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DISCUS PROJECT

Digital Transformation in the Construction Sector: challenges and opportunities

Country Case Studies

Report – Italy

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INTRODUCTION

As we have already seen, the processes of innovation that are involving the construction sector are changing the value chains, also implying important changes in the way of working of the different professionals. In order to explore these processes, three different case studies have been undertaken, chosen with an increased focus on the differentiation of the sectors.

Each of these case studies tries to analyze concrete experiences of industrial relations that address digital and technological changes in the construction industry by considering the complete value chain and actors involved.

The methodology based on desk analysis and interviews with different actors involved in these processes: workers' union representatives; employers and representatives of employers' organizations; experts; professional associations.

Specific analytical dimensions are explored in each work, which cover:

- the main characteristics of the case: description of the company and/or activities, actors interviewed, methodology employed;
- description of the main innovations that characterize the case study;
- impact of the digitization process on work organization and value chain;
- how new technologies impacted on professions, skills and recruitment;
- relationship between innovations and quality of work life;
- drivers and barriers of the digitization process;
- how new technologies changed social dialogue and the new role of industrial relations;
- the impact of Covid in the digitalization processes.

The first of the case studies concerns the application of Building Information Modeling through the description of three different projects, chosen with the aim of giving an overview of the multiple implications of BIM applications in relation to overall value chain of the construction industry. The first of the projects is from 2012 by Exa Engineering and concerns the application to a civil construction (the construction of the infrastructure linking the city and the Marina di Mirabello) of a software until then used mainly in the mechanical field. The second, also developed by Exa Engineering, concerns the extension and requalification of the La Spezia Gulf Terminal. In the last project considered, BIM was included in the construction phase and concerns the construction of the connection of a new pier to Terminal 1 and

the restructuring of Terminal 1 of the "Leonardo Da Vinci" International Airport in Fiumicino.

The second case study focuses on the application of smart-devices on site building, through the experience of Brescia where the innovation process involves several professional profiles, even very different from each other. In this case, the introduction of such innovation is the result of a complex negotiation process aimed at finding a balance between the interests and skills involved. Moreover, the Brescia Case involves a wide range of activities that generate the innovation process.

The third and last of the Italian case studies (smart-factory off site building) concerns the wood sector and analyzes the Mauro Saviola Group, a pioneer in the design and production of a 100% ecological panel, made completely from post-consumer wood. The Group, whose production is based entirely on a circular economy process, was chosen for the innovative imprint that has always characterized its corporate choices.

Case study A: Building Information Modeling (BIM)

BUILDING INFORMATION MODELING (BIM): WORK ORGANISATION, WORKING CONDITIONS AND SOCIAL DIALOGUE IN THE TRANSFORMATION OF THE BUILDING PROCESSES¹

1. Methodology and main characteristics of the case study

This report investigates the role of Building Information Modeling (BIM) in digitalisation and technological innovation processes in the construction sector in Italy through field research based on case studies. The analytical tools were based on the “triangulation” of data sources and survey tools: i) documentary analysis; ii) direct observation (although the COVID-19 pandemic has forced many interviews and site visits to be replaced with online contacts); iii) conducting in-depth interviews with “privileged witnesses”.

The selection of the cases to be studied was made as a reasoned choice based on the intrinsic theoretical relevance of the cases themselves. The aim is to provide an account of the multiple implications for work, businesses, the territory and the industrial relations system that derives from BIM applications in relation to the entire value chain of the construction sector.

To this end, the following cases were analysed:

- a “pioneer” project, in 2012, by the Exa Engineering studio, in which the choice to apply BIM was introduced experimentally in the design company, through the application to a civil construction of a software that was very evolved at the time, but used until then mainly in mechanics (the construction of the connection infrastructure between the city and the Mirabello Marina). This is a case of BIM being applied in the workshop, rather than on the construction site, where all the mechanical and steel parts of the construction were cut directly using the software files. Therefore, the simplification not only of the design of the work, but also of the practical realisation on site with the assembling of prefabricated pieces was remarkable;
- a project, again developed by Exa Engineering, which began, instead, as a BIM contract (though it is currently blocked by the advent of the pandemic). This is the expansion and redevelopment of the Terminal of the Gulf of La Spezia, with the completion of the third basin of the master plan. The project, which won “The Plan Award 2016”, is also interesting for its aspects of: i) redeveloping the entire urban

¹ Daniele Di Nunzio, Serena Rugiero.

area which will be connected to the city district of Fossamastra with the return to the city of the area intended for activities not subject to customs restrictions; ii) the search for eco-friendly solutions (cold ironing system for moored ships; electric-powered SSG, RTG and RMG cranes); iii) the enhancement of the intermodal connection with the rear port area of S. Stefano, in line with the goal of achieving 50% of rail traffic and integrated logistics systems.

- a case in which BIM was inserted during construction, starting from a 2D project to arrive at a “federated” model in order to use the model on direct site applications: the construction and connection project of a new pier at Terminal 1 and the renovation of Terminal 1 of Fiumicino “Leonardo Da Vinci International Airport”.

In addition to the players related to the development of the aforementioned projects, various other “privileged witnesses” from other companies and territories (BIM managers, executives, site managers, workers, trade union representatives) were interviewed to investigate the broad impact of Building Information Modeling on organisation and working conditions, on the role of industrial relations, and on the benefits and critical points of the digitalisation processes in construction.

Below is a list of all the interviewees, whom we thank for their willingness to participate in the survey.

Table 1 – Interviewed actors

Name (Alphabetical order)	Role	Institution	Institution description
Andrea Alvisi	HR manager CMB Modena	C.M.B. Cooperativa Muratori e Braccianti di Carpi	Execution and management of large-scale works and complex projects with innovative technologies and methodologies at national and international level
Not reported	Site manager and construction workers CMB Modena	C.M.B. Cooperativa Muratori e Braccianti di Carpi	Execution and management of large-scale works and complex projects with innovative technologies and methodologies at national and international level
Rodolfo Ferraro	Secretary-General	FILLEA-CGIL Modena	Trade Union of construction sector
Vittorio Banella	Building site director Area Terminal e Edilizia Aeroportuale (Hub di	ADR Infrastrutture	Construction, maintenance and modernization of Airport
Ing. Sabatino Tonacci	Founder	Exa engineering	Engineering company
Eugenio Pulsinelli	Structural Engineer and BIM Specialist at EXA Engineering srl	Exa engineering	Engineering company
Mario Gerini	Presidente Confindustria La Spezia	Confindustria La Spezia	Employers' association of manufacturing and service companies

Gianni Carassale	Secretary-General	FILLEA-CGIL La Spezia	Trade Union of construction sector
Ing. Roberto Roncoroni	BIM manager	Tecne SPA	Design and construction of routes infrastructures
Arch. Chiara Giacobbo	BIM manager	ARTELIA SPA	A world-class International Group in integrated engineering, project management and consulting

2. Digitalisation and innovations: BIM as a process and not only as a project

The digitalisation of processes and products can be considered as a process of creating, elaborating, sharing and storing data, which affects every phase of construction, considering both the construction site and the whole value chain, for the entire life of the work.

BIM is the innovation which, to the greatest extent, allows the linking of all the phases (and players) of the value chain (client, design, prefabrication, construction site, management, maintenance, disposal, reuse), in the setting of the more general transition from an economy segmented by phases to a networked economy, in which the various players are connected.

Digitalisation, in fact, accompanies and supports the industrialisation process oriented towards lean production, that is, a flexible and rational organisation of the production process. Building Information Modeling plays a fundamental role in promoting lean production and industry 4.0 – already widely applied in the manufacturing field – in the construction sector. The relationship between “industrial and construction” is important to understand the difficulties that constructions encounter in the development of what one interviewee defines as a “lean construction site” and which will be the subject of further study in the section of this report dedicated to “barriers to the development of digitalisation in construction”.

The capacity of BIM to create a shared model that involves the designer, client and business by connecting all the players in the value chain derives not only from the 3D design (which includes all the properties of each structure included in the project), but also from 4D which (by inserting the time variable) allows the scheduling of works, from 5D which (by inserting costs) goes in the direction of automatic industrial accounting and, finally, from 6D relating to facilities management, which improves processes related to the use, management and maintenance of the work.

Therefore, BIM offers important advantages from a design, construction and management point of view. On the one hand, it makes it possible to identify any difficulties that the design had not considered, highlighting all those refinements that need to be made in order not to run into subsequent problems, also relating to the real possibility of installing and assembling complex structures; on the other hand, it

allows the planning of the work and a control of what the work will actually cost. Finally, the model with all the properties linked to each object helps the manager who can supervise, control and programme maintenance cycles. However, it needs to be emphasised that BIM today is very much about planning and still has little direct relevance to the construction site. Therefore, the potential that BIM also has for the management of the construction site and for the client are often not fully exploited due to the fact that in Italy it is still rare for it to be possible to “govern the whole process” through the implementation of a cycle complete of BIM – from conception to implementation and on to subsequent management. This depends to a large extent on the gap in terms of the use of the tool in the public administrations and companies that still appear to not be adequately equipped: *“The problem is that everyone sees BIM only from the point of view of design as interaction. I work with businesses. For us it means the management of the construction site. That is, my process is the process that has to go from the beginning of the design to the demolition of the work. If I identify it and relegate it to design alone, then I have lost 95% of its potential”*.

3. Impacts on work organisation

BIM is considered as an organising model for the management, monitoring and evaluation of the working process to reduce wasting time and resources, to improve the total quality of the process and to provide a common framework to the different businesses operating on the building.

BIM is the result of an extreme rationalisation of the whole working process, with a segmentation of the whole process into activities, tasks, goals and materials.

It offers high predictability for each aspect of the project, because project managers and workers know in advance not only the materials and activities, but also their collocation in the final structure.

Firstly, the process of rationalisation led to a greater emphasis on the project phase. Secondly, it increased attention on the prefabrication phase and on “off-site” building, because companies know in advance which parts they need for the building and, also, the program itself helps the project manager to use prefabricated parts, and if they know their “virtual” shape to input this information in the project. Thus, we can consider the BIM as a common framework for the companies involved in the building process, as a present and, also, future base to facilitate the integration of the activities and cooperation between the players. Before BIM the whole building was a hidden object for most of the players while now, on the contrary, it is based on the sharing of and access to information for all the players.

The digital sharing of data and the interoperability favoured by BIM lead to a systemic and collaborative approach as opposed to hierarchical and stratified, and of overlaps, in construction. Synchronisation and automation tend to favour the emergence of new opportunities for cooperation, collaboration and networking.

As one interviewee puts it, it is precisely the fact that all the processes related to BIM implementation are codified by an initial procedure that is agreed between the designer, the client and the company, based on a single model that belongs to everyone (“*We, as designers, even lose ownership of the model in a way, the model becomes everyone's, it is almost a form of anarchy, not centralised*”) that makes necessary what he calls a much more complex “social organisation”. From this point of view, socialisation, exchange and teamwork that originally depended on the goodwill of the parties, on the internal organisation of the construction site or on the various participants, are now codified (just think of the IMP, Information Management Plan).

Being able to relate and communicate effectively with the various players involved in construction processes, developing socio-relational, communicative and cognitive skills, therefore appears to be stimulated by the process of codification of the model based on the principles of transfer and transparency of information, forecasting and programming that are very far from the traditional characteristics of a complex sector such as construction which, characterised by fragmentation, supply chains and very long timescales, is not used to sharing and planning.

The high specificity of BIM has led to a degree of conflict between the culture of the “programmed project” and the old culture of the traditional construction models, because in BIM all the players need to focus their attention on the project as it is developed by the management and there are no opportunities to review a part of the project without having an impact on the whole. There are also conflicts considering the culture of public institutions and procurement because they are not able to introduce and evaluate projects based on BIM.

As reported by EFWBB (2020, p. 13): “*One major task for social partners at sector but also at company level is the design of new work patterns and systems of work organisation. Digitalisation is another element that allows overcoming traditional forms of work divisions, such as a strict division of labour or the division of planning and execution. The process of digitalisation therefore does not only require new skills, but offers social partners an opportunity to reflect on progressive forms of work organisation and the related need to change curricula for the affected professions*”.

