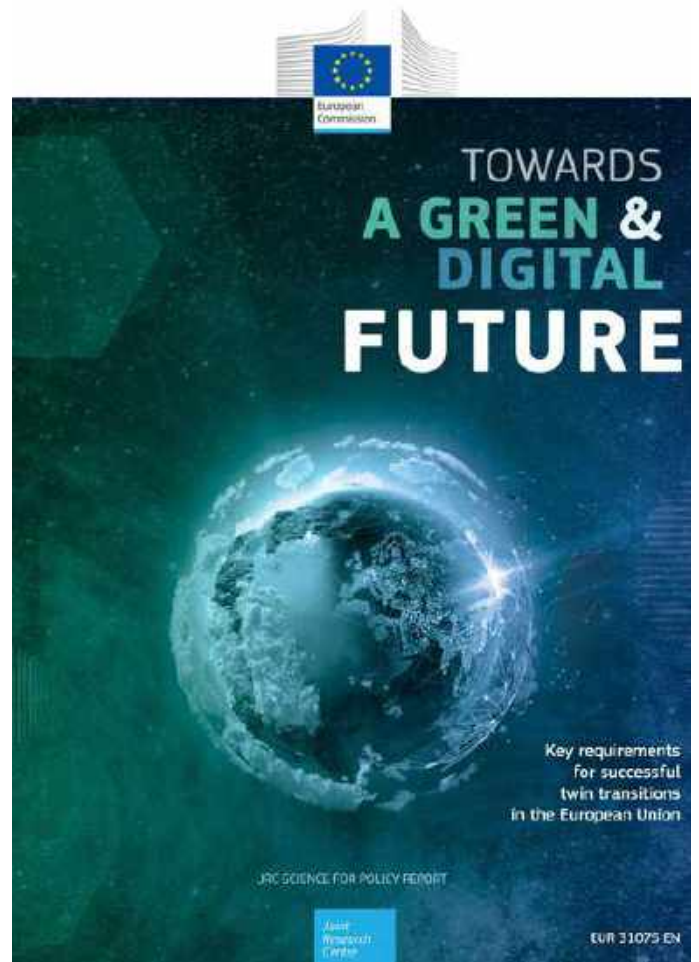
The Twin was adopted as a new concept by the European Union as part of its European SME Strategy and the European Green Deal (European Commission, 2021).

Next to the need for digitalization in general, SMEs are required to embrace the adoption of digital technologies and data to be able to demonstrate and measure the environmental footprint of their business activities.

Green innovation combined with digital tools to analyse emission levels can generate competitive advantages in material usage and production processes and create new markets for green products and services (George et al., 2021). As such, Twin innovation creates important opportunities to create additional value to SMEs.

However, a recent survey (European Union, 2022) indicates that most SMEs in Europe take limited and isolated actions to reduce resource usage, some with support of basic digital tools. Only 25% of SMEs in Europe have a strategy to reduce their carbon dioxide emissions and 4% indicate that they are carbon neutral.

Next to green innovation, digital technologies and capabilities can act as a catalyst and create synergies for green innovation processes and products through optimization of processes, monitoring and tracking of resources and virtualization of green products and services (Muench et al., 2021).



Despite the overall potential impact of digitalization, there is still a clear gap between the level of digitalization of both basic and emerging digital technologies among SMEs and larger companies. A recent study of PWC shows that SMEs have a significant gap in digital transformation even in basic technologies such as E-commerce, cloud computing, ERP or big data analysis (PWC, 2022).

The investment by SMEs in green measures and technology is still limited. SMEs face important barriers to Twin innovation including a perceived lack of benefits and the impact of both green and digital solutions on business performance.

Earlier studies indicate that SME business owners are mostly reactive as they see environmental measures as costly and affecting competitiveness without providing tangible benefits.

Another obstacle is found in the lack of internal environmental and digital expertise. Finally, SME owners indicate that there is no roadmap for planning and implementing Twin innovation (Martins, et al., 2022).



# Twin options



## **The need for Twin innovation in the construction sector**

Only 40% of companies in the construction sector are using emerging digital technologies in support of green innovation and an even lower percentage of companies engaged in organization wide green innovation (Muller, P., et al., 2021).

