RCMOS - Multidisciplinary Scientific Journal of Knowledge.
ISSN: 2675-9128. São Paulo-SP.

Year IV, v.1 2024. | submission: November 14, 2024 | accepted: November 16, 2024 | publication: November 18, 2024

Innovation in Construction Processes: Challenges for Qualifying Young People in Civil Construction

Innovation in Construction Processes: Challenges for the Qualification of Young People in Civil Construction

Author: Yudi Hayashi

Graduated in Building from the National Industrial Training Service.

Summary:

This article analyzes the impacts of technological innovation on construction processes and the challenges faced in training young people for the construction sector. The modernization of the sector requires a new approach to professional training, focused on technical and digital skills that align with Industry 4.0 trends. The research is based on a literature review and secondary data from institutions such as IBGE, SENAI, CBIC, and CNI, proposing a critical reflection on the role of technical education institutions and the transformative potential of youth when connected to innovation. Finally, the article argues for the importance of integrated policies that bring together education, technology, and the labor market in building a more sustainable, productive, and inclusive future.

Keywords:

Civil Construction. Technological Innovation. Youth. Professional Qualification. SENAI.

Abstract:

This article analyzes the impact of technological innovation on construction processes and the challenges involved in qualifying young people for the civil construction sector. The modernization of the industry requires a new approach to professional training, focused on technical and digital skills aligned with Industry 4.0 trends. The research is based on bibliographic review and secondary data from institutions such as IBGE, SENAI, CBIC, and CNI, offering a critical reflection on the role of technical education institutions and the transformative potential of youth when connected to innovation. Ultimately, the article advocates integrated policies that bring education, technology, and the labor market closer together to build a more sustainable, productive, and inclusive future.

Keywords:
Civil Construction. Technological Innovation. Youth. Professional Qualification. SENAI.

RCMOS – Multidisciplinary Scientific Journal of Knowledge.
ISSN: 2675-9128. São Paulo-SP.

1. Overview of Civil Construction in the 21st Century

The construction industry is traditionally recognized as one of the most important sectors for the economic and social development of any country. In Brazil, according to data from the Brazilian Institute of Geography and Statistics (IBGE, 2022), the sector accounts for approximately 6.5% of the Gross Domestic Product (GDP), employing millions of workers nationwide.
Furthermore, the construction supply chain is interconnected with other industrial and service segments, such as transportation, energy, technology, and education. However, the 21st century has brought about a series of structural transformations that have radically altered the way projects are planned, executed, and managed. Notable among these changes are the increasing digitalization of processes, the pursuit of sustainability, and the emergence of new forms of collaborative work.

The integration of technology into the construction industry has accelerated over the past two decades, especially with the introduction of tools like BIM (Building Information Modeling), which enables complete digital planning of a project, from design to operation. This innovation directly impacts costs, deadlines, and the quality of buildings, requiring a change in mindset among professionals in the sector. Furthermore, the use of drones for terrain mapping, 3D printers for structures, and robots for performing specific tasks points to the gradual automation of previously exclusively manual functions. As a result, there is a growing appreciation for technical and digital skills, and the traditional manual laborer figure is giving way to a more qualified and multidisciplinary professional.

Another factor that marks this new panorama is the pressure for more sustainable constructions. Environmental standards, such as Caixa's Casa Azul Seal and international LEED and AQUA certifications, require that projects minimize environmental impacts, optimize natural resources, and promote energy efficiency. This implies the adoption of smarter materials, water and waste reuse techniques, and careful energy management. These requirements increase the need for specialized and ongoing training, as professionals must master both technical concepts and sustainability principles, given that the sector is responsible for more than 50% of urban solid waste generation (ABRECON, 2021).

In this new scenario, innovation is no longer an option, but a market requirement.
Companies that invest in modern construction processes experience greater competitiveness, safety, and quality in their deliveries. However, the challenge lies in ensuring that the workforce keeps pace with this trend. The National Confederation of Industry (CNI, 2023) identifies the shortage of professionals trained to handle these technologies as one of the main bottlenecks in the Brazilian construction industry. This mismatch between technology and qualifications exposes a structural gap between education and work, especially among young people seeking their first job.

