THE FUTURE SKILL NEEDS IN THE CONSTRUCTION SECTOR IN ARMENIA

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Preface

Since 2020, the ETF has conducted several studies to understand how various drivers of change – both technological and non-technological – are impacting occupations and related skill needs in selected sectors and countries and how education and training system is adapting to these changing needs. This resulted in the identification of (emerging) future skill needs in the selected sectors, through a combination of traditional research methods with innovative Big Data mining. These included the agri-tech sector in Israel, automotive sector in Turkey, agri-food sector in Morocco, energy sector in Albania and in Tunisia, healthcare sector in Ukraine and platform work in the Eastern Partnership countries and Western Balkans.[1]

The study on the future of skills in the construction sector in Armenia is part of the above-mentioned series of studies that represent niches of innovation and potential for further development in the economic sectors in the ETF partner countries. The rationale behind this choice is twofold: besides the relevance of the construction sector to the Armenian economy, there is a need to understand how the construction sector has remained resilient and started to grow again despite the strong negative effect of the Covid-19 pandemic.

The study concentrates on changing skills needs and occupations driven by (mostly technological) innovation and non-technological developments. It does not assess potential changes in the volume of employment and skills demand; but it provides qualitative information on occupations, identifying the skills which people working in the construction sector will increasingly need to acquire. The study also provides information on how companies are adapting to technological change and acquiring the associated skills. As such, it indicates how the supply of skills is keeping pace with advances in the construction sector. Ultimately, the study aims to raise awareness about the changing skills demand, to identify drivers of change, and to stimulate a discussion among policy makers and practitioners in the field, so that the findings can be further exploited and used to adapt education and training provision.

The study is based on a combination of traditional research methods (desk research, data analysis and interviews) and big data text-mining techniques. Despite some limitations, text-mining of big data provides new insights as well as real-time information on recent trends. When combined with other methods – such as interviews with key stakeholders and companies, statistical analysis of skill trends, etc. – it provides a powerful means of identifying emerging skill needs and their implications for education and training provision and reskilling workers within companies.

Fondazione Giacomo Brodolini srl SB and Erre Quadro have been working with the ETF to conduct these studies on economic sectors in a variety of countries. A group of international and national researchers from each respective country have been brought together to carry out the studies in addition to the ETF's team of experts. The study in Armenia was conducted between March and December 2022. This report was drafted by Riccardo Apreda, Liga Baltina, Chiara Fratalia, Terence Hogarth, Valentina Mulas and Giovanni Pianigiani with inputs from the national expert Lilit Beglaryan and comments by ETF experts Ummuhan Bardak, Stefano Lasagni and Cristiana Burzio.

The report documents all steps of the research and presents the findings in a detailed manner. This is because ETF wants to raise awareness about changing skills needs in the construction sector to all stakeholders in the partner countries, be they researchers, practitioners, or policymakers. The findings not only raise awareness but also provide food for thought, especially concerning the ability of the education and training system to respond to changing skills demand and to prepare workers for the new jobs and occupations which are likely to emerge. Shorter and more targeted publications and further discussion papers will follow at a later stage after all the case studies have been completed.

Finally, the ETF would like to thank all the relevant public and private institutions and individuals (see the full list in Annex 2) in Armenia for sharing information and their views, and for actively participating in the ETF's online consultation workshop organised in May 2022 and the online validation workshop organised in November 2022. Special thanks go to the Ministry of Education, Science, Culture and Sport, the Ministry of Labour and Social Affairs and ARMSTAT. This report would not have been possible without their contributions.

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[1] See ETF 2020b, 2021a, 2021b, 2021c, 2021d, 2021e, 2021f, 2022a, 2022b, 2022c, 2022d, 2022e.

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Executive summary

The construction sector is a strategic area of the economy for many countries, covering the processes involved in delivering buildings, infrastructure, industrial facilities and associated activities through to the end of their life. The construction value chain includes an even wider range of economic activities, from the extraction of raw materials, the manufacturing and distribution of construction products up to the design, construction, management and control of construction works, their maintenance, renovation and demolition, as well as the recycling of construction and demolition waste.

This report adopts two definitions for the construction sector. The first one is a narrow definition limited to the pure construction projects, as listed in the NACE F codes (F41, F42, F43). The second one is a broader definition of the sector including its closely related value chain of production and sales of construction and building materials.

The Armenian construction sector has risen in recent decades to become one of the economy's most important sectors. It occupies a significant share of GDP (6.5% in 2021), employment (8.8% in 2021), and saw large growth in the 2000s as well as a recent resurgence following a pandemic-related pause. Indeed, although the pandemic caused a severe contraction in the sector, there are signs that the sector has begun to expand quicker than expected, largely thanks to the absence of any further lockdowns. In this context of surging growth, meeting skills demand is therefore a priority.

The sector is highly gender segregated with only 3% of workers being women in 2021, while women constituted 45.4% of workers in all sectors in 2021. However, the percentage has more than doubled since 2010, when women constituted only 1.3% of the total workforce in the sector. Workers in the 25-49 age group constitute most construction workers, representing almost 63% of the sectoral workforce in 2021 according to ARMSTAT data. Workers over 50 years of age represent 32% of the workforce in 2021, while people under 25 are only 5% of the total.

Construction projects are most common in Armenia's capital and largest city, Yerevan. In recent years, such projects have become more numerous again after appearing to peak in 2008. The construction boom has been criticised for neglecting safety concerns, which are especially important in an area that is vulnerable to severe earthquakes. It has also faced allegations of corruption for being connected to money laundering and for damaging the cultural heritage of the country.

In terms of financing, most funding comes from the private sector, followed by the state, individuals (diaspora and domestic), community funds and finally humanitarian aid. According to the OECD (2021) database, there are currently 34 major infrastructure projects planned or under construction in Armenia with a total value of USD 13.9 billion. At 51%, energy projects account for the largest share of this spending, followed by the transport sector (43%).

Whilst increasing skills in the Armenian construction sector is important, this must be contextualised in the reality of the economy and labour market, specifically the presence of low wages. This means that any increase in the skills of Armenian workers, even with the demand for them domestically, must compete with better paid options abroad, resulting in the emigration of workers towards neighbouring countries, and particularly Russia. The emigration can be permanent or, in most cases, seasonal, taking place every year in spring/summer as the busiest months for construction projects.

The growth of the Armenian construction sector is increasing the demand for skilled workers in the sector at all levels. ARMSTAT data for 2021 report around 5.6% of low-skilled workers in the construction sector, 82% of medium-skilled workers, and 12.4% of high-skilled workers. This reduces the opportunities for skills development in the sector compared to other sectors of high innovation such as knowledge intensive services.

No research has been carried out to identify the skill gaps in the construction sector during the last 5 years. This implies the need for field interviews and focus group discussion to identify these gaps from the industry directly, including educational providers (higher education institutions and vocational schools and colleges) and stakeholders such as the Ministries of Education, Science, Culture and Sports, Labour and Social Affairs and the National Centre of VET Development.

The development of qualification standards for the construction sector is under the jurisdiction of the Ministry of Education, Science, Culture and Sports (MoESCS), the National Centre for VET Development and the National Centre for Professional Education (ANQA). The latter is responsible for

institutional accreditation of VET institutions in Armenia. The Ministry of Economy and the Urban Development Committee of the Republic of Armenia define licensing and industrial standards.

Due to the importance of the sector, many experienced education institutions exist with a specialisation in construction. Technical colleges, for instance, provide a wealth of courses covering a range of skills from brick laying to insulation. Among all institutions, the oldest one is the National University of Architecture and Construction of Armenia (NUACA), a state higher education institution in Yerevan. The University offers both Bachelor's and Master's Degrees that are relevant for the construction sector. NUACA also offers vocational education programmes implemented via the Secondary Vocational Education College which was incorporated into the University in 2007.

Drivers of change

A combination of big data analysis, insights from desk research, and feedback from the interviews identified the following drivers of change in the Armenian construction sector from the highest to the lowest impact, based on the overall occurrence of the topic in the academic literature, and on relative growth pace in recent years:

1. **Environmental impact:** This is the driver that most frequently appears within scientific papers, with relatively fast growth over the last 5 years. The construction industry is contributing to the sustainability agenda through numerous strategies to improve energy efficiency in design, materials, and conditions of buildings. The rise of the so-called "green building activity" is driven both by environmental regulations to reduce carbon emissions and by client demands to create healthier buildings. Not only buildings but also work-sites should be sustainable and the adaptation to mandatory safety conditions are strictly required. For these reasons, training and education on sustainability are becoming fundamental for all workers, and the development of green construction related profiles could be very helpful.

2. **Digitalisation:** The second driver in order of relevance is digitalisation, which has been steadily increasing in recent years. At the construction site level, digitalisation means smart buildings that integrate Internet of Things and advanced automation equipment, as construction is exploring automation in additive construction, robotics, drone technology, 3D models and virtual reality. A digitally enabled performance management system could be used to design and manage buildings by embedding active technologies that can also reduce energy demand. The digitalisation of products and processes along with more data-driven decision making will also impact digital operations, design, manufacturing and sales channels.

3. **Natural events (e.g., avalanches, earthquakes, wildfires, flooding or drought)**: Armenia is located in a seismic active zone; in order to face the high seismic risk, housebuilding is increasingly characterised by seismic isolation technologies applied both to new constructions and to existing buildings. The main drivers behind this evolution are national regulations coupled with the demand of the Armenian population to have safer houses and public buildings. Other natural events are also a matter of concern and have implications for the sector: floods, mudflow and landslides are recurrent in various areas of the country. The risks of disasters resulting from these drivers are likely to increase as the severity and frequency of extreme climate events increases due to climate change.

4. **Job precarity and lack of skilled workers in the sector:** The failure to create enough skilled jobs in terms of remuneration and working conditions is a key factor that characterised the construction and building sector. As a consequence, the sector is characterised by a scarcity of skilled workers and the construction activity still relies on a large share of manual work performed by a largely blue-collar workforce. Training is fundamental in order to develop key skills in the future building industry, such as *IT skills*, *Management skills*, and *soft skills* such as communication.

5. **New construction materials and changing industrial production approaches.** Innovative processes such as modularisation, off-site production automation, and on-site assembly automation will foster a wider adoption of industrialised concepts and an off-site, product-based approach. Modular construction in particular is becoming a key driver as it leads to a reduction in the need for labour and consequently to cost reduction. The rising cost of materials is also pushing companies to adopt industrialisation processes to optimise resource usage. Innovation also concerns traditional materials (such as cement) in order to reduce carbon footprints, besides lighter-weight materials that allow simpler module production.

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6. **Increasing specialisation.** As production techniques become more sophisticated, there is an increasing range of companies operating in specialist niches. This has implications for skill demands and the extent to which increasingly specialist skills are required.

7. **Sector policies and regulations.** The policies and regulations driver has not particularly impacted technological change and developments in the sector over recent years. In the construction and building sector, several policies and regulations exist related to energy efficiency and energy saving, anti-seismic isolation, and minimum energy performance requirements for both new and renovated buildings. Job security issues also recur in the international scientific literature, due to the physical risks that are still very high in the construction sector. Health and safety conditions are regulated by the Labour Code of the Republic of Armenia, adopted in 2004 and currently under revision to bring the labour legislation in line with international requirements.

8. **Availability of national/international investment and diverse financing tools in the sector.** Being capital intensive, the construction sector is strongly related to the economy of a country and to the availability of funding, incentives or subsidies. In Armenia, apartment buildings are supported by funding from donor organisations, commercial banks, and credit organisations. The Government is also committed to cutting the growing housing needs by offering long-term, affordable mortgage loans, and by stimulating private sources of funding.

Construction technologies

Inventive activity in Armenia is rather limited in the period 2000-2021, with many ups and downs and a peak point in 1991 (year of independence). Overall, the country filed 311 patents in all sectors during the last 20 years, 55 of which were in the construction sector. This shows that socio-economic factors have a non-negligible impact on the country's innovation capacity. The filing of patents in all sectors has shown a decline in recent years (post 2011), which may be due to a downsizing of research and development investments in the country. Consequently, Armenia has a factual risk of losing competitive advantage and become an importer only of new technologies, with heavy implications also in terms of the competences that the country can display in key technological areas.

Looking at how Armenian patents in construction are distributed across sub-sectors provides insights about the possible relative availability of competences and of highly trained human capital in the different areas. The main subsectors of activity for patents filings in Armenia are the following (in order of relevance):
- Anti-seismic construction, and other seismic safety/protection measures (e.g. shelters)
- Structural elements and building blocks, in particular to speed up construction times
- Heat insulation, sound insulation
- Prefabricated buildings
- Road surfacing and reduction of the environmental impact of roads
- Automated parking.

Data on the limited number of Armenian patents in construction were complemented by the analysis of global patent fillings in the sector during the same period of 2000-2021, since global trends of innovation can be used to determine which of those will be affected most by technological developments. Based on the analysis of 190.653 global patent applications regarding construction in this period, the results suggest twelve technical sub-sectors as most relevant for the future of the country (in order of number of inventions): Building materials, Structural elements, Finishing elements, Green construction, Hydraulic engineering, Construction site processes, Street construction, Railways construction, Digital solutions, Bridges construction, Additive manufacturing and Robotics in construction.

The above list hides the dominance of the building materials sub-sector which is the topic of one-third of all patent filings; together with structural and finishing elements, they represent 66% of all patents. Nevertheless, all sub-sectors are receiving a constant influx of new technologies, and while the first three are the most numerous in terms of patents filed globally, some other clusters present an interesting and more pronounced growth rate in recent years, indicating their increasing relevance in the field, and possibly even more relevance in the future: this is the case for Digital solutions, Additive manufacturing and Robotics in construction. It is also worth noting that the three clusters specifically related to infrastructure, namely streets, bridges and railways construction, are growing at a pace in line with the general trend of the sector.

Emerging skill needs

The input coming from the various drivers of change has been correlated to the skills needed to properly use the new technologies or to manage the new challenges and opportunities, and to the professional profiles involved in the process, using semantic software and referring to the standard classification of skills, competences and occupations provided by the ESCO database.

The various occupational profiles of the sector have thus been ranked according to their degree of correlation with the new or growing technologies, whose adoption will impact the sector, and hence the labour market, the most. The resulting highest-ranking occupations will likely be in relatively high demand in the near future.

The first general finding is that three main categories of job profiles present a stronger correlation with the new technological developments and thus seem to be growing in demand: high skilled technical occupations (e.g. *civil engineer*), medium and low skilled technical occupations (e.g. *crane technician*), and business services related occupations (e.g. *energy manager*). In other words, the change is not limited to highly skilled profiles (actually medium-low skilled profiles impacted are as numerous as high-skilled ones), nor to technical professions only, since managers, salesmen and the like also need to have confidence with the new techniques.

The second finding is that, while many high-ranking profiles are traditionally related to the Construction field (e.g. various types of engineers, but also labour profiles such as *concrete finisher* or *building construction worker*), some other job profiles, on the contrary, seem to be coming from innovative cross-sectional sectors. For example, the *energy engineer*, the *solar energy engineer*, and the *energy manager* plausibly refer to the emergent necessity of including concepts related to sustainability, energy efficiency and environmental impact, within the Construction design processes.

In a similar way, while certain technological advancements support the work of already existing professions, other innovations lead to the creation of completely new professions (at least for the sector) such as *3D printing technician*, *3D modeller*, *Data analyst* or *Laser marking machine operator*.

The emergence of new professions is an important finding, but surely the sector in the future will still rely on several traditional job profiles to face the technological change. Architects as much as various labour workers will still be needed in rather big numbers. The analysis tells us that those traditional profiles will not be left untouched by the adoption of new technologies: in order to transit to the new scenario or stay competitive in the changing labour market, they will need to upskill and widen their range of competences, for example learning digital skills, or the usage of new materials.

The list of competences related to the introduction of new technologies provides a useful compendium of what new life is expected for old, traditional jobs. An interesting role will be played by the technologies for the organisation of construction works, which will likely have a transversal impact on many different profiles. These are the omni-present digitalisation, the rise of modular construction, freeform/additive construction, new health and safety measures and devices.

Limiting factors

- **Large gap in practical training and transversal skills.** Much of the practical work is conducted in classrooms and the students do not have the opportunity to gain on-field experience prior to actual working. In most cases, education providers have an outdated training infrastructure that does not allow students to fully put to work their theoretical skills. Similarly, although the higher education system has some laboratories and built-in practical learning sessions and workshops, the students do not manage to implement new technologies (such as the metal carcass reinforced buildings) because there is (a) a lack of private sector companies using the latest technologies in production; and (b) no major practical training in the vocational education and training (VET) provision of the relevant occupations. In some cases, organising training poses particular technical and financial challenges, particularly for the operation of large machines (cranes, ground movement equipment, etc.), alongside raising safety concerns. Moreover, companies often report gaps in transversal skills such as digital skills and project management skills which need to be addressed by the education and training system as a whole.

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- **Lack of attractiveness of the sector and non-replacement of older workers**. The general perception of the sector as hard, physical work, with low wages that are not in balance with the effort required by the profession, despite a recent generalised hike in salaries, affects the choices of young people. This, in turn, has led to a situation where young workers do not replace the ageing workforce in the sector, slowing down innovation and preventing valuable knowledge to be passed from older workers onto younger recruits. Young people seem to be attracted to more prestigious professions when making their career choices, and also seem to prefer shorter educational pathways, leaving out specialisations for the construction sector such as engineering. Students do not seem to have an accurate picture of what the modern professions looks like, and in particular they are not aware of the multitude of jobs that surround construction work, such as inspectors, energy advisors, sustainability managers, etc.

- **Large shares of low-skilled workers in the economy and low shares of high-skilled professionals for the sector**. About 65% of unemployed people in Armenia do not possess any formal qualification. 17.2% of them are 16-27 years of age, which is the top target group that would need to be upskilled to bring new workers in the construction sector. 43.1% of all the unemployed are 30-44 years old (another potential target group for the construction sector). Jobs in the construction sector, especially low-skilled ones, are often carried out by people that do not possess any relevant qualification. As it is not their career goal, they often end up switching to other careers, permanently or temporarily. Therefore, employers regularly lose the investments they have made in training their workers to make them independent in their jobs. Qualified and trained people are lacking in the sector. The sector is mostly made of jobs requiring completion of some level of VET, but people fulfilling this requirement are not easy to find. For this reason, most companies resort to employing underqualified and/or low-skilled people and training them on the job. When the country recently invested in the construction of critical infrastructure like power plants and nuclear plants, it was necessary to engage specialists from abroad on multiple occasions because the necessary skills simply were not available in the country. There is a shortage of urban planning professionals despite an observed increase in the construction volumes. Also engineering professions are less attractive for many applicants: the skills that are hard to find and are in high demand in the construction sector cover all types of engineering - from civil to mechanical. The shortage of these skills will be felt more severely in a couple of years, as the best specialists in these fields are growing old and they are not replaced by younger generations. There is a shortage of skilled professionals in the construction of dams and highways, which is one of the main issues in current construction for big public infrastructures. As for the low-skilled workforce, such as builders or welders, there is a lack of strong vocational and middle professional schools to help develop the required human resources.

- **Weak interaction between public and private sectors.** There is a generally weak interaction between the public and private sector, and between education providers and employers. As Armenia is a small country, there are many SMEs and only few very big companies, therefore keeping them motivated to collaborate with the VET system is not easy. Also, SMEs have comparatively lower skill needs and need less people to recruit on an annual base, thus they count on being able to find good people and bring them up to speed with internal training, without relying on VET colleges. Even with tripartite commissions with employers and trade unions, there are no effective means of communication and collaboration. There are recently established working groups within the main Ministries involved in educational policy (Education, Economy and Labour) and there is also a sectoral skill council for construction to help identifying sectoral skill needs and to adapt sectoral education. However, the channel of communication and engagement of stakeholders reportedly needs to be reinforced. Most companies are ready and willing to engage with policymakers, but they do not have the capacity to engage throughout the whole process, therefore being unable to make their needs properly heard. Similarly, companies have difficulties in engaging with public education providers, as even work-based training programmes or similar activities where companies offer to take on students are slow to take off and to maintain due to (perceived) little interest in this type of activity for the construction sector.

A final word on the findings

The construction sector is an important driver of economic growth, including a panoply of building activities from mundane repairs, to constructing office complexes, to building new highways. Looking to the future, the twin green and digital transitions are placing new demands on the construction sector. All of the above creates a demand for new skills. This requires an education and training system which is aware of emerging skill needs and can plan accordingly, but also one which is able to respond flexibly and quickly to emerging skill needs if skill shortages are not to hinder growth in the sector. This suggests that the education and training system not only needs to focus on producing a talent pipeline so that the young generations possess the skills of tomorrow, but also on upskilling and reskilling the existing workforce so that they too are suitably skilled.

Many of those employed in the construction sector are learning their skills on the job, and relatively few hold qualifications relevant to construction. This suggests that there may be a need to certify the existing skills of the workforce alongside the provision of upskilling or reskilling. Thinking about meeting the future skill needs of the construction sector, employers reported a problem of attracting people to develop their careers in construction. The construction-related jobs are often regarded as unattractive employment, where people tended to start working due to a lack of choice, only staying for a short time before going on to work somewhere else. If the sector is to meet its future skill needs, some extra incentives and measures would be needed to make the sector more attractive for newcomers, and so are sufficient number and quality of construction training for young people and adults who are prepared to develop their careers in the sector.

In order to design and/or upgrade education and training programmes that are relevant to the sector, it is crucial to regularly conduct skills anticipation activities and use the results to adapt and/or expand the existing offer. Besides identifying the need for specific professions in the sector, one must also be aware of longer-term worldwide trends, such as the increasing digitalisation of construction activities and the increased focus on sustainable practices. Detecting the potential changes that these trends bring to the construction sector is crucial to stay ahead of the developments and address future skill needs in a timely fashion.

The education and training system, including VET, cannot achieve a high-tech, high productivity construction sector alone. It requires the support of government to drive growth in construction and create partnerships between education and training providers and construction sector companies. All findings from the current study point to the need to increase skill provision in Armenia's construction sector. This encompasses increasing the provision of both initial and continuing training.

Meeting the future skills of the sector in Armenia will require the following to be undertaken:

- Expand the training infrastructure in the sector, including the number of training institutions, so that access to training in different construction professions and specialisms is widely available across the country.
- Assess the existing skills of the workforce given that the sector's workforce largely lacks formal qualifications. This will necessitate recognition of acquired prior learning for those workers who obtained their construction-related skills by learning on-the job.
- Develop stringent quality criteria to be met by training providers licensed to deliver accredited training. All training provision must lead to the award of a qualification which is recognised in the wider labour market.
- Upgrade existing training programmes and courses so that they better meet the needs of the sector. This will require the updating and/or new design of programmes for upskilling and/or reskilling existing workers. Programmes and courses will need to reflect the use of the latest technologies being used globally to improve the quality of the built environment. This has the potential to increase the attractiveness of the sector to would-be employees.
- Provide incentives and extra measures to increase the participation of companies and individuals in construction training. Grants and subsidies can be provided to ensure that training in new technologies includes those not commonly in use today but are likely to come on stream in the near future. Public procurement can be used to ensure that the construction workforce is appropriately trained by, for example, introducing training clauses into contracts.
- Strengthen the institutional partnerships between employers, training providers, and policy makers and promote the sharing of resources between education providers and employers to increase effective skill provision in the sector. For instance, personnel from construction companies can be

used by training providers to deliver training. Construction companies can also make equipment available to training providers.

- Learn from international best practice in the training of construction workers and use tools and measures to deliver training which are seen to work well in other countries, e.g. the use of work-based training such as apprenticeships, or the use of micro-credentials for accrediting the skills acquired from short-duration training or on-the-job learning.

- Provide improved career guidance and effective incentives to increase the attractiveness of construction sector jobs to young people – and potentially adults who are looking for a career change – so that they are fully informed of the relative merits of working in construction.

- Consider reviewing the current system of occupational licensing given to the companies carrying out construction work by the Urban Development Committee. Stricter requirements could be asked of skilled personnel and licensing could be time-limited rather than being granted in perpetuity. Training in occupational health and safety could be made compulsory for all construction work.

1 Introduction

1.1 Country overview

Armenia is an upper middle-income country[2] which has seen strong overall economic growth since its independence in 1991. After a period of instability in the 1990s, growth increased dramatically in the 2000s with a slower trend after the 2008 global financial crisis which also coincided with a fall in population. After 30 years of transition to a market-oriented economy, many assets are now owned privately, though agriculture plays a significantly larger role. The economy is strongly reliant on remittances from the Armenian diaspora and loans from the donor community for major infrastructure projects. The country has a GDP per capita of USD 4.760 and an unemployment rate of 18.3% as of 2019 (World Bank, 2021).

From 2017 to 2019, Armenia's economy expanded rapidly with an annual GDP growth rate of 6.8%. However, this progress has largely been derailed due to the onset of the COVID-19 pandemic and a military confrontation with neighbouring Azerbaijan. This resulted in a 7.4% contraction of the economy in 2020. This has increased poverty most profoundly in urban centres and for people outside of government assistance systems. Like many countries, in response to the pandemic, the public debt ratio increased, in Armenia's case to 67.4% of GDP in 2020.

As Armenia recovers from these latest crises, it must also tackle long-running structural issues relating to widespread financial informality, emigration, demographic ageing, and skills mismatches. More widely, geopolitical tensions have destabilised market investor confidence. Despite this, GDP was forecasted to increase by 7% in 2022 (IMF, 2022).

Much like the economy, the Armenian construction sector has been marked by a period of crisis in the 1990s, followed by a boom in the 2000s and a decline after 2008. This contraction was finally ended in 2017 when the sector began to grow substantially again. Most of the construction is financed by private companies (42%), with the government as the second largest financier (29.5%) followed by individuals (25.2%) and humanitarian aid accounting for the rest (ARMSTAT, 2020). There are signs of a strong recovery for the construction sector with a 10% increase in spending in November 2021 compared with the same time the year before (ARMSTAT, 2021).

