



Comisión
Nacional de
**Evaluación y
Productividad**

EXECUTIVE SUMMARY

Productivity in the Construction Sector

2020

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The construction sector represents about 7% of GDP, employs about 10% of the country's workers, and has the highest growth rates in the number of companies and workers. Globally, construction is considered a critical economic sector, with over 10 trillion dollars spent annually on goods and services delivered by the industry. However, its social benefits are its most significant effects, for example, through housing solutions for families or due to infrastructure that connects countries and allow long-term economic growth.

The Construye 2025 program, the 30/30 Plan, the Santiago Transportation Master Plan to 2025, the 2021 Infrastructure and Water Resources Plans, and the 2020-2050 National Infrastructure and Mobility Plan are part of the government's programs and measures to boost growth and citizens' well-being. The most recent initiative, Plan Paso a Paso Chile se Recupera, aimed at reactivating the economy from 2020 to 2022 (in the pandemic context) through a USD 34,000 million investment.¹ This plan's magnitude reflects the will to energize and strengthen the sector. However, it is necessary to consider the capacity of the State to process the large number of projects involved if these investments are to contribute to greater social well-being.

Critical indicators regarding the execution of works, such as the degree of compliance with planned deadlines and costs, reflect the capacity mentioned above. Inefficiencies around the development of construction works need to be revised. Chile outstands among OECD countries as the one that takes the longest to award a public contract, with some cases (road works) being as long as 15 months, as opposed to South Korea, which takes five months. The World Economic Forum has indicated that Chile should focus, among other aspects, on deepening its teaching curriculum and investing in innovations and sustainability, to improve its global competitiveness. In addition, the OECD (2017) points out that the most significant weakness identified in the country -concerning infrastructure- is the need for more medium and long-term infrastructure planning and that public entities need integration and alignment, features that reflect institutional problems. The sector's productivity could be more active and sustainable, depending on the indicator analyzed. Various entities mirror these diagnoses nationally, including the General Government Internal Audit

¹ See: <https://www.gob.cl/chileserecupera/inversion/>

Council (2018), the General Comptroller of the Republic (2016), and the executing services. These reflect relevant problems at all stages of the construction works development process, such as flaws in the design and operation of contracting works, regulatory non-compliance, and irregular contract modifications.

In this context, in October 2019, the President of the Republic mandated the National Productivity Commission to determine and analyze the main obstacles to productivity in the sector and to propose a roadmap with measures to overcome these obstacles.

This study results from public-private collaboration: Matrix Consulting² has played a crucial role in gathering information for this study. At the request of the Chilean Chamber of Construction, Matrix collaborated with various construction companies, both within Chile and internationally, to gather and organize data concerning their high-rise construction and infrastructure projects. This collaboration adds significant value to the study, offering detailed evidence and emphasizing the importance of public-private partnerships in shaping public policy proposals.

The study and its findings

The construction sector has profound productivity problems. Some may be due to inevitable and undesired regulation consequences (poor State action), and others are attributable to the private sector and its inertia. This study focuses on the former, for their solution is within reach of public policies.

This report's mandate required the identification of the main factors that affect the optimal development of construction works. We conducted over 400 interviews and workshops between October 2019 and August 2020 with public, private, national, and foreign actors. Additionally, and in alliance with Matrix Consulting, we reviewed and analyzed all public databases related to the development of construction works,³ which were the basis for the work's methodology. Overall, the evidence incorporates 98 construction works throughout Chile (belonging to 25 companies)

² Private consulting firm that had previously contributed to the development of the Productivity Study in the Large Copper Mining, commissioned by President Bachelet to the National Productivity Commission.

³ We highlight the statistical database of over 27,000 public infrastructure projects available in the BIP of the MDSF.

and 40 works outside the country (from 40 companies), which allowed for the generation of a national and international productivity benchmark. Thus, this study plays a crucial role in discussing public policies and private strategies to improve the productivity of a relevant sector in the Chilean economy.

The low availability and information systematization on public projects were relevant in the study's context, constituting a challenge for data collection. On the private sector's side, the problem was similar since productivity indicators such as constructed area per person-day or added value per worker are not frequently measured. The data necessary to build indicators are usually dispersed in companies and rarely structured. The same is true for road works utilization data, essential for measuring efficiency in the use of capital. In short, this is this report's first relevant finding since the traceability, monitoring, and evaluation of past project experiences is one of the critical inputs for the design and subsequent implementation and evaluation of public policies.

Regardless of the indicator used, the country's construction sector's productivity is lower than the OECD average and the rest of the Chilean economy. First, the construction productivity gap between Chile and the OECD benchmark average increased by 20% during 2009-2018, from 43 percentage points (pp) to 52 pp. Benchmark productivity is more than double that of the benchmark. Second, the construction productivity in Chile is lower than that of most other sectors, equivalent to 80% of the economy's average. Third, according to the Matrix benchmark,⁴ the national works present an average indicator of 0.24 m² person-day in construction. At the same time, the international sample averages 0.37 m² per person-day, that is, 53% higher. In other words, if an average building in Chile is 13 floors high, reaching the productivity level of reference countries could mean adding six floors and employing the same amount of people. Similarly, local road⁵ infrastructure works are less productive (be they private or public). When measuring productivity as value-added,⁶ the national jobs average USD 99 per person-day, while in the international sample; it is USD 317 per person-day, 220% higher.

⁴ The average height of the sample (buildings intended for housing with concrete as the predominant material) was 13 floors, with an average area of 16,000 square meters.

⁵ . This includes improvement, conservation, construction, replacement, and expansion works, with an average length of 12 kilometers and an average budget of CLP 9,370 million.

⁶ Valor agregado considera la utilidad del proyecto y el gasto en remuneraciones. Es medido en dólares y corregido por el poder de paridad de compra de cada país.

