ConTech: Technology in construction

Construction sector digitalising but showing little industrialisation

ING Economics Department • February 2019

Summary

Construction sector digitalising but showing little industrialisation

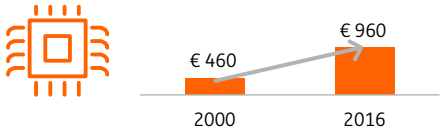
The construction sector has been catching up in terms of digitalisation over the past several years. Partly because of this, the productivity of the European construction sector is now growing, after years of stagnation. Innovation in digitalisation in particular has been boosting efficiency, while industrialisation of the construction process is still lagging behind.

Construction companies are digitalising...

Construction companies have been catching up in terms of digitalisation over the past several years. In 2000, an employee in the European construction sector had almost €500 in software at their disposal. Sixteen years later, this had increased to almost €1,000. Digitalisation can provide many advantages in construction, where every project often has to be designed from scratch. It increases the efficiency of the design process and enables construction errors to be picked up as early as the design phase. But smaller matters in construction are also being performed more quickly as the world goes digital. Estimates for minor maintenance jobs can be provided on the basis of digital photos, for instance, which saves a visit to a potential customer.

More software being made available to the European construction sector*

Value of software and data per worker



... but despite new technologies, industrialisation is still facing bottlenecks

Industrialisation has not been quick to take off in the European construction sector. An employee in the sector has approximately €10,000 in machinery at their disposal. That is approximately one fifth the value available to employees in the manufacturing sector. This is because construction companies require a very high degree of flexibility. They have to build something different each time, and each time at a different location. This takes place in a volatile market that demands quick scaling up and down. It makes sense that many construction companies opt not to invest in machinery that puts significant pressure on the fixed costs and which can also often only perform one type of task. Robotics and 3D printing (combined with prefab) could offer a solution to some extent, since this would allow the mass customisation required. High investment costs and building at a different location each time continue to pose bottlenecks, however.

European construction worker has little machinery*

Value of machinery per worker

Manufacturing sector
€ 55,200

Construction
€ 9,900

Construction sector focusing primarily on digitalisation

Digitalisation is coming into its own:
- Relatively low investment costs.
- There is much to be gained because almost every building work must be designed.
- Rapid mobile internet enables digitalisation at the construction site.

Industrialisation using robots and 3D printing offers opportunities:
- 3D printing and robotisation facilitate mass customisation.

But other bottlenecks for industrialisation remain:
- Relatively high investment costs and volatile market.
- A different construction location each time.

* Source: Eurostat and calculations by the ING Economics Department based on data from the countries: Belgium, Germany, France, Italy, Luxembourg, The Netherlands, Austria & Finland (selected on the basis of available data).

Introduction

The construction sector is not known for being extremly innovative: bricklaying is often performed in the same way it was hundreds of years ago, and there was hardly any increase in labour productivity in construction for a long time. In 2016 and 2018, respectively, the ING Economics Department published the Dutch-language reports 'Technologie in de bouw' [Technology in construction] and 'De bouw digitaliseert volop maar industrialiseert nauwelijks' [Construction sector fully engaged in digitalising but showing little industrialisation].

The conclusion reached by the reports was that new technologies (3D printing, robotics and especially digitalisation) could cause productivity to increase in the Dutch construction sector in the next few years. This can already been seen in the Netherlands to some extent.

For this publication, we looked at what impact new technology is having on European construction. In chapter 1, we discuss the need for innovation as well as the impediments and the possibilities presented by new technologies. Chapter 2 talks about the trend in labour productivity in the European construction sector and the number of construction companies already investing in digitalisation and industrialisation.