1.2 Methodology

The aim of this study is to identify signals that reveal something about emerging or future skill needs. Anticipating the labour market evolution is a complex task that cannot rely only on the photography of the current situation. In order to reach that goal, a multifaceted methodology was developed, based on conventional approaches to skills anticipation combined with the opportunities afforded by data science. The resulting methodology comprises the following steps.

1. A **background analysis,** using well-established methodologies derived from social science, including a literature review and a secondary analysis of employment and skills data. The analysis builds on analysis of national (ARMSTAT) and international data (mostly Eurostat, ILOSTAT, World Bank), as well as a collection of national and international reports and papers on the topics of economy and skills.

2. A **data science (big data) analysis**: text-mining techniques have been applied on a large volume of patents and scientific publications related to the sector to identify drivers of change as well as emerging technologies. Subsequently, the identified societal and technical trends have been correlated using semantic software to the standard ESCO classification of jobs and competences to identify which occupations and skills will likely be more in demand. Data sources used in the study are:

    a. OpenAire, a network of Open Access repositories, archives and journals, developed within the Horizon 2020 scheme, and containing over 132 million publications and research

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[2] According to WB classification: https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups. It ought to be noted that this is just one schema and Armenia is defined differently elsewhere.

projects from main open access databases (arXiv, PubMed etc.) and individual academic institutions.

b. Google Scholar, a web search engine, displaying probably the largest coverage of scholarly sources with around 389 million entries indexed.

c. ResearchGate, a social network for the academic community, with 135 million entries.

d. Selected publications from World Bank and International Energy Agency.

e. "Journal of Architectural and Engineering Research," edited by the National University of Architecture and Construction of Armenia (NUACA – the unified academic institution for the sector in the country)[3].

f. Armenian Intellectual Property Office, consulted to study both patents filed at national level and trademarks and brand names registered in Armenia.

g. Espacenet, a repository of worldwide patents developed by the European Patent Office, consulted to study patents filed by Armenian companies and research centres at international level, as well as general innovation trends for the construction sector worldwide.

h. World Intellectual Property Organization, consulted for trademarks registered by Armenian companies at international level.[4]

i. ESCO, the multilingual classification of European Skills, Competencies and Occupations, a standardised taxonomy for the labour market and education and training comprising 3000 occupations and 14.000 skills and competences.

3. **Fieldwork with employers and stakeholders**, to gather direct information from the actors of the sector and enquire about issues where data were scarce. During this phase, one focus group was held with key stakeholders representing the sector and education and training system and 17 semi-structured interviews were conducted with employers and sector stakeholders.

4. **Validation of the findings**, through a focus group with key stakeholders where the findings from the study were presented and feedback was obtained for the final report.

For further details on the approach adopted in the study, see ETF's methodological note for conducting studies on the future of work (ETF 2021c) and its update (ETF 2022h).

1.3 Structure

The report follows a simple structure. After the introduction, Chapter 2 starts with an overview of the Armenian economy and labour market characteristics, while Chapter 3 focuses on the features of the construction sector, policies and actors, based on the literature review and a secondary analysis of official employment statistics. Chapter 4 analyses the main drivers of change affecting the sector, both technological and non-technological. Chapter 5 analyses the impact of technological trends on emerging skill needs by comparing and matching them with occupational job profiles. Chapter 6 reviews the skills bottlenecks that could prevent change from happening, discusses sector initiatives and training strategies put in place as a response, and provides policy recommendations.

The report also includes the detailed analysis of patent clusters (Annex 1), a list of the key stakeholders and companies in Armenia that were consulted for the study (Annex 2), a glossary of terms relating to employment, skills and technology (Annex 3) and a bibliography.

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[3] Sources a-e combined contain over a million entries concerning the construction sector in general, of which about ten thousand are dedicated to, or contain information about, the Armenian specific situation.
[4] Sources f-h combined provided over 200.000 patent families for the construction sector, of which only 55 from Armenia, and 170.000 trademarks, of which about 1.500 from Armenia.

2 The country: economy, employment, and skills

KEY ITEMS IN THIS CHAPTER

- Armenia's recent economic history can be distilled into three distinct periods: crisis and recession following independence (1991-1999); profound economic growth (2000-2008); a sharp recession and slow recovery (2009-2019). In recent years, Armenia's labour market has had some success in increasing wages as well as robust non-agricultural sector growth in recent years. However, it is still characterised by a high unemployment rate, emigration, low rates of participation and high gender segregation.
- There are certain structural constraints to the Armenian economy, such as: being a landlocked country that relies upon good relations with neighbours for import and export; a heavy reliance on remittances from Armenian workers abroad; being a net-energy importer in a region of net-energy exporters, placing it in a weaker state of energy security.
- Armenia has a population of 2,963,234 million with a low activity rate (almost 58% in 2021 decreasing from 61% in 2010). The employment rate has fallen from around 50% in 2010 to 49% in 2021. Youth unemployment peaked at almost 39% in 2010 before slowly declining to 32% in 2021. The gender dynamics of the labour market reveal that men are far more likely to work than women, at just 48% of working-age women in 2021 compared to 70% of men.
- The educational system is comprised of pre-school and primary (lower), secondary education, preliminary and middle VET (medium) and higher education (higher). Compared to neighbouring countries Armenia has a wider coverage of early childhood education programmes.
- Developing a comprehensive vocational education and training system is underway in the country. In the five years prior to 2018, VET saw an average annual growth rate of 4.5% by student admission. Current VET governance is overwhelmingly centralised, despite efforts to move to a more participatory approach.
- The share of VET students in secondary education as a whole increased over the period 2014-2019, reaching almost one-third of the upper secondary education system. The share of women in VET reached 30% in the academic year 2018-2019.

2.1 The economy

Armenia's post-independence economic history can be distilled into three distinct periods (Figure 2.1): (1) crisis and recession following independence (1991-1999); (2) a period of profound economic growth (2000-2008); and a sharp recession and slow recovery (2009-2019). These overarching trends are shown in Figure 2.1 below. Armenia is now likely entering a fourth distinct period of pandemic recovery and conflict resolution, the effects of which are estimated to far outweigh even those from the 2008 global financial crisis (ILO, 2021).

Despite significant problems, Armenia's economic performance was highlighted as a relative success story among fellow transition economies (World Bank, 2017). It is now member to many European organisations and initiatives, including the European Bank for Reconstruction and Development, the Council of Europe and the Eastern Partnership. It also maintains commitment to regional organisations such as the Asian Development Bank, the Eurasian Union and Eurasian Development Bank.

Figure 2.1: GDP growth in Armenia, 1990 to 2021
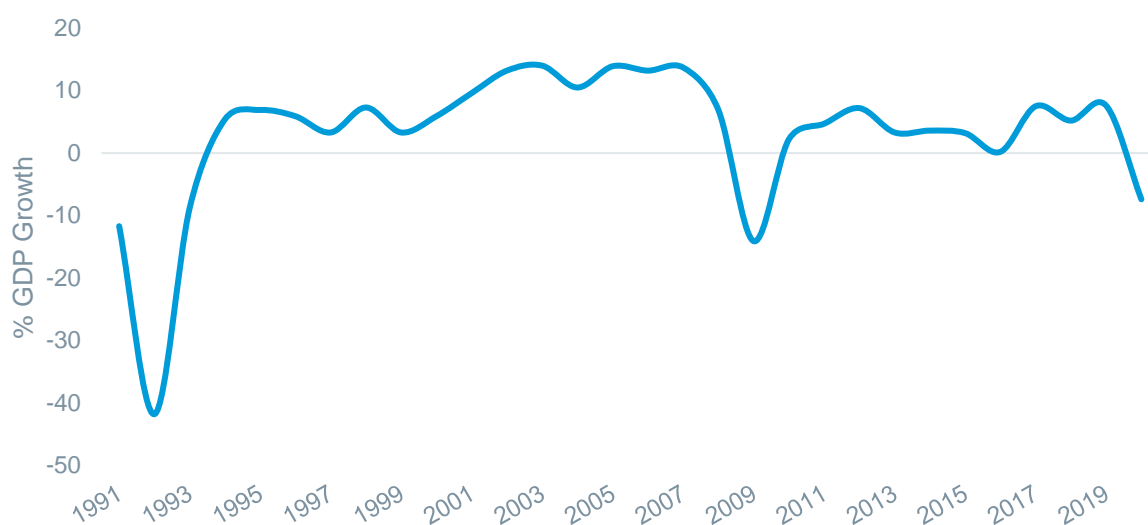
Source: World Bank Data

Armenia's economy has undergone a large transformation from a Soviet-era centralised economy integrated with the Soviet Union to a market-oriented economy with private ownership and greater international openness. Armenia is now well integrated in the global economy with exports representing 39% of GDP and imports 53%, amounting to a large trade deficit (ILO, 2020). This has created an influx of foreign capital and donor funding, helping to contribute to an economy twice as large as it was in 1990. This period has seen a sectoral change in the Armenian economy with services and agriculture growing in importance and manufacturing slightly declining.

The Armenian economy is now primarily reliant on services, replacing the prior dominance of industry. In 2019, services accounted for 59% of value added in the economy with industry second at 27% and agriculture accounting for 14%. Armenia imports more than it exports. Its main import markets are Russia (28.7%), China (10.4%) and Georgia (7.9%). Armenia's main export markets are Russia (22%), Switzerland (20.4%) and China (6.6%) (OEC, 2020). Its main exports are copper ore (26%), gold (13.2%) and rolled tobacco (8.1%). The country is a net importer of energy, with hydro and nuclear providing most of domestic production. The war in Ukraine may have an impact on the share of the export market to Russia in future.

There are certain structural constraints to the Armenian economy which cause persistent limits to the country's potential. Firstly, Armenia is a landlocked country and therefore relies upon good relations with its neighbours for the smooth import and export of products and services – something which is tested by the highly complex history of the region. The country relies heavily on remittances from Armenian workers abroad, the majority of whom are in Russia, although this source of income has declined from 14.3% of GDP in 2008 to 10.9% in 2019 (ILO, 2020). This decades long trend was disrupted recently with around 100,000 Russians moving to Armenia because of the war in Ukraine (BBC, 2022). Armenia is also a net-energy importer in a region of net-energy exporters, placing it in a weaker state of energy security. The labour market faces prolonged crisis, marked by low participation, high unemployment, emigration, low productivity, low female participation and a lag in matching demand for skills. An overview of Armenia's key macroeconomic indicators is displayed in Table 2.1 below.

Table 2.1: Main macroeconomic indicators

	2017	2018	2019	2020	2021 proj.
GDP growth	7.5	5.2	7.6	-7.4	5.0
Inflation (average)	1.0	2.5	1.4	1.2	6.9

Government balance/GDP	-4.8	-1.8	-1.0	-5.4	-4.0
Current account balance/GDP	-1.5	-7.0	-7.4	-3.8	-2.9
Net FDI/GDP (ng. sign = inflows)	-1.9	-2.1	-1.7	-0.6	1.6
External debt/GDP	91.3	87.7	90.9	102.1	n.a.
Gross reserves/GDP	20.1	18.1	20.9	20.7	n.a.
Credit to private sector/GDP	53.0	57.1	62.6	73.3	n.a.

Source: EBRD, 2022 Data

The strong period of growth during the 2000s resulted in a period of persistent poverty reduction. The poverty rate decreased by one third to 28% and extreme poverty was cut in half in just four years from 2004-2008 (IMF, 2017). This was facilitated by an increase in jobs and social protection expenditures during the period. This success was partially undone by the 2008 financial crisis, with the poverty rate returning to 34% in 2009 (Ibid). During the recovery period the poverty rate returned to pre-crisis levels. Armenia does not have a large urban/rural divide in terms of poverty, with levels of poverty similar in both contexts. This is a legacy of the importance of regional mining and agriculture in the economy. Economic inequality in the country remains low, with a Gini coefficient of 29.9 in 2019 (World Bank, 2022). Inequality had been growing since the 2008 crisis with a sharp correction in 2019. However, when examining the growth incidence curve for the country, the highest income earners benefit much more from economic growth than the rest of the population and especially the poorest.

Covid-19 has placed particular strain on low- and middle-income economies which tend to have poorer social safety nets and less developed public health systems. In order to combat the pandemic's effect, the government put together a package of measures worth USD 367 million (2.9% of GDP) to help the economy (EBRD, 2022). Measures included direct wage subsidies to SMEs, social assistance and subsidised loans to the most affected sectors such as tourism. Banks were encouraged to restructure loans and extend payment holidays to ease borrowers' liquidity difficulties.

A noteworthy policy during the crisis was a green public works programme involving the employment of unemployed citizens to plant tree seedlings along designated areas to contribute to re-forestation goals and a 'greener' recovery. The programme created 1000 jobs as of June 2020 and planted more than 2 million seedlings (EU4Environment, 2020). This is part of the government's ambitions to increase forest cover by 12.9% of Armenian land by 2030 under plans to meet the Paris Climate Agreement.

The Economic Response Programme and action plan was approved by the government in February 2021 to support economic recovery efforts. This targets 12 action areas and 14 assistance programmes to rejuvenate the market and contribute to a medium-term economic policy programme. The programme is showing signs of effectiveness, with economic growth forecast at 7% in 2022 (IMF, 2022).

With a growing international focus on tackling the climate crisis, the Armenian government is launching its own plans for a carbon net zero future. As of April 2021, Armenia updated its nationally determined contributions (NDCs) under the ongoing Paris Agreement requirements for 2021-2030. The standout commitment is to reduce the country's greenhouse gas emissions by 40% by 2030 (with a 1990 baseline). As part of this process, the government aims to double the share of renewable energy production by 2030.

Digitalisation efforts are underway too in Armenia. The new digitalisation strategy was approved in February 2021 and aims to accelerate the digital transformation of public, private and civil sectors through the promotion of innovative technologies, cyber security and higher data standards. The process

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aims to upskill the work force for a digital era and to improve the speed and transparency of public services, public governance efficiency, and data-driven decision making.

Institutional corruption in Armenia remains a problem despite impressive progress in recent years according to Transparency International's Corruption Perceptions Index (2020). As of March 2021, the Armenian parliament passed legislation to replace the ineffective Special Investigative Service with an Anti-Corruption Committee wielding more powers of investigation. Further reinforcing the rule of law in 2021 is the creation of an Anti-corruption Court. This new institution will focus on corruption cases with enhanced powers to examine lawsuits regarding property confiscation.

2.2 The labour market

Armenia has a population of 2,963,234 million. Among the working-age population, almost 55% have participated in the labour market in 2021 (see Table 2.2). The activity rate has decreased over time since 2010, with consistently higher activity rates for males. The employment rate is similarly low at 46.4% in 2021. The total number of employed people in the same year was 1.096 million people. The employment rate has also declined over time, and the gender difference remains with higher employment of men compared to women (ARMSTAT, 2021).

Table 2.2 Activity and employment rates (% aged 15+)

	2010	2015	2016	2017	2018	2019	2020	2021
Activity rate - Total	**61.2**	**62.5**	**61.0**	**60.9**	**58.8**	**58.8**	**55.4**	**54.8**
Male	72.3	72.6	71.3	70.7	71.5	70.9	66.3	67.3
Female	52.2	54.3	52.5	52.8	47.8	48.2	46.3	44.8
Employment rate - Total	**49.6**	**50.9**	**50.0**	**50.1**	**47.7**	**48.4**	**45.4**	**46.4**
Male	59.9	59.8	58.4	57.9	58.7	59.1	53.8	56.8
Female	41.1	43.8	43.2	43.5	38.0	39.0	38.4	38.0

Source: ETF KIESE 2022, based on ARMSTAT data

The sectoral share of employment is a good indicator for the skills demand of the economy. As Table 2.3 below shows, services employ 56% of the total workforce, a share that has consistently increased since 2010. On the contrary, employment in agriculture has decreased dramatically in the last decade, from almost 39% in 2010 to 22% in 2021.

Table 2.3 Employment by broad economic sectors (% aged 15+)

	2010	2015	2016	2017	2018	2019	2020	2021
Agriculture	38.6	35.3	33.6	31.3	26.0	23.4	22.1	22.1
Industry + Construction	17.4	15.9	15.8	13.1	22.8	23.8	20.9	22.0
Services	44.0	48.8	50.6	55.5	51.2	52.8	57.0	55.9

Source: ETF KIESE 2022, based on ARMSTAT data

The unemployment rate in Armenia more than doubled because of the 2008 global financial crisis – from 9.8% in 2007 to a peak of 19.0% in 2010. This then decreased during the initial recovery before increasing once again in the latter half of the decade to a new peak of 19.0% in 2018, and a new

decrease to 15.5% in 2021 (Figure 2.2). This comes after near zero unemployment during the centrally planned Soviet era; a quick increase in the 1990s before plateauing around 10% during the 2000s.

**Figure 2.2 Unemployment rate in Armenia and EU-27 (aged 15-74)**
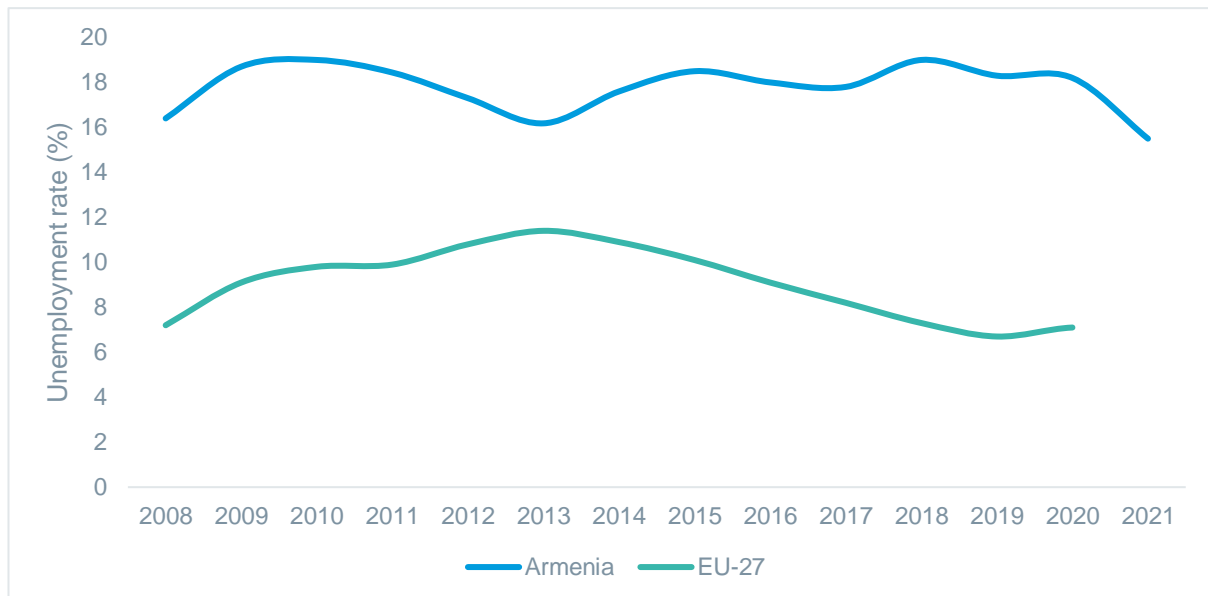
Youth unemployment (those aged 15-24) peaked at 38.9% in 2010 before slowly declining to 30.5% in 2021 (ETF, 2022g). A similar story can be found in the country's youth not in employment, education, training (NEET) rate for those aged 15-24 which peaked at 45% in 2011 before declining to 28% in 2019 (Ibid) and to 20.3% in 2021 (ETF, 2022g). Among NEETs, the gender gap is evident, with 16.2% of males aged 15-24 being NEETs, compared to 24.6% of females. This is evidence of the challenges Armenia faces in transitioning to a market economy from a position of full employment. These statistics omit the prevalence of informal labour in the economy.

The country's labour market has been marked by a persistent lack of well-paid secure jobs since the collapse of the Soviet system. Results of this include emigration, a mass of working poor, and population decline. The period 2016-2019 saw what looked like a reversal of fortunes for the labour market in this regard. Non-agricultural employment began to grow considerably, both in manufacturing and construction. It is estimated that non-agricultural employment grew by 23% or 150,000 persons over the period. This is promising for an economy which has struggled to revitalise a once robust manufacturing sector. Construction stands out as a particularly booming sector, with a 162% increase in workers employed from 2016-2018.

The gender dynamics of the labour market reveal that men are far more likely to work than women. In 2018, 38% of working-age women were in employment compared with 59% of men (ILO, 2020). In this respect, Armenia performs poorly compared to its northern neighbour Georgia which has a female labour force participation rate of 54.5% (ILO, 2021). Furthermore, women were more likely to be in the category of NEET at 34% compared to 17% of men. Women are more pressured to withdraw from the labour market completely due to the unavailability of work and socially constructed family obligations. Many young women are highly educated, hence their exclusion from the labour market represents a severe underutilisation of the human capital in the country (World Bank, 2019a).

The type of work found in Armenia is predominantly wage labour at 62.6% of the total employed. This is most common in urban areas where it accounts for 83% of employment compared to 39.9% in rural areas (Figure 2.3). This is in the context of an estimated 64% of the population living in urban areas (World Bank, 2019a). It is evidence of the widespread informality of employment in rural areas as well as the seasonal nature of work in that area. Women are more likely to be wage earners than men, correspondingly men are more likely to be self-employed and engaged in informal work in some capacity. The share of the economically active population is higher in rural areas engaged in agriculture where forms of self-employment are prevalent.

Figure 2.3: Wage of employees as a percentage of the work force, gender and geography (2019)
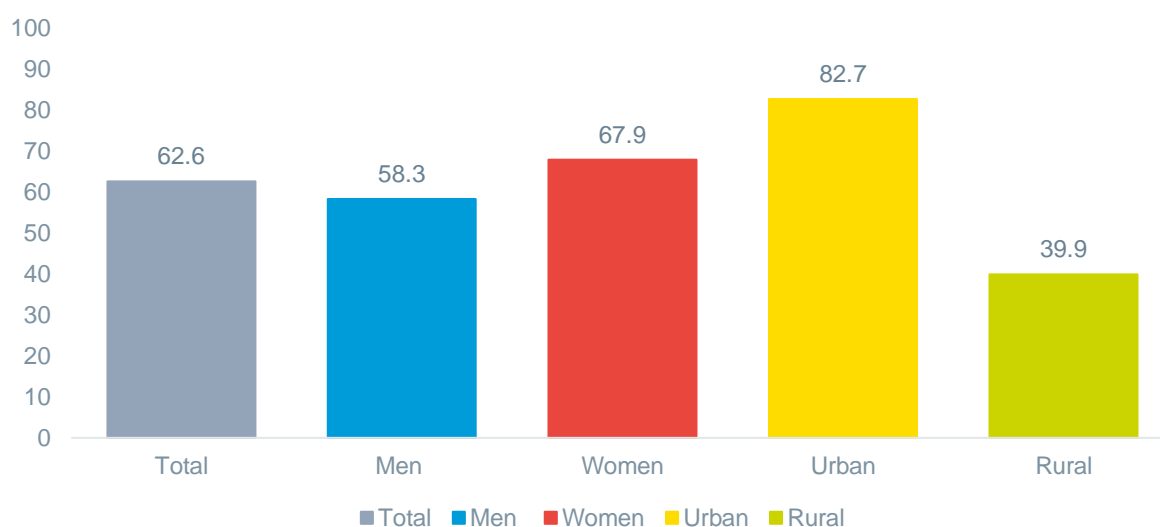
Source: World Bank Data

The last decade has seen an overall increase in real and minimum incomes as represented in Figure 2.4. This amounts to an average wage increase of 79% between 2008-2019. A recent reform pursued this trend, increasing the minimum monthly salary from the current 68,000 drams (approx. USD 169) to 75,000 drams (approx. USD 186), starting from January 2023. The government's 2021-2026 plan stipulates that the minimum monthly salary in Armenia shall reach at least 85,000 drams (approx. USD 211) in 2026.

Figure 2.4: Armenian average monthly net wage and minimum monthly wage (AMD), 2008-2020
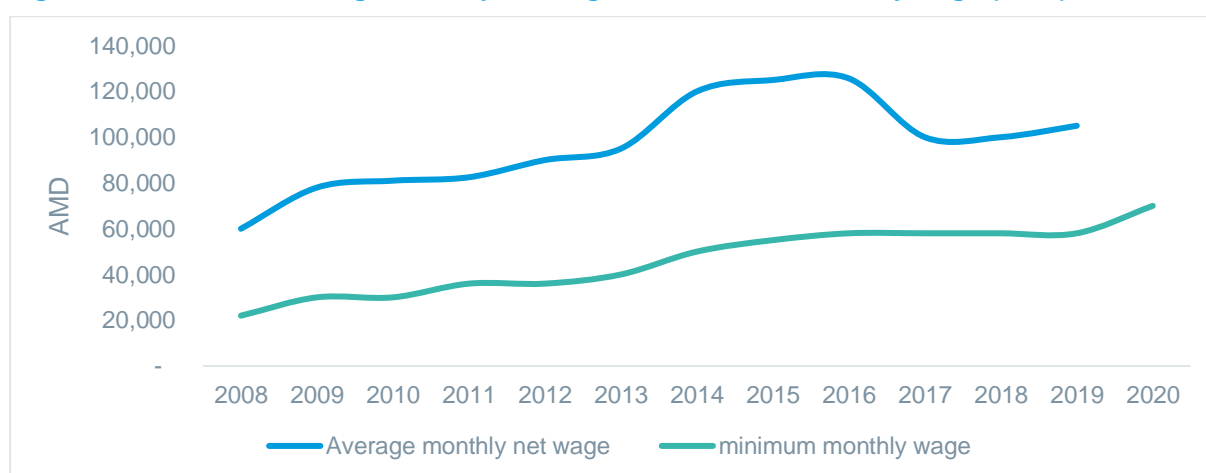
Source: ARMSTAT

The table below summarises the labour market situation in Armenia.