4. Impacts on employment

BIM generates new specific high-skilled professions, in particular:

- the BIM specialist who carries out the modelling;
- the BIM coordinator who manages and coordinates a group of BIM specialists and all the contract activities;
- the BIM manager, a sort of information manager who deals with the processes of company standards, the management of standards, who is a more transversal profile figure for the various projects;
- the fourth role is the person responsible for the data-sharing environment and they manage the organisation of the documentation, to guarantee the sharing of the documents available to all the players who participate in the design, supervision or construction of the work.

As stated during one interview, “These roles already existed and have taken on different skills,” because they are roles of “modelling”, “coordination”, “management” and “documentation” that are basic to every building project, but are performed through the use of BIM.

Within a company, it is principally the technical office that provides the information to the construction site for the building that deals with BIM. The planning part of the work too, through the figure of the planner, is clearly called on to deal with Building Information Modeling processes, especially with regard to the implementation of 4D and 5D. To date, the new challenge, which will increasingly involve the technical office and the plant engineering side, will be the implementation of the as-built in BIM, i.e., the handover to the customer with all those properties that will then have to favour its use.

Among the new professional figures that arise with the development of BIM, the BIM Manager stands out. This figure is responsible for the organisation of the process, forming relationships and building the basis for developing a model that has the requisites for everyone to draw on the information necessary to carry out their role by organising them appropriately. The BIM manager has the important task of managing communication by connecting everyone. This is a managerial figure whose skills do not end in a knowledge of the software.

Regarding this “new figure who organises new processes” many companies are relying on external planning firms, but the need for internalisation will increasingly arise. According to the BIM managers interviewed, training in this methodology represented a “qualitative leap, still growing” and a professional leap. Other new emerging figures of interest related to the development of digitalisation and BIM are those profiles that allow work to take place in data and legal security for the operations that are carried out.

This is the “data manager”, responsible for ensuring the correctness of the data and its physical location, and the professional figure who is responsible for ensuring that all data comply with the rules on privacy and proper data management. There are also figures related to the legal side such as Legal BIM which manages contracts and deals with all the rules that exist between customer and client.

Moreover, considering the whole working process, BIM led to a reduction of workers on-site and new job opportunities for off-site workers (in the prefabrication phase), as well as offering a qualification of the maintenance phase, and we have to consider the need for maintenance technicians to improve their skills to work on BIM projects.

As regards jobs that are more at risk, which might be destined to disappear, those more intrinsically linked to the analogical model of bureaucratic management of orders and “paper” stand out and appear to be more easily replaceable by computerisation.

“The changing nature of work due to technological and environmental changes will make the issue of new skills and qualifications and the right for all workers to receive an adequate income/protection a key debate for the next decades, in which the social partners of our industries should take the lead” (EFWBB, 2020, p. 14-15).

To effectively face the challenges of digitalisation it is necessary, at a transversal level, to acquire some basic IT skills, in order to have an understanding of what a fully digitised IT environment is like. As part of planning, in addition to the technical background that is also needed to use the 2D project, specific skills are required for the management of all BIM processes, which is codified in all its parts.

Furthermore, considering new professions, we have to think of the ICT programmer or, more generally, the improvement of ICT skills required by BIM software to work.

Focusing on blue-collar workers, it seems there are not a great change in the professions or skills, even if we need to consider the increase in skills to use ICT technologies and a greater capacity to work on a project and read it with the aim of respecting all the activities and communicating any changes. There is a certain difficulty for older people in understanding these new methods based on the relevance of shared information and a continuous updating of changes in the working process. On the other side, there is a difficulty in finding young people who want to work in the construction sector, but BIM could help increase the attractiveness of the building sector.

As part of the reality of the construction site, the site manager, a central figure in management, needs the skills to run a BIM project and coordinate it through the use of digital information. The workers also have to be able to interact with the various players connected in the digital process.

In general, each worker has to take into account the role of other figures, with a systemic view of the

entire process, a more collaborative, communicative and integrated approach than in traditional construction. All the professional figures must therefore share knowledge, and in particular there is a growing need for operators in possession of a “culture of data”.

At the same time, as underlined by a construction worker, the new emerging figures linked to BIM design also require training on the executive and construction site, to ensure adequate planning in the transition to the actual construction of the work and in order to reduce the gap that is often created between the design and execution phase, to limit errors and continuous alterations. In addition to updating their technical skills, the workers involved in the construction supply chain therefore need to acquire some systemic and transversal skills.

It might easily be assumed that the acquisition of these IT skills, transversal and systemic, closely linked to new activities and ways of working, requires a generational leap which, however, finds a significant obstacle in the structural characteristics of the workforce in construction, considering that construction is characterised above all by a high average age of workers with low generational turnover, a low incidence of highly skilled professions and a high incidence of foreign workers. In fact, the basic provision of computer skills to site personnel encounters its greatest difficulties in those of a certain age.

5. Impacts on working conditions

BIM as a rationalisation process provides many opportunities to programme the working phase and to better consider the workload, professions, materials and interference between companies, with the aim of reducing errors as well as accidents at work and health problems.

The analysis of all the working phases also provides other opportunities to control the companies on the building site and to combat the illegal economy. Generally, BIM can help to control the “risk for interferences” and to plan, monitor and evaluate working relations between companies on-site.

The potential positive effects of digitalisation involve, as mentioned, not only the planning but also the construction and subsequent management of the work. In general, BIM contributes, together with other digital technologies, to simplify the extensive fragmentation of construction processes with a possible improvement in the dialogue between the different players. In the words of one interviewee: “When we go to tell someone about our projects and open the drawings, people look me in the face: they don’t look at the drawings because they don’t see what I see in the drawings, while instead a tool like this allows me to have a much simpler approach, and allow them to enter the model and show what I see,

then what I see at that point the interlocutor sees as well". So too the workers on the construction site, by coming into contact with BIM information, can easily view the characteristics of the construction site. From a trade union point of view, the advantages that such changes can have in terms of greater opportunities for accident prevention and OSH protection are of particular importance. First of all, the accuracy of the project and the immediate recognition, through software, of any problems that might arise – both at the technical level of construction on site and as conditions of risk for workers – favour an 'inside prediction' approach, passing from a reactive to a predictive attitude.

Not only is it the software that will highlight any changes to be made, but with the advent of 3D modelling, the designers themselves are more induced to solve problems they once would not have thought of: "Because before they reasoned in a different way, I reasoned through plans, sections, but then it was difficult to put them together; I was mentally trying to build my model, but now I see it, so I can't leave any gaps in the model, I have to solve them. And this obviously leads me to resolve the aspects related to safety as well."

The fact of not being able to leave anything to chance in the design phase and having to model each new element with all the information that makes the difference between a normal project and a BIM project consequently increases the timescale for planning, rather than reduces it.

There also some problems related to the risk of intensification in labour and working time saturation due to certain specific factors. BIM facilitates the continuous change of the working process and of the final building ("change in real time"), but often these changes are not followed by a review of the timesheet or the costs, with an increase in the number of activities without the opportunity to have any more time. Moreover, the process of rationalisation aims to reduce the activities that are not valued and are considered a waste of time, with a growing saturation of working time. As explained during one interview: "There is gap between the project management and on-site activities, because there is an acceleration of the project activities through the use of ICT technologies, but it can't be the same for the physical activities on site."

Furthermore, as detailed as BIM may be, the continuous design changes during construction collide with the reality of construction sites, made up of workers, companies, machinery that has to be managed in the field with a strong capacity for sharing, communication and management and, in general, the intervention of prevention systems.

Therefore, a "separation" seems to emerge between the planning and the executive part, which often complains about the difficulty on site in keeping up with the continuous design changes further acceler-

ated by digitalisation, which appears to be attributable to the use of digital innovation with an old mentality: "This technology is used with the logic that I continually modify the project, then we review it together; which is an old logic that is not the digitised one but the typical one of the construction system where there is a lot of overlapping, hierarchies, etc." However, while before it was modified on paper and this had its own times, now the speed in real time of the design change leaves behind the execution that needs operating times that sometimes do not seem to be recognised by the design part.

A gap is therefore created between the speed of technological development and the manual component, which we can summarise in a difference between the digital and analogue approaches. On the executive level, on site, "It feels like a race against time in achieving a technological innovation that is very rapid. Previously, design times were as slow as the executive ones might be, they were two manual jobs, done by people, different but human; instead, this very fast innovation makes it difficult to update and execute the works".

The tendency to modify the project during construction, largely deriving from the clients, has consequences on workloads, ancillary costs and safety. "At each change it is necessary to speak with the workers who have to carry out the change, to recontact the suppliers of the materials, with problems with the supply chain. So time is taken away from controlling the activities. Compared to the past, we are much more drawn into the construction site offices to look at drawings because I find changes, and to share them with the site manager. But there are also important consequences for safety, requiring the verification of safety conditions after each change."

Moreover, compared to the past, in BIM projects the changes to be made leave less freedom on the construction site in solving any problems with free choices, adopted directly on the spot making use of the construction experience gained over the years by individual workers.

Even if BIM can help the prevention system, most of the interviewees underline that on-site prevention remains central and cannot be delegated to BIM, because the reality of the working space, materials and activities cannot be reduced to mere virtual information, not to mention the unexpected accidents and errors that might be caused by people as well as plant.

6. Drivers and barriers to digitalisation

Drivers: innovation, digitalisation and sustainability

Digitalisation, and BIM in particular, can play a role in accelerating technological innovation processes connected to sustainability. BIM is useful for all the operations related to design choices that allow for green results and offers a vision of what the energy saving or consumption of the building itself might be.

BIM allows the production, storage and sharing of relevant information to manage energy efficiently and favour territorial planning of sustainable building, both considering information useful for building maintenance and that which might be useful for the public administration in local planning.

Another positive aspect in terms of environmental sustainability encouraged by the transition to design with BIM is the reduction of paper consumption.

In Italy, then, the relations that can be created between BIM and the opportunities linked to the “110% superbonus”, recently launched by the Government, which allows a 110% tax deduction – until 30 June 2022 – of expenses incurred for interventions that improve the energy efficiency of buildings and reduce seismic risk, would appear to be very interesting. This instrument might have an important function of relaunching production and employment in the sector, as well as being an incentive in favour of sustainability and energy efficiency in buildings.

To grasp the significant opportunities that derive from the push in favour of the regeneration and redevelopment of buildings, as underlined in the interviews by the union, it is however fundamental to deal with the fact that, under the pressure of innovation and digitalisation, work is changing: *“The new working phases are no longer those of the ‘70s-‘80s, the construction site now has new working phases, but today we have too many old companies that want to face the challenges of our sector with the skills of 30, 40 or 50 years ago”*. The weak point is the low investment in training that ought to combine the culture of safety with that of innovation to improve work.

Barriers: between digital and analogical culture

A first difficulty that emerged in many interviews is in identifying suitable software for scheduling and accounting for work. At the level of adequate software there is a particular lack in the development of 4D and 5D.

At the same time, there is a tendency to confuse BIM with software rather than a new methodological approach, a new mentality.

Indeed, another obstacle that is reported is the difficulty in promoting digitalisation in the workplace.

On the one hand, BIM managers underline the problematic nature of promoting the management of projects in BIM instead of in the traditional way, due to the tendency to consider them only from the point of view of the software and the consequent inability to grasp the positive effects that might derive at a systemic level from the application of Building Information Modeling. The logic of calculating costs and times prevails over longer-term benefits. On the other hand, there is also a "mistrust" when trying to bring models on iPads to the construction site, instead of paper documents.

A cultural problem therefore emerges: the long and segmented construction supply chain struggles to deal with innovation, especially as regards the transfer and transparency of information, on the one hand, and forecasting and planning, on the other, key elements on which BIM is based.

However, it is precisely the structural characteristics of the sector, in particular the powerful fragmentation of the building system that make the entire construction process complex and difficult to control, from conception to management following the completion of the work. However, the use of BIM is a valid tool to try to govern the entire construction process, but provided that all the players in the supply chain gain the necessary knowledge to read and manage this process.