Brazilian youth currently face a challenging scenario. Data from the International Labor Organization (ILO, 2022) indicate that unemployment among young people aged 18 to 24 in Brazil exceeds 25%, a figure considerably higher than the national average. At the same time,

The construction sector has unfilled vacancies due to a lack of qualified labor.
This contradiction reveals a strategic opportunity: training young people to fill these positions with technical expertise and an innovative vision. To achieve this, it's necessary to coordinate vocational education, public policies, and the productive sector, building bridges between youth and new construction processes.

Therefore, the construction industry landscape in the 21st century is marked by a paradox: while technological innovation advances and demands new professional profiles, millions of young people remain excluded from the market due to a lack of qualifications. Overcoming this challenge requires not only revamping curricula but also transforming the way Brazilian society understands vocational training and the role of youth in rebuilding a more modern and inclusive country.

2. Technological Innovations in Construction Processes

One of the main characteristics of digital transformation in the construction industry is the application of technologies that increase productivity, reduce waste, and ensure greater precision and safety on projects. Among the most impactful innovations is the use of BIM (Building Information Modeling), which allows for the integration of all project stages into a three-dimensional digital model. This methodology reduces errors, facilitates planning, and enables real-time monitoring, optimizing time and resources. According to a McKinsey & Company (2020) report, companies that adopted BIM reported a reduction of up to 20% in construction costs and a 30% reduction in turnaround time.

In addition to BIM, other technologies are being incorporated into construction projects, such as drones, which assist in aerial terrain mapping and monitoring large construction sites, increasing safety and efficiency. Automated robots are also gaining ground, especially in repetitive and precision tasks such as block laying and welding.
3D printers are being successfully tested in the construction of entire structures, with significant gains in agility and sustainability. These innovations directly challenge the traditional construction model, based on intensive manual labor, and require a technically trained workforce.

The Internet of Things (IoT) and artificial intelligence (AI) are also transforming construction sites into smart environments, where sensors monitor temperature, humidity, vibrations, and other factors relevant to safety and performance. These technologies enable preventive interventions, minimize accidents, and facilitate predictive maintenance. Modular construction and prefabrication are also on the rise, promoting logistical efficiency and reducing environmental impacts. These changes significantly reduce rework, one of the main causes of delays and increased costs in traditional construction projects, according to SENAI (2022).

These technological advances, while promising, also reveal a significant challenge: qualifying the workforce to keep up with this new reality. A large portion of construction professionals are still trained using conventional methods, with little or no familiarity with digital tools. This exacerbates the exclusion of segments of the population— especially low-income young people — who do not have access to up-to-date technological training. As research by the Votorantim Institute (2021) points out, the biggest barrier to technological adoption in small and medium-sized companies in the sector is precisely the shortage of professionals prepared to operate them.

This is where the role of technical training institutions becomes crucial. The National Industrial Training Service (SENAI), for example, has developed specific programs for Civil Construction 4.0, focusing on automation, digital project reading, and sustainability. These courses, geared especially toward young people, have shown significant results in the employability and performance of graduates. The combination of theory, practice, and technologies applied to the daily workload of construction sites is a differentiator that can reverse the current scenario of exclusion and professional gaps.

Therefore, technological innovations in construction processes are irreversible and necessary. However, its transformative potential will only be fully realized if there is consistent investment in the technical training of Brazilian youth. The link between technology and inclusion needs to be strengthened for the construction industry to continue being a driver of growth. not only economic, but also social.

3. Youth and Interest in Civil Construction

Despite the importance of construction to the country, the sector faces increasing difficulty in attracting young people to its activities. Part of this lack of interest is related to the profession's social image, which is still largely associated with hard labor, informality, and precarious employment. Many young people, when planning their professional future, end up opting for more "modern" sectors or those that offer more technological work environments. In this context, construction needs to rebuild its image among young people, positioning itself as a field of innovation, continuous learning, and professional growth.