While the challenges of SMEs apply to most economic sectors, the type and adoption levels of Twin innovations and the sectoral contribution to European environmental pollution vary widely among sectors. In general manufacturing, infrastructure and service industries are much ahead in Twin innovations (European Commission, 2021).

The construction sector is slow to implement Twin innovations as a result of its highly decentralized, a lack of collaboration in the value chain and a lack of expertise. SMEs are key actors in the sector representing 99.9% of all companies, 90% of employment and 83% of value added in the European Union. SMEs in the sector have limited capacity to implement and use digital technologies to support the green transition.

SMEs will only be able and interested to engage in a twin transition process if they gain better insights in the twin options, their impact of twin innovations on business performance and understand how and where to start with twin innovation. These three challenges will be looked at in the next chapters. First we list the most relevant Twin options in this chapter.

To identify relevant Twin innovation options we look at options for different levels in the value chain including the twin options relevant for the supply chain, options for internal production processes and relevant innovation in products and markets.

These three business processes are aligned with the standard greenhouse gas emissions or carbon footprint of business activities, including scope 1 emissions of direct emissions in operations, scope 2 emissions from energy usage by the company and scope 3 level indirect emissions of suppliers and clients' products and services.

## **Twin innovation in the Supply chain**

Relevant green and digital innovations in the supply chain include the use and local sourcing of low carbon and nature-based materials and digital tools to compare materials and transport costs.

To enhance sustainability in the supply chain, the experts indicate that local sourcing of materials has since long been considered as an option to achieve lower emissions and low carbon materials are increasingly chosen as an alternative in building projects. The use of nature-based materials is less common due to elevated costs and limited to pilot projects in the construction sector.

Larger construction companies such as Dura Vermeer combine the green innovation with data analytics to measure material cost and emissions. Eventually, these will be developed into product passports and life-cycle models at product and construction project levels.

### Twin innovation for Business operations

Twin innovation for Business operations: At business operations level, construction companies are to seek greener, less use and recycling of materials, energy, water and waste products with support of enterprise resource planning tools, data analysis and smart meters.

Whereas business operations are concerned, the interviewees indicate that construction companies seek efficiencies in the use of materials, technologies supporting waste and water reduction, reuse and recycling.

Larger construction companies such as Dura Vermeer and Stamhuis are also experimenting with the electrification of construction and transport equipment, even though this implies additional investment costs and a period of adaptation by staff.

They are also investing in renewable energy solutions. In most cases smart meters and some level of data analytics are used to monitor energy resource usage.

In a smaller number of cases, companies such as Dura Vermeer experiment with novel technologies such as 3D concrete printing. There are also initial experiments with using sensors integrated into infrastructure and buildings to optimize the maintenance activities, e.g. in bridges.

In line with other studies earlier mentioned, the adoption of Twin innovation by SMEs is still limited due to higher costs and a lack of knowledge. Also, due to the complexity of integration of environmental data, there is limited integration of related data in ERP systems.

### Twin innovation for Products & markets

Looking at products and services, the construction sector can benefit from innovations in efficient construction processes, maintenance and energy sourcing and renovation and recycling empowered by product digital tracking and tracing technologies, big data analysis and machine learning.

When considering Twin products and services, the experts interviewed indicate that there is important scope for sustainable construction projects with higher investment but lower operational costs. Yet, most clients take decision exclusively based on investment costs so they are not willing to collaborate with constructors to develop a more sustainable and integrated design, planning of infrastructure and buildings, supported by digital modeling.

In this area, companies have also started with basic life-cycle analysis that can show clients the longer term sustainability of projects. This also applies to retrofitting and efficient heating and cooling systems. Due to complex ownership issues, the experts indicate that shared digital building management systems and 'construction as a service' is not yet a viable option in the sector.