Table 2.4: The labour market situation in Armenia compared to EU-27

	Armenia			EU-27		
	2010	**2021**	**Change**	**2010**	**2021**	**Change**
Population size (million and percentage change)	2.9	3	+0.1	440.7	447.2	+6.5
Relative size of youth population (age group 15-24, % of total)	18.7	12.9	-5.8	11.9	10.6	-1.3
Activity rate (15+) – Total	61.2	57.8	-3.4	69.7	73.6	+3.9
Men	72.3	70.0	-2.3	76.2	78.7	+2.5
Women	52.2	47.8	-4.4	63.3	68.5	+5.2
Employment rate (15-64) – Total	49.6	48.9	-0.7	62.6	68.4	+5.8
Men	59.9	59.0	-0.9	68.5	73.3	+5.8
Women	41.1	40.5	-0.6	56.8	63.4	+6.6
Unemployment rate (15+) – Total	19.0	15.5	-3.5	10.1	7.0	-3.1
Men	17.0	15.7	-1.3	10.0	6.7	-3.3
Women	21.2	15.2	-6	10.2	7.4	-2.8
Youth unemployment rate (15-24)	38.9	31.8	-7.1	22.4	16.6	-5.8
	2015	**2021**	**Change**	**2015**	**2021**	**Change**
Youth not in employment, education, training (NEET % aged 15-29) - Total	44.6	35.9	-8.7	15.2	13.1	-2.1
Men	41.8	29.8	-12	13.6	11.8	-1.8
Women	47.3	42.0	-5.3	16.9	14.5	-2.4

Source: ARMSTAT, Eurostat

Net migration remains a significant drain on the Armenian labour market. However, the situation over the 2016-2019 period saw an improvement, with net migration[5] falling from -24.8 in 2016 to -18.5 in

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[5] The net migration rate is the difference between the number of immigrants and the number of emigrants (people leaving an area) throughout the year.

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2018 (ETF, 2020) (see Table 2.3 below). In 2017, 22.2% of households contained a member of the household who had migrated either internally or externally during the period 2014-2017, in which 52.4% of these people had not returned. In total, 13.9% of migration was internal (within Armenia, principally to Yerevan), 10.5% to the Republic of Artsakh[6] and 76.6% was international. Most international migrants were destined to the Russian Federation, in total 91.8% of all labour migration was directed to Russia. Over 50% of migrants send money back to their families, friends or relatives in the first 12 months of emigration, representing in many cases an important income stream for Armenian families.

Table 2.5: The net migration in Armenia

| Year	January - December	January - March
2016	-24.8	-5.7
2017	-24.0	-5.1
2018	-18.5	-4.0
2019	n.a.	-3.9

Source: ETF, 2020

In summary, Armenia's labour market has had some success in increasing wages, as well as robust non-agricultural sector growth in recent years. However, it remains typified by a high unemployment rate, emigration, low rates of participation and high gender segregation.

2.3 Skills

The labour productivity rate in Armenia – defined here as the value of output per worker – has seen consistent growth over the past decade. This measure is historically linked to wages, economic growth and competitiveness. Interestingly, Armenia's labour productivity level is higher than neighbouring Georgia despite the larger economy of the latter. These countries are both transition economies facing similar economic challenges in the region.

Figure 2.5: Labour productivity rate in Armenia
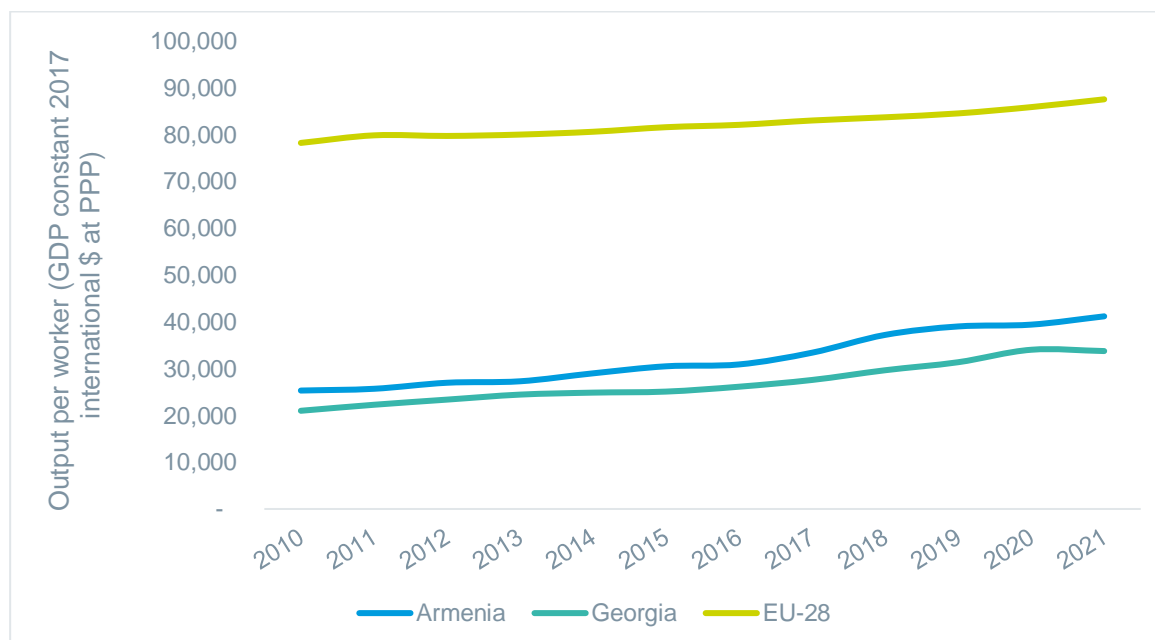
Source: ILOSTAT

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[6] The Republic of Artsakh is a contested state in the South Caucasus, whose territory is internationally recognised as part of Azerbaijan whilst having a majority Armenian population which is closely integrated with Armenia.

As a country of scarce natural resources, Armenia views the development of human capital as a crucial means to accelerate productivity and growth. For this reason, human capital is one of the key priorities in the country's development strategy (Armenian Government, 2014). This strategy highlights the need to increase education and training whilst preparing for a digital transition in learning. However, public expenditure on education fell from 3.2% of GDP in 2010 to 2.3% in 2018, although its share in the state budget increased from 8.7% to 9.4% in the same period (ETF, 2019).

The educational system is comprised of pre-school and primary (lower), secondary education, preliminary and middle VET (medium) and higher education (higher). Compared to neighbouring countries, Armenia has a wider coverage of early childhood education programmes (World Bank, 2015). In 2017, the share of the population with higher education was estimated to be 23.2% in 2018, those with medium 66.8% and those with low education 9.8%. In 2021, percentages are 26.2%, 64.3% and 9.5% respectively, showing a rather stable share for the low-skilled but a slight growth of higher educated people compared to medium-skilled people (ETF, 2022g). Those with tertiary education are the most likely to be employed, with an employment rate at 62% compared to 27.1% of those with low education. Higher levels of educational attainment are strongly correlated to labour force participation throughout ages, although low-skilled people seem to have an easier time in entering the labour market. Looking at the distribution of active population by educational attainment, the majority consists of medium-skilled workers (63.8% completed a secondary school as highest educational programme), followed by high-skilled (33.1%, tertiary) and low-skilled employment (3.2%, primary).

Developing a comprehensive vocational education and training system is underway in the country. In the five years prior to 2018, VET saw an average annual growth rate of 4.5% by student admission. For the academic year 2018-2019, the share of students in secondary VET was 32.1% of total students in secondary education. Like many countries in Europe, Armenia has struggled to build a convincing VET offer to prospective students. A lack of funding leaves a substandard physical and soft infrastructure presence in the country. Furthermore, VET is seen as a 'failure' option for students not able to take the academic route. The material explanation for this being the low-income and insecure work on offer for VET graduates. The number of unemployed adults with VET education in the country is also higher than all other types of education at 22.6% in 2018 (ILO, 2020).

Current VET governance is overwhelmingly centralised, despite efforts to move to a more participatory approach. The National Centre for VET Development (NCVETD) is responsible for teacher training, curricula development and methodology reform. The National Council for VET is responsible for VET legislation and reforms. Management boards operate in all VET colleges, they include representatives from the student body, social partners, employment officers and local institutions. Such boards help approve strategic programmes, tuition fees and budgets and elect the college director.

The largest share of workers in the economy are in elementary occupations and skilled agricultural, forestry and fishery (Figure 2.6). However, the share of such workers in the economy declined substantially between 2015 and 2019, from 42% to 33%. Meanwhile professionals, service and sales workers, craft and related trades workers have all increased their share of workers in the population. This is consistent with the country's ongoing sectoral shift towards services.

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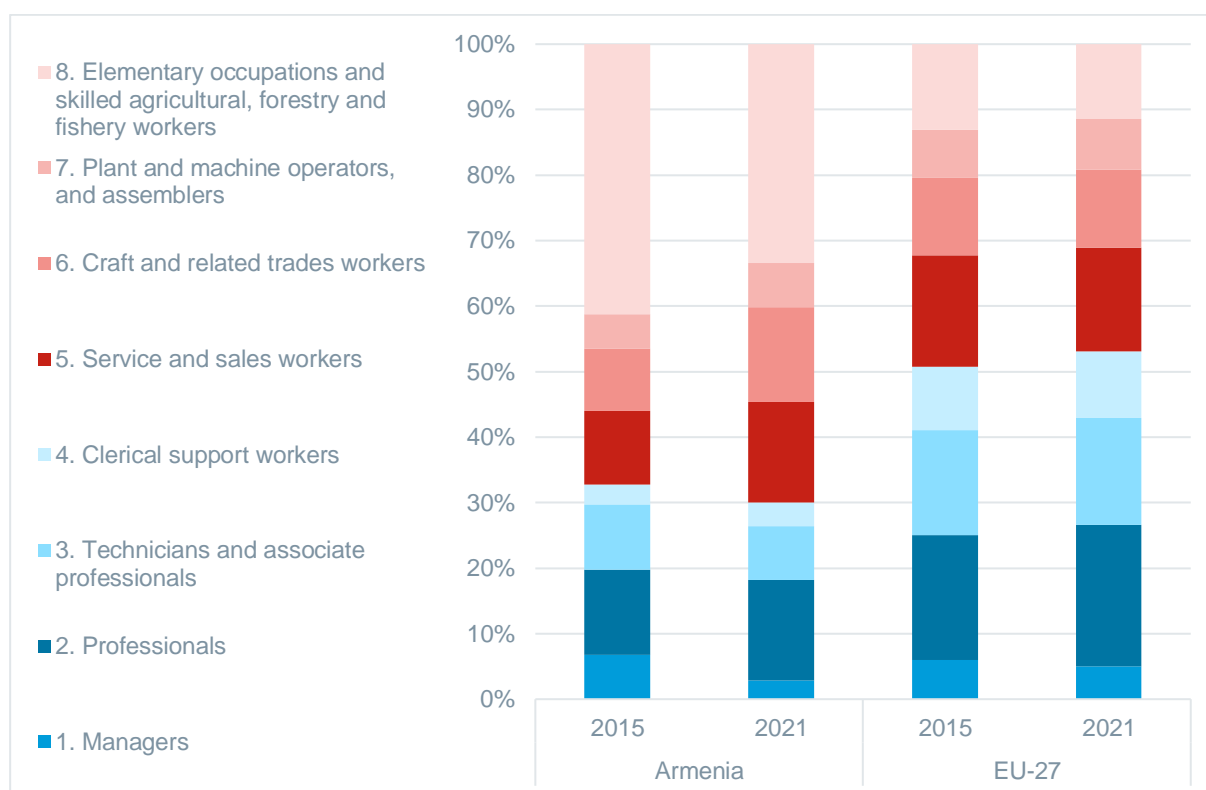**Figure 2.6: Employment by occupation, 2015 – 2021**

Figure Source: ILOSTAT, Eurostat, ARMSTAT

In terms of identifying skills gaps, it is useful to identify growing sectors of the economy. For Armenia, these include construction (the focus of this report), ICT, tourism, mining, tobacco, food processing, footwear, textiles and jewellery making. Hence skills foresight exercises in these areas are crucial for ensuring the education system is able to match the skills demanded by these sectors to ensure their success and increased employment. The general business environment ought to facilitate this, with Armenia achieving a respectable 47 in the World Bank's 2020 Doing Business report.

In 2019, the World Economic Forum ranked the 'skill level' (resulting from the assessment of a variety of indicators linked to the education system and the labour market) of the Armenian workforce in the bottom half (84th) of the 141 countries measured. It scored most highly under the sub measure 'Mean years of schooling' (19th), followed by 'digital skills among active population' (50th), 'Ease of finding skilled employees' (85th) and finally it performed worst under 'Skillset of graduates (100th) (WEF, 2019).

In 2017 only 2.7% of GDP was spent on education, representing 10.4% of total government expenditure (UNESCO, 2020). The proportion of young people achieving at least a minimum proficiency level in mathematics was 54.6% of primary school leavers in 2015, compared to 86% in Europe (ibid).

Figure 2.7: Proportion of young people achieving at least a minimum proficiency level in mathematics

Armenia

EU

- Yes
- No

45.4 54.6

14 86
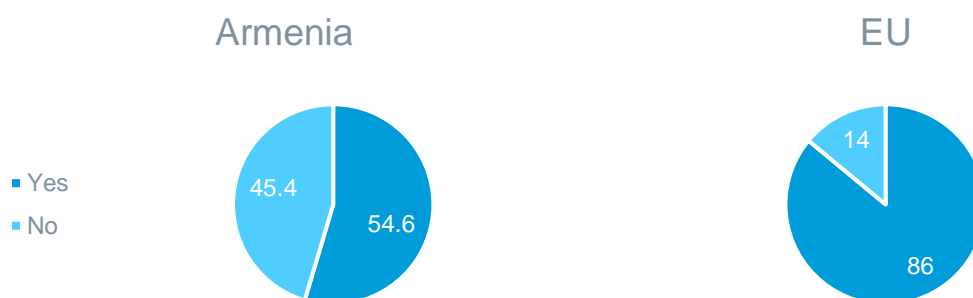
Source: UNESCO

Figure 2.8: School-age population by education level, 2022

Level	Population in absolute numbers
Pre-primary	128,745
Primary	169,786
Secondary	294,730
Tertiary	171,747

Source: UNESCO

Armenia's education system is regulated by three main laws: the Law on Education (1999), the Law on State Non-Commercial Organisations (2001), the Law on Higher and Postgraduate Vocational Education (2004), and the Law on Preliminary (Craftsmanship) and Middle Vocational Education (2005). Responsibility for the sector lies in several government organisations, all of which answer to the Ministry of Education, Science, Culture and Sports (MoESCS).

Overall, the education system in Armenia has two types of educational establishments: general ones and professional ones. Since 2006, Armenia has a 12-year general education system split into three levels: elementary school (four years), middle school (five years) and high school (three years). Elementary school and middle school together form compulsory education. The age of students at graduation from compulsory education is 15-16 years, after which they continue their education either choosing a primary/middle VET track or attending and graduating high school. As for the professional (VET) establishments, the system has two distinct levels:

- Primary vocational education (technical schools, IVET and VET) is aimed at equipping students with basic knowledge related to their chosen profession and provides them with a primary vocational qualification (craftmanship) upon completion.

- Middle vocational education (colleges, formal VET) is aimed at giving students specialist knowledge needed for their chosen profession and provides them with a secondary vocational qualification as part of their basic education.

Both paths lead to higher education institutions (HEI), comprising universities, institutes, academies and conservatories.

The system has benefitted from the EU-funded Better Qualifications for Better Jobs programme, with a budget of €15.2 million. The programme had a particular focus on the agricultural sector with an in-depth research process on skills and NGO grant system to develop work-based learning schemes. The Covid-19 crisis has forced the programme to refocus on crisis-related policies and post programme support. A new Education Strategy (State Programme for the Development of Education in the Republic of Armenia until 2030) has been drafted and adoption by the National Assembly is expected soon.

The share of secondary VET students in secondary education increased over the period 2014-2019 from 27.1% to 32.1% (ETF, 2020). The share of women in VET reached 30% in the academic year 2018-2019.

Figure 2.9: Share of secondary VET students in secondary education

Year	Share of secondary VET students in secondary education (%)
2014-2015	27.1
2015-2016	29.4
2016-2017	30.5
2017-2018	31.5
2018-2019	32.1

Source: ETF, 2020

The strategy for lifelong learning (LLL) in Armenia began in 2009 under the Concept of Lifelong Learning endorsed by the Government. This process analysed the situation of LLL in Armenia, including challenges and solutions. This identified funding, coordination and management as structural weaknesses to a better LLL system in Armenia.

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3 The Armenian construction sector

KEY ITEMS IN THIS CHAPTER
- The Armenian construction sector has risen to become one of the economy's most important sectors in the recent decades. It occupies a significant share of GDP (6.5%) and employment (8.8%) and saw large growth in the 2000s as well as a recent resurgence. The pandemic has caused a severe contraction in the sector, although there are signs that the sector has begun to improve more quickly than expected.
- The sector employed around 96 000 workers in 2021. It is highly gender segregated with only 3% of those workers being women in 2021, while women constitute 45.4% of workers in all sectors in 2021. However, this percentage has more than doubled since 2010.
- Workers in the 25-49 age group constitute most construction workers, at almost 63% of the sectoral workforce in 2021. Workers over 50 years of age represent 32% of the workforce, while people under 25 are only 5%. The sector fails to attract young and educated people to work due to its relatively tough working conditions.
- The construction sector employs a relatively lower-skilled workforce compared to the average economy: 82% of the sector's workforce is medium-skilled, almost 6% low-skilled and 12% high-skilled. The respective shares in total employment are 63%, 3.3%, and 34%. Almost half of the construction workers belong to crafts and related trade, and another 34% are in elementary jobs.
- Construction projects are most common in Armenia's capital and largest city, Yerevan. In recent years such projects have increased again after peaking in 2008. The construction boom has been criticised for neglecting safety concerns and has also faced allegations of corruption for being connected to money laundering.
- In terms of financing in the sector, most of the funding comes from the private sector, followed by the state, individuals (diaspora and domestic), community funds and finally humanitarian aid.
- Wages in the sector are generally low, and higher remuneration abroad is a primary factor for workers to emigrate. An important part of the seasonal migration to Russia is linked to construction work there.
- No research has been carried out to identify the skill gaps in the construction sector during the last 5 years. The development of qualification standards for the construction sector is under the jurisdiction of the Ministry of Education, Science, Culture and Sports (MoESCs), the National Center for VET Development and the National Center for Professional Education (ANQA).

3.1 Overview

The construction sector in Armenia has played a key role in the country's recent economic history. Like many countries, it underwent huge growth in the 2000s (Figure 3.1), to the extent that it became a domestic construction bubble, with gross capital formation amounting to 40.9% of GDP (EBRD, 2019). This bubble burst in the 2008 global credit crunch, accelerated by a drop in global remittances, which exposed the country more severely to the global downturn (ILO, 2020). Almost a decade of decline and stagnation followed, until in 2017 the sector started to rebound. As of 2018 the construction sector accounted for 9.4% of employment, making it the 5th biggest in Armenia, after Agriculture, forestry, and fishing (25.4%), Education (10.1%), Trade & Repair (11.1%), and Manufacturing (9.9%). The sector accounts for 6.5% of GDP in 2021, down from 7.3% in 2017[7].

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[7] https://statbank.armstat.am/pxweb/en/ArmStatBank/ArmStatBank__1%20Econnomy%20and%20finance__15%20National%20Accounts__151%20SNA%202008__1511%20Annual%20data__15111%20Production%20of%20GDP/EF-NA-08AP02.px/table/tableViewLayout2/?rxid=9ba7b0d1-2ff8-40fa-a309-fae01ea885bb

Figure 3.1: Volume of construction, million drams
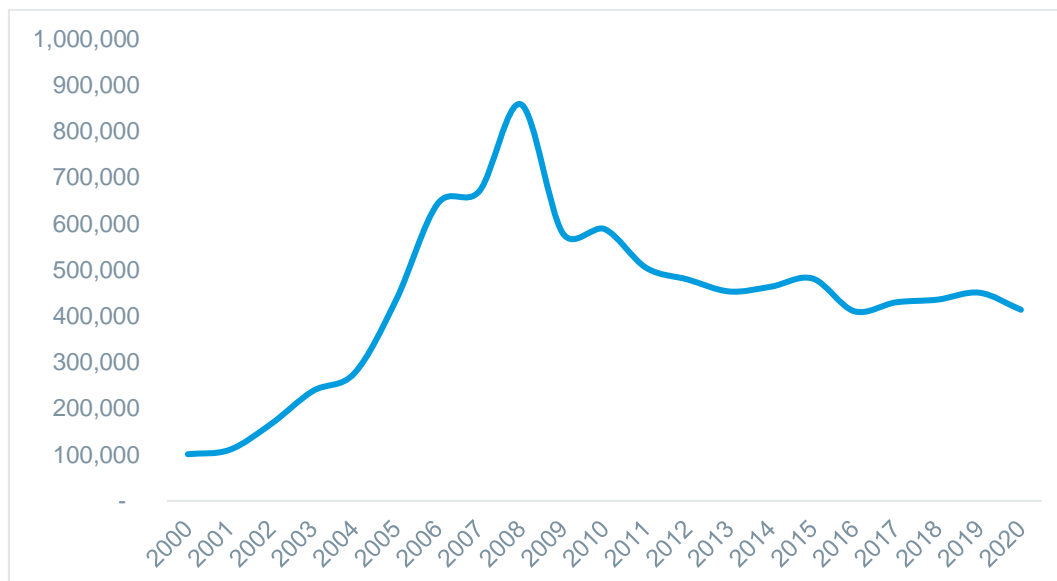
This report adopts two definitions for the construction sector. The first one is a narrow definition limited to pure construction projects, as listed in the NACE F codes (F41, F42, F43)[8]. This is the definition used in the analysis of employment statistics here in this chapter. The second one is a broader definition of the sector including its closely related value chain of production and sales of construction and building materials, which is used in framing the big data mining exercise from the patents and scientific papers. The list of additional NACE codes included in the broader definitions of the construction sector is given below:

- C.16 - Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
- C.23.1 - Manufacture of glass and glass products
- C.23.2 - Manufacture of refractory products/clay building materials
- C.23.3 - Manufacture of ceramic tiles and flags, bricks, tiles and construction products
- C.23.5 - Manufacture of cement, lime and plaster
- C.23.6 - Manufacture of articles of concrete, cement, plaster, mortars
- C.23.7 - Cutting, shaping and finishing of stone
- C.24.1 - Manufacture of basic iron and steel and of ferro-alloys,
- C.24.2 - Manufacture of tubes, pipes, hollow profiles and related fittings, of steel
- C.24.3 - Manufacture of other products of first processing of steel)
- C.25 - Manufacture of fabricated metal products, except machinery and equipment (25.1: manufacture of structural metal products)
- C.27 - Manufacture of electrical equipment (e.g. manufacture of electric motors and electricity distribution and control apparatus, wiring and wiring devices, fibre optic cables, wiring devices, electric lighting equipment, etc.)
- G.46.13 - Agents involved in the sale of timber and building materials
- G.46.63 - Wholesale of mining, construction and civil engineering machinery

The share of construction sector (as defined by NACE F41, F42 and F43) in total employment has fluctuated between 7.2% in 2010 and 8.8% in 2021. As of 2021, a total of almost 96.000 people were employed in the construction sector in Armenia. From 2010 to 2021, ARMSTAT data recorded that employment in the sector (narrow definition) increased from 85.700 to 95.998, with a slight decrease of over 1.000 units between 2019 and 2021. This is the largest employment growth of any sector in the same period. The impact on employment in the sector from Covid-19 pandemic was large, mainly due to its high dependence on low-skilled work and obvious in-person work requirement. In April 2020,

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[8] The Statistical Classification of Economic Activities in the European Community, commonly referred to as NACE, is the industry standard classification system used in the European Union.

construction was down 50% on April 2019. This partially recovered after lockdown restrictions were lifted, but it has yet to correct the prior growth trends seen in the period 2015 – 2019. The impact of the pandemic has been visible from decreasing employment in 2020, down to 7% of total employment from 9% in the previous year.

The sector is highly gender segregated with only 3% of workers (2285 units) being women in 2021, while women constitute 45.4% of workers in all sectors in 2021. However, the percentage has more than doubled since 2010, when women constituted only 1.3% of the total workforce in the sector.

Figure 3.2 below shows the age profile of the workers in the construction sector versus in total employment. ARMSTAT historical data on age distribution testify to the ageing workforce in the sector.