As mentioned, digitalisation can perform a function of accelerating the processes of technological innovation connected to sustainability, in particular with respect to the energy requalification of the built heritage. However, in Italy the transformation of the sector towards the redevelopment of buildings is based on a market of small and very small companies which, linked to the niche of micro-recovery of existing assets, are not overly stimulated structurally to invest in digitalisation. The development of digitalisation, instead, finds more fruitful terrain in new and standardised construction.

Another barrier to the implementation of BIM is given by the fact that, although the world of construction companies of a certain level, especially in a competitive environment, is proceduralised at very high levels (in terms of safety at work, quality, EEC kitemark), in most situations the constructed product still remains a unique, crafted product, created manually.

The customers who are able to better understand these innovations are the industrial ones who already think in terms of lean and 4.0. The difference between industrial and construction mentality was well summarised by one of our interlocutors: "*In traditional construction the projects were almost a 'declaration of intent' because, once presented, then the company and the client introduced all their variants. In industry this doesn't happen, if you design a piece, a machine, it comes out as it was designed. In mechanics too, if there is a need to modify a piece, someone will modify it during construction, but do so with awareness, because they want to make an improvement, not as happens in construction where I move a window because I don't like the plan*". The greater flexibility and craftsmanship of construction

contrasts with the greater standardisation and governability of processes in mechanics and industry. In this sense, BIM favours prefabrication and the use of prefabricated elements outside of the construction site which can become a winning element from the point of view of time and quality of work. Large structures that take up a lot of volume, drainage, prefabricated bathrooms, beams, pillars, can be built offsite, but it is more difficult to intervene later.

Precisely with reference to the cultural aspects, from the testimony of several interviewees it emerges that one of the main obstacles to the development of BIM is being forced, even for those who intend to invest in innovation and digitalisation, to have the two models coexist, the traditional and the new one, analogue and digital with the delays that derive from having to meet the needs of both systems. *"The relationship with our clients, with the authorities, was old-fashioned, they couldn't take advantage of the new process. We did the project in BIM and it is a model, but then we also had to print it for the bodies that had to approve it, spending a lot of money".*

7. Industrial relations and social dialogue: trends, critical points and opportunities

A weak starting phase

In the case studies, the relation between BIM, bargaining and social dialogue is weak or at a very early phase. Generally, the previous situation of the industrial relations system influences the relationship between managers and workers, but without a specific impact on the application of BIM. However, there are some relevant aspects we can consider to strengthen the role of the social partners and institutions in the BIM process. The challenge of digital transition touches on many dimensions of the role of workers and trade unions in society and the principles and practices of industrial relations.

Bargaining BIM

The greater importance of the project and planning phase can help to strengthen the "advance bargaining system", increasing the participation of trade unions, workers' representatives and workers in the design phase of the project, giving them the opportunity to have a voice in the whole working process. However, there are also some risks associated with the specific features of BIM, such as a centralisation of project management and a separation between the design phase and the material building process and, so, between white- and blue-collar workers.

Also, there is a risk of a segmentation in the industrial relations system between sectors, in particular

between on-site and off-site companies, with an impact at site level. To avoid this, it is helpful to improve the agreement for the OHS representatives at site level.

In the phase of the COVID-19 epidemic, the trade unions have assumed a decisive role in the prevention system through the national and corporate protocols signed between the social partners, with the establishment of joint committees and procedures the role of which will also be relevant in the future, in favour of a shared management for prevention and transformation strategies for labour organisation.

As put a BIM manager put it, "*Verifying the assembly of certain structures, the positioning of the equipment, then using one machine rather than another is obviously a huge advantage in terms of safety*".

Although another BIM manager points out, "*The culture of safety means investing in digitalisation to help workers perceive the construction site as a safe place, but this leads to frictions: those who were not used to it or those who did as they liked feel their autonomy was being diminished*".

In this scenario, on the one hand, there are the advantages of a digitization that participates in the culture of safety in the workplace as a valid tool to mitigate safety risks by preventing criticalities and unexpected events and non-compliant behaviour. On the other hand, doubts and perplexities emerge regarding the issue of workers' surveillance through digital technologies, as well as problems of unshared use of personal data.

8. Social dialogue, laws and standards: the role of bilateral bodies

Compliance with regulations and workers' rights appears to be the fundamental basis for ensuring an advanced industrial relations system, capable of encouraging the introduction of BIM.

The DURC (tax compliance certificate) and approval system (aimed at ensuring compliance with the minimum standards set by the national collective agreements for the construction industry) represent opportunities to highlight irregular work and counteract contractual dumping by companies which, while carrying out construction or mainly construction activities, apply contracts other than construction contracts, to the detriment of regular competition between companies and the protection of equitable remuneration, training and safety in favour of workers.

On 10 September 2020, the national social partners signed an agreement to be sent to the Ministry of Infrastructure and Transport and to the Ministry of Labour for the implementation of the instrument of approval, so that it becomes an integral part of the legislation for carrying out construction activities, both public and private. The national social partners, in consideration of the significant variability of

construction work and the varying production organisation of construction companies, agree that these indices will be the subject of a nine-month trial period, starting from 1 October 2020 and ending on 30 June 2021. By 31 May 2021, they foresee that a verification of the progress of the experiment will be carried out by the organisations that signed the agreement. Approval aims to protect virtuous companies. It contrasts unfair competition and prevents financial and procedural consequences for the supply chain.

The attestation of approval must be made by the territorially competent Cassa Edile/Edilcassa for the purposes of issuing the DOL, as the only body that possesses the data concerning the workforce employed in each site. For this reason and, as we shall see, for their central role in training, the joint bodies appear to be a central subject in strengthening the role of the social partners in industrial relations and social dialogue.

If we consider the role of the institutions, some managers as trade unionists express the importance of strengthening the obligation for the use of BIM for companies in public procurement, with an attention to the criteria of the call for tender. At the same time, it is important to strengthen the relationship between public procurement, BIM and industrial relations and OHS prevention systems with the aim of supporting collective agreements at local, site and company level.

Training

Employers' associations, trade unions and institutions all need to support training in BIM because most of the actors do not have the skills or possess only a general idea of its functioning, while it requires a deep knowledge to be able to play an active role in the definition, monitoring and evaluation of the project.

The role of the joint bodies is also fundamental in relation to the training of workers in BIM, to be included within a broader logic of qualification of the sector that is capable of tying together the aspects of legality with those of the growth of the skills of managers and workers, as noted during an interview with a trade unionist: "*Another important point is the qualification of companies through the introduction of the points licence to qualify those healthy, serious companies that invest in safety and training, which means, on the one hand, giving rights regarding the quality of work to the workers and, on the other, also giving quality to the company itself*".

The other trade unionists interviewed converge on this aspect, for example, highlighting that "*Bilateral bodies are at the centre of our sector: the centrality of the construction fund emerged as fundamentally and crucially in the last contractual renewal of 2018, as a body for training, updating and specialisation of the sectors, to look to the future and really train the movers of the future*".

Social role

Finally, trade unionists underline the opportunity to consider the role of the social partners in relation to the development model at local and national level, in particular considering the innovation and rationalisation process of BIM as part of a wider process of urban planning as well as the growing relevance of smart cities, smart buildings and green building.

As expressed by one trade unionist: "*The union that we have to create is not just for disputes, but also has to have a social role [...] Today construction is changing, fewer and fewer buildings are being built and we are moving towards quality work in regeneration and urban redevelopment as well. It is important to think about designing the cities we want in the future and, as Fillea-CGIL, we know that we can give a lot to the community to understand how new cities should be in regeneration and redevelopment*" considering both the environmental and social aspects, in particular to counteract ghettoisation and housing problems.

Case study B: Smart devices for Building Site

BRESCIA CASE STUDY²

1. General information on the case study (company and interviewees)

This study on site digitisation is a part of a wider analysis of technological innovations and digitisation processes in the construction sector. The organisation of this report is based on the Discuss project methodology, aimed at analysing innovation processes in the whole value chain of the construction sector, by focusing on three main areas: a) the construction site; b) Building Information Modeling (BIM); and c) the new relations between on-site and off-site construction organisation, specifically in the case of wood for building.

In order to introduce the case, we need to consider two main aspects. Firstly, despite us considering the construction site as a productive unit, in reality it is not. Instead, the construction site is a productive space where more than one organisation (and innovations) play a role. This element is crucial to understand the complex chains of innovation we will discuss. Secondly, we decided to focus on the Brescia Case following the suggestions raised in previous interviews with experts. With respect to the other cases of digitisation, the characteristics of this case better fit our knowledge needs. Firstly, the innovation process involves several players, both inside the traditional construction chain value and outside: from the university and academic players to the administrative representatives, from the union organisation to the companies, from the engineers to the doctors. Secondly, the introduction of such innovation is the result of a complex bargaining process aimed at finding a balance between the interests and skills involved. Thirdly, if, on the one hand, by innovation process we actually mean a wide range of activities, on the other, the Brescia Case can tell us something about many of these. Clearly, these characteristics also make the Brescia Case a problematic one, above all because of its blurred borders and the long chain of players involved.

To explore the case, we will start with the people we interviewed. We contacted several players along the innovation chain, starting with the academics involved in innovation processes all the way up to the actual innovators. In this case, among the innovators we also have to consider the workers' representatives, because of their role in promoting the innovation process and in fostering it among the workers,

² Gianluca De Angelis, Nicoletta Brachini.

and also because of their participation in training policies as a partner in the *bilateral bodies*. As explained by H. Farrel A.L. Holten in *Changing governance of local economies: Responses of European Local Production System*, edited by C. Crouch et. al in 2004³, “Nowhere is the role of associations in making up for the deficiencies of the state clearer than in the so-called enti bilaterali, bilateral bodies set up by trade unions and small firm associations” (page 38). In each economic sector where the bilateral body is present, it can have specific functions. In the construction case, territorial bilateral bodies are in charge of workers’ training and integrative insurance (Casse Edili).

Table 2: Interviewed players

Name (Alphabetical order)	Role	Institution	Institution description	Web page
Angelo Ciribini	Professor in Construction Production	Brescia University	Academic Institution	https://www.unibs.it/ugov/person/2476
Antonio Crescini	Director of training area	ESEB “Ente Sistema Edilizia Brescia”	Bilateral Body of the construction sector in Brescia	https://www.eseb.it/web/
Massimo Angelo Deldossi	President	ANCE Brescia	National Association of Builders – Brescia	https://www.ancebrescia.it/
Ibrahima Niane	Secretary-General	FILLEA-CGIL Brescia	Trade Union of construction sector	http://www.cgil.brescia.it/sito_cgil/public/index.php?sss=fillea

Despite the Covid-19 emergency, we were able to carry out face-to-face interviews, but not observe any construction sites.