## Twin green and digital options for the construction sector

Value chain level	Green innovation options	Digital innovation options
Supply chain management level (Scope 3)	<ul style="list-style-type: none"> <li>• Use of low carbon materials (low grey energy, lifetime, energy efficiency, potential for repair and recyclability)</li> <li>• Use of nature-based materials</li> <li>• Local sourcing of materials</li> </ul>	<ul style="list-style-type: none"> <li>• Digital tracking of materials (sensors, (block chain, product passport)</li> <li>• Data analytics to measure carbon intensity &amp; cost analysis of materials (databases &amp; dashboards)</li> </ul>
Business operations level (Scope 1 and 2)	<ul style="list-style-type: none"> <li>• Improved efficiency of materials</li> <li>• Technologies to enhance waste reduction, reuse &amp; recycling</li> <li>• Technologies to reduce and clear water</li> <li>• Electrification</li> <li>• Use of renewable energy</li> </ul>	<ul style="list-style-type: none"> <li>• Enterprise Resource Planning (ERP)</li> <li>• Smart digital metres &amp; data analytics (databases, dashboards, AI)</li> <li>• Smart production methods (robotics and 3d printing)</li> </ul>
Products and markets level (Scope 3)	<ul style="list-style-type: none"> <li>• Integrated building design and planning based on sustainable, resilient and recyclable materials</li> <li>• Improved efficiency of materials</li> <li>• Building retrofitting through energy renovation (shading, solar &amp; geothermal energy)</li> <li>• Low carbon heating &amp; cooling systems</li> <li>• Development of business service models for living and office buildings</li> </ul>	<ul style="list-style-type: none"> <li>• Integrated digital building modelling</li> <li>• Life cycle analysis, simulation and forecasting models for buildings</li> <li>• Digital building management systems</li> <li>• Digital platforms for living and office space sharing</li> </ul>

# Measuring Twin impact

To better understand the potential impact of Twin innovations we have used the Triple Bottom Line and other scientific studies as a starting point to define economic, social and environmental impact of twin innovation:

- **Economic impact:** We have identified a series of financial and economic indicators that can help to measure the impact on the business performance of the company including production costs, productivity, local and international competitiveness, and compliance with customer demands and government regulations.
- **Social impact:** As for social impact we focus on access to new talent and the levels of satisfaction of employees.
- **Environmental impact:** The environmental impact includes greenhouse emissions, materials efficiency and recycling and efficiency in water and energy usage.

## Indicators of Twin impact on business performance

Business process	Economic impact	Social impact	Environmental impact
Supply chain management level (Scope 3)	<ul style="list-style-type: none"> <li>1.1 Purchasing costs</li> <li>1.2 Customer compliance</li> <li>1.3 Government compliance</li> </ul>	<ul style="list-style-type: none"> <li>2.1 Access to new talent</li> <li>2.2 Employee satisfaction</li> </ul>	<ul style="list-style-type: none"> <li>3.1 Greenhouse gas emissions</li> <li>3.2 Materials efficiency</li> <li>3.3 Recycling of materials</li> </ul>
Business operations level (Scope 1 and 2)	<ul style="list-style-type: none"> <li>1.1 Production costs</li> <li>1.2 Productivity</li> <li>1.3 Competitiveness</li> <li>1.4 Customer compliance</li> <li>1.5 Government compliance</li> </ul>	<ul style="list-style-type: none"> <li>2.1 Access to new talent</li> <li>2.2 Employee satisfaction</li> </ul>	<ul style="list-style-type: none"> <li>3.1 Greenhouse gas emissions</li> <li>3.2 Materials efficiency</li> <li>3.3 Recycling materials</li> <li>3.4 Water efficiency</li> <li>3.5 Energy efficiency</li> </ul>
Products and markets level (Scope 3)	<ul style="list-style-type: none"> <li>1.1 Product costs</li> <li>1.2 Revenues</li> <li>1.3 Customer compliance</li> <li>1.4 Government compliance</li> <li>1.5 Local competitiveness</li> <li>1.6 International competitiveness</li> </ul>	<ul style="list-style-type: none"> <li>2.1 Access to new talent</li> <li>2.2 Employee satisfaction</li> </ul>	<ul style="list-style-type: none"> <li>3.1 Greenhouse gas emissions</li> <li>3.2 Recycling materials</li> <li>3.3 Materials efficiency</li> <li>3.4 Recycling materials</li> <li>3.5 Water efficiency</li> <li>3.6 Energy efficiency</li> </ul>

# Twin impact in the supply chain

## Impact of Twin innovation in the supply chain of the construction sector

The innovation towards the use of low carbon materials supported by data analytics will strongly contribute to the reduction of scope 3 emissions and positively impact the compliance of customer and government requirements. Also the use of natural materials will positively impact emissions. The use of natural materials and locally acquired materials will not lead to improved material efficiency or compliance with client or government regulations.