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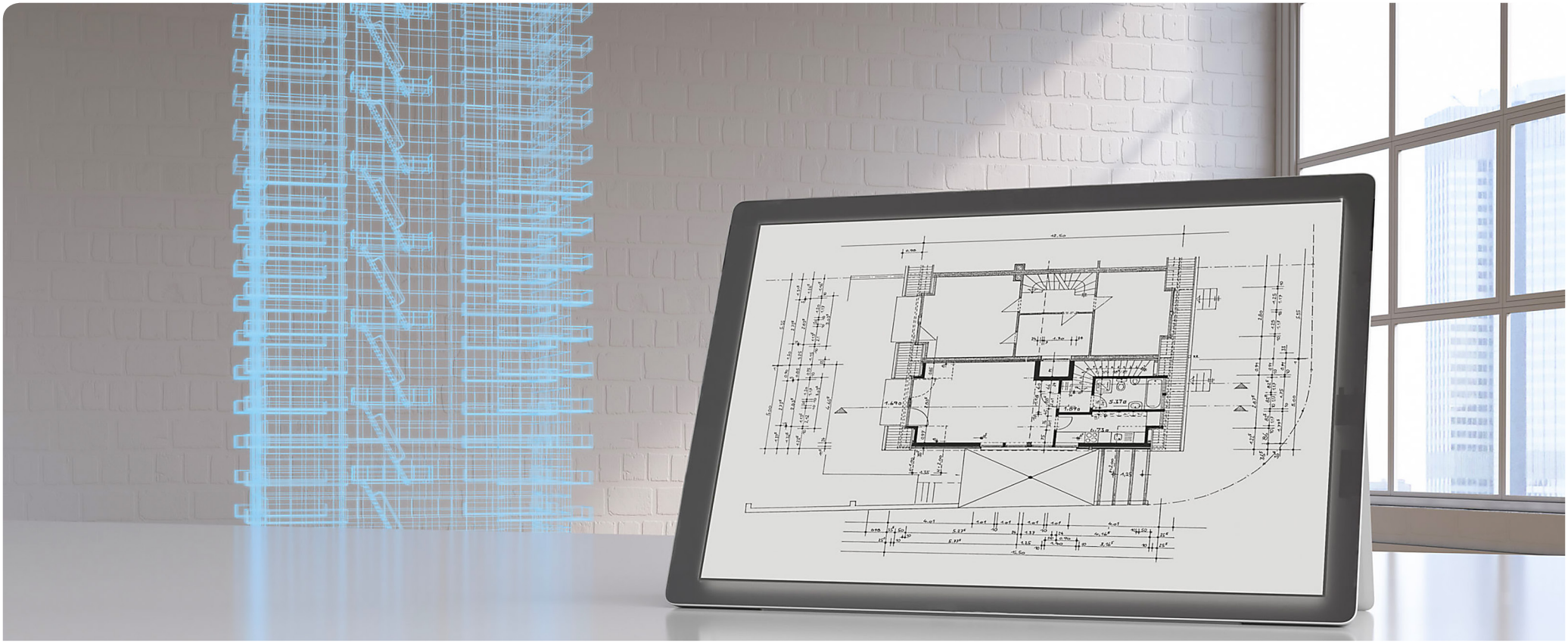


Chapter 1 | Innovation in construction is difficult, but new technology offers possibilities

Labour shortages & higher prices force innovation

Working more efficiently to compensate for personnel shortages

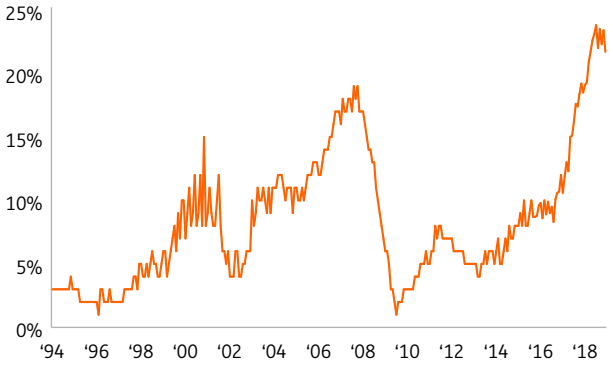
We're hearing demands for even more innovation, but why? The construction sector is picking up in most European countries, isn't it? While this is true, the bottlenecks in the sector have shifted over the past few years, from too little demand to not enough production capacity. Almost a quarter of the construction companies in the EU stated at the end of 2018 that labour shortages are an impediment to construction volume. Innovation in more efficient construction methods could mean that construction companies would need fewer personnel and still grow.

Without innovation, construction companies will become too expensive

The construction sector will also price itself out of the market in the long term if it does not innovate. Growing efficiency means that industry is producing increasingly more per labour hour, often resulting in products becoming cheaper. Take the electronics sector, for instance, where prices continually decline. In construction, however, costs are increasing ever faster, which means new construction and renovations are becoming more and more expensive. In deciding between a new car or an extension to their home, for instance, consumers will be more likely to opt for the car if the gap in price widens. This also makes room for newcomers from outside the sector who are actually innovating, creating more efficient processes and in turn pushing construction businesses out of the supply chain.