Figure 3.2: Age distribution of employment, all sectors and construction sector (narrow definition), thousands
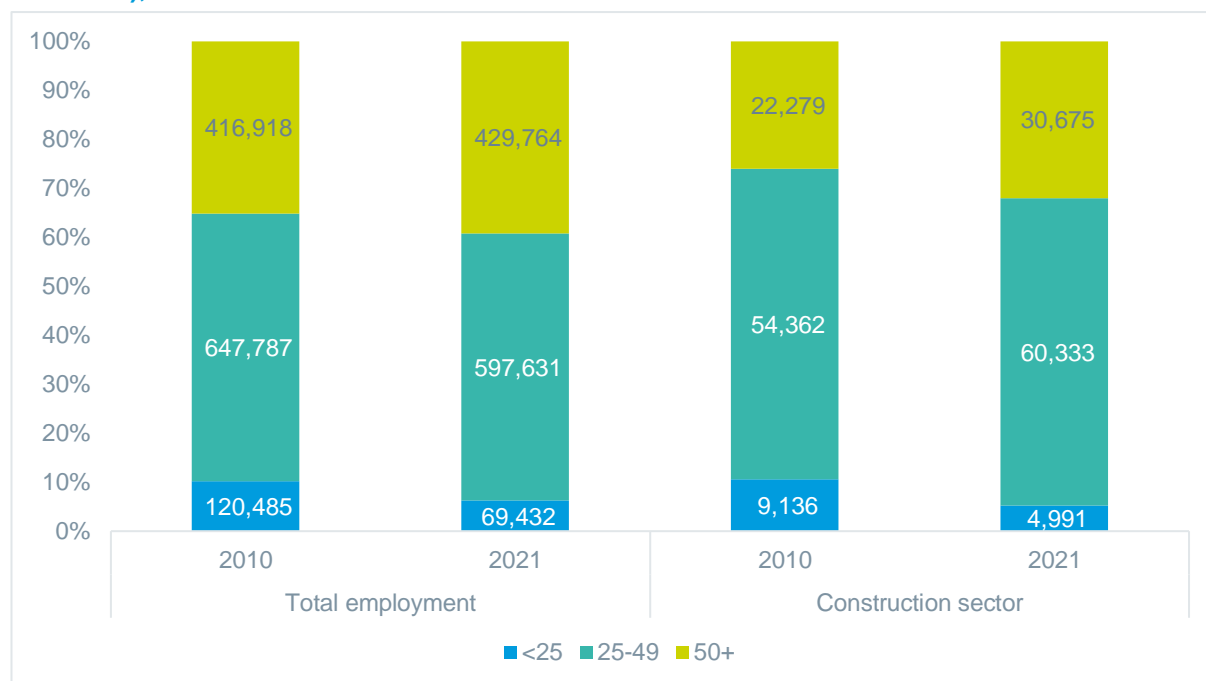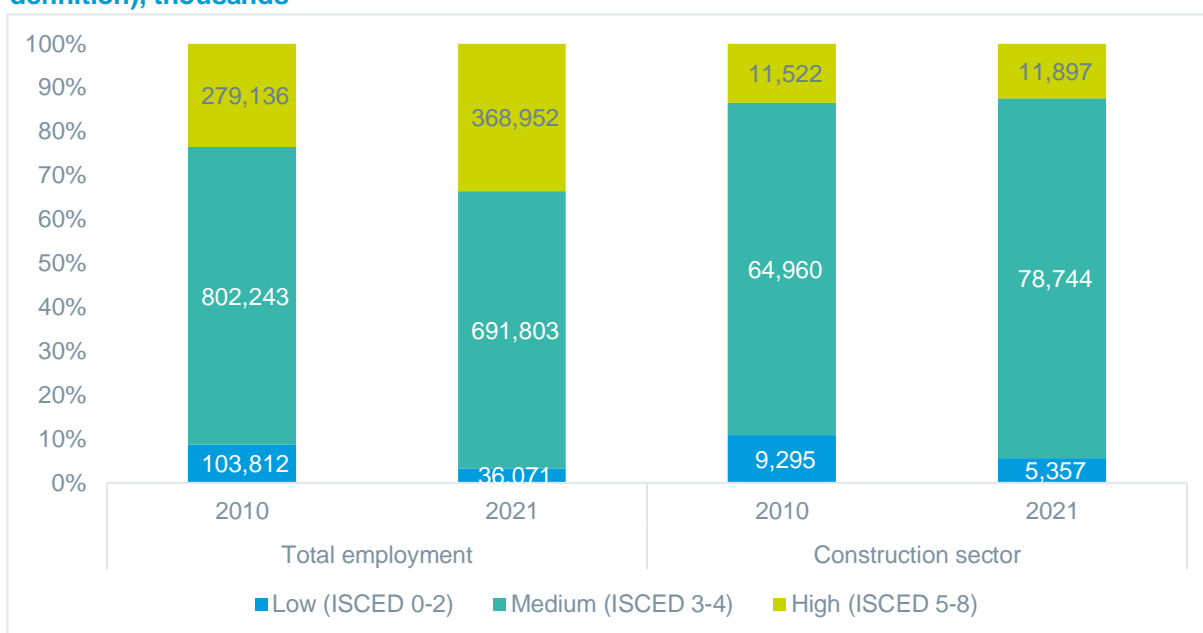

Source: ARMSTAT

In terms of education levels of construction workers, in 2021 the sector employed a slightly higher share of low-skilled workers (5.6%) compared to the average of total employment (3.3%), while it employed a significantly lower number of highly skilled workers (12.4%) compared to 33.6% high-skilled in the total employment. As shown in Figure 3.3. below, the share of low-skilled workers has slightly decreased both in the overall employment as well as in the construction sector since 2010. In contrast, the share of highly skilled workers has been increasing consistently in total employment in the last decade, while its share in the construction sector remained the same.

Figure 3.3: Skill distribution of employment, all sectors and construction sector (narrow definition), thousands

Source: ARMSTAT

In terms of occupational profiles, Figure 3.4 shows the comparison between the skill structure of total employment versus the skill structure in the construction sector for 2021. It clearly shows the low share of high-skilled professions employed in the sector (only around 8% of workers are in high-skilled occupations 1-3), compared to the employment in total economy (almost 32%). The most dominant occupations in the sector are 'craft and related trade workers' (almost half of all workers in the sector), followed by 'elementary occupations' (34%). The corresponding figures for the total economy are 12% and 11% respectively.
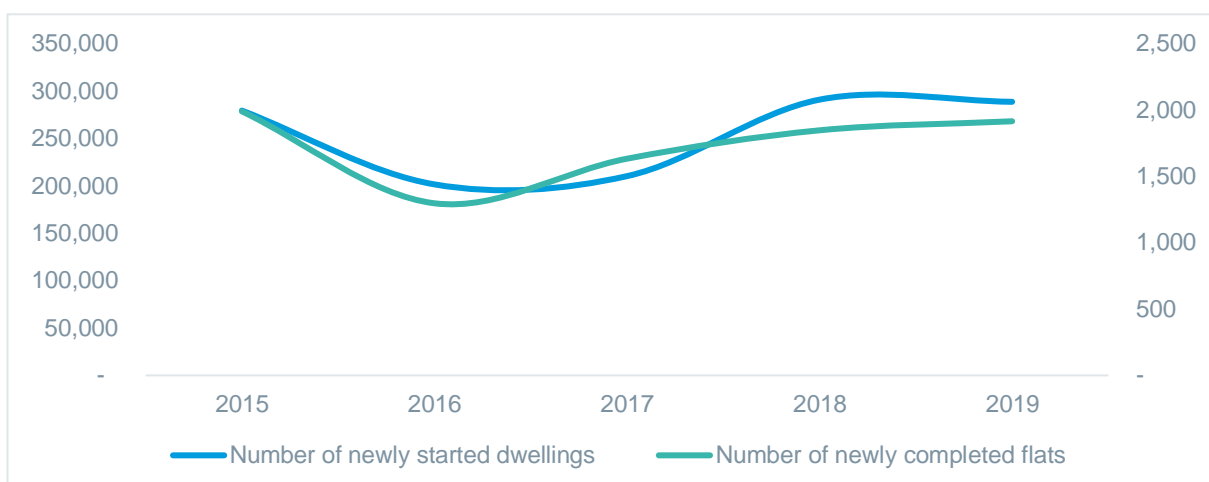
Figure 3.4: Occupational profile of total employment and sectoral employment, 2021
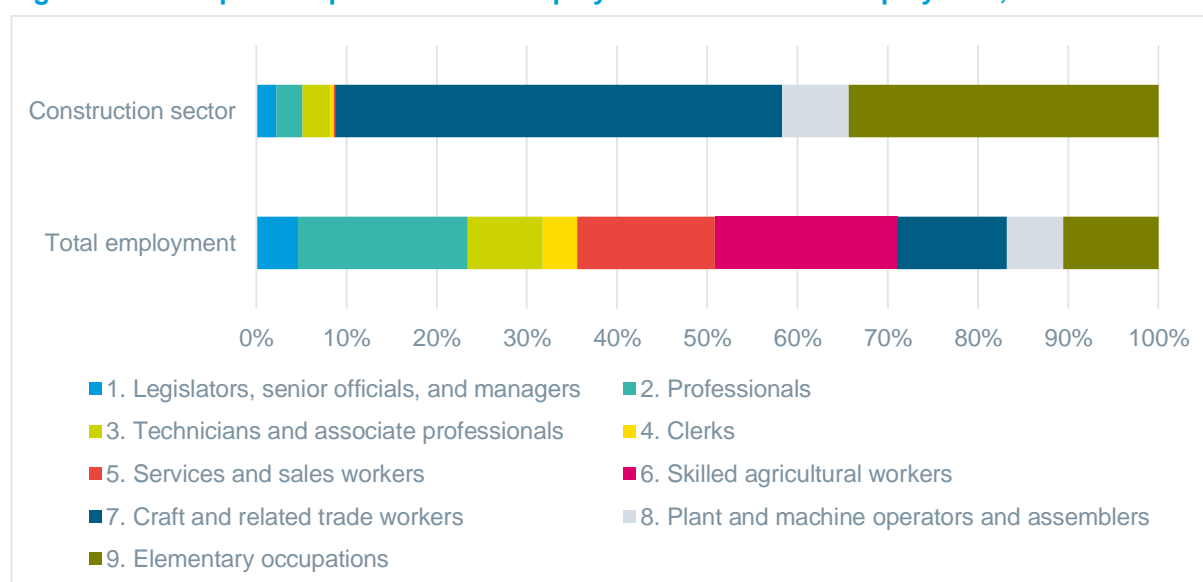
Source: ARMSTAT, Note: Armenia still uses ISCO-88 classification of occupations.

The recent growth in the construction sector is also reflected in the increase in newly started dwellings and flats in the country (Figure 3.5).

Figure 3.5: New construction projects, units

Construction projects are most common in Armenia's capital and largest city, Yerevan. In recent years such projects have increased again after peaking in 2008. In the years 2005 - 2015 more than 2.6 million square metres of housing were built in Yerevan, this was six times more than the period 1991 – 2004. The construction sector is an appealing source of economic growth for a country otherwise focused on mining, trade and agriculture. Demand for newly built real estate is fuelled by the wealthy Armenian diaspora and domestic high-income groups. A concurrent rise in construction companies has also occurred (Figure 3.5). As can be seen, construction companies have risen in number from 925 in 2015 to 1023 in 2019.

Figure 3.6: Number of operational construction companies in Armenia
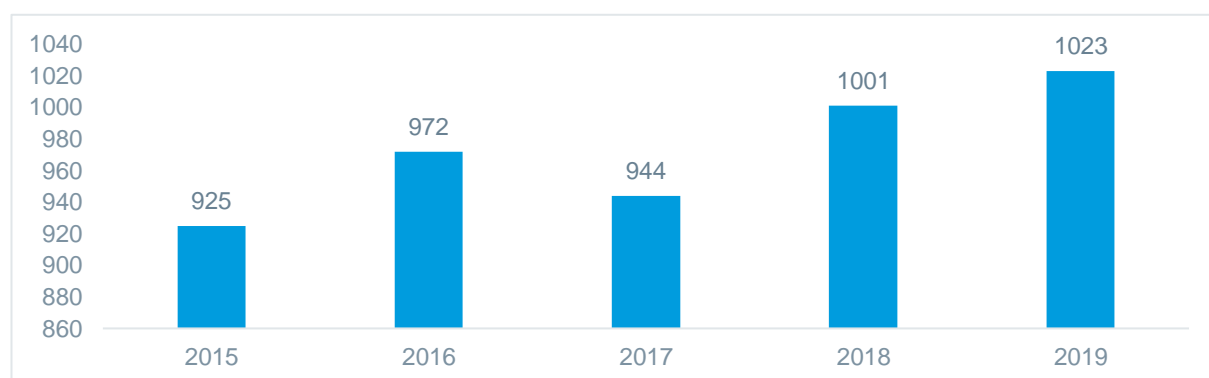
The construction boom has been criticised for neglecting safety concerns, which is especially important in an area that is vulnerable to severe earthquakes. To help address this and strengthen construction quality control, the Armenian government imposed stricter qualification requirements for architects and engineers (World Bank, 2019b). The construction boom has also faced allegations of corruption for being connected to money laundering and for damaging the cultural heritage of the country.

In terms of financing in the sector, most funding comes from the private sector, followed by the state, individuals (diaspora and domestic), community funds and finally humanitarian aid (figure 3.6). In the period 2015 – 2019, very little fluctuation is found in the financing from different sectors, with only a slight continual increase in state-funded projects.

There are approximately 2000 licensed construction companies, but only around 500-600 of them are active and involved in construction works.

Figure 3.7: Volume of construction by source of financing
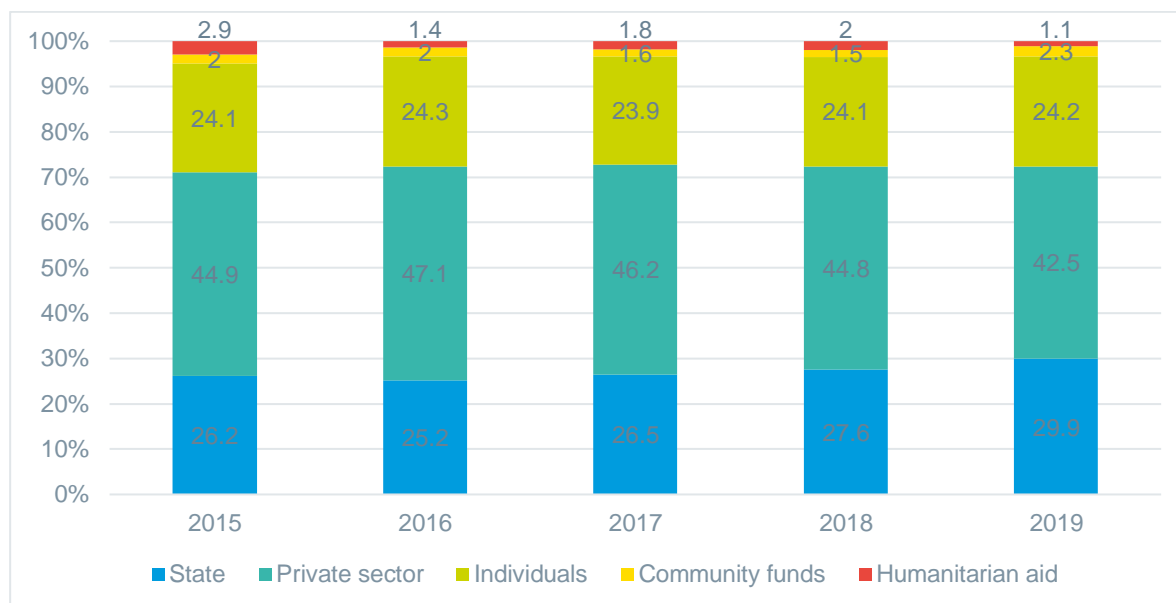
Source: ARMSTAT

Whilst increasing skills in the Armenian construction sector is important, this must be contextualised in the reality of the economy and labour market, specifically the issue of low wages. This means that any increase in the skills of Armenian workers, even with the demand for them domestically, may lead to increased competition with better-renumerated options abroad.

According to the OECD (2021) database, there are currently 34 major infrastructure projects planned or under construction in Armenia with a total value of USD 13.9 billion. At 51%, energy projects account for the largest share of this spending, followed by the transport sector (43%). Some of the largest transport projects include the Armenia M6 Interstate Road and Lifeline Road Network Improvement Project. Due to the prevalence of outdated Soviet-era infrastructure, there are many areas in which construction works are desperately needed, above all in energy and transport but also industry and housing. An important obstacle in this area is the inefficiency of the process surrounding construction permits, which are ranked 98th out of 140 countries in the WEF index (2019).

In summary, the Armenian construction sector has risen to become one of the economy's most important sectors in the recent decades. It occupies a significant share of GDP (6.5% in 2021) and employment (8.8% in 2021) and saw large growth in the 2000s as well as a recent resurgence. The pandemic has caused a severe contraction in the sector, although there are signs that the sector has begun to improve more quickly than expected, largely thanks to the absence of any further lockdowns. It is in this context of surging growth that meeting skills demand is a priority.

According to the ARMSTAT Statistical Yearbook 2021, there was an increase in average monthly wages in the construction sector from 2.8% in 2018 to 8.7% in 2020. The source of the indicator is the State Revenue Committee (SRC) Income Tax and Social Payment Individual Accounting Database. This refers only to the taxpayers or officially registered employees.

According to the household survey conducted with returning Armenian labour migrants working in construction sector, the majority of them (this accounts for almost 70% of the returning population) are low skilled, earning USD 500 a month (World Bank, 2019). 23% of returned migrants are qualified in engineering, industry and construction.

3.2 Main policies and actors in the Armenian construction sector

As already mentioned, construction is one of the most important economic sectors in Armenia. After its independence in 1991, Armenia was left with many Soviet-era buildings that needed maintenance and renovations. The government regulated these initiatives on many occasions. For example, in 2015 the Government of Armenia collaborated with the Asian Development Bank in implementing a seismic safety

improvement programme. The Law on Energy Saving and Renewable Energy[9] was adopted in 2004 and also included energy efficiency indicators for heating, lighting, ventilation, water supply and sewerage in buildings and constructions and required the establishment of energy audits for existing and planned buildings. Since then, three National Energy Efficiency and Renewable Energy Actions plans have been developed. Building construction norms were adopted in 2016, covering construction sector requirements linked to energy performance in building, also making it mandatory to fulfil energy efficiency and energy saving standards in new apartment buildings.

Changes in regulations towards enhancing seismic safety and energy efficiency can be a big push for new technologies and materials. For example, raising standards for the use of materials enhancing seismic resistance for multi-storey buildings.

The main government institutions related to the construction sector and education in Armenia are:

- **Ministry of Labour and Social Affairs:** The Republic of Armenia Ministry of Labour and Social Affairs is a republican body of executive authority, which elaborates and implements the policies of the Republic of Armenia Government in the labour and social security sectors. The Ministry has dedicated departments on public infrastructure and other strategic sectors for the Armenian economy (of which construction is a part) and is also responsible for granting construction licences to companies.
- **Ministry of Education, Science, Culture and Sports:** The Ministry of Education, Science, Culture and Sport of the Republic of Armenia is a central body of executive authority that elaborates and implements the policy of the Government of the Republic of Armenia in the spheres of education, science, culture and sport. This also includes the provision of VET and higher education for professions linked to the construction sector, such as engineers, architects, technicians for various occupations, etc.
- **Urban Development Committee:** The Urban Development Committee implements the policies of the Government of the Republic of Armenia in the field of urban development and issues construction licences to companies.
- **National Centre for VET Development:** The National Centre for VET Development aims to increase the efficiency of vocational education and training in Armenia, including adult education system reforms, to foster its development and the international recognition of awarded certificates and qualifications in the Republic of Armenia. The Centre supports VET policy development, medium and long-term development programmes and action plans for the development of VET. The Centre also has a role in the rationalisation of the VET system, including developing proposals concerning its reorganisation, budgetary allocation and revision. The Centre also ensures communication between the VET system and the labour market, promoting the consideration of labour market trends and needs in VET development programmes and the involvement of involvement representatives of industries into VET. Finally, the Centre works to develop a National Qualifications Framework that is compatible with the European Qualifications Framework, along with its implementation and continuous modernisation.
- **National Centre for Professional Education Quality Assurance (ANQA):** ANQA was established in Armenia as a non-membership, non-commercial, state-funded Foundation. ANQA strives to promote public trust, social cohesion, equity, responsibility and competitiveness through systematic enhancement of tertiary level education (higher and vocational) provisions. ANQA is formally recognised in Armenia as the only agency to provide external quality assurance (EQA) services and to stimulate the tertiary level institutions (TLIs) to develop, disseminate and enhance a quality culture. ANQA is also responsible for running the State Accreditation Register.
- **National University of Architecture and Construction of Armenia (NUACA):** Having existed for more than 100 years, the University is the main public education provider for higher education in the field of construction. It provides a variety of courses in the domains of engineering, architecture, design, finance and accounting at both the Bachelor's and Master's Degree levels, with a focus on private or public infrastructure. NUACA also has a Secondary Vocational Education College, whose main objective is to provide services related to the current needs of the country and its further development by educating specialists in the field.

Currently, companies must have a construction licence to carry out any construction work. This must be issued by the State Urban Development Committee and lasts an indefinite amount of time. Construction

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[9] http://www.parliament.am/legislation.php?sel=show&ID=2119&lang=eng

ETF Working together Learning for life
European Training Foundation

licences are issued with one or more specialised appendixes, allowing for work to be carried out in the following areas of construction:

- housing, public or production facilities
- transport (roads, bridges, tunnels)
- hydraulic facilities
- energy infrastructure
- communication infrastructure.

The appendix is issued in the name of the specialist responsible for the specific type of construction works. The applicant company must demonstrate that it employs at least one qualified specialist in the respective area. The specialist(s), to be certified as such, needs to demonstrate their competence by possessing a bachelor's diploma and proof of five years of uninterrupted work experience in the given field, or a master's diploma and proof of three years of uninterrupted work experience in the given field.

Licensing is also required for companies that carry out preparation of design drawings (with the exception of structural design drawings), examination of construction documents, inspection of construction works, architectural inspection, and technical inspection of buildings and structures.

However, certain types of works can be performed without a licence. These include:
- Works which do not require a construction permit (renovation and interior design works)
- Construction of personal houses that have a maximum of one underground and two above-ground floors and measure a maximum of 300 m^2 in total space
- Houses that are built on the basis of approved standard design documents
- Adjacent constructions measuring up to 150 m^2 in total space
- Garages measuring up to 50 m^2 in total space
- Greenhouses measuring up to 1000 m^2 in total space
- Auxiliary agricultural buildings measuring up to 500 m^2 in total space
- Auxiliary public buildings measuring up to 100 m^2 in total space.

3.3 Skills demand and supply

The growth of the Armenian construction sector is increasing the demand for skilled workers in the sector at all levels. Armenia has a solid foundation of construction workers, with emigrants from the country most likely to find work in the sector abroad. Indeed, 8 in 10 of the Armenians in Russia work in construction jobs, many of which are semi-skilled[10] (World Bank, 2020). However, a large minority of emigrating workers in the sector have low levels of qualifications. More broadly, the Armenian construction sector is defined as a low-innovation sector by the World Bank (2015). This reduces the opportunities for skills development in the sector compared to other sectors of high innovation such as knowledge intensive services.

There is little information on the skill gap in the construction sector (especially from the training needs perspective). This implies the need for field interviews and focus group discussion to identify these gaps from the industry directly, including educational providers (higher education institutions and vocational schools and colleges) and stakeholders such as the Ministries of Education, Science, Culture and Sports, Labour and Social Affairs and the National Centre of VET Development.

In 2015-2016, within the frame of the EU Tempus "ARMENQA" project, Sectorial Qualification Frameworks were drafted in five fields of higher education including civil engineering. The descriptors presented for Bachelor's and Master's levels covered very broadly the knowledge and skills in civil engineering and a range of related fields to undertake professional work. Nevertheless, this framework was not adopted by the national body.

The development of qualification standards for the construction sector is under the jurisdiction of the Ministry of Education, Science, Culture and Sports (MoESCs), the National Centre for VET Development and the National Center for Professional Education (ANQA). The latter is responsible for the institutional

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[10] A semi-skilled job involves some technical skills (perhaps low and middle level qualifications) but not to the extent that the work is classified as highly skilled.

accreditation of VET institutions in Armenia. The Ministry of Economy and the Urban Development Committee of the Republic of Armenia define licensing and industrial standards.

According to the currently applicable law in terms of VET, the Law on Primary Vocational (Craftsmanship) and Middle Vocational Education, those two levels of VET offer the following educational programmes for the construction sector:

1. Primary vocational education programmes providing the qualification of craftsmen: The duration of programmes is from six months to three years. In the construction sector these are the programmes providing the necessary qualification to such occupations as welder, bricklayer, plasterer, painter, crane-driver, etc.

2. Middle vocational education providing the qualification of specialists: The duration of these programmes is from two to five years and the graduates are technicians (ISCO Major group 3). In the construction sector these are the programmes providing the necessary credentials to work in a number of jobs, such as technician of construction and exploitation of houses and buildings, technician of water supply and sewerage, etc.

The VET system also provides supplementary educational programmes at both the primary and the middle vocational education levels. These programmes are meant to provide training, updating the qualifications of specialists or re-training them according to needs.

Education providers offer different vocational specialisations for students. Technical colleges, for instance, provide a range of courses covering a range of skills from brick laying to insulation. Among all institutions, the oldest one is the National University of Architecture and Construction of Armenia (NUACA), a state higher education institution in Yerevan, which became independent out of the former Department of Architecture and Construction at the Polytechnic University of Armenia. The University offers both Bachelor's Degrees and Master's Degree that are relevant for the construction sector. A Bachelor's Degree usually lasts four years, while a Master's Degree usually lasts two years. The most common ones for both cases are the Degrees in Architecture and Engineering (various specialties). Other courses include also finance and management, graphic design, etc., all of them with a strong focus on the construction sector and construction companies. The university is focused on delivering high-skilled construction sector graduates such as civil engineers. NUACA also offers vocational education programmes implemented via the Secondary Vocational Education College which was incorporated into the University in 2007.

During an interview, the Ministry of Education, Science, Culture and Sport reported that vocational specialisations in the field of construction are offered by only a few VET institutions: only six to seven VET providers, comprising less than 10% of all VET institutions in the country. Some of these institutions do not provide training across all professions in the construction sector and do not fully meet the requirements of the private sector in terms of quality and skills provided. There is therefore scope for an improvement and expansion in the system that can more effectively address skill gaps.