However, the selection of low carbon and natural materials in some cases is hampered by a lack of information or unwillingness to provide information by part of the suppliers. Furthermore, the use of alternative materials do imply higher costs which in many cases cannot be translated into market prices as private and public customers do not consider additional costs in their price setting. Therefore constructors are to absorb higher costs during the next few years until regulations force customers to adjust prices.

The table below shows the impact level of each twin in terms of positive (+) or negative impact (-), neutral (o) or unclear positive or negative impact (+/-) on economic, social or environmental performance.

Business process	Twin green and digital innovation options in the construction sector		Impact on business performance
Supply chain management level (Scope 3)	1. Use of low carbon materials (low grey energy, lifetime, energy efficiency, potential for repair and recyclability)	1. Digital tracking of materials (sensors, (block chain, product passport) 2. Data analytics to measure for carbon intensity & cost analysis of materials (databases & dashboards)	<b>Economic</b> 1.1 Purchasing costs -- 1.2 Customer compliance + 1.3 Government compliance + <b>Social</b> 2.1 Access to new talent 0 2.2 Employee satisfaction 0 <b>Environmental</b> 3.1 Greenhouse gas emissions. ++ 3.2 Materials efficiency + 3.3 Recycling of materials +
	2. Use of nature-based materials	1. Digital tracking of materials (sensors, (block chain, product passport) 2. Data analytics to measure for carbon intensity & cost analysis of materials (databases & dashboards)	<b>Economic</b> 1.1 Purchasing costs -- 1.2 Customer compliance 0 1.3 Government compliance 0 <b>Social</b> 2.1 Access to new talent + 2.2 Employee satisfaction + <b>Environmental</b> 3.1 Greenhouse gas emissions ++ 3.2 Materials efficiency 0 3.3 Recycling of materials +
	3. Local sourcing of materials	1. Digital tracking of materials (sensors, (block chain, product passport) 2. Data analytics to measure for carbon intensity & cost analysis of materials (databases & dashboards)	<b>Economic</b> 1.1 Purchasing costs +/- 1.2 Customer compliance 0 1.3 Government compliance 0 <b>Social</b> 2.1 Access to new talent 0 2.2 Employee satisfaction 0 <b>Environmental</b> 3.1 Greenhouse gas emissions +/- 3.2 Materials efficiency 0 3.3 Recycling of materials 0

# Twin impact in business operations

## Impact of Twin innovation on business operations in the construction sector

The use of low-carbon and natural materials can result in lower scope 1 emissions if material characteristics and usage can be monitored and if the material flow can be integrated in the companies' information management systems. Digital tools as smart meters and material passports are seen as an important differentiator in which companies are to invest now to secure both competitiveness and compliance with future regulations. The experts indicate that twin innovation requires companies to show results through small and effective solutions to enhance awareness and create support among both decision makers and staff.

The impact of twin innovations in the companies' waste and water reduction and recycling on scope 1 emissions is high and will contribute to more efficient resource usage but very limited financial and social impact. Companies do see electrification of construction equipment and renewable energy solutions for production and transport -including digital tools for monitoring- as necessary but these require high investments which can only be recovered in the long term. These innovations also require durable internal leadership and awareness building to overcome initial resistance among staff. Once implemented, companies do gain broad support from employees.

The table below shows the impact level of each twin in terms of positive (+), negative (-), neutral (o) or unclear positive or negative impact (+/-) on economic, social or environmental performance.

Business process	Twin green and digital innovation options		Impact on business performance
Business operations level (Scope 1 and 2)	1.Improved efficiency of materials	1.Enterprise Resource Planning (ERP) 2.Smart digital metres & data analytics (databases, dashboards, AI) 3.Smart production methods (robotics en 3d printing)	<b>Economic</b> 1.1 Production costs - 1.2 Productivity + 1.3 Competitiveness + 1.4 Customer compliance + 1.5 Government compliance ++ <b>Social</b> 2.1 Access to new talent ++ 2.2 Employee satisfaction + <b>Environmental</b> 3.1 Greenhouse gas emissions ++ 3.2 Materials efficiency +++
	2.Technologies to enhance waste & water reduction, reuse & recycling	1.Enterprise Resource Planning (ERP) 2.Smart digital metres & data analytics (databases, dashboards, AI) 3.Smart production methods (robotics en 3d printing)	<b>Economic</b> 1.1 Production costs + 1.2 Productivity o 1.3 Competitiveness o 1.4 Customer compliance o 1.5 Government compliance + <b>Social</b> 2.1 Access to new talent o 2.2 Employee satisfaction o <b>Environmental</b> 3.1 Greenhouse gas emissions ++ 3.2 Recycling materials ++ 3.3 Water efficiency ++
	3.Electrification & Renewable energy	1.Enterprise Resource Planning (ERP) 2.Smart digital metres & data analytics (databases, dashboards, AI) 3.Smart production methods (robotics en 3d printing)	<b>Economic</b> 1.1 Production costs - 1.2 Productivity o 1.3 Competitiveness + 1.4 Customer compliance o 1.5 Government compliance + <b>Social</b> 2.1 Access to new talent + 2.2 Employee satisfaction o <b>Environmental</b> 3.1 Greenhouse gas emissions ++ 3.2 Energy efficiency ++