Increasing labour shortages at European construction companies

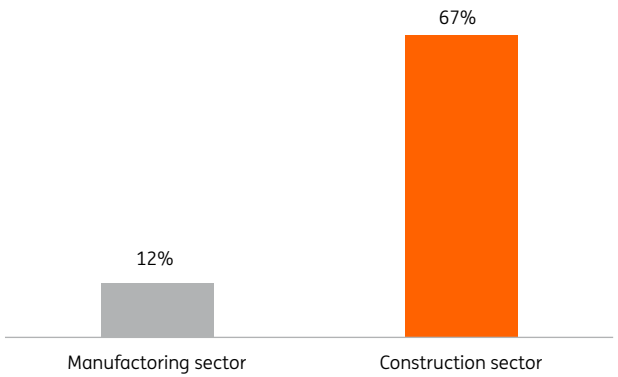
Trend in EU construction companies facing impediments to production (seasonally adjusted)



Source: European Commission

Construction becoming relatively more expensive

Change in the price of the added value (2017 vs 1997)



Source: Eurostat, ING Economics Department

Need for flexibility makes innovation difficult

It's not that construction companies are deliberately not innovating. The culture of the sector is often cited as a cause: it's said to be traditional and averse to new ideas. However, we believe that it's the market structure of the construction sector that's to blame for the fact that many existing 'old' technologies that facilitate mass production are not suitable for the construction industry, which is why innovation has been slow. Below we describe how these factors hindered innovation for decades because they could not offer the much-needed flexibility required in the construction sector.

Need for flexibility makes innovation difficult

- Localised production
- Having to build something different each time
- Volatile market

→ Forces construction companies to remain flexible → Major investments for mass production not an option

Localised production

A construction company works at a different location each time. Because production is tied to the location (construction site), the construction process is difficult to industrialise (in a factory building). Heavy machinery is difficult to move, conditions are different at every location and regulation varies from country to country. This is why flexibility is important, and construction companies retain this flexibility by doing a lot of work manually. This also means that few construction companies are active in multiple countries, so innovations are also less readily implemented in the local home market.

Building to someone else's plan

The building design is often created by architects and then outsourced with specifications and drawings. As a result, construction companies find themselves building something different each time. Compare this with the automotive industry, where every buyer has their own car built according to their own wishes. Industrialisation is hardly possible in such circumstances. This also promotes 'beginner's mistakes' (failure costs), does not encourage industrialisation of the construction process and results in little investment in machinery (which can often perform only one type of task).

Volatile market

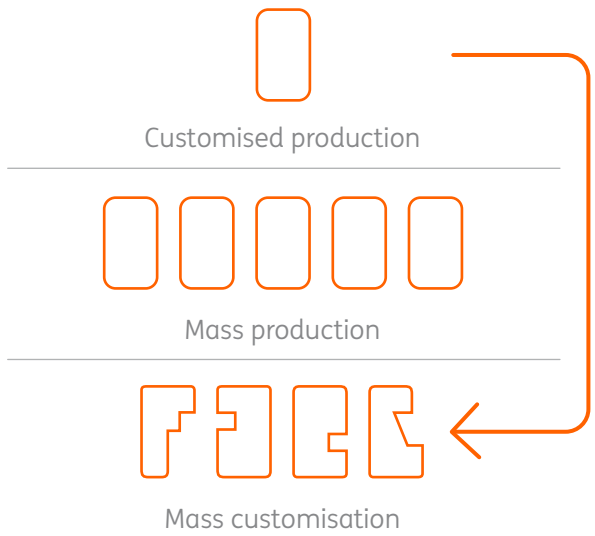
Because of the volatile demand for new construction, construction companies must remain flexible. Investments in means of production drive up the fixed costs. In times of crisis, this can become fatal. Because construction is so concentrated on a locality, it is almost impossible to spread risks internationally, i.e. a resurgence in one market counterbalancing a crisis in another. Finally, construction companies cannot produce for stock and cushion temporary shocks in demand by allowing stock to increase or decrease.

New technologies do enable innovation

New technologies facilitate mass customisation

New technological developments can give construction the necessary flexibility. This enables the construction sector to immediately take the step from the current system of unit manufacturing to mass customisation. Higher production numbers can also be achieved, with the required customisation.

Construction can immediately take the step towards mass customisation



Industrialisation through robotisation and 3D printing

Technology such as robotics is still not commonly used, even though it could be suitable for many activities in construction. Robots can manufacture 100 different building parts as easily as they can 100 of the same, thus enabling mass customisation. Prefab encourages an expansion of the number of robots. It is easier to have robots functioning in a factory than outside at the construction site where conditions are changeable. This would enable construction companies to switch over from customised production to mass customisation with the use of new technology, which would boost labour productivity (page 10).