Furthermore, the lack of policies to encourage technical training in the construction industry contributes to the disengagement of young people from the sector. Although there are specific initiatives—such as industrial apprenticeship programs and vocational training courses—they are insufficient to meet demand or compete with other areas that are more highly publicized in the media and social networks. The construction industry still suffers from a lack of effective communication strategies that connect with young people and present the sector as an environment for transformation, creativity, and professional fulfillment.

The COVID-19 pandemic further exacerbated this situation, creating a physical and symbolic distance between young people and the job market. Many interrupted their technical studies and lost opportunities for professional advancement. In contrast, the construction sector was one of the fastest to recover after the health crisis, demonstrating its resilience and ability to absorb skilled labor. For this recovery to be inclusive, it is necessary to develop programs that purposefully reconnect young people to the sector, focusing on innovation, sustainability, and career stability.

According to a study by the Roberto Marinho Foundation (2022), 78% of young people interviewed said they would like to work in sectors that promote some kind of positive social or environmental impact. This represents a significant opportunity for the construction industry, provided it can link its operations to values such as sustainability, inclusive urbanism, and green technology. Programs such as "Escola de Fábrica" and "Mundo SENAI" are positive examples in this regard, as they combine technical training, youth leadership, and real-world market experience.

Another factor to consider is the transformative potential of the construction industry in vulnerable areas. By training young people from peripheral communities, the sector contributes not only to job creation but also to citizenship, self-esteem, and local development. As Cardoso and Rodrigues (2021) state, the construction industry plays a strategic role in developing autonomous individuals and agents of urban and social transformation. This perspective needs to be reinforced in public policies and institutional discourses, so that young people see the sector as more than a job—a path to life.

Therefore, the challenge is not only to train young people, but also to inspire them. The construction industry needs to better communicate with young people, offer attractive training paths, and establish connections with the values and expectations of new generations. Only then will it be possible to bridge the gap between a generation full of potential and a sector thirsty for innovation and transformative energy.

4. The Role of SENAI and Technical Education Institutions

The National Industrial Training Service (SENAI) has established itself as one of the most important institutions for technical training in Brazil, especially when it comes to training young people for the construction sector. Founded in 1942, SENAI works to provide professional training, promote innovation, and disseminate new technologies, and is responsible for over 70% of technical training for the national industry (SENAI, 2023). Its comprehensive scope provides access to practical, modern courses aligned with market demands, playing a strategic role in building a more prepared and competitive workforce.

SENAI's work in the construction industry has been particularly important in promoting the integration of technological innovation and professional training. Its

Buildings, civil construction technician, BIM, 3D modeling, digital blueprint reading, and more have attracted young people interested in entering the job market with technical skills. These courses are structured to offer theoretical and practical knowledge, with access to modern laboratories, partnerships with companies, and the opportunity to learn in simulated construction environments. Furthermore, industrial apprenticeship programs encourage the entry of adolescents and young people into the world of work, focusing on values such as ethics, responsibility, and safety.

Another relevant point is SENAI's work in low-income communities and regions with greater social vulnerability. Through mobile units and partnerships with local governments, the institution brings quality training to places where regular technical courses would be difficult to find. This contributes to the democratization of knowledge and the social inclusion of youth, reducing historical inequalities in access to professional qualifications. As the Industry Observatory (CNI, 2022) report points out, young SENAI graduates are 70% more likely to obtain formal employment within one year of completing their course.

In addition to SENAI, other institutions such as Federal Institutes, the S System (SESI, SENAC), and civil society organizations also play a fundamental role in professional qualifications. Federal Institutes, for example, have an integrated pedagogical approach that combines secondary and technical education, promoting critical thinking, innovation, and student empowerment. NGOs that provide job training, such as Fundação Gol de Letra and Instituto Ethos, promote employability based on values such as citizenship, equity, and sustainability, complementing technical training with personal development.