4 Main drivers of change in the Armenian construction sector

KEY ITEMS IN THIS CHAPTER
- This chapter discusses the results of big data analysis from the patents and scientific papers in the field of Armenian construction sector and identifies the main drivers of change. Based on the scientific papers, the following socio-economic factors affect the sector the most: environmental impact, digitalisation, natural events, job precarity and lack of skilled workers in the sector, new construction materials and changing industrial production approaches, sector policies and regulations, availability of national/international investments and diverse financing tools in the sector.
- Looking at national patent filings, Armenia has limited innovation in the period 2000-2021, with many ups and downs. Overall, the country filed 311 patents in all sectors during the last 20 years, with 55 of these in the construction sector. Based on the analysis of construction-related patents, the subsectors where the most research is conducted are anti-seismic construction and other seismic safety/protection measures, structural elements and building blocks, in particular to speed up construction times, heat insulation, sound insulation, prefabricated buildings, road surfacing and reduction of the environmental impact of roads, and automated parking.
- Given the low national inventive activity, the analysis was complemented by the analysis of global patents filed in the construction field, given the fact that many of the new technologies that are needed to advance the Armenian construction industry will actually be imported from abroad. Based on the analysis of 190.653 patents in total (from 2000 to 2021), the highest innovations are seen in the building materials sub-sector (one-third of all patents), followed by structural elements, and finishing elements, all of which represent 66% of all patents.
- Global patents also indicate other subsectors such as green construction, hydraulic engineering, construction-site processes, streets construction, railway construction, digital solutions, bridges construction, additive manufacturing, and robotics in construction. All of these represent a growing trend for Armenia as well, implying that they will eventually undergo changes due to the adoption of new technologies. Although small, some clusters such as *Digital solutions*, *Additive manufacturing* and *Robotics in construction* present an even more pronounced growth rate in recent years, indicating their increasing relevance in the field.

4.1 Analysis of scientific literature to extract drivers of change

Rapid technological development and environmental sustainability are major factors influencing the demand for skills. But technology does not account for everything. There are many other factors that shape future skill needs - these may be social, economic, or related to natural events. Given that drivers of change are defined as those factors that influence or even guide the evolution of the job market, this chapter identifies the major non-technical drivers of change inside the construction sector.

To identify such factors, multiple databases of open-access scientific papers and a set of documents from selected websites were used and processed with text mining techniques. Firstly, the entire openAire database was scanned to find scientific papers related to the construction sector in Armenia, with also papers from Google Scholar and ResearchGate. Moreover, particular attention was given to a specific source, the "Journal of Architectural and Engineering Research", edited by the National University of Architecture and Construction of Armenia (NUACA - the unified academic institution for the sector in the country). Selected reports from the World Bank and International Energy Agency have also been included.

In the second step, the most recurrent keywords in the data pool were extracted and mapped using a network diagram. The output is shown below in Figure 4.1. This is an exploratory analysis, aimed at extracting the most important concepts of the domain of knowledge from the scientific papers. Figure 4.1 represents, for sake of simplicity, just a part of the overall graph of relationships between various relevant concepts. The nodes represent the topics found in papers and arcs are formed when at least two topics are mentioned within the same paper. The bigger the node, the higher the frequency in which that concept appears in papers.

Figure 4.1 clearly identifies several main clusters of concepts such as:

▪ Those related to the "**energy impact**" **factor** of the Armenian construction sector with particular attention to emissions' reduction and environmental care (green and brown clusters).

▪ The one related to **industrialisation** and manufacturing processes, including **digitalisation** and **technology and material innovation** (red cluster).

▪ Those related to **natural events** such as the Spitak Earthquake and all the seismic measures associated to the seismic risk (purple and orange clusters).

▪ Those related to the **financial** and **labour market-related aspects of the sector**, especially for labour migration and housing finance (yellow cluster).

Figure 4.1: Network graph of the keywords extracted from papers and related to construction
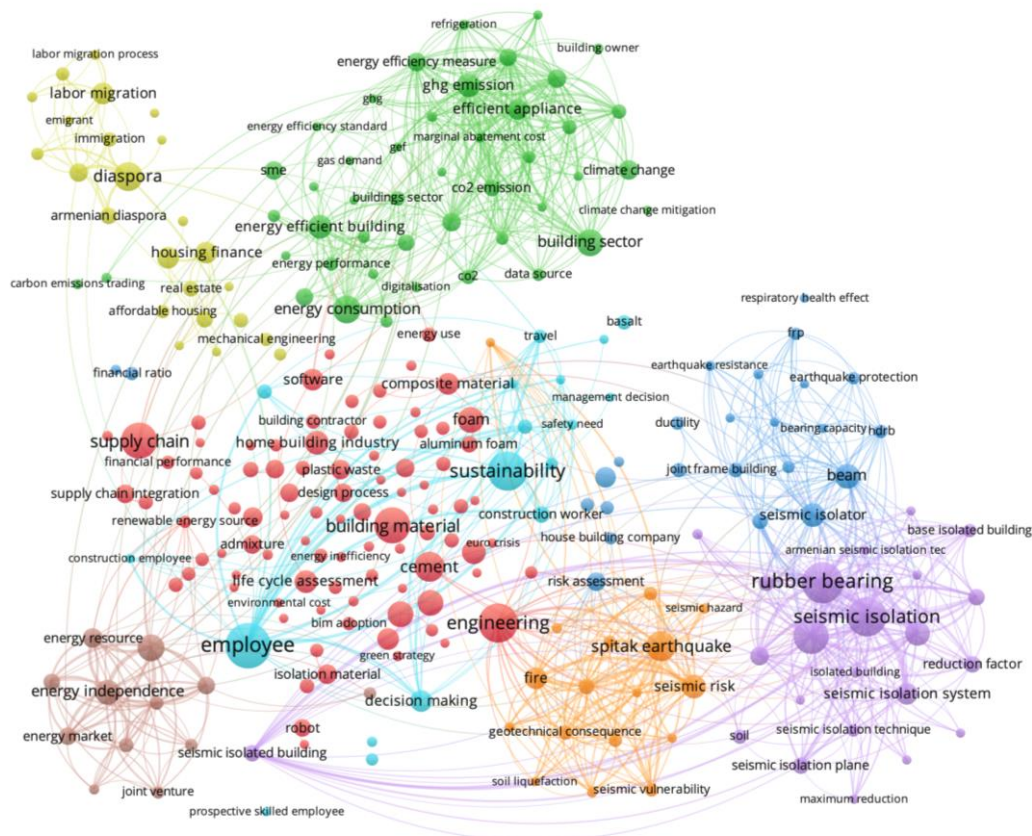
As seen from the links connecting the red cluster to the others, the technical development of the construction sector is connected to several aspects that may be socio-political (labour migration, diaspora), environmental (energy independence, energy efficiency) or linked to natural events (e.g. earthquake). The network confirms the importance of emission reduction activities in the country, represented by the nodes of the green cluster, which in turn links to the relevance of government fundings for constructing more efficient buildings.

Starting from the entire network of relationships found by the software (of which the graph in Figure 4.1 is just a snapshot), it is possible to indicate the main factors of change that may affect the construction sector in Armenia. Such factors can be identified by cross-checking each cluster of topics through the analysis of its evolutionary trends. In Figure 4.2, each plot represents the distribution of articles related to certain topics over the years. For example, in the chart below, *digitalisation* refers to papers that correlate the technological innovation and the introduction of digital solutions within the construction sector. The chart shows a growing amount of academic research related to such topics over the last 15 years.

Figure 4.2: Trends of drivers of change found in papers related to the Construction sector
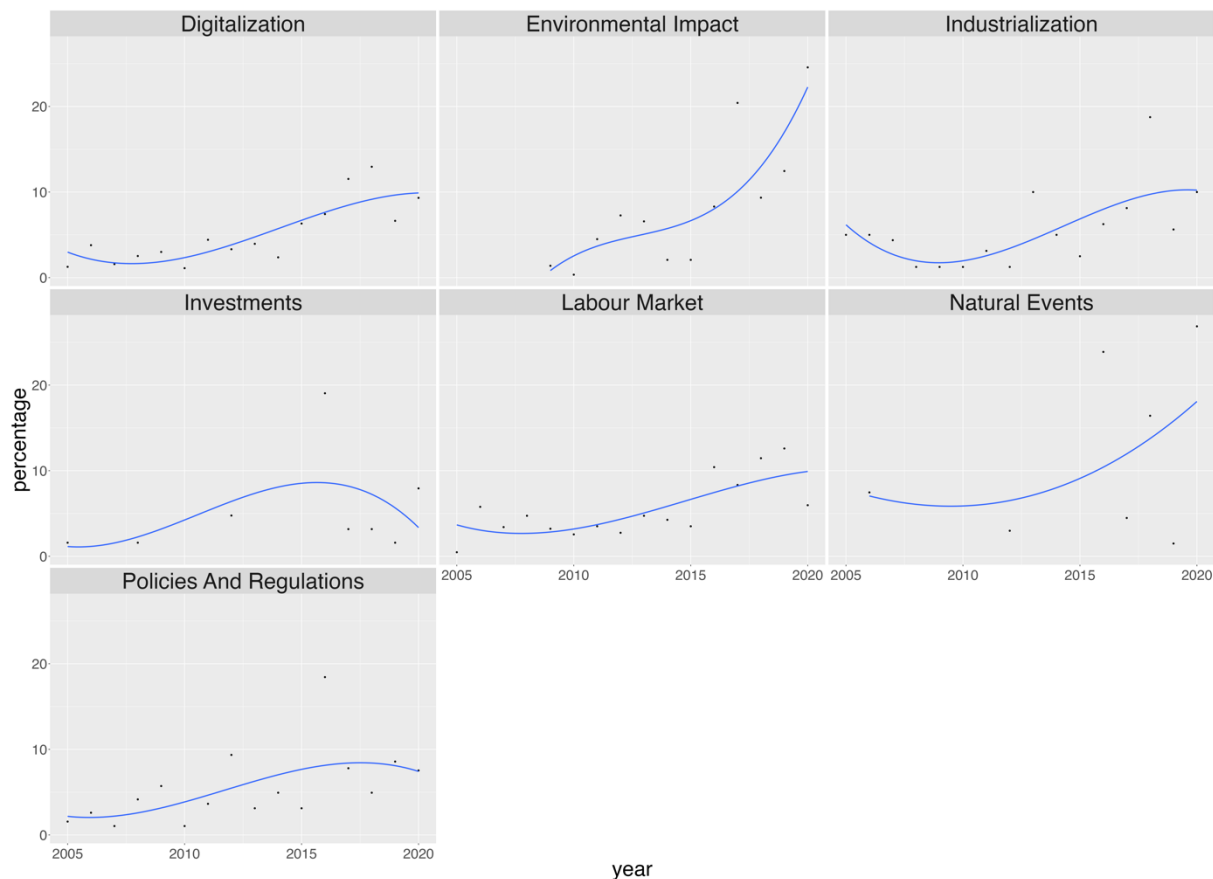
Note: values in the last year in the plots are not final (due to the referee and publication process). It therefore might not represent the real number of articles related to that specific topic.

According to trends shown in Figure 4.2, the clusters with greater relevance within the scientific literature related to Armenia are: digitalisation, environmental impact, industrialisation, investments, labour market conditions, natural events, and policies and regulations. Most graphs show an increasing trend for the main drivers of change, except for *policies and regulations* and *investments*. This is an indication that the construction sector in Armenia has been the subject of increasing research and debate over the last years, also at the international level.

Compared to others, the **environmental impact** cluster reaches the highest number of occurrences per year within the dataset of scientific papers, indicating how the great attention to sustainable growth, requested by institutions and the public alike, has become a driving force for the sector. The second and third most recurrent topics (i.e., **digitalisation** and **industrialisation**), indicate that the rapid change brought about by innovation will reshape the need for skills and competences, while also affecting how the sector will manage other driving factors, such as the need for a green transition. Another cluster that is growing at a steady pace is that of **damage prevention** in case of natural disasters, with particular reference to earthquakes. This in turn is correlated to an increase in **education** for predicting such events and to **policies and regulations** related to the construction sector.

The next section provides a detailed breakdown of each non-technical driver of change, underlining their relative significance and the potential set of skills that they might entail. Drivers are listed in order of overall occurrence of the topic in the academic literature, and of relative growth pace in recent years:

1. **Environmental impact:** Compared to other drivers, the **environmental impact** is the one that most frequently appears within scientific papers, with relatively fast growth in the last 5 years. The construction sector includes a sub-sector of **sustainable construction** that is mostly characterised by **energy conservation** measures, **resource conservation** strategies and **waste reduction** issues (IEA, 2020). The sector is contributing to the **sustainability agenda** through numerous strategies to improve **energy efficiency** in design, materials, and conditions of buildings. The so

called **"green building activity"** continues to rise and is driven by both **environmental regulations** to **reduce carbon emissions** and client demands to create **healthier buildings** and improve occupants' health through better conditions in warmth, comfort, and indoor air quality. This is a crucial key factor of change in Armenia since a huge number of buildings in the country were built during the Soviet era, without considering any kind of energy-saving technologies. On the positive side, green buildings are entering the political agenda, for example with the introduction of an assessment standard for green construction in Armenia (Papoyan et al, 2021). Moreover, the government is concentrating its efforts on improving hydro power plants, nuclear power plants and developing new geothermal, solar and wind station sources (Atanes et al., 2021). **Green construction** puts emphasis on *skills* to reinforce the sustainability and *green skills* agenda (Papoyan et al, 2021). For this reason, training and education on sustainability are becoming fundamental and the education of **green-construction professionals** could be very helpful. Not only buildings but also work-sites should be **sustainable** and the adaptation to mandatory **safety conditions** is strictly required.

2. **Digitalisation:** The second driver in order of relevance is digitalisation, which has steadily increased in importance in recent years. **Digitally enabled** performance management could be used to **design** and **manage** buildings by **embedding active technologies** that can also reduce energy demand. The digitalisation of products and processes along with more **data-driven decision making** will impact digital operations, design, manufacturing, and sales channels. In the building and construction industry, digitalisation means **smart building construction** that integrates **Internet of Things,**[11] **data availability, and advanced automation equipment** as construction is exploring automation in **additive construction, robotics, drone technology, 3D models** and **virtual reality** (Niftiyev et al, 2021)**.** One exemplary application of smart construction is AI-based structural damage assessment in case of earthquakes (see next driver of change). Inside the digitalisation process the design and the value chain is improved by the usage of **building-information modelling (BIM)** (Ghazaryan, 2019) whose models can support decision-making activities and make the innovation process more agile (IEA, 2020). Particularly, at present in Armenia BIM is highly appreciated when adopted for architectural and design works, cost estimation and budgeting, time efficiency and so on, but is considered of low importance when used during technical and architectural supervision (Ghazaryan, 2019). The importance of the software for the latter aspects can be expected to rise in the future.

3. **Natural events** (e.g., avalanches, earthquakes, wildfires, flooding or drought): In recent years, the cluster related to natural events has shown an important increasing trend in scientific papers. One of the reasons for this is that Armenia is located in a **seismic active zone** that has been hit by several strong earthquakes. The 1988 Spitak earthquake in particular had devastating effects, killing over 25.000 people, injuring many more, destroying 10.000 apartments, and completely disrupting the region's infrastructure. In order to face the high seismic risk, housebuilding is increasingly characterised by **seismic isolation technologies** applied both to new constructions and to existing buildings (Melkumuan, 2018). Seismic resistance can be reliably strengthened by using **RC (reinforced concrete)** or **steel jackets** as well as **FRP** (Fiber-Reinforced Plastic) technology. This driver of change is particularly pushed by the Armenian population's demand for safer houses and public buildings. For example, data are collected on a long-term basis in order to promote seismic isolation of buildings, underlying advantages of seismic isolation vs. conventional construction; particularly about the role of seismic isolation laminated rubber-steel bearings (SILRSBs) manufactured in Armenia (Melkumyan, 2022). While the main threat is related to earthquakes, other natural events are also a matter of concern and have implications for the construction sector. For example, floods, mudflow and landslides are recurrent in various areas of the country; around 40,000 people are affected by flooding each year costing around USD 100 million in national GDP (GFDRR, 2017). Such events are caused by climatic conditions but their effects are made worse by an improper management of territories or insufficient containment works; the damages caused to housing and infrastructures also need to be assessed and repaired. The risks of disasters resulting from these drivers are likely to increase as the severity and frequency of extreme climate events increase due to climate change.

4. **Job precarity and lack of skilled workers in the sector:** The **failure to create enough quality jobs** is a key factor that also characterised the construction and building sector. As happened for

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[11] Please see the Glossary in Annex 3 for the definition of terms used here such as "Internet of Things", smart buildings, green building, building-information modelling (BIM), etc.

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other sectors (agriculture, electricity, gas and water supply), **most job destruction occurred** between 2007 and 2017 (Honorati, 2019). As a consequence, the sector is characterised by a **scarcity of skilled workers** and the construction activity still relies on a large share of manual work by a largely blue-collar workforce. **Training** is fundamental in order to develop key skills in the future building industry, such as *IT skills*, *management skills*, and *soft skills* such as communication. Given the increasing digitalisation of the sector, *ICT basic skills* should be mandatory in the construction industry. Moreover, the labour market in Armenia is also strongly affected by the **labour migration** phenomena (Yudina, 2018): in 2012 Armenian migrants were mostly represented by males employed in the construction sector moving abroad, mainly to seek **better paid jobs** (World Bank, 2021).

5. **New construction materials and changing industrial production approaches:** The introduction of new production approaches, materials and technology increases the industrialisation of the sector. Innovative processes such as modularisation, off-site production automation, and on-site assembly automation will foster a wider adoption of industrialised concepts and an off-site, product-based approach. The rising cost of materials is also pushing companies to adopt industrialisation processes to optimise resource usage. Modular construction (Martinez, 2008) is also becoming a key driver as it reduces the need for labour and thereby also reduces costs. It is related to prefabrication and product innovation, as well as to the usage of new materials that enable more efficient production of modules. Innovation also concerns traditional materials, such as cement, in order to reduce carbon footprint, or lighter materials such as light-gauge steel frames and cross-laminated timber that simplify module production. Regarding the manufacturing process, the automation of the machinery manufacturing is fundamental as the introduction of robotics impacts both the production of materials and component and the building activity itself.

6. **Increasing specialisation.** As production techniques become more sophisticated, there is an increasing range of companies operating in specialist niches and segments by using innovative materials or methods. This has implications for skill demand and the extent to which increasingly specialist skills are required. A concrete example of this is the initiative called **Energiesprong** consisting in the combined usage of prefabricated facades, efficient heating and cooling equipment, and roofing materials equipped with photovoltaic equipment. The initiative demonstrates the feasibility of retrofitting entire neighbourhoods at once rather than targeting buildings individually (Energiesprong, 2020) and could be particularly advantageous for Armenia (IEA, 2020).

7. **Sector policies and regulations:** The **policies and regulations** driver has not experienced rapid growth over recent years. Most policies in the sector are strictly related to **energy efficiency**, **energy-saving regulations** and minimum energy performance requirements for new and renovated buildings (see section 3.2, and World Bank, 2011). **Occupational safety and health** in the sector also recur in the international scientific literature, due to the **physical risks** that remain very high. Health and safety conditions are regulated by the Labour Code of the Republic of Armenia, adopted in 2004, and need to be updated given the changes occurring in many activities of the sector. As the industry suffers from *accidents and fatalities*, **digitalisation** could also be leveraged to help employers put **safety measurements** in place. **Climate change** is affecting the building industry through various ways for **low carbon development** strategies (Govinda, 2017). Armenia is also characterised by natural phenomena that directly affect the housing policy (such as the earthquake in 1988). Local regulations give priority to the housing provision for citizens that lost their homes because of the earthquake and the war and to the improvement of the legislation on housing rental. Such policies are strictly related to building more energy-efficient houses and can be translated as: **safety of people by sustainability in operations of building**, harmonisation of the urban development with the natural environment, earthquake-resistant design and construction (the latter being covered by the 2006 Regulation "Seismically Resistant Construction: Design Codes").

8. **Availability of national/international investments and diverse financing tools in the sector:** Finally, the **investments** driver is the only one with a decreasing trend in scientific literature. Indeed, being capital intensive, the construction sector is strictly related to the economy of a country and to the availability of **funding**, both public and private, and incentives or subsidies. In the case of Armenia, apartment buildings are supported by fundings from donor organisations, commercial banks, and credit organisations. However, the financial crisis contracted demand, leading to a decrease in housing construction, which in turn negatively affected the sector: of the total 14.4% of national GDP lost to the crisis, more than 50% was in the construction sector. The Government is

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also committed to addressing the growing housing needs of Armenians by offering long-term, affordable mortgage loans, showing great interest in stimulating private sources of funding to serve these needs. The large part of funding in the housebuilding sector is aimed at **improving technology innovation** and promoting **greater energy efficiency** (IEA, 2020).

4.2 Technological changes occurring in the sector

This section conducts a fully-fledged analysis of the ongoing changes in the technological landscape through data mining of the patents from Armenia on the construction sector. Patents are deliberately chosen as the relevant data source here to analyse how technological innovation is impacting the development of the sector, due to the following considerations:

▪ Patents are a significant cost for companies and hence are filed to protect only those innovations that are highly relevant for the business of the firm, i.e., very likely to be produced on a large scale in the future. Thus, the correlation of patents with the impact of innovation on the economy is much more direct than in other technical documents, such as scientific papers. Their analysis can provide valuable insight into how technologies are evolving and possibly highlight the causes behind these changes. Even more importantly, given their connection to actual business strategies and to industrial production, patents are a reliable indicator of how the new technologies will affect future skill needs.

▪ Existing literature (Terragno, 1979; Kütt, 1998) has shown that about 80% of the technical information contained in patents is not available elsewhere due to company policies. Even though this percentage might have changed in recent years, it still makes patents an important source that complements the traditional technical and scientific literature.

To sum up, patents as a unique source of technical information can capture, better than any other data, the trends of innovation and technological evolution that has a real impact on the demand for skills. The analysis of patents is divided into two subsections:

1. **Armenian patent activity in all sectors**: this part provides a general understanding on the investments in new technologies in the country (using the number of inventions as an indicator).
2. **Inventive activity in the construction industry on a global scale**: this part of analysis aims at mapping all innovation trends and the most relevant technologies that, by being adopted in the near future, will shape the need for skills and professional profiles in the sector. A subsequent analysis will determine the adoption rate of such new technologies in the country.

4.2.1 Armenian patent activity

The first part of the analysis studied the temporal distribution of all patents filed in Armenia, without any restriction in terms of economic sector. Such information is useful at the beginning of the analysis in order to understand the tendency of a country to create innovation within its own borders.

As for the timespan, the most relevant period for the prediction of future skill needs is the last 5-10 years (considering the rather long cycle of innovation generation and adoption for the technologies in the field, compared for example to the much shorter cycles of pure ICT). At this stage, it is interesting to look back in time for a longer period (1983 - now) to better understand the dynamics of change that are not strictly technological, but are rather linked to social and economic developments, and take place over a longer period.

For the representation of the trends in Figure 4.3, patents either filed at the Armenian National Patent Office or issued internationally by companies located in Armenia (both national ones and local branches of multinationals) have been included. Figure 4.3 compares the number of Armenian patents filed over the years in all sectors (green trend) and in the construction sector (yellow trend).

Figure 4.3: Armenian patents in all sectors and in construction sector filed over the years

Note: Patent applications are generally published no sooner than 18 months after the filing date, a timeframe often called the secrecy period. Hence, the number of registered filings of the period 2020-2021 is necessarily underestimated. A grey screen covers this period, that if considered would lead to wrong and distorted interpretations. The same holds for all subsequent plots having the time dimension on the x-axis.

The figure shows that a limited number of inventions originated from the country in the last 20 years, as the total number of Armenian patent families filed in the period 2000 - 2021 is **311 in all sectors.** Similar ups and downs are observed in the two trends with an evident peak in 1991, which corresponds to the independence of Armenia: clearly, socio-economic factors have an important impact on the innovative activities of the country. Strong correlation of the inventive activity in construction with the general trends for the country implies that the sector's ability to innovate is not self-sufficient or self-sustained but is strongly correlated to the country's overall economic and political conditions.

The submission of patents in all sectors has never stopped from 1983 until today but it has shown a decline in recent years (post 2011). Though on a different scale, the construction sector displays similar behaviour, including the later decrease in the number of patents, which may be due to a downsizing of research and development investments in the country.

The Armenian patents in construction are limited in number, with a total of **55 DOCDB patent families** filed since 1989 (mainly from national companies). Therefore, they are not sufficient for a fully-fledged analysis of the future evolution of technological inputs in the sector and the related skill needs. Nevertheless, it is still useful to study the subsectors covered, as even limited inventive activity indicates an existing focus and a possible availability of competences and highly trained human capital in selected areas. Looking at the subsectors to which Armenian patents belong, both in residential buildings and infrastructure, the main topics covered are the following (in order of relevance):
- Anti-seismic construction, and other seismic safety/protection measures (e.g. shelters)
- Structural elements and building blocks, in particular to speed up construction times
- Heat insulation, sound insulation
- Prefabricated buildings
- Road surfacing and reduction of the environmental impact of roads
- Automated parking.

Given the low number of Armenian patents, many of the new technologies that are needed to advance the Armenian construction industry are likely to be imported from abroad. After all, the construction sector is very sensible to the cost issue, and those technologies that present clear economic or competitive advantages over existing solutions will eventually be introduced in any country, regardless of where they were first invented. Therefore, to have a complete picture of the new technologies that are entering (or are about to enter) the sector, and that will shape the competencies needed by the

labour market in the near future, this report integrates the data from Armenian patents with the worldwide patents on the sector.

Companies usually file patent applications for the same invention in multiple nations, to get the widest market protection possible. The set of different documents referring to the same innovative idea is called a patent family. To avoid duplicating the estimates of relevance for each technological area that could arise because of multiple filings, it is useful to choose only one of such documents for each family. For this report, European Patents (EP) have been used as representatives for the global innovative activity of the sector. Although some isolate inventions may not get an EP extension, a data check confirmed that all technical areas present worldwide are covered in the EP database.

Additionally, the geopolitical relations with Europe have been increasing since the foundation of the Republic of Armenia. Armenia is a member of numerous European organisations and initiatives including the Council of Europe, the Eastern Partnership, Eurocontrol, the Assembly of European Regions, and the European Bank for Reconstruction and Development.