2. Digitalisation and innovations

Description of innovations

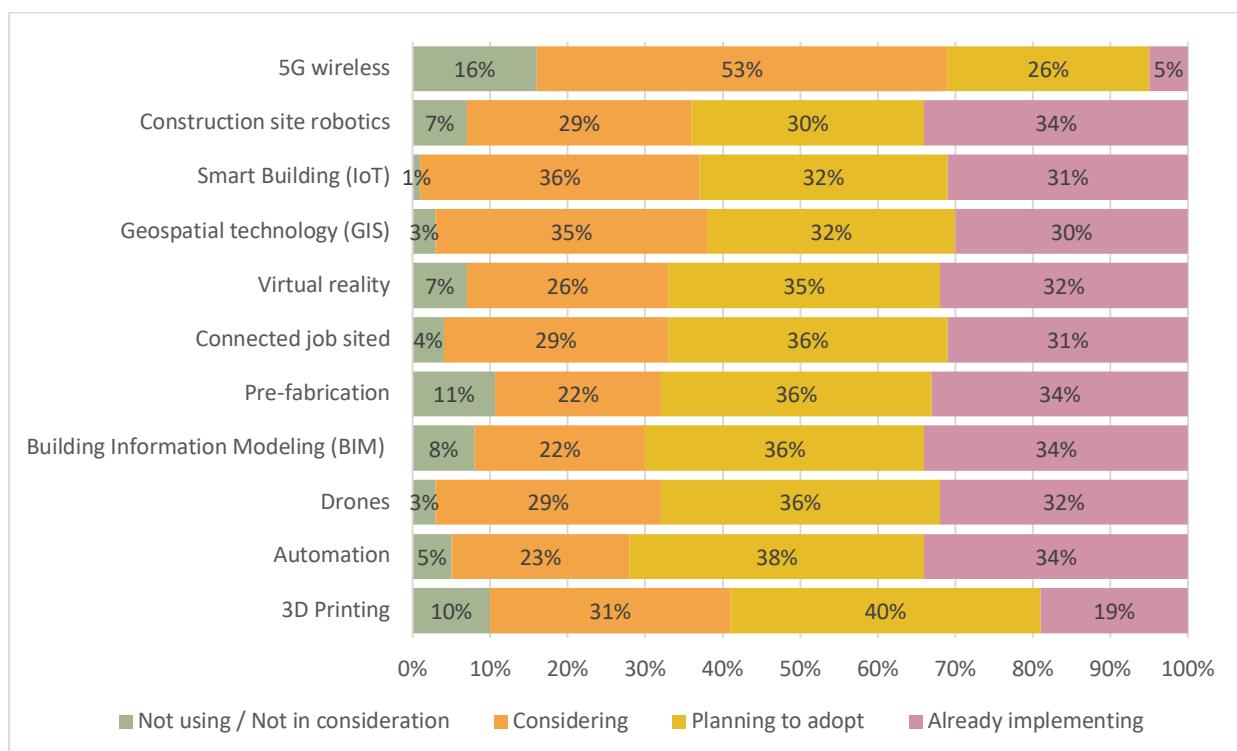
Despite the real estate and construction sector being profoundly involved in new technology implementations, construction sites are considered the weakest element in the chain. Experts tend to consider that this is a result of the high labour dependence of sites, bringing technology into conflict with the workforce⁴. Following our findings, this interpretation is based on a perspective bias: as we

³ See <https://oxford.universitypressscholarship.com/view/10.1093/0199259402.001.0001/acprof-9780199259403>

⁴ As example of this, please consider the interviews provided in the last Altus Group report, available here: <https://www.altusgroup.com/featured-insights/global-property-development-trends-report-2020>

will observe, a construction site is not an industrial firm. On the one hand, the construction site is the ground where the innovations introduced along the whole value chain converge, so probably to understand the slowness in construction site innovations we should consider it as a product of the value chain organisation; on the other hand, the lack of consolidated innovations on construction sites make them more receptive than other locations or, in other words, sites are locations where the innovations might actually produce a difference, both on the capital and on the labour side. Indeed, considering the Altus Global Property survey on new technology implementation in the real estate sector, we can observe how innovations on construction sites are largely underrated and limited to the automation dimension.

Figure 1 – Rate of adoption, by technology⁵



Source: Altus Group Global Prop report – 2020

Despite the great variety of ready-to-use technologies, the revolution in the construction sector seems to be largely unrealised, at least in Italy. The reasons for this will be discussed in the *drivers*

⁵ The Altus Group global survey involved surveying 404 C-level and senior property development executives in both front and back office positions at property development firms, and owner-operators and owner-investors with property development divisions in North America, Europe, the Middle East, Asia Pacific and Latin America. All the participating companies had a development pipeline equivalent to at least \$200 million USD under development at the time of the survey.

and barriers section, but for now we have to recall the role played by a) the fragmentation of the productive fabric, and b) the characteristic of demand in the building sector, and c) the workforce. These elements are crucial to understand the difficulties in the introduction of innovation on construction sites. Nonetheless, there are significant elements of progress.

As we observed above, the construction site is the area where all the innovations of the building sector converge, from the planning phase to the finishing touches. This means that to better understand the innovation process we need to consider the full building process and, above all, its logic. The building process is characterised by two main peculiarities: the fragmentation of the process and the unicity of its output. If in the industrial organisations the industrialisation of a product represents the condition for profits, in real estate sector the reiteration of a productive process is exceptional. Even in the case of twin buildings, changes in exposition or ground characteristics, make each building a sort of prototype.

Starting from these two specificities of the sector we can easily understand the crucial role played by digitisation in terms of communication exchange and interoperability throughout the value chain and in terms of management efficiency. The main dimensions of this process concern production, the organisation and the exchange of data, which is why we can reduce the digitisation process to two main elements: sensors and other data production devices and data organisation and exchange platforms.

A sensor world

The introduction of sensors in the real estate sector concerns the whole construction sector area with interesting impacts in terms of real-time monitoring and interaction with other innovations such as the Digital Twin systems⁶. The use of sensors in building materials to monitor the conditions of buildings and infrastructures is not new⁷, but when we speak about the sensorisation of the construction site we are speaking about something else: working spaces, workers and vehicles. In our case study, the introduction of sensors in construction sites is still in an experimental phase. The project aims to define a passive safety infrastructure based on proximity detection and the monitoring of workers' health. The aims should be considered separately. Indeed, while proximity detection represents a less problematic field, with health

⁶ As observed in PropTech report (2020): "while BIM is used to provide a user interface, the development of digital twins offers additional simulation and control, the digital twin is based on the collection of real time data via sensors and IoT devices embedded during construction which feed an AI powered digital model" (pag. 43) – The report is available here: <https://www.sbs.ox.ac.uk/sites/default/files/2018-07/PropTech3.0.pdf>

⁷ In Fast and Slow buildings, by the British Council Office, we can find the rise of digital technologies in controlling buildings also from a historical perspective.

https://www.bco.org.uk/Research/Publications/Fast_and_Slow_Buildings_Responsiveness_Through_Technology_and_Design.aspx

monitoring some specific issues rise in terms of privacy and impact on workers' lives. We will discuss this below.

From a general perspective, both aims of the project are based on available technologies and more precisely on Ultra Wide Band (UWB). Wearable sensors can alert workers when they are approaching a falling risk area, or when they are too close to a vehicle in operation, while the sensor on the vehicle can stop it, reducing the risk for the workers. Using the same technology, wearable devices can transmit the worker's health conditions to the doctor in charge of the monitoring. Besides risk reduction, firms see in the data collection on workers' positions the possibility to obtain a faster and easier way to calculate working hours. Nowadays this activity is often still the result of direct observation and communication on the part of the construction site manager, who collects and counts the hours of each worker for each task. The mistakes and the approximations produced by this procedure are considered a significant obstacle to the industrialisation of the construction process and, above all, to cost estimates.

Finally, we need to consider how sensor technology has become an opportunity also in terms of the fight against the spread of the SARS-CoV-2. In recent months we have seen several agreements among unions and employers regarding the introduction of wearable devices to reduce the infection risk (see the box below).

Devices for the prevention of COVID-19 infection: the ISA Safety case study

Nicoletta Brachini

Several companies decided to use electronic tools to reduce the risk of COVID-19 infections within their plants and ensure greater worker safety. One example is the company Industrie Scaffalature Arredamenti-ISA Spa, which introduced the use of an electronic device for tracking employees (ISA Safety).

This small wearable device has the function of monitoring compliance with social distancing and tracking close contacts in the event of workers resulting positive. The device therefore has a dual function:

- prevention: the device sends messages to the smartphone and progressive alerts to reset social distancing between workers;
- risk reduction: the collection of data on contacts allows the identification of workers who have come into direct contact.

The collection and storage of data is completely anonymous and only concerns contacts with a positive result. Access to information occurs only in the case of need and is reserved for members of a company committee specifically set up and composed of trade union and safety representatives.

This result was achieved thanks to an intense phase of negotiation between the company and the trade unions, initiated after the forced closure of the company under the legislative decree of 22 March 2020 (which provided for

the closure of all non-essential production activities). The purchase and use of these tracking devices allowed for the early re-opening of the company, because these guaranteed that employees could work in safe conditions.

The union representatives asked for and obtained the delegation of the management of the data from the devices to a special joint committee, ensuring that the information collected was exclusively intended for risk prevention, without representing any kind of control on workers.

This point was the key issue in the concerted process because workers, finding themselves in a situation of high risk of contagion, were willing to give up their privacy. The union representatives were able to negotiate this point well, even as the company was able to re-open due to their approval.

The employment of ISA Safety, along with other prevention measures, prevented contagion in the company and guaranteed the health of the workers.

Furthermore, the agreement provides that the device will be used only as long as the health emergency lasts, but representatives are considering expanding its use in the future. In an industrial setting with production lines, keeping a constant physical distance between operators can reduce the risk of injury and provide greater safety. Therefore, the ISA Safety model could be applied beyond the present emergency and in other situations, such as construction sites.

Step by step, platform by platform

As we have observed, the construction process is the result of a long chain of interactions between various players of different natures. We can imagine this chain organised by the main player in each phase: the buyer, the planner and the builder. This does not mean that in each phase the main player acts alone. On the contrary, the interactions are continuous or, rather, they should be, to reduce errors and delays. This is the why the data platforms represent a great opportunity in terms of reducing of time-wasting and costs. In line with the purpose of this section, we will focus on the third phase of the construction process, but following the findings of our study we should be able to go back up the chain up the first phase.

Behind the building phase there are numerous economic players, from technicians to subcontractors up to the producers of materials, which may traduce the value chain out of the construction sector. This is why despite its underutilisation, BIM is still considered the best partner for an improved and effective work organisation of construction sites. This concerns the organisation of the whole site, from the planning phase to the material supply and building maintenance. For this reason, we should not be surprised if the first platform we encountered in our case study is directly connected with the BIM logic (and name): BIMrel.

As we can see on the BIMrel web site:

BIMReL is a digital system for managing information throughout the entire life cycle of a building, based on information and technology needs.

To implement said tool, the Politecnico di Milano, One Team S.r.l and TraceParts S.r.l. carried out research and development activities intended to:

- create an open-source interoperable database of products and components for buildings, based on the technical sheets linked to BIM objects, according to the most recent developments in Italian and international regulations;
- develop a web platform in the cloud that can be accessed by multiple users (the general public, private clients, public administrations, designers, manufacturing companies, construction companies and trade associations), which allows a user-friendly but exhaustive consultation of all the information in the databank;
- promote Lombardy and national manufacturing companies through the visibility of products at an international level and with detailed specifications suitable for enhancing the quality of products;
- popularise and validate the platform with the collaboration of some of the main stakeholders interested in its operation and with some of the main category associations of materials and components manufacturers.

Figure 2: The BIMrel webpage

The screenshot shows the homepage of the BIMReL portal. At the top, there is a green header bar with the BIM ReL logo, navigation links for HOME, SEARCH FOR PRODUCTS, SERVICES AND FACILITIES, LOGIN, and SIGN IN, and a language selection icon. Below the header, the main title "Welcome to the BIMReL portal" is displayed in bold. A subtitle explains the portal's purpose: "Uploads, exports and compares standardized technical data sheets of products structured according to prEN 17473 (Smart CE) and CPR 305/2011, conforming to UNI 11337 and complete with BIM objects". A large green "SEARCH FOR PRODUCTS" button is centered below the subtitle. Below this section, there are six circular icons representing different product categories: "Construction products" (a bricklayer), "Plant products" (a water tap), "Furniture" (an office chair), "Machinery and equipment" (a crane), "Companies" (a factory building), and "Associations" (three people). At the bottom of the page, a footer bar contains logos for the Region of Lombardy, Politecnico di Milano, One Team, and traceparts, along with a note about the project's support by the Lombardy Region.

The idea behind BIMrel is quite simple and is aimed at increasing the choices in building materials through a standardisation of technical details of supplies in contrast with the competitive strategies of materials producers and suppliers. Indeed, each producer tends to communicate the highlights

of their products, reducing the visibility of the limitations but also comparability with products from competitors. The project follows other European platforms, such as the NBS National BIM Library in the UK, Kroqi in France, BIM Deutschland, and the Innovance project, in Italy, which has not been updated since 2013. At the time of writing, BIMrel is still under construction, so we cannot really test and show its functions. Nonetheless, from its implementation, we can see both the need which such a sort of platform might satisfy and an indication of its satisfaction.

From another perspective, the digitisation of constructions site should not depend on the digitisation of other phases or other players. Indeed, the construction site too can be considered as an organisational unit of a larger firm and it has to be managed as such.