Digitalisation thanks to big data, faster computers, tablets and 4G

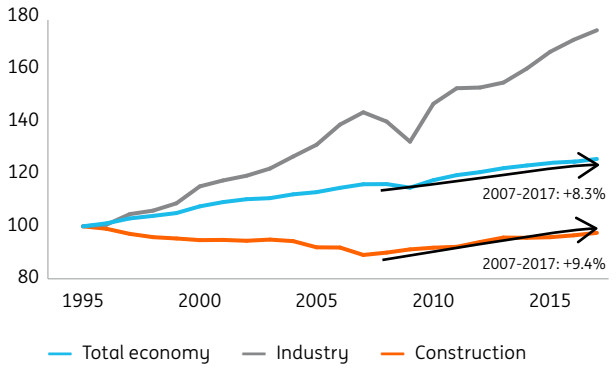
What is being applied more and more is digitalisation. A great deal of customisation is provided in construction. This means that nearly every project has to be designed from scratch. Digitalisation increases the efficiency in this process. Designing digitally using BIM (Building Information Modelling) therefore produces a relatively high number of advantages. Rapid mobile internet (4G and later 5G) and mobile devices (like tablets and smartphones) that bring digitalisation to the construction site wirelessly make this design method very suitable for construction. Other forms of digitalisation also yield major efficiency gains in the construction process (page 11).

Chapter 2 | Much digitalisation but little industrialisation

Finally an increase in productivity

Labour productivity in construction lagged behind for a long time

Labour productivity of the added value in volume per hour worked in the eurozone, 1995-2017 (index 1995=100)



Source: Eurostat, processed by the ING Economics Department

Trend in labour productivity lagged behind in construction for a long time...

The innovation in new technology (e.g. digitalisation and industrialisation) enables construction companies to work more efficiently. More construction activity or higher quality construction activity is performed per hour worked, which boosts productivity. However, labour productivity did not increase at all in the construction sector for a long time. In 2007, productivity in construction in the eurozone was approximately 10% lower than in 1995. In this period, productivity in industry increased by approximately 40% and that of the eurozone as a whole by 16%.

...but from 2007, keeping pace with the overall economy...

However, since 2007, the average growth in labour productivity in construction (2007-2017: + 9.4%) has come into line with that of the total economy.

... even with contracting volume

The growing labour productivity in construction since 2007 is striking since production in the European construction sector has contracted significantly over the past 10 years. A contraction in volume at businesses usually results in a worsening of productivity, as it creates overcapacity. It therefore appears that the growing productivity is also structural to some extent, due to innovation and more efficient construction methods.

On the following pages, we see that construction companies have focused mainly on digitalisation and, to a much lesser extent, on industrialisation in order to increase productivity.

Construction production in EU12 has contracted over past 10 years

Development in added value in EU12 in volume

Source: Eurostat, processed by the ING Economics Department

Still little industrialisation

The construction sector has relatively few machines and installations

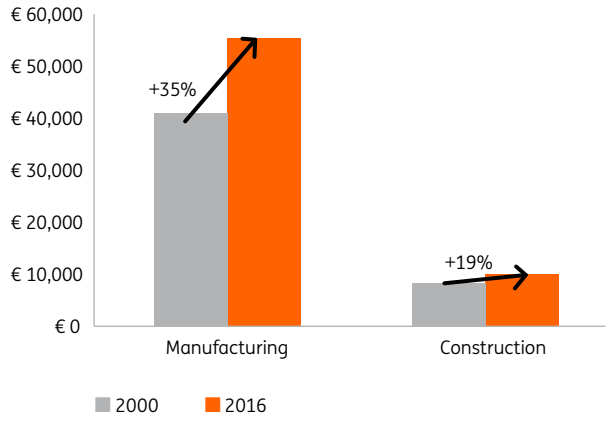
Industrialising the construction process requires machinery and other equipment. The figure at the side shows that companies in the construction sector still have little in the way of this kind of machinery and equipment on the balance sheet compared with industry. An average 'European' construction company has less than €10,000 in machinery and installations for every worker, while this figure is over five times higher in industry, with €55,000 in machinery and installations per worker. As a result, the industrialisation of the construction process is still limited.