However, even with successful initiatives, the number of vacancies offered still falls far short of meeting the demand of young people seeking technical training in the construction industry. The country still lacks a coordinated national vocational education policy that integrates the actions of these institutions with urban development plans and Industry 4.0 goals.
Coordination between companies, technical schools, and municipal, state, and federal governments is essential for the expansion and continuity of these programs. Without this connection, there is a risk of maintaining the current fragmentation, in which technical training does not align with real market demands.

Therefore, the role of SENAI and other technical education institutions is vital to the future of civil construction in Brazil. They serve as bridges between youth and the job market, between tradition and innovation, between potential and achievement. Investing in them is investing in social and economic development, in inclusion, and in a country better prepared for the challenges of the present and the future.

5. Challenges for Qualifying Young People in the Face of New Technological Demands

Despite the advances promoted by institutions like SENAI, the challenges for training young people in the construction industry remain numerous and complex. One of the main obstacles is the gap between the content taught and the technologies used on modern construction sites. Many courses still maintain an overly traditional approach, with little focus on the innovations that are already part of the daily routine of Construction 4.0. This gap compromises the employability of young people, who, upon completing their training, often lack the knowledge required by companies.

Another significant challenge is unequal access to quality technical education. Young people from urban outskirts and rural areas face transportation difficulties, a lack of school infrastructure, and often the need to enter the informal market early to supplement their family income. This compromises these students' retention and performance in technical courses, in addition to reducing their chances of entering formal, skilled jobs. Data from the IBGE (2023) show that less than 10% of young Brazilians between the ages of 15 and 24 attend vocational education courses, a percentage even lower than in neighboring countries such as Chile and Uruguay.

The lack of teachers up-to-date on new technologies is another critical issue. Many teachers struggle to adapt to the rapid pace of innovation and lack ongoing access to technological refresher training. This compromises teaching quality and student motivation, in addition to creating a gap between theory and practice. Ongoing teacher training programs and incentives for pedagogical innovation are essential measures to address this issue. The appreciation of technical educators must be accompanied by public policies that invest in infrastructure, curriculum updates, and equipment.

Brazilian educational culture also presents specific challenges. The emphasis on higher education over technical training is still prevalent in society and among families. Many young people end up forgoing technical courses because they believe they are "inferior" or less prestigious. This outdated view needs to be countered with campaigns promoting vocational education and by disseminating success stories of young people who have found a promising path in the construction industry. The role of basic education in this process is essential, presenting technical training options from an early age as legitimate and transformative alternatives.

Another relevant aspect is the rapid obsolescence of technologies. What is considered innovative today can become outdated in just a few years. This requires a lifelong learning approach, with ongoing refresher training opportunities for workers. Retraining programs, modular certifications, and blended learning are tools that can make technical training more flexible and aligned with the sector's constant transformations. SENAI, for example, has already been investing in microcertifications and short courses focused on technological refresher training, with positive adoption and market impact.

Given these challenges, it's clear that training young people for the construction industry cannot be addressed in isolation. It's a cross-cutting public policy that must encompass sectors such as education, labor, economic development, urban planning, and social inclusion.
Only with coordinated actions and continuous investments will it be possible to ensure that young people have not only access, but also permanence and success in their professional careers in the construction sector.

7. Conclusion: Building the Future with Technology and Youth

The Brazilian construction industry is undergoing a period of profound transformation. The incorporation of advanced technologies, such as BIM, drones, automation, and artificial intelligence, is reshaping the way buildings, cities, and infrastructure are constructed. In this new scenario, it is urgent to understand that the future of the sector depends, to a large extent, on the ability to train a new generation of skilled workers with technical expertise, social sensitivity, and a critical view of the role of construction in the country's sustainable development.

Youth, in turn, represent immense transformative potential. In a country where more than 20 million young people between the ages of 15 and 29 neither study nor work formally (IBGE, 2023), investing in technical training is a strategy not only for productive inclusion but also for human development. Young people who receive concrete training opportunities become agents of change in their communities, contributing to reducing inequality and building more equitable, efficient, and livable cities.