As in other sectors, the main indications of the digitisation process in the construction sector are represented by the absence or reduction of the classical elements of building sites, such as containers for archiving and administration. Although the first result of digitisation is a reduction in paper, in our case study the digitisation of building documentation forms part of a broader renewal of the productive organisation process based on a full management platform called CHECK.

CHECK is presented as a dashboard where all the players involved in the building process can access the complete construction site documentation, from the authorisations, to information on the vehicles and staff involved. The platform allows a certified messaging system, with which staff can communicate. Players involved can simply check the time schedule or the authorisation of individual workers to carry out a task. It reduces the risks and the duties inherent with printed documentation such as loss, theft, translation problems or movement. Finally, it represents a safeguard in terms of legality in a sector where informal work still is a problem.

In operational terms and beyond the web platform, some of the functions of CHECK directly involve the workers, who are required to use a badge to access the construction site and vehicles. Without an up-to-date licence, the worker cannot use the vehicle; if a worker is not recognised, they cannot access the construction site and this might represent a benefit both for the worker and for the employer.

In this case as well, similar platforms start to appear in other contexts, also of national importance, such as the experimentation in Marche Region for monitoring work organisation on construction sites in the area affected by the earthquake. In parallel, CHECK is going out of the Brescia area to other districts in northern Italy.

This last observation allows us to start to explore the main critical issue which characterises these experiences: the scale of innovations. BIMrel, like CHECK, rises from social dialogue in regional contexts and is subject to the limitations of local governance. This is why as of now most effort has been in the promotion of these platforms at national level, also involving the public authorities, not only as a manager and guarantor of data, but also as an economic player in construction sector, as a partner in the planning phase and as end client.

Relations between Technological Innovations/digitalisation and environmental and energy issues

As observed above, innovation on construction sites is the result of innovations applied in various production areas. So we need to divide our reflection by distinguishing the environmental impact of each area. Even more, the environmental issue can be tackled from the dual perspective of direct and indirect effects of innovation along the entire value chain.

Unlike the case of building materials, where the environmental issue can be considered a driver for R&D, the construction site does not offer a concrete opportunity for in-depth analysis. Nonetheless, as observed during the study, digitisation on construction sites reduces the use of paper and the consumption of tons of paper (direct impact). Secondly, a more effective construction process can help reduce environmental impact. But we are speaking about indirect impacts, also in the case of the introduction of monitoring of vehicle fuel costs, which can reduce the carbon footprint of a site.

3. Impacts on work organisation

Impact of technological innovations/digitalisation on specific areas of work organisation

Digitisation appears as a radical innovation process involving the logic of prior work organisation before the material elements of work organisation. The principle elements of this process rest on the planning of construction work organisation, allowing estimates of costs and earnings. These are the key to access in a new era for the construction sector, one which is closer to the industrial rather than artisan logic. As explained by the interviewees, profit reduction increases competition between construction companies, but also reshapes it around organisational effectiveness, replacing the competition based on labour and material costs. To be grasped, an opportunity like this depends on an innovation chain involving all the players, from the buyers to the suppliers and subcontractors. In this sense the BIM software and the BIM logic play a pivotal role. As explained by one of our interviewees, a full understanding of this logic

means that innovation should start from the buyer. Above all in the case of the public buyer, the technical document should be presented employing a BIM logic. The builder should know the parameters of all requested objects, the dimension of a wall, the preferred material, and from this the builder can know the actual cost of this wall, calculating the cost of cement, logistics, etc. Thus the builder can add their fixed costs, their profit and decide whether or not to apply for the tender.

Opportunities in terms of time reduction fostered by digitisation go beyond site organisation. Our interviewees highlighted how platforms and algorithms could help reduce the bureaucratic time for work approvals. They underline how nowadays approvals are mostly based on objective elements, such as measurements, materials, characteristics of the companies involved, etc. The official called to approve should check all these parameters to be sure of avoiding mistakes. But, because we are speaking about objective elements, it is likely that algorithms based on existing rules could reduce this time and the responsibility of the public officials, placing the responsibilities of planning professionals centre stage.

Impacts of technological innovations/digitalisation on the value chain

As a multiplayer field, construction sites see the converging of innovations that are introduced along all the construction value chain. On the one hand, this means that, to be effective, the innovation directly introduced by a construction firm should interact with innovations introduced by other organisations, and, on the other hand, it means that the innovation introduced by other organisations should interact with innovations introduced by the construction firm. This is the reason because we cannot speak about effectiveness without also speaking about interoperability: the more the innovation chain is interoperative, the more the value chain is effective.

But, where does the chain start?

In this case too the answer depends on the perspective. From the point of view of the construction site, it could be considered as a part of a longer chain starting with the buyer, as well as the starting point of smaller chains, whose rings represent the firms in subcontracting, the professionals or the supply producers, fully independent of the buyer. In this second case, the introduction of specific platforms calls the partners to interoperate with such platforms. We observed how BIMrel tries to encourage the standardisation of materials description, while CHECK forces subcontractors to digitalise and provide detailed documentation on their workforce. So, a first implication of such innovations concerns the selection of partners. In some cases this selection will be based on the economic characteristics of firms, because of the cost of innovations, while in others the balance sheets play a more minor role. Subcontractors who cannot provide full documentation on training, permits

and licences are probably excluded by construction sites, but, as a product of the bilateral body, the construction site platform CHECK is available free. In Barriers section, we will discuss generic costs. From another perspective, when the construction site is viewed as the location for the convergence of several innovations, the analysis involves other players and issues. The elements we should consider as potentially affecting the value chain through the digitisation process are principally two: the provision of information and the language used to communicate it. Both elements could act as a selection driver for value chain components.

Provision appears as an issue when we take into account the public buyer. Each administration tends to have its own means of communication. Each municipality, district or region could potentially ask to the construction firm in a specific way to communicate the same information. If, on the one hand, this might be considered an old issue, on the other, the digitisation process might have made it worse. The old fragmentation of communication schemes nowadays tends to be the cause of a multiplication of platforms. This means that over that the production and reproduction of the same information in different formats, firms are called learn how interact with each different administration, with an increase in costs in terms of the time required to understand and learn new praxis.

Secondly, the language can be considered directly as a critical dimension regarding the construction site through its output: the building and, more precisely, the smart building and domotics. The introduction of significant innovation in building elements, such as automated windows, heating and electrical systems and so on, has a direct impact on construction site organisation in terms of skills and planning. The main producers tend to use their own coding language to steer the choice towards their products and reduce interoperability with their competitors' products. This implies that for each device the builder should consider one specific bus cable for one specific function. A multiplication of costs, without any added value. In this time we note the appearance of an opensource code language, called KNX, which could reduce this kind of cost, but producers tend to increase the cost of the same device with an interoperable soul⁸.

The interoperability theme could produce more significative impacts on value chains in the future. Indeed, the experimental phase of wearable tools for workers involves construction vehicle producers. If today the electronic badge allows the vehicle to know that the worker who is using it is titled to do so and the bracelet alarm warns the worker who is too close of the risk, tomorrow the vehicle should be able to stop itself if someone is too close. But this kind of innovation is too profound to

⁸ [https://en.wikipedia.org/wiki/KNX_\(standard\)](https://en.wikipedia.org/wiki/KNX_(standard))

be applied without the collaboration of the producers. This is why we should expect a reaction from producers.

Lastly, increasing the role played by data, the construction value chain could extend its field to the areas of software and data-archiving company. In the case we are observing, the software company involved in site management innovation can be directly considered a part of the social dialogue.

4. Impacts on the workforce

New technologies and changes in the workforce:

Digitisation appears as a simplification process the impacts of which on work organisation are more or less visible depending on the working area. Moreover, we observed that in construction contexts the sites can be considered as organisational units of bigger firms. In this sense, the introduction of innovations based on digitisation can have different impacts on different sites.

The most visible effects of digitisation probably concern the administrative organisation of the site. The reduction of paper reshapes many tasks usually taking place on construction sites, by centralising and automatising them. While the construction site manager was in charge of site bookkeeping, in the digitised context the bookkeeping is automated, and the construction site manager can spend their time on other tasks. Clearly, the automation of bookkeeping reduces workers' freedom in terms of declaring their working hours, as well as errors. But, on the other hand, this allows the firm to know the exact cost of an individual task. It is interesting to note that in the case we are focusing on the automation of bookkeeping is organised on work and not on workers. It means that the site manager does not know how many hours each worker spent to carry out a task, but the total of the hours all the workers spent to carry it out. Later, we will observe how social dialogue played a pivotal role in achieving this. Above all, our interviewees highlighted how the digitisation process allows a reduction in time wasted, both in terms of communication exchange, as for example with public administrations and in terms of construction site organisation. From the McKinsey observations on productivity, wrench-time on construction sites is 25%-30%⁹. Building workers are often called on to solve planning problems, improvising solutions based on their experience and knowledges, but with the risk of unpredictable time wasting.

⁹ <https://www.mckinsey.com/business-functions/operations/our-insights/control-capital-project-duration-and-cost-with-schedule-optimization>

Sometimes the planners overlooked a few centimetres in the crawl space, sometimes a material is delivered too soon and workers have to move it from one place to another. But these small delays, nowadays, are unaffordable. Faced by a gain of 5%, the sum of small errors could lead to the failure of a firm. On the other hand, increasing wrench-time from 30% does not seem to produce any actual effects in terms of an intensification of work. It is probably different for piece-worker sub-contractors, if present. In this case, the increase in terms of productivity could further push research into time saturation, but as observed by the interviewees, if regular workers are happy to spend less time on unexpected incidents, beyond the perimeter of salaried work anything can happen.

As we saw in the value chain regarding the selection of partners, the introduction of new software or hardware should affect the logic of recruitment. This seems not to be an issue for the construction sector. We have to consider two aspects. The first is the innovation elements we are discussing. A digitised construction site does not require a complete innovation in worker skills. On the contrary, for most construction workers digitisation should not appear as something to be managed. The second is the current crisis of recruitment in the Italian construction sector. The decrease in work makes worker selection less demanding and pushes firms to invest in in-house skills development.

This general discourse does not mean that the innovations we are discussing do not have any impact on the characteristics of the workforce as a whole. Clearly, the introduction of new devices and applications should be more or less significant depending on the working area of the workers. Site construction managers should be able to use and manage the site though a tablet or smartphone, and administrative staff should be able to use new management software and be ready for updates, but it seems not to be very relevant.

When we asked about the new skill requirements, the director of the training centre explained to us that firms are looking for workers able to drive construction vehicles, rather than anything connected with the digitisation process, and this is a critical point. Despite, from a global perspective, construction labourers being considered redundant¹⁰, in Italy we observed a sort of workforce shortage. Because of this lack of workforce supply, over the last few years the smaller firms have hired people with few years of experience with respect to their age. In Italy most new construction workers are over 40, who find in construction a second or third career opportunity. But, as we understood, they cannot be considered as the construction workers the new construction sector need. On the contrary, this attitude encourages a decrease in wages and an increase in risks on sites. This last observation drives us to a last emerging

¹⁰ The future of job Report 2020, OECD. Available here: <https://www.weforum.org/reports/the-future-of-jobs-report-2020>

element which affects the relation between digitalisation and work force changes: training. Training rises as a pivotal dimension to improve and to consolidate innovation dynamics. On one hand training, is the key to keep workers skill up to date. On the other, it is the most important way to making innovation understandable and, so, affordable. In other terms, we are speaking about the condition for workers participation to processes which are involving them.

5. Impact on working conditions

As we observed, new technologies in construction sites affect above all the organisation of the site. One the one hand, we spoke about the introduction of site management software and, on the other, we spoke about the introduction of wearable tools for workers' health and work monitoring (experimental phase). So we need to consider the two aspects separately.

A more effective organisation of the site seems have positive effects on working conditions. Without intensification issues caused by unexpected events, workers can better organise their work in a cleaner and safer site, without overtime work and aware of the fact that all their colleagues are entitled to be there, and are trained and regularly paid. So, the introduction of the electronic badge seems not to cause serious problems. At the same time, the introduction of tools for monitoring could have a more significative impact on working conditions. But we have to consider that, in this case, the balance between safety and security is the result of a negotiation phase that fosters the trust of the workers (see below). Secondly, we also need to consider that our interviews were made during the pandemic. This is an important element to consider because the emergency situation got us used to the trade among giving up to something to increase safety, and that is what happened. A safer construction site is a site where workers actually know where they are, if they are approaching a falling risk area or are too close to a moving vehicle.