Robotics & 3D printing provide opportunities, but other bottlenecks remain

Robotics and 3D printing provide solutions to some extent, since these allow the mass customisation required. Prefab also encourages the use of robots. It's easier to have robots functioning in a factory than outside at the construction site, where conditions are changeable. However, high investment costs in the volatile construction market and building at a different location each time continue to pose difficult hurdles.

Value of machinery per construction worker low

Total value of machinery per worker in EU8*

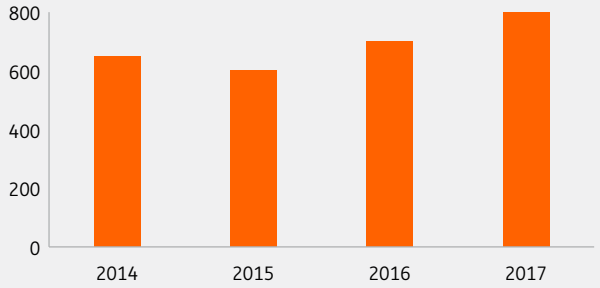


Source: Eurostat, processed by the ING Economics Department

* Belgium, Germany, France, Italy, Luxembourg, The Netherlands, Austria & Finland (selected on the basis of available data).

Number of robots in construction on the rise

Number of robots sold to the construction sector worldwide



Only 0.2% of all robots sold worldwide go to the construction sector. This is just a drop in the ocean, but the number is on the rise.

Source: IFR World Robotics, processed by the ING Economics Department

Digitalisation still limited but showing significant growth

The construction sector is investing substantially in software and data

Digitalisation has been catching up in construction over the past few years. In 2000, 'European' construction companies still had a limited volume of software and databases on their balance sheets. By 2016, contractors had doubled the value of the software and databases available to almost €1,000 per worker. This is not yet at the level of the manufacturing sector, but this double means it has made some way towards catching up. Digitalisation can provide many advantages in construction, where every project often has to be designed from scratch. It increases the efficiency of the design process, enables construction errors to be picked up as early as the design phase and allows all the parties involved to access the latest changes.

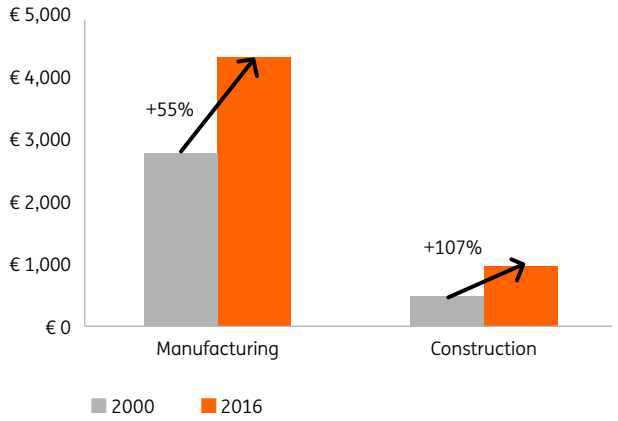
Digitalisation offers many different advantages

It is not just in the design phase that digitalisation offers advantages for construction: 'smaller matters' in construction are dealt with more efficiently as the world goes digital:

- Navigation systems enable maintenance workers to reach their destination more quickly;
- Digital platforms (e.g. HomeAdvisor) mean customers and contractors can find each other more easily, so that less time is 'wasted' looking for work;
- Weather radar keeps painters updated on when they can and can't do outdoor painting;
- Estimates for minor jobs can often be provided solely on the basis of digital photos, saving a visit to a potential customer.

Value of software per construction worker low

Total value of software and data per worker in EU8*



Source: Eurostat, processed by the ING Economics Department

* Belgium, Germany, France, Italy, Luxembourg, The Netherlands, Austria & Finland (selected on the basis of available data).

Fewer errors and more efficient maintenance through digital design

BIM (Building Information Modelling) is much more than just designing in 3D software: it monitors the use of materials as well as the contribution by third parties. Construction errors are picked up as early as the design phase (instead of it only becoming apparent during work on the scaffolding that a particular component doesn't fit). 'We don't talk about BIM any more, we talk about digital construction', says Patrick Van der Vliet of BAM Wonen. 'First we build digitally, and only after that outdoors. We make it before we make it.' The fact that an enormous amount of construction data is available is useful not only during the construction. For instance, this also makes it possible to have maintenance schedules at the ready, so that if there is any glass damage, a pane can be immediately replaced to measure. It also makes circular building much easier: if you know what material you put into the building and how, you also know how to take it apart and re-use it.

Het Financieel Dagblad, 5 July 2018

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