# Twin impact on products & markets

## Impact of Twin innovation on products & markets in the construction sector

Twin innovations to support more sustainable building and utility planning and management are important to diminish scope 3 emissions on the longer term but will generate additional production costs. Integrated digital construction planning and life-cycle models for building projects will support resource efficiency, reuse and recycling. These additional costs cannot be compensated with higher product and service price levels. The experts of both Stamhuis and Dura Vermeer indicate that clients need to be more genuinely interested in sustainability and to share at least part of the investments in twin innovation. Within this logic, they can strengthen longer term competitiveness and differentiation in local and particularly in international markets. They will also make a company attractive to new talent and motivated staff, but may challenge employees with less interest to grow and innovate.

The companies interviewed have also gained some experience with advanced business model innovation such as Construction as a Service. These approaches are of interest as it can generate a regular source of cash flow and enables true circular management of materials and resources. Yet, experience so far shows that these options are still complicated to implement due to its complex legal implications for ownership and management and are difficult to explain to, and gain support from, customers.

Building retrofitting covers smart energy solutions such as shading, solar and geothermal and introduction of low carbon heating and cooling systems in existing buildings. These solutions will have a large impact on reduced emissions but are complex and comes at high costs to the construction companies. They will attract new talent but will require additional training of existing staff.

The table shows the impact level of each twin in terms of positive (+) or negative (-), neutral (o) or unclear impact (+/-) on economic, social or environmental performance.

Business process	Twin green and digital innovation options		Impact on business performance
Products and markets level (Scope 3)	1. Integrated building design and planning based on sustainable, resilient and recyclable materials	<ol style="list-style-type: none"> <li>1. Integrated digital building modelling</li> <li>2. Life cycle analysis, simulation and forecasting models for buildings</li> <li>3. Digital building management systems</li> </ol>	<b>Economic</b> 1.1 Production costs --- 1.2 Revenues o 1.3 Customer compliance o 1.4 Government compliance o 1.5 Local competitiveness + 1.6 International competitiveness ++ <b>Social</b> 2.1 Access to new talent ++ 2.2 Employee satisfaction +/- <b>Environmental</b> 3.1 Greenhouse gas emissions ++ 3.2 Recycling materials ++
	2. Building retrofitting through energy renovation (shading, solar & geothermal energy) & low carbon heating & cooling systems	<ol style="list-style-type: none"> <li>1. Integrated digital building modeling</li> <li>2. Digital building management systems</li> </ol>	<b>Economic</b> 1.1 Production costs ---- 1.2 Revenues o 1.3 Customer compliance + 1.4 Government compliance + 1.5 Local competitiveness + 1.6 International competitiveness ++ <b>Social</b> 2.1 Access to new talent ++ 2.2 Employee satisfaction +/- <b>Environmental</b> 3.1 Greenhouse gas emissions ++ 3.2 Water efficiency +++ 3.3 Energy efficiency +++
	4. Development of business service models for living and office buildings	<ol style="list-style-type: none"> <li>1. Digital platforms for living and office space sharing</li> </ol>	<b>Economic</b> 1.1 Production costs o 1.2 Revenues ++ 1.3 Customer compliance - 1.4 Government compliance - 1.5 Local competitiveness + 1.6 International competitiveness + <b>Social</b> 2.1 Access to new talent ++ 2.2 Employee satisfaction - <b>Environmental</b> 3.1 Greenhouse gas emissions +++

# Twin Roadmap

NEXT

NOW

LATER

**The research also enables us to understand at what activity level in the value chain SMEs are best to start with Twin innovation.**

The short-term time frame covers the next two years and the mid-term period a three to five-year period. The long-term timeline for twin transition refers in the period up to 2030, where major emission and waste targets are set in the construction sector (European Commission, 2021).