Probably we should also add that a safer construction site is also a site where workers know how they are. But in this case, we observed a greater focus on privacy. The reason for this is a fear of losing jobs in the event of poor health. If this were (was to be) to be confirmed, the issue would open the classical issue of the salary blackmail, a paradoxical destiny for such innovations.

6. Industrial relations and social dialogue (impacts and trends)

How the new technologies change industrial relations/social dialogue

We were well aware of the centrality of social dialogue at the basis of the start of the digitisation process in construction sites. Firstly, we have to consider that in the construction sector social dialogue plays a specific role in Italy in the areas of training and mutualistic action. Secondly, with respect to the innovation process, this centrality can be observed by an enlargement to new players. The reason is most closely connected to the introduction of new topics and interests, beyond the salary issue and the contrast between capital and work, but also it can be referred to the need for cooperation to involve the whole sector, regardless of its fragmentation. So we can organise our observations starting from the main perspectives we ought to be able to recognise during the process. The first arises from the contextual representative players and, more precisely, it rests on the involvement of representatives of public or private interests. Beyond the union and the firms and the bilateral body, in our case we have to consider the Italian Tax Police, the labour inspectorate and, as a promoter, the regional administration. The second perspective is that of the technicalities and specific skills needed to implement the innovations. In our case we have to consider the role played by the academic field, the software production, the lawyers involved to prevent privacy abuses, and so on. Each of these players participates in defining and orienting the whole sphere of the contents of the dialogue. In this case, we can consider legality and labour rights respect as the two main areas of this sphere.

Legality

The high incidence of irregular work in the construction sector is an old issue in Italy. The share of irregular work is estimated at around 16% by the National Statistical Office, the highest among the most significant sectors. Irregular work is the result of the great fragmentation of the sector, with a high incidence of fragile workers, autonomous workers and small firms working as subcontractors also in major works. This allows irregular firms to reduce the price of their work and increase their profits, making the construction sector an optimal terrain for organised crime. The dumping effect becomes unaffordable for regular firms which fight for a more serious recognition and enhancement of legality and contracts being respected. From this point of view, data became a crucial player because of its transparency. This is the reason why in our case the enlargement of the social dialogue involves the Italian Tax Police and the labour inspectorate. The aim of their involvement is to inform

the innovation process in a framework of legality beyond the limits of the single firm. Moreover, it is to be considered that the labour inspectorate also acts as a guarantor of the participative process, independent from the roles of firms and unions. Despite the introduction of such innovations always being presented as an opportunity in terms of safety improvement, the players know how data could be used to reduce workers' freedoms and affect their rights. From this perspective, the use of company or "yellow" unions to legitimise such innovation is a real risk. This does not mean that an official player can replace a representative one. On the contrary, as we observed, in our case, in a bilateral body, the role played by CGIL is pivotal in a double sense, on the one hand to prevent abuses by firms and, on the other, to promote and explain the innovation introduction to the workers. As the union representative explained to us, the opportunity to reduce work risks through such innovations is too good to be refused out of fear of the unknown. This is the reason why the union, he says, should anticipate the risks of abuse, by participating in the process and not just reacting after the processes have already been implemented.

But what does participate in the digitisation process mean? Basically, despite digitisation seeming to lead us far from the dialectic process, in the case which we observed dialogue is the framework within which innovation takes place. Dialogue on innovation is a part of a wider *ex ante* mechanism informing the innovation process. This is the basis to understand the distribution of rights and duties arising from innovation. On the one hand, the companies should be able to increase their working capacities and profits, on the other, workers should be able to obtain direct and indirect improvements in working conditions, the first through the implementation of innovations on working sites, the second as the result of the transfer of a part of the increased profits to the company health protection policy.

As observed by scholars such as Alain Supiot¹¹, generally the contract defines the limits of the subordination. How many hours per day or the value of these hours are the main individual dimensions of such limits. Instead, while the laws states what the employer cannot ask of the worker during the hours they are paying for, the contents of working hours contents are a specific topic in collective bargaining. Despite in Italy the articulation of collective bargaining being reasonably effective, with several levels from the general to the company one, some of the elements characterising recent innovations could slip through the traditional forms of bargaining or social dialogue. In the case of digitisation, the risk of a lack of transparency is easily understood, above all when digitisation rests

¹¹ See Supiot A. (2015), *La gouvernance par les nombres cours au Collège de france (2012-2014)*, Nantes-Paris, Fayard.

on the agreement between the company manager and the software developer. On the contrary, in our case the digitisation process is fully embedded in the social dialogue dynamic, as result of a bilateral interest. This is the reason why we can consider the developers as new players in social dialogue. On the one hand, they have to translate the topics and issues emerging from the dialogue in a new collective property in the form of a code; on the other, they are the only ones who are actually able to manage this new property. This should prevent private agreements between companies and software houses, both in terms of the production of undiscussed features and in terms of data management and extraction. In the case of Brescia, the technician in charge of data extraction and provision is a member of the bilateral body, the owner of the data, dependent on the construction firms as well as the union.

Not all skills needed to implement the new organisational tool that can be found in the area of the construction sector. On the contrary, the more devices are used to interact and transmit data, the more analysts and technicians became essential. In the case of health monitoring, the doctors are the experts who know what kind of data should be monitored and processed, in the same way that the engineers are the experts called on to implement the tools and new devices. In this case, the research purposes can be considered an efficient tool for the involvement of organisations, such as academic ones, beyond the economic interests. With some differences, we also should consider in this scheme those value chain players who interested in the developing process. As we observed above, the introduction of a device able to stop a vehicle if a worker is too close, cannot be implemented without the involvement of the producer, able to certify this profound intervention on its products. In our case, TAKIUCHI Europe seems to be interested in this project, even suppling experimental vehicles. Clearly in this case the economic interest is evident, but we should not ignore the positive externalities.

As are developers and other technicians, so too are lawyers expert in privacy issues a new essential player. Above all in the case of data collection through the wearable tools, they are the ones able to reduce the risk of issues regarding the actual use of data.

Further developments

From an economic perspective, to be implemented the innovations should be able to pay back the investments they cost. But, as we observed, in the case of construction, the innovation process cannot be considered within the boundaries of a single organisation. On the contrary, the required condition for the innovations we are speaking about, is increasing the number of players involved.

Also considering the single construction site management software, CHECK, its value changes on the base of the scale of its use. If CHECK remains a local best practice, the cost of its development would be less justified than if, on the contrary, it became the reference case for construction site management software. That would mean less fragmentation in formats and processes, but also a competitive advantage for firms that already use it. We could say the same about BIMrel, the platform for building suppliers, created with an economic contribution from the Regione Lombardia. This is the reason why public authorities represent, now, another kind of player, essential in the race for the standard definition. From this perspective, we should consider that while we are finishing this report, a group of these players is presenting Check and BIMrel as fundable projects within the framework of the recovery fund to the Italian Economic Ministry. This also helps us to approach to the last part of this report. The struggle against fragmentation and the public partnership is crucial to understanding the barriers to innovations.

7. Drivers for and barriers to innovation and digitalisation

To conclude, our findings can be reviewed through a double lens. The lens of the drivers for the innovation process, useful to identify the factors fostering the innovation process; and the barriers to innovation or, in other words, the elements which obstruct the process.

Clearly, in this section we refer to main the findings concerning the case study of digitisation on construction sites.

Barriers

Fragmentation

Fragmentation is a condition which affects the value chain, the production organisations and the market. The fragmentation on the value chain reduces the digitisation opportunity represented by the simplification of exchanges and the interoperability of the features implemented. The main resistance factors depend on the procedures of the public player and on private suppliers' interests. On the one hand, the lack of standard in terms of transmission of data, makes each public administration a separate world. This fosters a multiplication of the task, lessening the simplification effect

of digitisation. Some examples: electronic invoices should reduce the time required to send documentation, but the request for a “courtesy copy” increases the tasks; each administration tends to define its own protocol to receive technical documentation, so alongside the firms administrative staff are called on to perform different tasks to do the same thing.

On the other hand, private producers’ tendency to increase the fidelity of their customers reduces the opportunity for interoperability. Some examples: to highlight its strengths, each supplier tends to make its products not-comparable with the products of other producers; to increase sales, producers tend to reduce the interoperability of their products with the products of others. This is particularly evident in the case of the language used by elements to interoperate in the same system, as in the case of heating systems and other home automation features.

This fragmentation can also be seen as a barrier with reference to the production organisations. The construction sector in Italy is highly fragmented and competition on prices encourages polarisation between the bigger firms, able to innovate their processes, and the smaller ones, less interested in innovation, which play their game by betting on a reduction of costs. So we observe a double dynamic of the same polarisation which also affects the value chain. Innovators are involved in value chains able to evaluate innovations, conservatives tend to interact with players less interested in innovation than in prices. The latter group is favoured by the fragmentation of buyers, often families, unable to afford innovations. Some examples: a higher incidence of private housing reduces buyers’ interest in innovation processes. As buyers, families usually prefer to reduce the costs rather than increasing the quality. Often the large buyers, such as public administration, have the same orientation. Still now we have public competitive bidding based on prices, not on quality or maintenance. This dynamic nourishes a poor economy, in terms of quality, but also in terms of wages and safety for the workers involved in it.

The fragmentation of buyers also represents a barrier. To be effective, the majority of innovations should be integrated in new construction work. In a context such as the Italian one, where the wealthiest Regions signed protocols to reduce green belt consumption (in Italian, *consumo di suolo*), firms are often engaged in renovation works, smaller than undertakings aimed to fully build or rebuild buildings. To better understand the relationship between market fragmentation and the public role as buyer, in data collected by the Altus group on development planning, the public infrastructure investment is the most influential item, while housing supply is least (75% compared 25%)¹².

¹² Here the full report: <https://www.altusgroup.com/featured-insights/global-property-development-trends-report-2020>

Cultural barriers

Cultural barriers can be highlighted along all the value chain. Firstly, to evaluate innovations, buyers need to understand the innovations. Technical specificities of materials and work processes are not a knowledge that is immediately available. For the majority of potential buyers, a brick is a brick, and the conditions of its production or maintenance tend to be less significant than its cost. On the construction firm side, organisational innovation implies a cultural revolution to transform a craft sector into an industrial sector, based on rationality, reduction of unexpected events and forecasts.

Workforce characteristics

Despite the innovation we describe having a relative impact on most of the workforce, we have to consider the lack of turnover in the construction sector. New workers are often middle-aged men, fragile workers, without training, who supply a workforce demand greater than the young and trained workforce can supply. This aspect reduces the inclination of firms to innovate: firstly, fragile workers cost less than innovations¹³, secondly, a fragile work force cannot be so demanding in terms of health and safety.

Drivers

The main drivers for digitisation in construction sites remain the economic opportunities for firms and safety improvements for the workers.

We observed how in a context of crisis, the reduction of profits pushes firms to assume an industrial posture, based on rationality, effectiveness, strategies and forecasts. The digitisation of construction sites, from planning to implementation, should make the firms able to take full control on their works. However, at this time this opportunity depends on the actual organisation of the chain value and the construction site digitisation of documentation is a first step, essential to make the organisations ready to react to the value chain progress. Simultaneously, the digitisation of the construction site makes the firms able to reduce risks depending on documentation and lack of licences or depending on irregularities out of the control of the firm, such as informal employment among subcontractors, lack of documentation and so on. In economic terms we also should consider the reduction of time wasted during official checks and requests from the public authorities.

¹³ See also L. Nedelkoska and G. Quintini (forthcoming), here: https://www.oecd-ilibrary.org/employment/automation-skills-use-and-training_2e2f4eea-en

As an indirect effect on the economic dimension, we also should consider the improvement of workers' health safeguards. At this time, public insurance rates in the construction sector are the highest. An improvement in terms of risk reduction could produce a reduction of this cost. However, improvements in working condition are an independent driver. Despite the risk of a reduction in autonomy, workers representatives see the centrality of health safeguarding in a working context as a foundational factor of improvement, able to nourish a virtuous process. Indeed, a safer site also could reduce the negative image of construction sector jobs, which lies behind the shortages in terms of trained and younger workers.