4.2.2 Patent activity in the construction sector

Considering the construction sector at a global level, the trend showed in Figure 4.4 below starts from 1983 which is the year of the first Armenian patent (as in Figure 4.5) to favour a comparison between the two figures. The total number of patent families filed to the European Patent Office since 1983 is 211.156, with most of them filed in the last twenty years (190.653 from 2000 to 2021).

Figure 4.4: Patent families (EP representatives) in the construction sector filed over the years
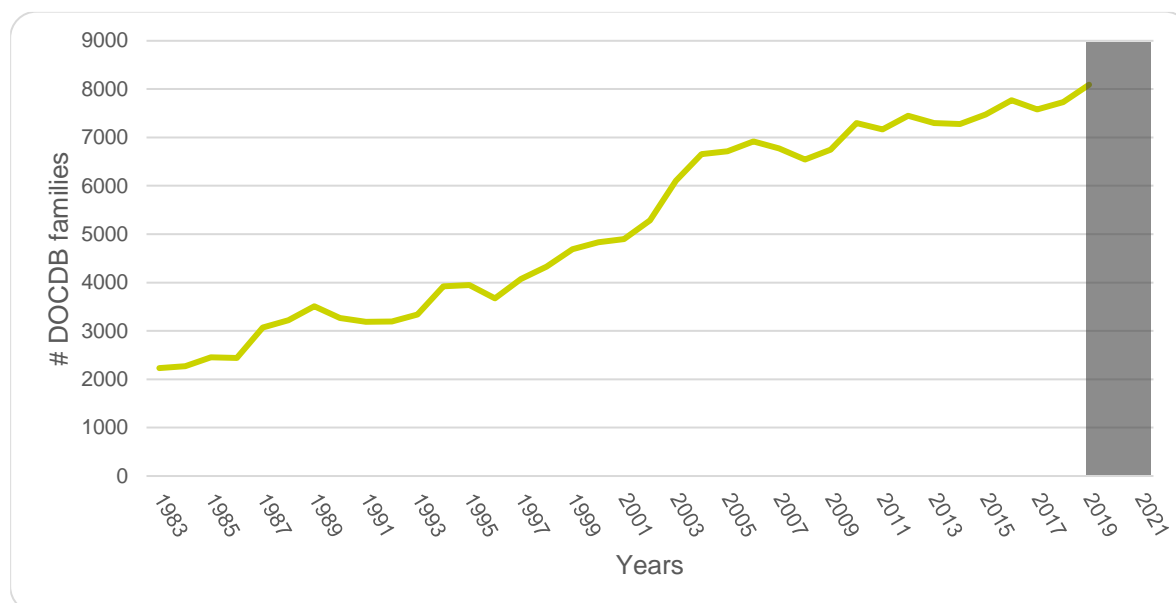
As we can see by comparing the above graph with that of Figure 4.3, the rate of innovation in the sector is ever increasing at international level, while patent activity in the construction sector in Armenia is practically absent in recent years. Consequently, Armenia is a country with a factual risk of losing competitive advantage and becoming an importer only of new technologies, with heavy implications also in terms of the competences that the country can display in key technological areas.

Investigating how innovation is distributed within the sector could provide relevant clues about which subsectors are more active, also in relation to internal drivers and capabilities. Moreover, the level of innovative activity in a subsector provides an indication of where investments are being concentrated and in which direction the Armenian construction sector is most likely to move in the future.

Table 4.1 reports the list of all construction subsectors that are relevant for Armenia (as derived from the drivers of change analysis and from desk research), and for each, the related inventive activity as represented by EP filings. Building materials emerges as the dominant subsector as it covers approximately one third of the total patents (i.e., 31%). If considered together with the second and third more relevant clusters (i.e., Structural and Finishing elements) the number of patents covers two thirds

of the total (i.e., 66%). Solutions for the construction of bridges, additive manufacturing and robotics are the less covered subsectors.

Table 4.1: Sub-sectors covered by global patents (with EP representatives)

Sub-sectors	Number of DOCDB[12] families
Building materials	79 299 (31% of total)
Structural elements	50 330
Finishing elements	41 510
Green construction	28 779
Hydraulic engineering	18 707
Construction site processes	14 896
Streets construction	12 623
Railways construction	4 626
Digital solutions	4 469
Bridges construction	1 893
Additive manufacturing	1 572
Robotics in construction	1 242
Total number of patents	**211 156[13]**

By analysing the number of patents filed over the years, it is also possible to create temporal trends for each of the most important clusters (at least from an innovative point of view). Figure 4.5 thus represents trends for each construction subsector. Compared with Table 4.1, the representation of trends provides a more dynamic view. Furthermore, when addressing changes occurring in the sector, trends are the key variable to analyse since they resemble the evolution of a specific concept.

Most of the trends represented in Figure 4.5 show linear growth, similarly to the trend of the overall construction sector shown in Figure 4.4. Some other clusters present a more pronounced growth rate in recent years, indicating their increasing relevance in the field: this is the case for *Digital solutions*, *Additive manufacturing* and *Robotics in construction*. The total number of patents related to these clusters remains relatively low, as they represent new areas of innovation in the sector of construction, hence their low positions in Table 4.1, but their relevance can be expected to grow in the near future.

It is worth noting that the clusters related to infrastructure, namely streets, bridges and railways construction, are growing in line with the general trend of the sector: innovation in construction thus concerns both residential buildings and infrastructure. Any policy concerning the development of the country's infrastructure should therefore consider a rapidly changing technological scenario and the possible related skills issues.

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[12] DOCDB stands for "document database" i.e. families of a patent set.
[13] The simple addition of all numbers of families for the various sub-sectors is actually greater than the total number of documents. This discrepancy is due to the fact that some inventions pertain to two subsectors at the same time and are thus counted twice in the table.

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Figure 4.5: Temporal trends related to the construction sub-sector
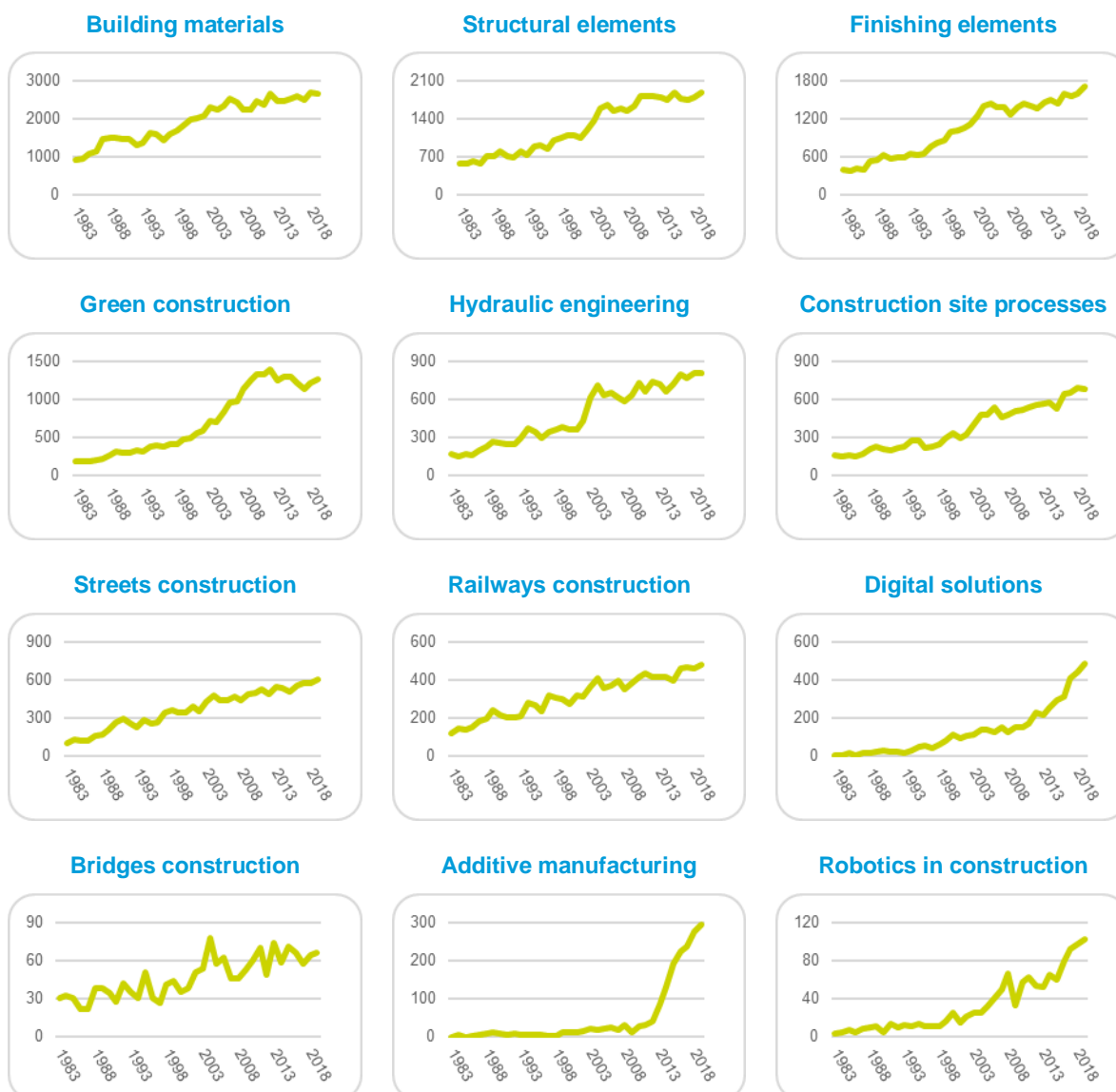
Trends are a good indicator of how and where focus is shifting over time, but to have a deeper understanding of the specific technologies being developed – and to complement the analysis of scientific papers – word clouds are exploited, since they provide an overview of the most recurrent topics found in each cluster. The full results are presented in Table A.1, in Annex 1 of this report. Some examples of the key specific technologies that are expected to impact the sector in the near future are summarised here. These may require a change in the set of skills possessed by the workforce or even the development of new professional profiles.

Among the changes in the way the work is organised, we notice for example the clear rise of solutions based on *augmented reality* or *simulations*; increasing signals about the use of *Artificial Intelligence* and *data analysis;* and the adoption of robotics to help workers (*robotic arms*) or to substitute them in performing dangerous or difficult tasks (*unmanned vehicles*). *Smart Personal Protection Equipment* will also be an important addition to the way work is performed on site.

As concerns the new opportunities that can derive from the adoption of specific technologies, interesting examples are those related to *heat insulation, sound insulation, earthquake-proof systems*, installation of *solar panels, smart buildings, water depuration, prefabricated and modular structures,* and of course new types of materials such as *new glasses* or *concrete* (e.g. *self-healing concrete).*

A different type of intellectual property (IP): trademarks

The analysis of the competitive scenario for the construction sector of Armenia, compared to the international situation, is mainly based on the technical innovation capacity as described by patents. Such a picture can be further enriched by considering a different point of view and a different indicator, still related to creative activity, but not of technical nature: the number of trademarks, brand names and logos registered by Armenian companies. In fact, even the simple numbers of trademarks filed for a certain sector provides a quick overview of the variety of actors involved in the field, and their relationship with the local and global market. For example, a sector where only a few state-owned corporations operate in a non-competitive setting will have a very limited trademark landscape, while a thriving production of logos, brands and so on can be correlated to an expanding sector with many players that compete to gain the attention of a wide consumer/end-user base. Comparison among sectors or among countries also provides useful insights into competitiveness and dynamism.

The following table shows the statistics of Armenian and worldwide trademark filings at the Armenian Intellectual Property Agency (AIPA) and the World Intellectual Property Organisation (WIPO), for the three main classes of interest for the construction sector. Please note that trademarks are organised according to their own classification, different both from that of patents and from other categorisations of economic sectors. We adopt here the international Nice Classification[14] that assigns a trademark to one or more of 45 classes of goods and services.

Table 4.2: Trademarks related to the construction sector

Nice Classification	# at Armenian IP Agency	# at WIPO from Armenia	# Total at WIPO
6 (Metal materials for building and construction)	399	4	60.311
19 (Non-metal materials for building and construction)	319	4	47.040
37 (Construction services; installation and repair)	766	3	65.386
All classes	26.649	461	1.247.820

When interpreting the above data, one should bear in mind that trademarks at the Armenian Intellectual Property Agency are also filed by foreign companies (nevertheless, most marks in the classes considered still come from local companies). More importantly, certain firms extend their protection to all 45 classes of the Nice Classification for trademarks, regardless of their sector of activity, thus part of the indicated numbers may not be directly related to construction. Finally, classes 6 and 37 of the Nice Classification do not cover exclusively construction activities but include other metal parts in the case of class 6 and mining activities in the case of class 37.

Even when taking into consideration the above remarks, Table 4.2 shows that the Armenian construction sector, overall, is not actively pursuing a brand equity strategy in the international market. At national level there is more activity, but this remains limited with respect to the total in all sectors.

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[14] The Nice Classification (NCL), established by the Nice Agreement in 1957, is an international classification of goods and services for the purposes of registering trademarks and service marks. In the case of goods, 34 classes exist to register trademarks for certain goods. These classes range from Class N° 1 to Class N° 34. For services, there are 11 classes ranging from Class N° 35 to Class N° 45. For more info, see https://www.wipo.int/classifications/nice/en/

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5 Insight into future jobs and skill needs

KEY ITEMS IN THIS CHAPTER
- This chapter presents the results of a semantic matching algorithm which connects the new technologies identified with the skills and occupations provided in the ESCO database.
- The results show a growing demand in three main categories of job profiles: high-skilled technical occupations (ISCO groups 2 and 3); medium- and low-skilled technical occupations (ISCO 7,8,9), and a group of business services-related occupations (e.g., energy manager). In other words, change is not limited to highly skilled profiles or technical professions only, since managers, salesmen and the like also need to have confidence with the new techniques.
- While many profiles are still those traditionally related to the construction field (e.g., various types of engineers, but also profiles such as concrete finisher), technological innovation is leading to the introduction of new professions such as 3D printing technicians, 3D modellers, Data analysts and Laser marking machine operators.
- Other non-traditional job profiles are coming from innovative cross-sectional sectors. For example, professions related to green technologies such as the energy engineer, the solar energy engineer, and the energy manager plausibly refer to the emergent need to include sustainability, energy efficiency and environmental impact within the construction design processes.
- The sector will most likely still rely on traditional job profiles to face technological change. Architects as much as various labour workers will still be needed in substantial numbers; yet, in order to transit to the new scenario or stay competitive in the changing labour market, they will need to upskill and widen their range of competences, for example learning digital skills, or the usage of new materials.
- The list of competences related to the new technologies provides a useful compendium of what new life is expected for old, traditional jobs. An interesting role will thus be played by those technologies for the organisation of construction works, which will likely affect transversally many different profiles; in particular the omni-present digitalisation, the rise of modular construction, freeform/additive construction, new health and safety measures and devices.

5.1 Connecting new technologies to skills and occupations

This chapter connects new technologies to skills and occupations to study the skills that are needed to deal with the technological innovation of the sector. Anticipating such links is of considerable importance to many stakeholders, ranging from policy makers to training providers. The latter in particular must constantly keep up to date with the current dynamics in the sector. Moreover, knowing which competencies have and will have higher demand in the near future is equally crucial for workers to seek success in today's labour market. Finally, the competitiveness of a country also depends on the skilled human resources trained in response to market demands (Jagannathan, 2013).

There are various ways to achieve such a goal. For this study, the bridging process is undertaken by a semantic matching algorithm using the **ESCO database** (European Skill/Competence Qualification and Occupation). This database provides a **standard** definition and classification of skills, knowledge, qualifications and occupations and systematically shows the relationships between these concepts.

The most recurrent technologies or technical concepts found in patents (see Table A.1, in the Annex 1 for word clouds displaying some of them in an intuitive representation) were searched for in this database using an algorithm for semantic matching. Each technical concept was matched with a certain number of competences (either skill or knowledge), each linked to a certain number of occupations in the ESCO database.

To illustrate this process, an extract of the resulting output can be found in Table 5.1, where only a selection of the matches between technologies, skills and related occupations is shown. This table shows, from left to right, each technological concept in the first column identified in recent patents, and thus assumed to be relevant in the future for certain workers of the sector. To master and use properly such technology, the knowledge or skills in the second column are needed. In turn, possessing the skills/knowledge mentioned in the second column is considered relevant for certain occupations (third

column); according to ESCO, for any given profession the skill/knowledge can be essential or optional (fourth column).

Table 5.1: Extract of the output of the matching process between construction technologies and ESCO skills/occupations

Technology	ESCO skill	Occupation	Notes
3D Printing	3D Printing Process	3D Modeller	Optional Competence
Self-Healing Concrete	Apply Finish to Concrete	Building Construction Worker	Essential Competence
Machine Learning	Apply Statistical Analysis Techniques	Data Analyst	Essential Competence
Anti-Seismic Design	Approve Engineering Design	Civil Engineer	Essential Competence
Wall Construction	Building Construction Principles	Construction Manager	Optional Competence
Wall Construction	Building Construction Principles	Building Construction Worker	Optional Competence
Smart Building	Building Materials Industry	Construction Manager	Essential Competence
Smart Building	Building Materials Industry	Building Construction Worker	Optional Competence
Computer-Aided Design	CAD Software	Civil Engineer	Essential Competence
Computer-Aided Design	CAD Software	Energy Engineer	Optional Competence
Solar Panels	Calculate Solar Panel Orientation	Energy Engineer	Optional Competence
Sliding Doors	Carpentry	Building Construction Worker	Optional Competence
Building Energy Management System	Carry Out Energy Management of Facilities	Energy Engineer	Optional Competence
Sealing Materials	Check Compatibility of Materials	Building Construction Worker	Essential Competence
Arch-Type Bridges	Consider Building Constraints in Architectural Designs	Construction Manager	Optional Competence
Roof Drainage	Construct Wood Roofs	Building Construction Worker	Optional Competence
Cantilevered Erection	Construction Equipment Related to Building Materials	Construction Manager	Essential Competence
Electric Actuators	Control Engineering	Robotics Engineering Technician	Essential Competence

Technology	ESCO skill	Occupation	Notes
Cranes	Crane Load Charts	Crane Technician	Optional Competence
Simulators	Create 3d Environments	3d Modeller	Essential Competence
Building Energy Management System	Design Electric Power Systems	Energy Engineer	Optional Competence
Free-Form Construction	Review Construction Plans Authorisations	Construction Manager	Optional Competence
Free-Form Construction	Review Construction Projects	Construction Manager	Essential Competence
Articulated Robot	Robotics	Robotics Engineering Technician	Essential Competence
Articulated Robot	Secure Heavy Construction Equipment	Building Construction Worker	Optional Competence
Cantilevered Erection	Set Up Crane	Crane Technician	Essential Competence
Seismic Simulators	Simulate Mechatronic Design Concepts	Robotics Engineering Technician	Optional Competence
Solar Panels	Calculate Solar Panel Orientation	Energy Engineer	Optional Competence
Solar Panels	Types Of Photovoltaic Panels	Energy Engineer	Optional Competence
Predictive Analytics	Unstructured Data	Data Analyst	Essential Competence

5.2 Ranking of construction job profiles

Once the bridge between technologies and job profiles has been created, it is possible to attempt a ranking of the same profiles according to their future request or employability. In other words, it is possible to have a general idea of which occupations could encounter greater demand in the near future based on which technologies or topics they are related to.

To create a ranking function, it has been assumed that the relevance of a job profile depends on:

▪ whether the job profile is associated with more technologies, i.e. its importance grows if it has skills related to more than one technology or topic (so-called '*transversality*');

▪ following ESCO's classification, the essential or optional nature of skills in relation to a technology or topic and the related profile;

▪ the weight of technology/ies and topics to which it has been matched in terms of potential future use, as expressed by the normalised number of patents it appears in.

The three conditions above are combined in the mathematical formula below:

$$Importance\ of\ job\ profile\ j\ (y_j) = \sum_{i=1}^{m} T_{ij} E_{ij} W_i$$

Where:

$$T_{ij} = \begin{cases} 1\ if\ technology/topic\ i\ is\ linked\ to\ job\ profile\ j \\ 0\ otherwise \end{cases}$$

$$E_{ij} = \begin{cases} 1 \; if \; technology/topic \; i \; is \; essential \; to \; job \; profile \; j \\ 0.5 \; otherwise \end{cases}$$

$$W_i = Importance \; of \; the \; technology/topic \; i$$

The values of T_{ij} are based on the analysis of the matching table (Table 5.1): the higher the number of correlations the job profile has with the technologies, the higher the T_{ij} value. Such value represents the number of appearances of a specific job profile in association with the technologies that have been extracted from patents. The values of E_{ij} can be 1 in case a specific technology is essential for a job profile or can be 0,5 otherwise, (whether a given competence is essential or optional for an occupation is assessed in the ESCO database). Finally, W_i considers the temporal trends of each identified construction sub-sector: the greater the number of patents falling within a sub-sector, the greater the relevance of a single technology compared to technologies belonging to a less representative sub-sector.

The application of the previous formula to the professions extracted from ESCO returns a ranking of relevance. The relative scores can be compared using bar plots, which provide a visual understanding of the most relevant occupations in the analysed sector.

Figure 5.1 shows an extract of the output that considers the first 31 positions of the ranking. Many of the reported profiles are traditionally related to the construction field, e.g., the ones coming from the engineering realm: *mechanical engineer*, *civil engineer*, *industrial engineer*. Also, traditional labour profiles like *concrete finisher*, *building construction worker*, *crane technician*, appear in the list. Some other job profiles, on the contrary, seem to come from innovative cross-sectional sectors. For example, the *energy engineer*, the *solar energy engineer,* and the *energy manager* plausibly refer to the emergent necessity of including concepts related to sustainability, energy efficiency and environmental impact within the construction design processes. Other profiles, like the *3D printing technician* and *3D modeller*, emerge from the list, a symptom of the growing application of additive manufacturing in construction, as also indicated by the relative trend in patent activity (see Figure 4.5).

Figure 5.1 Bar chart displaying the ranking for first 31 occupations in the construction sector
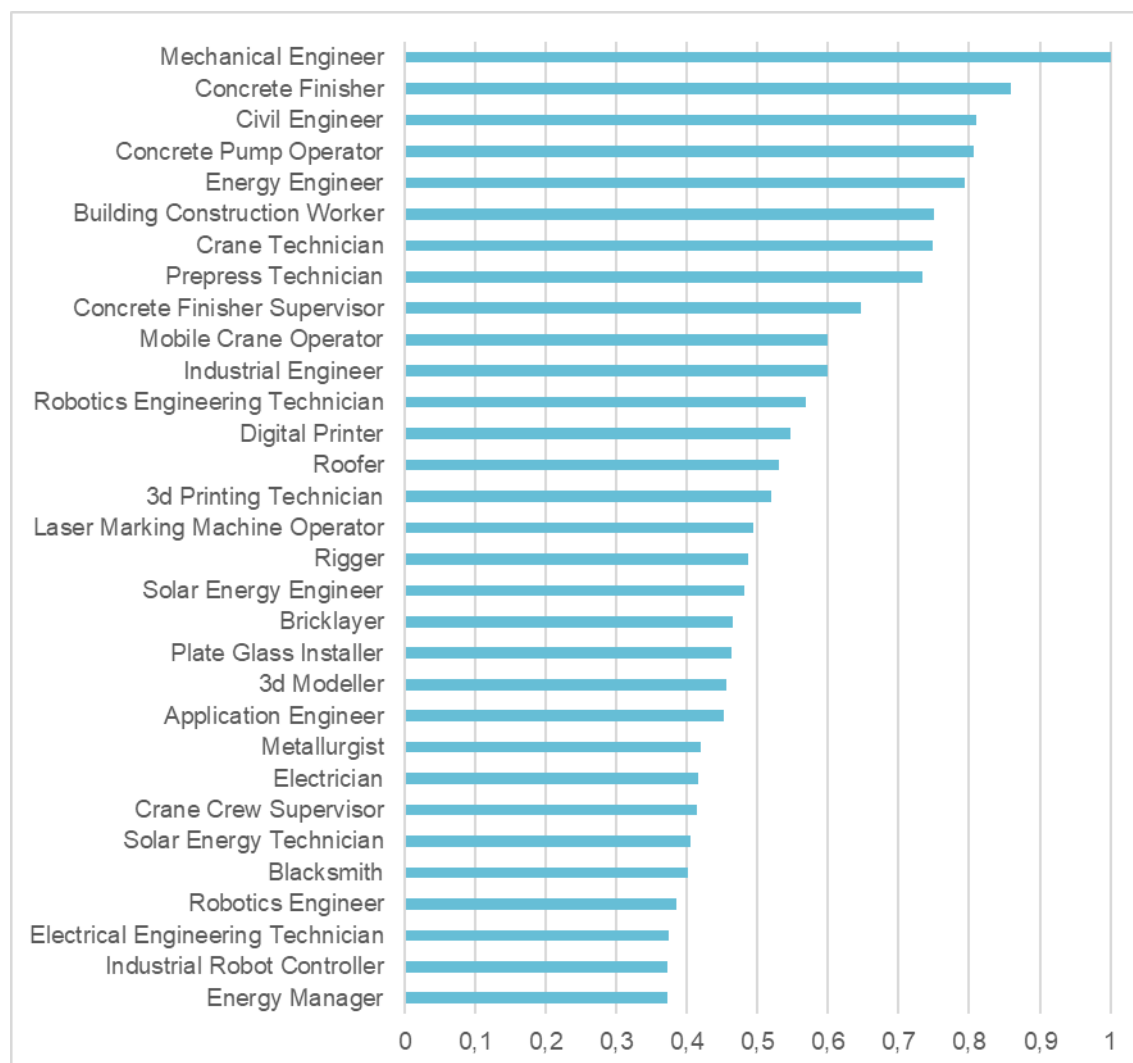
Note: a full description of any of the occupations in the list may be found at ESCO website https://ec.europa.eu/esco/portal/occupation.