**Short term:** In the short term companies are to start with Twin innovation at the level of their business operations. Their argument is that construction companies are already legally bound to comply with European Climate Law and national government regulations that focus on emission levels scope 1 which are directly related to business operations.

Furthermore, companies have more control over their own processes than over suppliers or customers and they can exploit the presence of basic digital infrastructure.

Construction companies can also benefit from the more proven green innovations available. Finally, despite the negative impact on production costs, twin innovations are expected to have a positive impact on the companies' competitiveness as a result of resource efficiency gains can reduce resource costs and even generate new sources of revenues from the sales of waste and energy.

**Mid term:** In the middle-long term, companies are to further integrate Twin innovation in their supply chain. This is needed to comply with the increase in the EU and national regulations regarding resource efficiency in the next 3 to 5 years which will oblige suppliers to source more carbon efficient materials.

Without the Twin innovation, smaller construction suppliers may not be able to comply with increased standards for green building materials set by contracting construction companies and thereby lose market access and competitiveness.

**Long term:** In the longer term from five to ten years, construction companies are to look out for Twin innovation in products and services delivered to customers in the construction sector. This includes multiple innovations to increase material efficiency and reduce emissions by developing digital life-cycle and simulation models and introducing service based construction. These innovations will be needed to respond to fast developing EU and national regulations for buildings in Europe to reduce Scope 3 emissions

They also stress the importance of new forms of collaboration and contracting between construction companies and their clients such as real estate investors or governments where partners seek shared ownership of the innovation process and the necessary additional costs, time and efforts.

**Short term:**  
Twin innovations improving scope 1 emissions in business operations

**Mid term:**  
Twin innovations improving scope 3 emissions at supplier level

**Long term:**  
Twin innovations improving scope 3 emissions in products and markets

# Conclusions & Recommendations



**This study confirms that Twin innovation will become a necessity for companies in general and the construction companies in particular. And yes, Twin innovations will implicate investment, higher costs and risks. Yet the innovations are needed now to diminish the environmental impact of construction and in mid term to comply with environmental regulations and reporting standards and to compete with larger companies that do invest in the Twin. On the longer term Twin innovation also provides opportunities for innovative products in local and international markets. For this to happen and mitigate financial implications we recommend you to take following decisions and actions.**

**Good luck with a new challenge! Arjan & Stijn**

## **Strategic decisions**

- Seek a common definition of sustainability (to speak the same language)
- Make Green and Digital transition key elements of your innovation strategy
- Make sure that decisions on Twin innovation consider market position, financial and environmental costs and benefits
- Use digital innovation to develop knowledge and advice customers on costs and benefits of green innovation
- Seek structural integration of green monitoring data in your ERP/BIM
- Identify your 2-3 key priorities & KPIs in Twin innovation. e.g. Product passport, Material efficiency..

## **Human resources**

- Secure a Twin champion at strategic board/director level
- Increase awareness and information about the need for environmental reporting and positive and negative impact on business performance
- Secure coordination and proactive collaboration between digital and sustainability teams
- Setup an innovation department / team including ICT, data and sustainability experts
- Trained current staff & combine with new talent

## **Where to start**

- Start with Twin in business operations to show fast impact and get internal support
- Experiment with fast track Twin innovations in a chosen project
- Secure fast integration on successful innovations in your processes & ERP/BIM
- Also work hard to get large suppliers start providing emission data to support monitoring of materials
- Be a Twin facilitator to help your smaller suppliers & contractors to be able to provide data
- Be a first mover in applying Twin innovation in product innovation to build a longer term competitive advantage in local and international markets

## **Implementation**

- As any innovation, Twin innovation implies costs, time, risks and trial and error
- Accept that Twin innovation will imply higher investment cost not compensated by higher prices but also can reduce longer term operational costs
- If you invest now you will be ahead of future CSRD requirements by customers & regulations
- To be successful and lower costs, seek collaboration with suppliers, contractors and clients in sharing knowledge, data and investments in Twin innovation



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The research made use of a series of articles and studies you can use to get more insights in the Twin Green and Digital Innovation

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