Case C: Smart-factory off site building

MAURO SAVIOLA GROUP, A ECO-ETHICAL COMPANY¹⁴

Introduction

This case study is based on the analysis of a company in the wood industry, a key sector in the construction sector which, in recent years, has been affected by various digitalisation processes. Generally, the wood-furniture supply chain is broad and articulated, but also integrated into the different sectors that make it up. The system encompasses all the activities that make it possible to move from the raw material, i.e. wood, to the finished product, in its various forms, from the simplest ones to designer products. The entire wood and furniture system has been the protagonist of a positive trend at global level in recent years; suffice it to say that for the wood sector alone, in the EU there are over 170,000 companies and almost one million employees, with a production of over 134 billion euros in 2018¹⁵. The furniture industry in Europe accounts for over a quarter of global production and it is the world leader in the high-end segment, although we are seeing strong growth for this sector in the Asia-Pacific region, driven mainly by Chinese production.

In this sector, Italy is a leading country of the EU market, as it is the first European manufacturer with a production value of over 23 billion euros for the furniture sector alone, mainly devoted to exports outside the EU (46%). As to wood, Italy accounts for 10% of European production (around 14 billion), second only to Germany.

The entire supply chain in Italy involves 75,000 companies, more than 310,000 employees and, in 2018, it generated a turnover of over 42 billion euros, of which about 65% was for furniture¹⁶.

The Italian production is characterised by a strong territorial nature with some traditional industrial districts located mainly in Lombardy and Veneto and with over three fourths of national production concentrated in the Northern regions. The Italian system is strongly characterised by the prevalence of small and medium-sized family-owned enterprises and traditionally does not make use of the capital market¹⁷.

¹⁴ Nicoletta Brachini.

¹⁵ CDP (2020), *Legno-arredo e Covid-19: alcuni fatti stilizzati*.

¹⁶ Centro studi FederlegnoArredo (2019), *Rapporto Federlegnoarredo*.

¹⁷ Mediobanca (2017), *Focus Aziende Legno-Arredo*.

The excellence of Italian wood-furniture is not limited to the high-quality end products, but includes the entire virtuous system of circular economy that hinges around the supply chain. In fact, the Italian wood-furniture sector ranks first in Europe in terms of recycling economy (over 90% of chipboard panels produced in Italy are made of recycled wood) and last in terms of polluting emissions (the Italian system produces 26 kg of emissions for every thousand euros of production)¹⁸.

The Italian wood-furniture sector is also characterised by significant investments in R&D but, in this context, there is still room for development towards the digitalisation of the sector, also through the new frontier of smart furniture.

The Covid-19 pandemic has caused a strong contraction of the wood-furniture sector at global level, with a -3.6% decline in 2020. This is entirely attributable to the impact of the measures put in place to contain the spread of Covid-19 and, in fact, the market is expected to resume growth at a 7% average rate as from 2021¹⁹.

Forecasts for Europe are also negative, with a turnover in the sector which is expected to fall by over 6% compared to 2019. If we consider that the entire European wood and furniture sector is worth almost 2% of GDP and employs over 2 million people, making it the fifth largest sector in terms of employment, it is clear that this lockdown could have major repercussions for the European labour market²⁰.

Estimates for Italy are even worse, because we expect a loss of turnover for the entire wood-furniture system of 20%, i.e. around 8 billion euros, with the related loss of tens of thousands of jobs²¹. The side effects of the pandemic will be felt particularly on the sector's exports, which are expected to close the year with an overall drop of 18% compared to 2019. In addition to the difficulties on the production side, obviously a non-negligible impact on the sector has also been caused by the stop of people's mobility and the resulting disruption in sales. Furniture retail is one of the sectors most affected by the lockdown. Against this background, as in other sectors, the key to resilience seems to have been the digital channel, which has proved decisive both on the production side and in the marketing of products. Obviously, furniture e-commerce has also had to face the difficulties related to the disruption of logistics supply chains and the need to operate in emergency mode. Nevertheless, the forecasts for online furniture purchases point to strong growth in the coming years, and the pandemic seems to have been the driving force.

¹⁸ Symbola (2020), *L'Italia in 10 selfie*.

¹⁹ Ap (2020), *Global Furniture Markets 2020-2030: COVID-19 Impact and Recovery Assessment*.

²⁰ EFBWW (2020), *COVID-19: To fight the Corona pandemic, the European Woodworking and Furniture Industries propose measures to protect workers' health, support economic activity and the sector's recovery*.

²¹ Stime FederlegnoArredo (2020).

Generally, in view of reacting to the crisis, it will be necessary to implement new strategies in Italian companies, focusing on creativity and the study of materials, attention to sustainability, digitalisation of production and commercial processes, as well as investment in training and human capital²².

1. Main characteristics of the case study

As seen above, the wood industry has modernised its production lines, often using automated processes, employing an increasing number of skilled workers and implementing a circular economy model. In this context, the Saviola Group is an interesting Italian example of these processes. Founded in 1963 by Mauro Saviola at Viadana, in the Province of Mantua, the Group has been a pioneer in the design and production of 100% ecological panels, thus becoming the top company in the world in the processing and transformation of recycled wood.

The information on the Group, its digital development and the related implications, was obtained from interviews with various company professionals, workers and union representatives, listed in the table below. Furthermore, reference was made to some secondary sources such as the Saviola Group's Sustainability Report 2017-2019 and the latest company-level supplementary contract of the Wood Business Unit (2018).

Due to the Covid emergency, the interviews were conducted online and it was not possible to visit the production sites.

Table 1 Professionals interviewed²³

Name	Position
Alessandro Ciaramelli	HR Director Saviola Holding
Stefano Saini	IT Director Saviola Holding
Valentina Bolis	Communication Director Saviola Holding
Claudio Pasolini	Secretary Fillea-CGIL Mantua
Francesco Paolino	RSU Fillea- Mauro Saviola
Enzo Pascarelli	RSU Fillea- Composad

²² CDP (2020), *Legno-arredo e Covid-19: alcuni fatti stilizzati*.

²³ We also thank the national secretary Tatiana Fazi for her important collaboration in the organization of the interviews.

The Group, with various sites in Italy and abroad, currently employs around 1,500 people. Its turnover is approximately 588 million, 60% of which is produced in Italy and the rest abroad. The Group, which has always been oriented towards production diversification, comprises **four main business units**:

- **Saviola**, which deals with wood, produces around 55% of the total turnover and employs 670 people in 7 different plants. A number of smaller companies are also part of Saviola: Sitapan (production of thin panels for furniture); Sitech (surfaces, edge banding and coatings); Sage (management of services offered by the Group), Trasporti Delta (logistics and transport); Sadepan Latino Americana (located in Argentina); Trendcor (designer company located in Frankfurt);
- **Sadepan**, which produces glues and resins for wood panels (chemical branch) and employs around 182 people in three plants, one of which is located in Belgium;
- **Composad**, which manufactures kit form furniture mainly targeted to foreign customers, employs around 184 people, and produces over a quarter of the 26.5% of turnover;
- **Saviolife**, which is the most recent business unit since it has started operating in 2011. It deals with the development and production of natural and sustainable products for agriculture and animal husbandry (5.1% of turnover and 8 employees).

Besides them, there is Saviola Holding (80 employees) which is responsible for managing the Group.

In particular, the Group's main activity is based on the production of an ecological chipboard panel, composed entirely of recycled wood, manufactured since 1992. Since 1997 the company's entire production has been based on post-consumer wood, thus actually becoming an Eco-Ethical company, whose production is entirely based on a circular economy process.

Saviola is the only company in the world to have built a production cycle based exclusively on used wood, thus eliminating the need for virgin raw materials. In concrete terms, it recovers used wood (pallets, chipboard, reels for electric cables, planks, fruit crates, old furniture) collected in 19 Ecologno collection centres located throughout Europe, for a total of approximately 1.2 million tonnes of recycled wood each year. Then the actual production process begins and the post-consumer wood is cleaned of impurities and then chopped, glued and pressed to create the ecological panel. In this process, all residues of other materials are also recycled: the company obtains around 20,000 tonnes of iron each year from nails, hinges and sockets obtained from post-consumer wood. Over 75% of the plants' thermal energy requirements are met by the processing waste, thus making the entire production process circular.

It is precisely because of these production characteristics that the Group benefits from various certifications such as FSC (Forest Stewardship Council) and PEFC (Programme for Endorsement of Forest Certification schemes), which identify wood products based on strict environmental, social and economic

standards. These two reference certifications in the wood-furniture sector allow to develop a certified production chain, capable of ensuring that the standards and requirements are met in all the product processing stages.

The Group also has several partnerships in the field of R&D, such as collaboration with the IELD in Turin to integrate the creative aspect into the furniture sector. In addition, studies have been carried out with various universities in the field of life sciences, in order to investigate future product developments in the chemical sector.

2. Digitalization and innovations

The Saviola Group's investment in development and technology amounted to around 23 million euros in 2019, with an increase of over 20% on the previous year²⁴. The innovations introduced at industrial level have been constant and considerable over the years, but have not changed the Group's production chain or impacted on employment. The production process has undergone only one structural change, namely in the phase in which we switched from using virgin wood to recycled wood to create the 100% ecological panel. At the same time, efforts have always been made to pursue product innovation, also through production diversification. In this sense, sustainability and digitalisation are the two main drivers that have always guided the Group's management and which are inevitably interconnected through the circular economy paradigm.

Especially in recent years, the Group has constantly implemented tools that improve performance, making it more efficient (faster and better quality), without affecting the production process. An interesting example in this respect is the digital scanner recently introduced in the ecological panel production chain, which is used to digitally analyse the finish of a panel in order to find and classify any defects more accurately, thus ensuring more efficient and higher quality production. In this way, the worker who was previously in charge of panel quality control now operates the scanner, thus specialising in the use of a new technology.

However, the most important digital innovation introduced in recent years has been the implementation of the new single company management system – SAP²⁵ (System Application and Product), which

²⁴ Source: *Sustainability Report 2017-2019*, Saviola Group.

²⁵ SAP is part of the ERP software (Enterprise Resource Planning).

integrates and centralises the management of all the various production sites. It is not only an administrative tool, but ensures full control of every company's aspect, through constant monitoring of all incoming and outgoing flows and all other activities inside and outside the company. In fact, it manages the flow of data issued by each department, with a view to understanding the real efficacy of the areas and planning future activities and investment in the best possible way. SAP is a modular software, i.e. it is built on macro-areas that are separate from each other, but at the same time fully integrated with each other. Each module manages a different business area and the main ones are the following:

- financial management
- sales and purchasing;
- CRM (control of all customer and supplier information, balances and sales);
- warehouse and logistics;
- service (management of service contracts, service planning, tracking of interactions with customers);
- infra-group (sharing of resources between different sites);
- real-time analysis of company information and data.

Each employee only works on the modules that pertain to his/her business area and is specialised only in some macro-areas that together create a flow encompassing the entire company. It is important to point out that, while management software tends above all to collect, collate and reporting information in the various management areas, SAP is an integral part of the Group's organisational flows through maximum integration of all functions, as well as control and efficiency of the entire system, thus ensuring speed and quality of processes.

This data digitalisation process has affected all factory aspects, collecting real-time data on the handling of material, from purchasing, reception and control of raw materials, to production and customer management. This aspect of collecting information on the production system in real time provides dashboards that give evidence of production trends, ranging from the use of raw materials to waste; from hours worked to product quality.

It is therefore a new integrated approach to production based on the management of data that affects the entire value chain. Here we are not talking about robotization or automation but about digitalisation, i.e. improving product quality through more efficient control. Digitalisation is a process that allows to connect all stages (and players) in the value chain, thus leading to a transformation of the production process, particularly with the shift from a segmented economy by stages to a networked economy, in which the various players are connected.