Technical education institutions, especially SENAI, play a crucial role in this process. They serve as bridges between youth and innovation, between theory and practice, and between the present and future of civil construction. Through updated curricula, participatory methodologies, and partnerships with the manufacturing sector, these institutions have demonstrated that it is possible to train professionals ready to face the technological and environmental challenges of the 21st century without compromising the ethical and social dimensions of work.

However, the challenges remain significant. Fragmented public policies, underinvestment, historical bias against vocational education, and unequal access to technology hinder the advancement of universal, high-quality technical training. Low-income youth, women, and residents of peripheral regions continue to be the most affected by this reality. Overcoming these barriers requires political commitment, strategic planning, and coordinated action among governments, businesses, educational institutions, and civil society.

Transforming the construction industry into a more inclusive and innovative sector also involves valuing technical culture and promoting narratives that bring young people closer to engineering, architecture, sustainability, and innovation. Young people need to feel part of a sector undergoing transformation, to see construction projects as not just bricks and mortar, but also opportunities for creativity, intelligence, impact, and leadership. This requires

modern communication strategies, digital learning platforms and spaces for active listening for young people.

Furthermore, the rapid pace of technological transformations imposes the need for ongoing education. Initial training is not enough. Continuous development paths must be created, focusing on digital skills, logical reasoning, problem-solving, and collaborative work. The model of microcertifications, hybrid courses, and partnerships with innovation hubs has already been successfully tested by institutions like SENAI and should be expanded, democratized, and integrated into public employment and income policies.

Ultimately, innovating in the construction industry also means innovating how we educate citizens. Brazilian youth, when connected to real training and employment opportunities, are capable of driving the sector to new heights of productivity, sustainability, and social justice. Therefore, considering youth training within the context of Construction 4.0 is not just a market demand—it's a commitment to Brazil's future.

Thus, it can be concluded that innovation in construction processes must be accompanied by a profound transformation in the way technical training is structured in the country. Civil construction, when combined with education and social inclusion, becomes more than an economic sector—becomes an instrument of citizenship, autonomy, and progress. Investing in young people, therefore, means building not just buildings, but more just, intelligent, and resilient societies.

8. References

BRAZILIAN ASSOCIATION FOR RECYCLING CONSTRUCTION AND DEMOLITION WASTE – ABRECON. *Overview of Construction and Demolition Waste in Brazil – 2021.* Sao Paulo, 2021.

CARDOSO, Luiz Felipe; RODRIGUES, Camila. *Professional education and citizenship construction: youth experiences in urban communities.* Brazilian Journal of Professional and Technological Education, Brasília, v. 14, n. 2, p. 45-59, 2021.

CNI – NATIONAL CONFEDERATION OF INDUSTRY. *Industry Observatory: Annual Report 2022.* Brasília: CNI, 2022.

CNI – NATIONAL CONFEDERATION OF INDUSTRY. *Technical Report on Qualification and Labor Market in Civil Construction.* Brasília, 2023.

ROBERTO MARINHO FOUNDATION. *Youth and the Future of Work: Expectations and Perceptions.* Rio de Janeiro, 2022.

IBGE – BRAZILIAN INSTITUTE OF GEOGRAPHY AND STATISTICS. *Synthesis of Social Indicators 2022: An analysis of the living conditions of the Brazilian population.* Rio de Janeiro: IBGE, 2023.

VOTORANTIM INSTITUTE. *Training and Professional Development in Civil Construction.* São Paulo, 2021.

McKINSEY & COMPANY. *Reinventing Construction: A Route to Higher Productivity.* New York, 2020.

ILO – INTERNATIONAL LABOUR ORGANIZATION. *Global Youth Employment Trends 2022.* Geneva: ILO, 2022.

SENAI – NATIONAL INDUSTRIAL LEARNING SERVICE. *Professional Education in Industry 4.0: Technical Report.* Brasília: SENAI, 2023.