The identified job profiles can be further grouped according to the tasks and duties undertaken, with reference to the International Standard Classification of Occupations (ISCO). The construction sector has many diverse occupations and a large range of skills levels, from the low-skilled to the high-skilled, with an equally wide spectrum of competences affected.

From the results obtained by the previous formula, and following ISCO, three groups have been identified:

- technical professional and associate professional occupations (in the following pages also referred to as "high-skilled profiles", mainly ISCO groups 2 and 3);

- technical medium- and low-skilled occupations (mainly ISCO groups 7,8,9 i.e., trade workers and machine operators);

- business services, sales, and other occupations.

In the following three paragraphs, the analysis of each of these subsectors is presented.

High-skilled level job profiles

Half of the profiles at the top 30 position of the ranking (Figure 5.1) belong to the category of high-skilled profiles. In Figure 5.2, the twenty-five most relevant high-skilled professionals and associate professional profiles are represented.

Figure 5.2: First twenty-five high-skilled occupations in the construction sector that are correlated with rapidly growing technologies
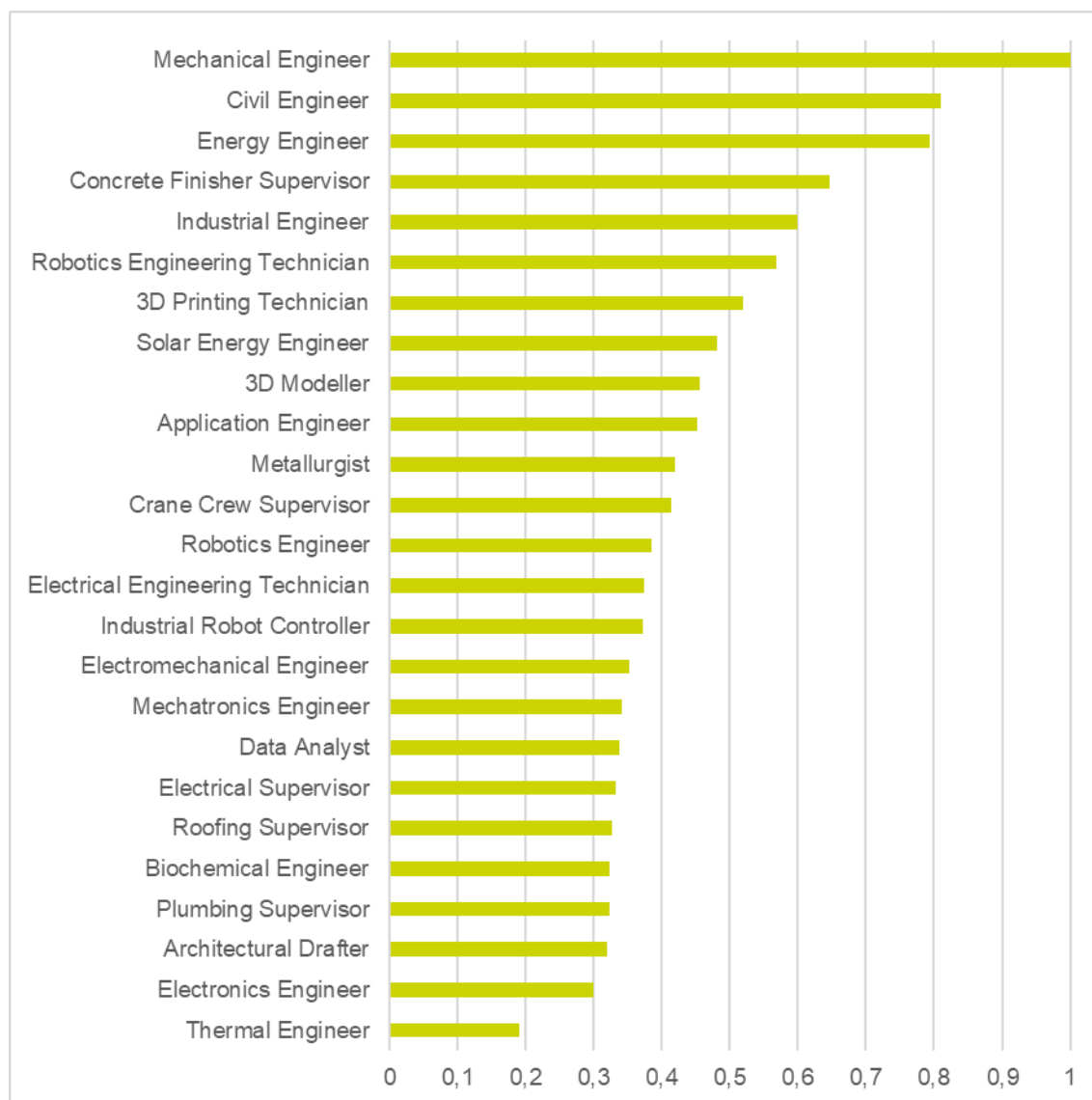
Job profiles previously listed belong to one of the categories of professionals (ISCO Major group 2):

- science and engineering professionals (ISCO 2.1);
- information and communications technology professionals (ISCO 2.5).

Some job profiles are in the category technicians and associate professionals (ISCO Major group 3):

- science and engineering associate professionals (ISCO 3.1);
- information and communications technicians (ISCO 3.5).

Looking at Figures 5.1 or 5.2, one may notice the absence of certain occupations, such as the architect, that are traditionally relevant to the construction sector. This absence is related to the way ESCO describes such profiles, with very few references to the technological aspects (as opposed for example to the case of civil engineers). This is an artefact resulting from ESCO's structure. It does not mean that architects will not be touched by the adoption of new technologies. In fact, architects will need to upskill and widen their range of competences (for example learning digital skills, or the usage of new materials) in order to stay competitive in the changing labour market. The list of competences related to the new

technologies that the matching software is extracting provides a useful compendium of what new life is expected for old, traditional jobs.

Medium- and low-skilled job profiles

Half of the profiles at the top 30 position of the ranking in Figure 5.1 belong to the category of medium- and low-skilled profiles. This balance between high and medium/low-skilled profiles indicates that in the future the sector will need high-skilled professionals, while in the meantime still relying on technical skills and specialised figures whose competences will be presumably needed to be upskilled to face the introduction of new technologies in the construction sector.

The following Figure 5.3 represents the first twenty medium- and low-skilled occupational profiles.

Figure 5.3: First twenty medium- and low-skilled occupations in the construction sector that are correlated with growing technologies
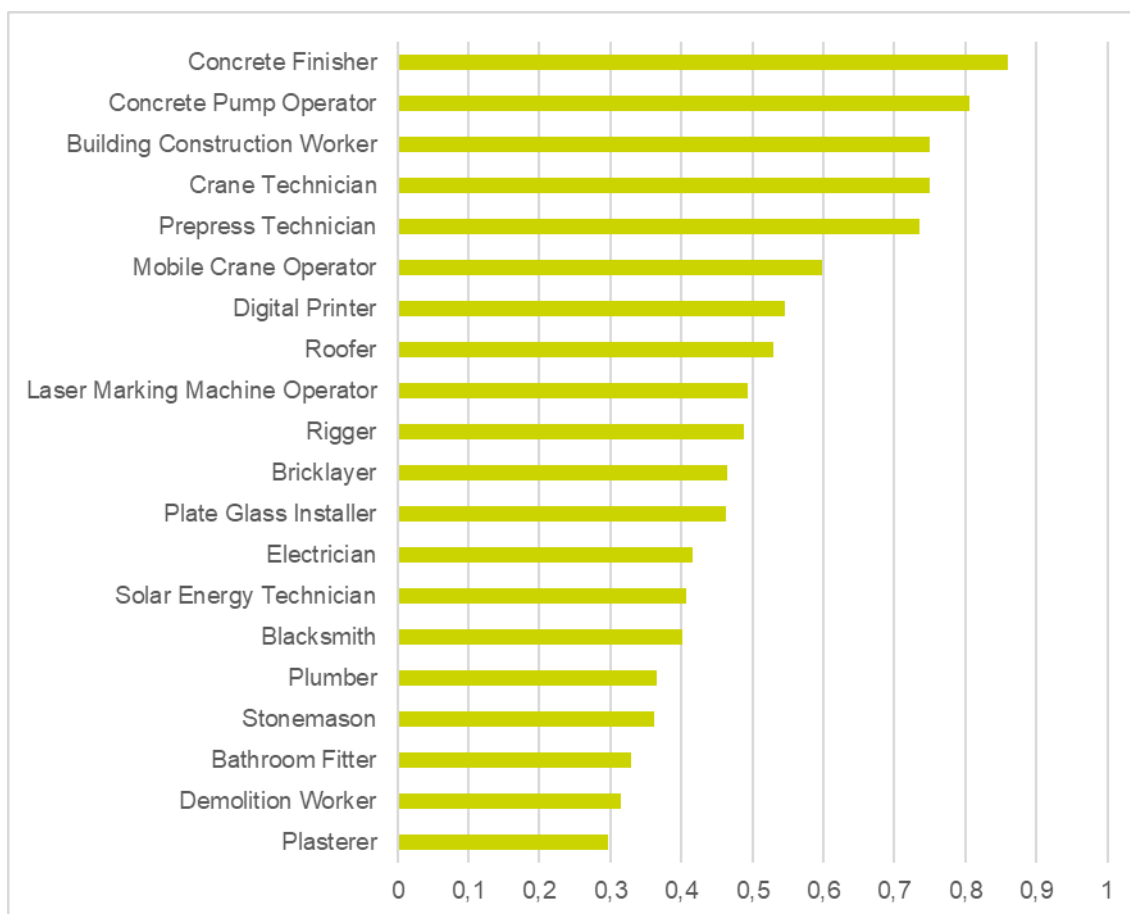
These occupational profiles can belong to the following categories:

- Craft and Related Trades Workers (ISCO Major group 7)
  - Building and Related Trades Workers (ISCO 7.1)
  - Metal, Machinery and Related Trades Workers (ISCO 7.2)
  - Handicraft and Printing Workers (ISCO 7.3)
  - Electrical and Electronic Trades Workers (ISCO 7.4)
- Plant and Machine Operators and Assemblers (ISCO Major group 8)
  - Stationary Plant and Machine Operators (ISCO 8.1)
  - Assemblers (ISCO 8.2)
  - Drivers and Mobile Plant Operators (ISCO 8.3)
- Elementary Occupations (ISCO Major group 9)
  - Cleaners and Helpers (ISCO 9.1)
  - Labourers in Mining, Construction, Manufacturing and Transport (ISCO 9.3)
  - Street and Related Sales and Services Workers (ISCO 9.5)

- o Refuse Workers and Other Elementary Workers (ISCO 9.6)

The ranking of the medium and low-skilled profiles affirms the relevance of changes introduced by the technology adoption for the future of the professional profiles that can be considered as traditional for the construction sector. Such professions will be asked to master new competences, ranging from the use of innovative construction materials to the adoption of new digital and automated solutions. Profiles in the list of Figure 5.3 have low transversality, meaning that practical competences will keep a vertical and specific application.

Business services and other-related job profiles

With a similar reasoning, the ISCO classification allows to identify profiles that are linked to managerial activities, business or sales operations (Figure 5.4). These can belong to several categories of the classification of occupations such as:

- Production and specialised services managers (ISCO 1.3)
- Business and administration professionals (ISCO 2.4)
- Business and administration associate professionals (ISCO 3.3)
- Sales workers (ISCO 5.2)

Figure 5.4: First seven business services-related profiles in the construction sector
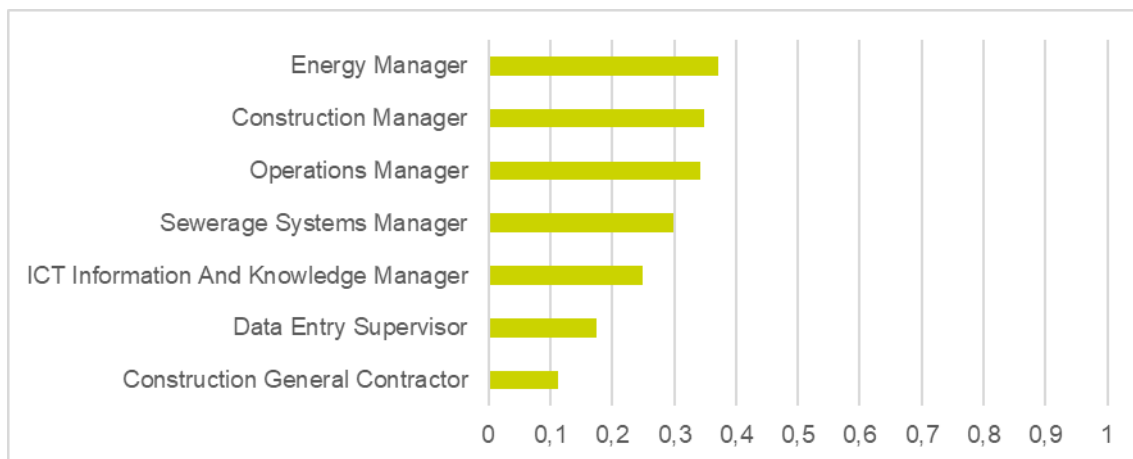
The only business-related profile that appears within the first 30 profiles of the ranking (Figure 5.1) is the *Energy manager*, whose presence - although far from the top positions - is interesting, especially if compared with the other managerial profiles of Figure 5.4. The *Energy manager* is, in fact, ranked higher than the *Construction manager* and the *Operations manager*, which could have been expected to be found at the top of the list. A possible interpretation of such a result could be that energy together with waste efficiency and sustainability are strongly emerging in the construction field.

5.1 Emerging skills and occupations for the construction sector

The above paragraphs show a sample of job profiles (according to the ESCO classification) that are linked to the innovations occurring in the sector (as represented by the patents filed to protect them). Results of the ranking can be interpreted in a future oriented way, i.e., occupations with high relevance scores can be considered occupations with higher employability in the near future. Indeed, it is reasonable to state that occupations which have knowledge or skills related to technologies on which companies are doing research and filing numerous patents today, will be highly requested tomorrow.

As for competences, some of the new technologies (e.g., lightweight beams) can still be managed with the existing set of skills; many more would require an upgrade of competences across all the various stages of realisation of civil works. The results also reflect the co-existence of these two categories, with a list of profiles that are equally distributed between high and low levels, embracing skills that are different and complementary.

Among the technical areas that require the acquisition of new skills and competences with increasing importance, one can find digitalisation, automation, support of activities through software solutions and the theme of sustainability and environmental impact (for example with the adoption of Artificial Intelligence to increase energy efficiency, or with new materials for better insulation).

The technological innovation is creating new occupational profiles such as *3D printing technician*, *3D modeller*, *data analyst* and *laser marking machine operator*. Professions related to green construction may also be found both among high-skilled and medium-skilled profiles, such as e*nergy engineer, solar energy engineer and technician, and thermal engineer.*

However, the number of new professions appears to be limited in relation to the total number of jobs. This means that the sector in the future will still rely on traditional job profiles to face the technological change. In accordance with the two rankings in Figure 5.2 and Figure 5.3, this is true both for high-level occupations (such as *Civil engineer, Concrete finisher supervisor, Metallurgist)* and for medium- and low-level occupations (from *Concrete finisher to Plumber)*. However, in order to transit to the new scenario or stay competitive in the changing labour market, all such professions will need to upskill and widen their range of competences, for example learning digital skills, or the usage of new materials.

The list of competences related to new technologies provides a useful compendium of what new life is expected for old, traditional jobs. An interesting role will be played by these technologies for the organisation of construction works, which will likely affect transversally many different profiles. In particular, the omni-present digitalisation, the rise of modular construction, freeform/additive construction, and new health and safety measures and devices.

It is also possible to analyse how occupations differ from one another based on which ESCO competence they are connected to. For instance, a bubble chart can be used to visualise which skills or sets of knowledge are associated with the occupations, and how important these are based on the technology/topic to which they are connected. Figure 5.5 visualises skills sets for the following six profiles: *3D modeller*, *Building Construction worker*, *Construction manager*, *Data analyst*, *Energy engineer* and *Robotics engineering technician.* The horizontal axis lists the six ESCO occupations that are matched on the vertical axis by the competences associated to them. Each competence is associated with a technology according to the procedure described at the beginning of the section, and the size of the bubble at the intersection indicates the relevance of the technology as determined by its occurrence in patents.

Figure 5.5: How competencies in construction are distributed across six selected occupations

Note: each point in the plot represents an association between a competence and an occupation, whereas its size is proportional to the weight of the technology to which the competence of interest is linked (as previously defined, the importance of a technology depends on the respective patent filing activity).

Figure 5.5 shows the distribution of competencies across six occupations and provides an understanding of why certain profiles have the ranks shown in Figure 5.1. For instance, the *3D modeller* has a very vertical set of skills, meaning skills and knowledge that are very specific to its field of study.

The bubble chart also clarifies why the *Energy engineer* came out high in the ranking of Figure 5.1*;* due to the presence of several dots in the relative column. This profile has many skills related to technologies that are filed for patents, which means it is relatively more important than the others in the innovative scenario of the construction sector.

In this sense, the bubble chart also gives an insight into which skills and knowledge are more important for each job profile, based on the relevance of each technology linked to each occupation. At the same time, by looking at Figure 5.5 from the competence's perspective, it is possible to see which skills and knowledge will be most likely required for future jobs.

6 Sector initiatives to meet changing skill demands

KEY ITEMS IN THIS CHAPTER
- This chapter identifies the sectoral initiatives and actions to meet changing skill needs. Multiple factors have been identified as obstacles for the adoption of new technologies, such as the lack of practical training and workshop training in most courses, the lack of attractiveness of the sector for young people and the resulting lack of their replacement and ageing workforce, the low levels of qualifications (or absence thereof) for a large share of construction workers, and generally weak interaction between public and private sectors in the design of curricula and VET provision.
- There are also other factors positively affecting the adoption of new technologies in the sector, such as the new regulations and standards, particularly in terms of environmental standards and seismic safety, the flexibility of VET and occupational standards allowing for new VET courses to be created rather quickly depending on needs, the controlled immigration plan to bring foreign professionals to work to Armenia, and the existing partnerships with national and international organisations that can set or improve standards and drive change for future cooperation to address gaps in the sector.
- Changes in the construction sector require an education and training system which is aware of emerging skill needs and can plan accordingly, but also one which is able to respond flexibly and quickly to emerging skill needs if skill shortages are not to hinder growth in the sector. This suggests that the education and training system not only needs to focus on producing young talent with the skills of tomorrow, but also on upskilling and reskilling the existing workforce in a timely manner to meet current skill needs.
- Stronger public-private cooperation is a potential solution to expand the skills provision and enhance the quality of construction training, allowing students to join companies on-site and witness their day-to-day work. This should go hand-in-hand with reforms of the education sector that allow for more work-based learning and more dual education to be introduced into VET.
- Reforms should increase the ability and power of social partnership bodies to bring together different stakeholders and establish closer cooperation. Similarly, increasing the number of education providers for the construction sector might spur competition between providers and in turn increase the quality of education.

This chapter identifies and analyses the sectorial actions and initiatives to meet changing skills demands. All the findings presented in this chapter come from the in-depth interviews and workshop discussions conducted with companies and key stakeholders in the construction sector in Armenia.

6.1 Limiting factors for adopting new technologies

Several factors have been identified as obstacles for the adoption of new technologies in Armenia.

Limited VET supply to the construction sector

Vocational specialisations in the field of construction are offered by only a few VET institutions – only six or seven VET providers, comprising less than 10% of all VET institutions in the country. Aside from some well-established providers providing a broad range of training at different educational levels, such as the National University of Architecture and Construction of Armenia and its secondary vocational college, the breadth of VET provision tends to be narrow and not spread across the country. Some of these institutions do not cover all professions in the construction sector and do not fully meet the requirements of the private sector in terms of quality and skills provided. In general, there is a big difference in the quality of education provided by public providers and private providers, and the Ministry is reportedly working to harmonise standards and invest more to reduce the quality gap between public and private providers and to strengthen cooperation.

Large gap in the provision of practical training and transversal skills gap

Much of the practical work is conducted in classrooms and the students do not have the opportunity to gain on-the-job experience. In most cases, education providers have outdated training infrastructures

that do not allow students to put their theoretical skills into practice. Moreover, stakeholders report the lack of a mandatory insurance policy for students, raising safety concerns for those wanting to work in construction sites and those companies willing to take on students. Similarly, workshop speakers noted that, although the higher education system has some laboratories and built-in practical learning sessions and workshops, students have limited opportunities to use new technologies in practice. In some cases, organising training poses technical and financial challenges, as well as safety concerns, in particular for the operation of large machines (cranes, ground movement equipment, etc.).

It is not just about technical skills. Companies report skill gaps in transversal skills such as digital skills and project management skills which needs to be addressed by the education and training system as a whole (including the training provided by companies). VET teachers need to keep pace with the latest developments to train the workforce for modern construction needs, while VET institutions also need to be better equipped for this task. Employers have specialists who lack the methodological and pedagogical background needed to teach skills and achieve expected learning outcomes. There is a strong need for cooperation between employers, colleges and universities (see also following sections) in retraining teaching staff.

Lack of attractiveness and non-replacement of older workers

The issue of the lack of attractiveness of the sector emerged in many discussions. Many participants pointed out the general perception of the sector as one that requires hard, physical work which has low pay levels despite recent increases in salaries. This, in turn, discourages young people to be attracted to this type of work. Accordingly, the workforce of the sector remains quite old with no replacement from younger generations, leaving older experienced workers with little opportunity to pass on their knowledge and experience to younger counterparts.

Some interviewees pointed out that young people seem to be attracted to more prestigious professions when making their career choices and/or pursue courses where the time taken to gain professional competence is relatively short. As a result, young people are not inclined to pursue career paths such as civil engineering because of the time it takes to become fully competent. Most interviewees noted that students do not have an accurate picture of what a modern construction profession looks like or the variety of jobs on offer in the sector.

Large share of low-skilled workers

During the field research, interviewees underlined that jobs in the construction sector, especially low-skilled ones, are often carried out by people who do not possess any relevant qualification. They reported often having to hire people with low levels of education, who had no other opportunities available to them, and relied upon personal contacts to teach them basic construction skills. As this was never their career goal, they often ended up switching to other careers after some time.

Some interviewees reported that qualified and trained people are lacking in the sector. Whereas many occupations require highly qualified people, these were generally not available. Stakeholders report this to be particularly the case for occupations such as construction and building inspectors, construction equipment operators, elevator and escalator installers and repairers, structural iron and steel workers and photovoltaic equipment installers, among others.

To remedy this, companies tended to rely on employing low-skilled people and training them on the job. When the country recently invested in the construction of critical infrastructure, such as power plants, it was necessary to employ specialists from abroad because the relevant skills were not available in the country.

Interviewees observed that the increase in construction volumes is leading to a shortage of urban planning professionals. Skills related to all types of engineering – from civil to mechanical – are in high demand and are hard to find because there has been insufficient investment in training the next generation of engineers. Some interviewees noted that the shortage of these skills will be felt more severely over the next few years as people increasingly retire from these roles. In particular there is a shortage of skilled professionals in the construction of dams and highways, which is one of the main areas of national infrastructure development.

It was also said there was an inadequate supply of VET graduates in construction to supply skills related to a range of non-professional occupations such as welders.

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Weak interaction between public and private sectors

Many stakeholders noted the weak interaction between the public and private sectors, and between education providers and employers. There is a large share of SMEs in Armenia, and it is challenging to engage them with the VET system. SMEs seem to prefer to engage in ad-hoc training to meet their occasional skill needs rather than systematically engaging with VET providers.

Interviewees noted that tripartite sectoral committees, which include government, employers and trade unions, are insufficient to ensure effective communication about the need to train and collaborate with the education system (including VET providers). Things have started to change when recently working groups were established within the main ministries involved in educational policy (respectively the ministries of Education, Economy, and Labour), along with a sectoral skill committee for the construction sector to help identify sectoral skill needs and adapt sectoral education.

The Ministry of Labour is currently exploring how to improve cooperation between key stakeholders. It is also looking at how ALMPs tailored to the needs of the private sector might be developed. It is also exploring incentives and capacity-building activities to empower companies to effectively engage with policymaking and educational programmes. As reported by the Ministry of Labour, most companies are ready and willing to engage with policymaking, but they lack the capacity to engage throughout the whole process and are therefore unable to make their needs properly heard. Similarly, companies reported experiencing difficulties in engaging with public education providers because initiatives in general are slow to develop and difficult to maintain.

6.2 Facilitating the adoption of new technologies and new skills

Stakeholders and interviewed companies also identified some factors supporting the adoption of new technologies and skills in the sector.

New regulations and standards

The importance of new regulations and standards (e.g., for urban construction) was highlighted by some stakeholders as a factor bringing about new ways of working and increasing the demand for technological change. Regulatory developments had led to: (i) demolition of existing buildings no longer respecting standards, to be replaced by new ones; and (ii) new construction employing new production techniques and new materials results in a demand for new skills. Some interviewees also pointed out the effect of new regulations on sustainability, energy efficiency and safety in terms of revamping and giving more importance and visibility to the profession of building inspectors.

The implications of sustainability have underlined the importance of professions linked to energy efficiency, while also supporting the development of new activities in terms of recycling waste materials. For instance, one interviewee reported the creation of factories turning waste originating from the extraction and processing of tufa stone (one of the main building materials in the country) into decorative concrete. This recent development has skill implications.

The changing attitudes of the general public towards sustainability and energy efficiency has also increased the demand for new housing that is, in turn, smaller and more energy-efficient, sometimes relying on renewable sources of energy. Again, there are skill implications resulting from this preference for energy-efficient housing powered by renewables.

Flexibility of VET and occupational standards

One interviewee reported that Armenian occupational standards are flexible, allowing VET providers to obtain agreement with stakeholders to tailor curricula to specific needs. Every year providers can adapt their curricula to consider new needs. For instance, they can specify which (new) technology or tool is included in a particular module. VET providers can offer short-cycle programmes for people who need upskilling. VET providers sometimes have training agreements with selected companies and develop modules according to upskilling and reskilling needs.