The introduction of this kind of digital technologies has spread a new organisational and management

culture of the Group, characterised by formalisation of knowledge, planning of activities and measurability of results. This paradigm shift has also led to an acceleration and interconnection with other innovative trends, so that more suitable machinery and equipment have been introduced to integrate with the new management and the related data and information collection.

3. Impact on work organization

The introduction of SAP has obviously had a significant impact on administrative and management work, but it has also led to changes in factory work, where analog processes have been completely converted into digital ones, introducing integrated data management. Workers' tasks have not changed substantially, but the software guides them in the management of production process, monitoring all steps, ranging from the creation of the panel, to the application of the decoration (paper that improves the raw panel) and guides them in terms of weights, measurements, waste, thus also establishing the quality of the different panels.

SAP helps above all in the management of materials, which has been optimised and speeded up. The analog management of materials in the warehouse has now been fully digitalised through the data production flow. Workers are satisfied with the implementation of these new tools, and see the room for improvement they allow. However, it must be pointed out that, for most of the workers in the factory, the work does not undergo any changes in the operating mode, even if it is simplified in some aspects. As seen above, through the SAP software, it has been possible to automate and monitor company processes, in order to identify problematic aspects and optimise the efficiency of each department. This is the reason why starting the implementation of this tool has taken time and has required adaptability on the part of workers who had to learn new working methods, but also to approach the value chain in a different way. In fact, there is greater interconnection between all factory departments and therefore we can say that we have moved from a stratified approach of the value chain to a more synchronic and collaborative one.

The only Business Unit where SAP has not yet been integrated is the furniture unit: the process, which was underway, has been slowed down by the breaking out of the pandemic. However, a virtual warehouse system is also used in Composad for the digital storage of material. In this case, however, there is no direct impact on the value chain, i.e. production is not interrupted in the event of problems. It should be emphasised, however, that Composad has made significant investment in factory machinery and

equipment that have speeded up, streamlined and simplified production. A case in point is the purchase of a number of completely autonomous trucks and forklifts which manage the warehouse and considerably reduce the physical effort required of workers.

4. Impacts on employment

The majority of Group's employees (95%) work with full-time open-ended contracts. The majority of employees are between 30 and 50 years of age, and the number of women, although still a minority, has increased by over 5% over the last three years²⁶.

The process of management digitalisation that has been carried out over the last four years in the Saviola Group has had a strong impact on factory organisation, both at administrative and worker levels. Various job profiles have become fully computerised: forklift truck drivers, loaders and carriers now work exclusively in digital mode.

In fact, this has led to an increase of the various workers' skills in the use of digital tools, thus ensuring the development of in-house skills. Furthermore, this new integrated management of all company departments has required more cross-sectoral skills on the part of workers, who have thus realised they operate in a complex and wide system in which all parts are interconnected.

All workers involved in the use of the new management system have been trained and updated on the new system in order to be able to use it correctly. The Group has therefore organised suitable training courses for the workers most affected by these changes in order to adequately retrain them.

As mentioned above, for many workers, tasks have only partly changed to be adapted to the use of new machines, but in fact the type of work has not changed. Nevertheless, also considering the quite high average age, also for these workers it has been necessary to start a process of technological training that has helped them to develop a more open approach to innovation.

Precisely for this reason, in the last agreement renewed in 2018, training has been indicated as a strategic choice to combine company's productive development and workers' growth and development through the enhancement of their skills²⁷. In this sense, particular importance has been attached to the development of the job profiles most affected by the IMPRESA 4.0 plan. Moreover, a revision of the job description and classification of workers has been envisaged, also by virtue of the retraining of some workers.

²⁶ Source: *Sustainability Report 2017-2019*, Saviola Group.

²⁷ Supplementary agreement of December 20, 2018 for the Saviola Group's Wood Business Unit.

Generally, the Group's approach is more oriented towards retraining internal workers, rather than finding external ones. External workers are hired mainly to fill more specific job vacancies and positions such as those related to the development of design and planning in the furniture sector.

Recruitment increased by 3% in the three-year period 2017-2019, but unions are pressing for further increasing the number of employees, also considering the growth in turnover that is characterising the Group. In one of the last meetings, union representatives called for the recruitment of young workers to ensure adequate turnover, given that over the next six to seven years almost half of workers will retire. In particular, according to union delegates, it is important to hire new staff sufficiently in advance to ensure them the necessary training and adequate shadowing with more experienced workers.

5. Impact on working conditions

Generally, the management of work flows and paces in factories is quite tried and tested and the new management tools have certainly improved the organisation of work. However, there are some particular processes that require quick paces and short times, which make management more difficult and increase workers' workload.

Furthermore, in case of temporary lack of staff (due to illness, holidays), job vacancies are filled by the other workers, who are required to increase the pace of work and perform different tasks in order to maintain standard production. According to union delegates, multi-tasking can be a problem in terms of efficiency, and sometimes even dangerous for workers' safety. According to unions, it is therefore important to invest more in human resources because this ensures the maximum efficiency of plants, as well as an improvement in working conditions.

In a context where production is on a continuous cycle, the increase in retirement age does not obviously help in managing workloads. It is quite natural that during the last years of work there are more occupational diseases and accidents; hence it would be necessary to recruit staff to fill these gaps and not burden younger workers too much. As mentioned above, we need to set up a turnover process including an adequate period of shadowing and training.

It should be made clear, however, that vocational training cannot be exclusively related to shadowing older and more experienced workers. Production plants are complex and constantly innovating; hence continuous updating of workers and adequate initial training for new employees should be provided. The current vocational training plan does not include modules on the operation and maintenance of

new plants. According to unions, it is not enough to invest in machinery and equipment if these innovations are not matched by adequate vocational training.

Therefore, according to unions, we need to invest in training and human capital in view of facilitating the necessary generational turnover throughout the supply chain and encourage the spread of innovation in the sector.

With specific reference to Health and Safety, it seems that the new organisational management ensures greater safety at the workplace, as all activities are organised in a more organic and systematic manner. The Saviola Group is investing ever more capital in health and safety, through training but also through dialogue with union representatives. Bearing this in mind, work tools and devices are being used which improve productivity, but also protect workers. A case in point is the purchase of 100% electric forklifts and trucks, which have replaced the diesel-powered ones whose emissions created an unhealthy situation inside the plants.

6. Drivers and barriers of digitalization

According to the workers themselves, the introduction of new technologies into the company has sometimes been a little destabilising but, as there have been no substantial changes in tasks or job losses, these innovations have been welcomed. There has never been any ostracism on the part of workers, in the common belief that technological innovation creates a climate of security in the workforce, thus contributing to restore a strong image of the company.

It should be said, however, that there have been some difficulties in implementing the new software, especially from the clerical viewpoint, because a completely new work management has been introduced in that case. In fact, the administrative staff has been destabilised by the introduction of a new tool, not previously used in any of the production units, which has completely changed the way they worked. We should also consider the great deal of dematerialisation work carried out at administrative level, with the complete elimination of paper documents in favour of digital ones. This has initially created difficulties for workers to adapt, but after some time there has been a marked improvement in the quality of work. This has been even more evident during the lockdown, because the fact that the work was completely digitalised has made it easier to work remotely.

The Group plans to continue investing heavily in new technologies, always with a view to improving processes and products, while trying not to impact on the workforce and employment. In 2020, Italy's

Cassa Depositi e Prestiti (CDP) announced a 30 million loan, staggered over 7 years, to support the Saviola Group's growth. Thanks to these resources, CDP will enable the Group to support the substantial investment envisaged in its three-year Business Plan, particularly in the areas of research, development and innovation and across the Group's wide range of products. During the three-year period, the Group will also be able to increase the production capacity of its 13 sites located in Italy and abroad.

The Saviola Group has proved to be a strong company, which has been able to react well to last year's events, reporting smaller losses and greater ability to react than its major competitors. This has been possible thanks to the entrepreneurial choices made by the Group, but also to the cooperative spirit shown by workers who, in this context of crisis, have shown dedication and a spirit of sacrifice to maintain adequate production levels. In this sense, the parties have been unanimous in their view that overcoming the pandemic crisis has been possible thanks to a collaborative approach between the Group and its workers.

The future prospects are therefore very encouraging, but, as seen above, it is important to promote generational turnover at the same time. The recruitment of young workforce is therefore essential, not least because they are more inclined to learn and adapt to new technologies.

Generally, changes in work tasks will create a need for new skills, knowledge and abilities. Future workers in the sector shall have the skills and abilities to recognise and adopt the ongoing changes that innovations will bring about, and to adapt to them. The technical skills required by the various professional profiles shall necessarily be integrated with digital ones, in a scenario where cognitive, social and behavioural skills will become a priority²⁸.

7. Industrial relations and social dialogue: trends, critical points and opportunities

The Group's union relations are managed by a national coordination unit consisting of a delegation of company representatives and territorial union organisations.

Generally, after the 2009 crisis, the Group has tried to undertake a strategy for uniting the various production sites, with a view to integrating the business units. Specifically, the Group's various companies, which were previously limited liability companies, have been converted into Business Units. The decision has been taken to represent them through a national coordination of union delegates. In this way, the

²⁸ CENFIM (2019), *DIGIT-FUR: Impatto della trasformazione digitale nel settore del legno-arredo*.

Group's different realities have been interconnected and no longer considered and managed as separate entities. This paradigm shift has greatly changed the situation at management level and this has been transposed, incorporated and integrated into the company bargaining process, through the new role taken on by the national coordination unit which has ensured an ongoing and effective exchange of views between the parties. Company bargaining is carried out for each of the Business Units and negotiated by the company, the national coordination unit and industry-wide national unions.

Within this process, the dialogue between the parties has been continuous and even heated on some aspects, but with the common idea of promoting the interests of the Group and of its employees. This process of integration between the Group's companies has required a considerable initial effort, and is still ongoing, also through the implementation of management tools that are the same for all of them, such as SAP.

In this context, the supplementary agreement provides for information at both territorial and national levels on issues relating to the technological innovations introduced by the Group. Specifically, the agreement requires the company to inform union delegates of "the quantity, type and timing of technological innovations, with specific reference to any innovation and investment programs falling within the scope of the IMPRESA 4.0 plans"²⁹. In general terms, these aspects are shared with union representatives, even if the information is not always constant.

Through company bargaining, the parties also undertake to support the training of union representatives and workers on environmental sustainability – energy efficiency, in particular – through the relevant bilateral bodies.

8. Covid-19 impact: the role played by digitalization

Like many other Italian companies, the Saviola Group had to face a period of lockdown between March and April 2020, following the breaking out of the Covid-19 pandemic. When the plants reopened, several protocols were drawn up with very strict rules on how to behave in the company, which were shared with the safety managers and the national coordination unit. Given the specificities of the various production units, each plant drew up its own protocol for anti-infection rules. In that phase, the role played by union representatives was fundamental because they made many requests to protect workers'

²⁹ Supplementary agreement of December 20, 2018 for the Saviola Group's Wood Business Unit.

health and safety, which were largely accepted by the Group. The protocols proved to be effective in terms of prevention because, although there were several confirmed cases of Covid-19, no outbreaks occurred in the workplace.

In spite of the temporary closure of plants, the administrative work could continue at full capacity, particularly thanks to the digitalisation work that had previously been carried out. As it turned out, in fact, the work of dematerialising documents and digitalising business management enabled the administrative staff to continue working on a regular basis, even remotely, during the lockdown.

With the previous separate management systems, there was no standardisation and integration of work, and therefore continuity of service could not be ensured. It was possible to resume operations after the emergency through the implementation of a true Disaster Recovery³⁰, i.e. the time and work required to become active and operational again after the forced period of inactivity due to the lockdown. The investment previously made by the Group made it possible to reorganise work in a few days and give 350 employees the tools to continue working from home effectively. The initial organisational effort was demanding, but in fact it made and still makes it possible to continue working with continuity, despite the emergency situation.

It is precisely in this sense that technological innovation should not be considered only as the introduction of more modern machinery/equipment. It is something much broader, which allows the full integration of the activities of different companies in the same industrial group and can ensure the system resilience in a completely unexpected moment of emergency, such as the pandemic.

³⁰ By Disaster Recovery we basically mean the approach taken by an organisation to restore access to and functionality of its infrastructure following a disaster or catastrophic event.