Controlled immigration of construction professionals

The Ministry of Labour is currently working on a plan for establishing flexible mechanisms to organise the immigration of high-skilled professionals (for all sectors, not just construction). This includes collaboration with the German government whereby experienced German workers teach their Armenian counterparts technical and managerial skills. Another initiative is under development with the United Arab Emirates (UAE). Armenia will provide workers to the UAE. In return, the UAE will invest in training and upskilling of Armenian workers in Armenia before they are employed in UAE. They will work in the UAE for a period of three years before being expected to return to Armenia with more knowledge and international experience. The Ministry of Labour will ensure that the training provided meets the future skill needs of the country. Armenia is planning to invest in bringing trainers from the UAE, and other countries, to collaborate with public VET institutions and/or private companies to develop training curricula.

Partnerships with national and international organisations

The Urban Development Committee is working with the National University of Architecture and Construction of Armenia (NUACA) on identifying applications of BIM technology in Armenia with the assistance of international partners, including European and American universities. Switching to BIM technologies will simulate the complete system of building from the beginning to the end of the design, bridging the architectural and engineering parts in a model based on clear indicators, thus avoiding deviations, and providing a complete picture of any given construction project. As a result of these partnerships, over the past five to six years NUACA has acquired well-equipped, modern laboratories. Last year the University launched its first highway and bridge research lab, which represents a great advancement in the field of evidence-based planning.

Similarly, KNAUF Armenia has launched a collaboration with the VET college of NUACA to start a new course for "Installer of frame-cladding constructions", learning the skills needed to build frame structures. The first class of graduates has completed the course in 2022. The pilot training course, it was said, showed promise, as KNAUF had established a workshop-classroom where the students could put theory into practice.

6.3 Other factors affecting sectoral skills supply and demand

Beside the factors directly or indirectly affecting innovation and change in the construction sector, the study has uncovered some issues with the educational system at large, which might be responsible for the persistence of labour and skill shortages in the Armenian construction sector. This section presents these issues and brings all findings from the research together in a short series of recommendations to sectoral stakeholders in Armenia.

Limited work-based learning and non-formal education

The National Centre for VET Development is currently piloting dual education and work-based learning. Dual education needs to be a priority in VET development, as reportedly colleges that offer dual education have much higher success/completion rates. In the view of most interviewees, dual education constitutes the perfect combination of theoretical and practical learning. Also, the government needs to further develop the recognition of non-formal education. There is legislation in place, but the procedures and framework require further development. The majority of interviewees regard practical training as more effective and productive than traditional learning but are aware that employers are often reticent to provide it due to safety issues.

Interviewees underlined the importance of an efficient system for recognition of non-formal education as a way to upskill and reskill the workforce and help overcome skill gaps. In all cases, both formal and non-formal education were recognised as important in closing skill gaps. Large amounts of unqualified workers (e.g., apprentices without formal qualification who have become workers in the companies where they served as apprentices) need to be assessed and provided with a certificate of their skills to provide them with currency on the labour market.

The Government Programme of the Republic of Armenia 2021-2026 attaches great importance to the introduction and expansion of dual training through the active involvement of the private sector and the

business community, which will help to improve the quality of the workforce in line with the demands of the labour market. Work-based learning is a priority for the Ministry of Education, Science, Culture and Sport, and the upcoming Education Strategy 2030 sets out how the introduction of work-based teaching and learning mechanisms will be systematically introduced. This is regarded as a key tool to boost VET quality, as well as to better match education supply to labour market demand. In 2022, dual education has been piloted in a number of professions considered as priorities for economic development, including construction ones.

Interaction between companies and education providers

Good examples of collaboration between education providers and employers were reported. Some companies send employees to teach in VET schools or take students to their workplace and give equipment to VET schools. In some cases, employers attend exam committees and then take on successful graduates as employees. For instance, the VET college of NUACA has cooperated with KNAUF to introduce a new profession related to cladding. These collaborations should serve as examples to attract more employers and set up more cooperation mechanisms to improve the quality of education and particularly of practical learning.

Companies usually report high levels of interest in cooperating with training providers, though they are often not sure how to proceed and report difficulties in creating tailored courses or classes that are relevant to address skill gaps in the longer term. Most companies report the need to conduct a systematic skills gap analysis in the construction sector, to map out sectoral needs accurately and to support the design of relevant educational pathways that can improve recruitment processes in future years. While interviewees report that a poor training infrastructure, in particular the lack of professional equipment, is often a problem for providing quality training, some interviewees pointed out that once good results from educational programmes are there and ready to be presented to companies, it will be easier to convince donors and employers to invest in enhancing training infrastructure.

Emigration and immigration

A large gap is documented in the supply of blue-collar, lower qualified workers, many of whom emigrate to the Russian Federation to work in construction sector with better remuneration, often finding a job and settling there. Most of these workers are of prime working age. Interviewees also reported seasonal labour migration of Armenian construction workers to Russia. Construction volumes in Russia are 10 times higher than in Armenia, and construction workers are paid twice as much as in Armenia. The invasion of Ukraine in February 2022 is expected to have some impact on skills supply. During the workshop, one expert mentioned that several recruiters are taking advantage of the influx of migrants from Ukraine and Russia to recruit experts who can share their expertise and teach Armenian workers the skills required by the companies.

Licensing and safety requirements

Currently, companies must have a construction licence to carry out any construction work. This must be issued by the State Committee of Urban Development and lasts for an indefinite period of time. Companies applying for a licence need to demonstrate that they employ at least one qualified specialist in the respective area of construction for which they are applying for. The specialist(s), to be certified as such, needs to demonstrate their competence by possessing a bachelor's diploma and proof of five years of uninterrupted work experience in the given field, or a master's diploma and proof of three years of uninterrupted work experience in the given field. However, certain types of works can be performed without a licence (see section 3.2 for more details).

During the workshop, participants noted the importance of establishing better licensing procedures and arrangements for construction companies. The improved licensing system could expand the list of activities requiring a construction licence and require higher skill requirements in terms of skills for companies, for instance employing a higher number of specialists employed (varying according to the size of the company) or specialists possessing qualifications better suited to the specialisation. Licensing could also be given for a definite period of time to be renewed, and subject to the assessment of health and safety standards for workers. The renewal mechanism could be put in place for the public authority to regularly assess whether companies are up to date with the latest requirements set by the law.

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6.4 Training and recruiting strategies of companies

Training

Most interviewees pointed that there were no policies targeted at upskilling and reskilling the existing workforce. Current legislation does not require construction workers to be certified, leading employers to manage their skill gaps and skills development through on-the-job training (learning by doing). In some cases, companies report having organised training for their employees together with sectoral organisations, or in some cases buying training from private providers. Companies have started to offer in-house training to address some skill gaps in their workforce, for instance on the environmental and social impact of construction projects. In these cases, teachers were often either experienced team members or experts from outside the company. In some cases, companies can exploit learning resources created by the organisations (often foreign companies).

Recruitment

Most employers reported the small size of the country as an important factor driving recruitment selection criteria. Most employers recruit through word-of-mouth and personal connections. In some cases, the small size of the country makes it difficult to find people with highly specialised skills. In others, companies reported working with universities to find new recruits. Other companies sponsor students' education in return for them joining the company after graduation.

All interviewed companies reported being unable to find young people ready to work in the construction sector after having completed their education, due to the niche nature of the jobs they wanted them to work in. This has often caused delays in filling vacancies and leads to an increase of the workload of existing staff. In these situations, provision of training to new recruits is seen as the only way to satisfy skill needs.

6.5 A final word on the findings

The construction sector is an important driver of growth in an economy. Infrastructure development, for instance, can be an important means of stimulating economic recovery following a period of recession or stagnant growth. Construction, of course, includes much more than infrastructure developments including a panoply of building activities from mundane repairs, to constructing office complexes, to building new highways. Looking to the future, the twin green and digital transitions, are placing new demands on the construction sector, including building digital highways, creating smart green cities, developing solar farms, making buildings environmentally sustainable (including via retro-fitting), and so on. At the same time, construction technologies are developing at pace, including those which assist with the design of buildings (e.g. building information modelling), the use of new materials, and new construction processes (often linked to off-site production). These are all applicable to solving the construction problems which arise when building in seismically active areas.

All of the above create a demand for new skills. Some of these will be for professionals involved in the design process, others will require different skills to be used on-site (for example, those required in laying optic fibre cables or installing prefabricated modules). This requires an education and training system which is aware of emerging skill needs and can plan accordingly, but also one which is able to respond flexibly and quickly to emerging skill needs if skill shortages are not to hinder growth in the sector. This suggests that the education and training system not only needs to focus on producing a talent pipeline so that the young generations possess the skills of tomorrow, but also on upskilling and reskilling the existing workforce so that they too are suitably skilled.

Many of those employed in the construction sector are learning their skills on the job, and relatively few hold qualifications relevant to construction. This suggests that there may be a need to certify the existing skills of the workforce alongside the provision of an upskilling or reskilling. Thinking about meeting the future skill needs of the construction sector, employers reported a problem of attracting people to develop their careers in construction. Construction-related jobs are often regarded as unattractive employment, where people tend to start working out of lack of choice, only staying for a short time before going on to work somewhere else. If the sector is to meet its future skill needs, some extra incentives and measures would be needed to make the sector more attractive for newcomers, as would sufficient number and quality of construction training for young people and adults who are prepared to develop

their careers in the sector. There is therefore a need to develop mechanisms to ensure that training is provided but also that a sizable number of people are attracted to train in construction skills and put those skills into practice.

In order to design and/or upgrade education and training programmes that are relevant to the sector, it is crucial to regularly conduct skills anticipation activities and use the results to adapt and/or expand the existing offer. Besides identifying the need for specific professions in the sector, one must be also aware of longer-term worldwide trends, such as the increasing digitalisation of construction activities and the increased focus on sustainable practices. Detecting the potential changes that these trends bring to the construction sector is crucial to stay ahead of the developments and address future skill needs in a timely fashion.

The education and training system, including VET, cannot achieve a high-tech, high productivity construction sector alone. This requires the support of government to drive growth in construction and create partnerships between education and training providers and the construction sector companies. Regardless of policy choices made, all findings of the study point to the general need to increase skill provision in the construction sector, both for initial and continuing training, including upskilling and reskilling pathways.

Meeting the future skills of the sector in Armenia will require the following to be undertaken.

- Expand the training infrastructure in the sector, including the number of training institutions, so that access to training in different construction professions and specialisms is widely available across the country.
- Assess the existing skills of the workforce given that the sector's workforce largely lacks formal qualifications. This will necessitate recognition of acquired prior learning for those workers who obtained their construction-related skills by learning on-the job.
- Develop stringent quality criteria to be met by training providers licensed to deliver accredited training. All training provision must lead to the award of a qualification which is recognised in the wider labour market.
- Upgrade existing training programmes and courses so that they better meet the needs of the sector. This will require the updating and/or new design of programmes for upskilling and/or reskilling existing workers. Programmes and courses will need to reflect the use of the latest technologies being used globally to improve the quality of the built environment. This has the potential to increase the attractiveness of the sector to would-be employees.
- Provide incentives and extra measures to increase the participation of companies and individuals in construction training. Grants and subsidies can be provided to ensure that training in new technologies includes those not commonly in use today but are likely to come on stream in the near future. Public procurement can be used to ensure that the construction workforce is appropriately trained by, for example, introducing training clauses into contracts.
- Strengthen the institutional partnerships between employers, training providers, and policy makers and promote the sharing of resources between education providers and employers to increase effective skill provision in the sector. For instance, personnel from construction companies can be used by training providers to deliver training. Construction companies can also make equipment available to training providers.
- Learn from international best practice in the training of construction workers and use tools and measures to deliver training which are seen to work well in other countries, e.g. the use of work-based training such as apprenticeships, or the use of micro-credentials for accrediting the skills acquired from short-duration training or on-the-job learning.
- Provide improved career guidance and effective incentives to increase the attractiveness of construction sector jobs to young people – and potentially adults who are looking for a career change – so that they are fully informed of the relative merits of working in construction.
- Consider reviewing the current system of occupational licensing given to the companies carrying out construction work by the Urban Development Committee. Stricter requirements could be asked of skilled personnel and licensing could be time-limited rather than being granted in perpetuity. Training in occupational health and safety could be made compulsory for all construction work.

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The above can be used to develop skills at all levels. It is not just about the supply of crafted and technician level skills but also about those at higher levels. Given that the nature of construction systems is becoming more complex, especially where key components are developed off-site sometimes in the manufacturing sector, education and training providers may need to develop relationships with these suppliers too.

The evidence collected in this report suggests that some progress has been made in moving towards achieving the above goals, but there is also a sense that progress has been slow and is hampered because large parts of the construction sector are characterised by relatively low-skilled, low-waged employment. This in turn discourages young skilled people from pursuing careers in the construction sector. Looking to the future, the sector needs to break-out of the relatively low-skill equilibrium which characterises its current position.

This will require concerted actions to simultaneously stimulate hi-tech growth in sector and the supply of high skilled professionals, associate professionals, and skilled craft workers. The big data analysis presented above clearly indicates the technologies which will increasingly characterise construction in the future. It is important that Armenia is able to adopt these technologies and acquire the skills associated with their use. Increasing the take-up of new technologies and providing training need to happen concurrently, in order that they feed-off one another and push for the construction sector towards being the high-tech, high productivity one that will serve the country well and facilitate the twin digital and green transitions.

Annex 1: Detailed analysis of patent clusters

Note: The font size of words found in word clouds is proportional to their occurrence in patents (the greater the size, the greater the importance of the word). Colours have an analogous interpretation: they are just a way of creating groups of words which have similar occurrence. Red and Orange are associated to words with the highest occurrence, whereas blue is the minimum occurrence. Of course, the latter varies depending on the patent cluster, e.g. the absolute frequency of a given term will be higher in "Building materials" since it contains more patents than in other clusters.

Table A.1 – Most recurrent terms in European patent clusters represented as word clouds

Building materials

Structural elements

Finishing elements

Green Construction

Hydraulic engineering

Construction site

Streets Construction

Railways Construction

Digital solutions

Bridges Construction

Additive manufacturing

Robotics in Construction

Annex 2: Key stakeholders consulted

The following table lists all the stakeholders which were met during the project, either during the focus group discussion or bilateral online interviews with Armenian representatives.

NO.	ORGANISATION (alphabetical order)
1	The National Center for Professional Education Quality Assurance Foundation (ANQA)
2	Aquatus
3	ARMSTAT
4	Avan Hills
5	Business and Education Partnership Foundation
6	College of Architecture and Construction of the National University of Architecture and Construction of Armenia (NUACA)
7	Energy Advisory LLC
8	European University
9	FastTransport
10	HALDI Consult LLC
11	Jrtuk LLC	Engineering-consulting services
12	Knauf Armenia LLC
13	Mavent Fasade Systems LLC
14	M-Group LLC
15	Ministry of Economy of the Republic of Armenia
16	Ministry of Education, Science, Culture and Sport of the Republic of Armenia (MoESCS)
17	Ministry of Labour and Social Affairs of the Republic of Armenia (MoLSA)
18	National Center for Vocational Education and Training Development
19	National University of Architecture and Construction of Armenia (NUACA)

20	Refrigeration, Air Conditioning and Heating Engineering Association of Armenia
21	Republican Union of Employers of Armenia (RUEA)
22	Shincertificate LLC
23	Union of Builders of Armenia
24	Urban Development Committee of the Republic of Armenia

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Annex 3: Glossary

Additive manufacturing	The construction of a three-dimensional object from a CAD model or a digital 3D model. It can be done in a variety of processes in which material is deposited, joined or solidified under computer control.
Anti-seismic design/ construction	Earthquake-resistant or aseismic structures are designed to protect buildings to some or greater extent from earthquakes.
API	Application Programming Interface (API), a computing interface that defines and allows interactions between multiple software without the need for human intervention
Artificial Intelligence	A general term used to describe a variety of technologies and approaches that allow computers to solve complex tasks (usually associated with higher cognitive levels), for example: recognition of objects or patterns; classification of entities; simulation and modelling of situations; predictions of future behaviours; generation of constructs similar to existing ones
BIM (Building-Information Modelling)	A shared digital representation of a built asset to facilitate design, construction and operation processes to form a reliable basis for decisions during its life-cycle, including planning, design, construction, operation, maintenance, and demolition phase (ISO 19650-1:2018).
Building safety	Provision about the safety of people in or about buildings and the standard of buildings.
Cognitive bias	A systematic pattern of deviation from norm or rationality in judgment. Cognitive biases are considered by many authors as linked to the normal functioning of the human brain and thus can arise in any activity involving human judgement
Competence	Means "the proven ability to use knowledge, skills and personal, social and/or methodological abilities, in work or study situations and in professional and personal development" (European Qualifications Framework). While sometimes used as synonyms, the terms skill and competence can be distinguished according to their scope. The term skill refers typically to the use of methods or instruments in a particular setting and in relation to defined tasks. The term competence is broader and refers typically to the ability of a person – facing new situations and unforeseen challenges – to use and apply knowledge and skills in an independent and self-directed way
Cross-laminated timber	Cross-laminated timber (CLT) is a wood panel product created from gluing together layers of solid-sawn lumber, i.e., lumber cut from a single log.
Cross-sectoral	(knowledge, skills or competences) – is one of the four levels of skills reusability identified by the ESCO initiative, whereby reusability it is meant how widely a knowledge, skills or competence concept can be applied in different working contexts. Cross-sector knowledge is relevant to occupations across several economic sectors, whereas sector-specific or occupation-specific knowledge is restricted to one specific sector or occupation. See also Transversal knowledge.

Cross-sectoral technology	Adopting the concept of cross-sectorality from ESCO's skills reusability levels, the term indicates a technology that finds application in many different economic sectors (e.g., Control unit or sensors)
ESCO	The European multilingual classification of Skills, Competences and Occupations. ESCO works as a dictionary, describing, identifying and classifying professional occupations, skills, and qualifications relevant for the EU labour market and education and training, in a format that can be understood by electronic systems. It lists over 3000 occupations and 13.000 skills and competences). For more info, see https://ec.europa.eu/esco/portal/home
Green buildings	Green building refers to both a structure and a building process that are environmentally responsible and resource-efficient throughout a building's life cycle.
Green skills	The knowledge, abilities, values and attitudes needed to live in, develop and support a sustainable and resource-efficient society.
IoT (Internet of Things)	The interconnection via the internet of computing devices embedded in everyday objects, enabling them to send and receive data.
IoS (Internet of Services)	Everything needed to use software applications are available as a service on the Internet, including the software, the tools to develop the software, and the platform.
ISCO	International Standard Classification of Occupations and is an International Labour Organisation (ILO) classification structure for organising information on labour and jobs. It is part of the international family of economic and social classifications of the United Nations. It contains around 7000 detailed jobs, organised in a four-level hierarchy that allows all jobs in the world to be classified into groups, from 436 lower-level groups up to 10 major groups
Job	A set of tasks and duties performed, or meant to be performed, by one person (ISCO-08)
Job profile	The description of a particular work function, developed by the employer or by the HR department of a company, that includes all the elements deemed necessary to perform the corresponding **job**. In particular, it includes general tasks, duties and responsibilities, required **qualifications**, **competences** and **skills** needed by the person in the job
Job title	Identifying label given by the employer to a specific job, usually when looking for new candidates to the position. In the absence of standardised nomenclature, it can coincide with either a description of the **job**, or the **occupation** group the job belongs too
Knowledge	The outcome of the assimilation of information through learning. It is the body of facts, principles, theories, and practices that is related to a field of work or study.

Light gauge steel/ frames	A construction technology using cold-formed steel as the construction material. It can be used for roof systems, floor systems, wall systems, roof panels, decks, or the entire buildings.
Modular construction	Modular construction is a process in which a building is constructed off-site, under controlled plant conditions, using the same materials and designing to the universal codes and standards as conventionally built facilities but in a much quicker timeframe. Buildings are produced in "modules" and then put together on site.
NACE	A four-digit classification providing the framework for collecting and presenting a large range of statistical data according to economic activity in the fields of economic statistics, provided by Eurostat. Economic activities are divided into 10 or 11 categories at high-level aggregation, while they are divided into 38 categories at intermediate aggregation
NDCs (Nationally Determined Contributions)	A nationally determined contribution or intended nationally determined contribution is a non-binding national plan highlighting climate change mitigation, including climate-related targets for greenhouse gas emission reductions.
Natural Language Processing (NLP)	An interdisciplinary field at the intersection of linguistics, computer science, information engineering. NLP deals with the interactions between computers and human (natural) languages, in particular how to program computers to process and analyse large amounts of natural language data, starting from the identification of the grammatical and logical parts of speech within a sentence, up to the complex representation of semantic relationships between words
Nice Classification	The Nice Classification (NCL), established by the Nice Agreement in 1957, is an international classification of goods and services for the purposes of registering trademarks and service marks. In the case of goods, 34 classes exist to register trademarks for certain goods. These classes range from Class N° 1 to Class N° 34. For services, there are 11 classes ranging from Class N° 35 to Class N° 45. Internationally, the Nice International Classification System makes a trademark easy to recognize, categorize and register among all signatory countries. It helps businesses to identify the nature of the related good or service and seek adequate intellectual property protection. A new edition is published every five years and since 2013 a new version of each edition is published annually.
Occupation	According to ESCO, an occupation is "a grouping of jobs involving similar tasks, and which require a similar **skill** set." Occupations should not be confused with **jobs** or **job titles**. While a job is bound to a specific work context and executed by one person, occupations group jobs by common characteristics (for example, being the "project manager for the development of the ventilation system of the Superfly 900 aircraft" is a job. "Project manager," "aircraft engine specialist" or "heating, ventilation, air conditioning engineer" could be occupations, i.e., groups of jobs, to which this job belongs)
Occupational profile	An explanation of the **occupation** in the form of: description, scope, definition, and list of the knowledge, **skills** and **competences** considered relevant for it. Each occupation in the **ESCO** database also comes with an occupational profile that further distinguishes between essential and optional knowledge, skills and competences
Profession	An **occupation** requiring a set of specific **skills** and dedicated training

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Qualification	The "formal outcome of an assessment and validation process which is obtained when a competent body determines that an individual has achieved learning outcomes to given standards" (European Qualifications Framework)
Regulated profession	A profession is called regulated if its access, scope of practice, or title is regulated by law
Semantic matching	A technique used in computer science to identify information which is semantically related
Semantic algorithm software	Semantic search is a data searching technique through a software, which a search query aims to not only find keywords, but to determine the intent and contextual meaning of the words a person is using for search.
Skill	"the ability to apply knowledge and use know-how to complete tasks and solve problems" (European Qualifications Framework). They can be described as cognitive (involving the use of logical, intuitive and creative thinking) or practical (involving manual dexterity and the use of methods, materials, tools and instruments). While sometimes used as synonyms, the terms skill and **competence** can be distinguished according to their scope. The term skill refers typically to the use of methods or instruments in a particular setting and in relation to defined tasks. The term competence is broader and refers typically to the ability of a person – facing new situations and unforeseen challenges – to use and apply knowledge and skills in an independent and self-directed way
Soft skills	Usually associated with **transversal skills**, and considered the cornerstone for personal development, also within the context of labour and employment. To distinguish them from other knowledge-based basic skills, they are often referred to as social or emotional skills. They can be further classified into personal skills (e.g., problem-solving, adaptability) or interpersonal ones (e.g., teamwork, leadership)
Smart building	A smart building uses technology to enable efficient and economical use of resources, for a safe and comfortable environment for occupants. Smart buildings may use a wide range of existing technologies and are designed or retrofitted in a way that allows for the integration of future technological developments. Internet of Things (IoT) sensors, building management systems, artificial intelligence (AI), and augmented reality are amongst some of the mechanisms and robotics that may be used in a smart building to control and optimise performance.
Smart personal protection equipment	Smart PPE combines traditional means of protection with improved materials or electronic components, and it may collect data on the user, the work environment or its own use.
Text Mining	A general term indicating a variety of techniques that allow computers to extract, discover or organise relevant information from large collections of different written resources (such as websites, books, articles). The first part of any text-mining process implies the transformation of texts in structured representations useful for subsequent analysis through the use of **Natural Language Processing** tools. Sometimes **Artificial Intelligence** techniques are used to perform Text-Mining tasks more effectively

Trademark	A symbol, word, or words legally registered or established by use as representing a company or product. It can be both for goods and services. See the definition of 'Nice classification' on the registry of trademarks, which is overseen by the WIPO, World Intellectual property Organisation.
Transversal (knowledge, skills or competences)	The highest of the four levels of **skills** reusability identified by the **ESCO** initiative, whereby reusability it is meant how widely a knowledge, skills or competence concept can be applied in different working contexts. Transversal skills are relevant to a broad range of **occupations** and sectors. They are often referred to as *core skills*, *basic skills* or *soft skills*, the cornerstone for the personal development of a person. Transversal knowledge, skills and competences are the building blocks for the development of the "hard" skills and competences required to succeed in the labour market.
Transversal technology	adopting the concept of **transversality** from **ESCO**'s **skills** reusability levels, a transversal technology is relevant to a broad range of **occupations** and sectors and is a building block for more specific technologies (e.g., computerised image analysis)
Virtual Reality (VR) vs Augmented Reality (AR)	Augmented reality (AR) augments your surroundings by adding digital elements to a live view, often by using the camera on a smartphone. Virtual reality (VR) is a completely immersive experience that replaces a real-life environment with a simulated one.
WIPO	World Intellectual Property Organisation. It is one of the specialised agencies of the United Nations, created in 1967 with the aim of encouraging creative activity and promoting the protection of intellectual property in the world. It provides intellectual property services that encourage individuals and businesses to innovate and create. The WIPO IP portal is a one-stop shop for global IP services from patents, trademarks, industrial designs to geographical indications, dispute resolution and domain names.

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