These measurements are consistent with a general efficiency deficit in our country⁷ and show the enormous potential for productivity gains in the construction industry. Closing this productivity gap concerning the rest of the Chilean economy would increase production by USD 4.5 billion, more than 20% of the sector's GDP today. Closing the productivity gap with the average productivity of other OECD countries would add about USD 13 billion more to the industry. In other words, it would increase its current GDP by 65%.

Additionally, the construction sector's productivity lags behind the evolution of the Chilean economy. During 2005-2018, the hourly productivity gap of construction in Chile concerning the economy increased by 13pp. The increase in the human capital gap favoring the economy was 9pp. Ultimately, the study identifies areas for improvement in all stages of project development. These include enhanced planning and explicit prioritization, improved design quality through standardized processes, early integration, and the adoption of standardized work methodologies. Additionally, there is a need for improvement in the adjudication of projects, regulation required for project development, effective works management, well-organized work processes, comprehensive worker training, and increased focus on sustainability in construction practices.

Planning and prioritization of public works

On average, significant public infrastructure works take more than three presidential terms to materialize, partly because of the need to plan and prioritize the works. Regarding the former, the National Investment System (SNI) processes most of the works (practically all large-scale works), fragmenting the development of most projects in at least a design and a construction stage. This has proven risky when considering significant latency times between stages, with an average lag of 2 years, which, in the last year, has increased to 3, with some extremes going up to 8 years. The study contrasts works (such as hospitals) that fragment these phases with construction works that do not. For the latter, the average cost is 12% lower and 140% faster.

The planning of the different authorities also lacks integration; that is, various entities exhibit different planning horizons between them and often lack decision criteria in cases as relevant as

⁷Informe Anual Comisión Nacional de Productividad 2016, 2017, 2018 y 2019

the work contract definition, for example, whether the execution of a hospital shall be via MINSAL, via MOP through the Department of Architecture, or via MOP through concessions. Significant variations in productivity and cost-efficiency exist among different modalities of hospital infrastructure development. in highly complex and medium complexity infrastructure. The evidence suggests a need for more planning in a significant proportion of works since close to 30% of the projects approved by MDSF in the SNI did not request resources from Dipres.

The non-existence of interoperability in the systems associated with the development of public investment -which involves more than US\$ 10 billion a year- makes it challenging to monitor planned projects and their evaluation once executed. Indeed, regarding project evaluation, since 2015, only about 20% of the annually completed initiatives have been analyzed, a sample that needs to be more representative. Likewise, concerning concessions, both the FNE and the World Bank have highlighted the lack of systematized information as a severe obstacle when surveying the performance of this type of contract.

Given the implementation of the Regionalization Strengthening Law, which grants new entities (GOREs) the authority to formulate their own projects, it is crucial to enhance project formulation and evaluation processes at the municipal level. Currently, these processes take at least 30% longer when conducted by a municipality compared to those managed by a ministry. Therefore, there is a pressing need to improve efficiency and streamline procedures at the local level to ensure timely and effective project implementation.

Role of pre-investment stages and deficiencies in design

Pre-feasibility and design activities lack the depth to, for example, estimate aspects such as capital cost, the work program, or the use of project maturity indicators. These stages are considered of minor importance since they represent 2-3% of the project's total cost, well below international practices (up to 10%). The prior stage of execution affects the work significantly -adaptations referred to in this stage account for up to 22% of the project's budget and represent 35% of the MOP modifications in a year. The international experience contemplates the incorporation of formative expertise at this stage, contrasting with the low importance given in Chile. In short, these shortcomings could translate, in comparative terms, into a greater frequency of projects with cost

overruns compared to benchmark countries (40pp gap) and delays exceeding the extensions of the international benchmark projects by 30pp.

Efficiency improvements in the awarding of public works to reduce process risk

The study uncovers problems in the public works contracts' design. These begin with the bidding process and the administrative bases. Over 60% of the explanatory circulars of the concessioned projects correct some administrative inaccuracies and need coordination regarding the timely inclusion of all the necessary background information to tender the work. Likewise, the bidding process shows uncertainties regarding the maximum times to bid on a project, doubling the original times. In addition, the question-and-answer system through which participants can clarify doubts needs to be revised since there are cases in which up to 76% of the answers refer to the same bases or regulations, leaving ample space to interpret the parts. Therefore, uncertainties arise for the State (regarding the programming of its projects) and the private sector (in projecting the presentation of offers).

Resolving disputes through the courts poses a complex scenario for the contractor. Traditional public works have no specialized conflict resolution mechanism, unlike the concession case - where there is a Technical Panel and an Arbitration Commission. This fact leads to extensive and costly legal proceedings between the parties, discouraging participation in these works (since the State wins 7 out of 10 cases) and making contracts more expensive. In the cases analyzed, 25% for Health Services and 30% for MOP terminated the contracts early, possibly triggering a need to re-bid said projects. Finally, there needs to be more competition in the tenders. Since 2016, the average number of bidders in the tenders analyzed⁸ has fallen by 53%.

Improving the regulatory framework would allow for more efficient project development with greater certainty.

There are fundamental institutional and regulatory⁹ problems relevant to the processing of authorizations and appropriate procedures of construction, which reflect efficiency issues

⁸ Average bidders for road conservation works over 5,000 UTM.

⁹ Further details and complementary regulations to those analyzed can be found in the "Regulatory Review in Strategic Sectors" report by the National Productivity Commission (2019).

(concerning delays and high opportunity costs), predictability (the uncertainty about the practical requirements of authorizations), and stability (on the possibility of removal of the authorization).

The shortcomings in efficiency and predictability are evident in the changes in services and expropriations related to public infrastructure works. Although changes in services occur infrequently, they are often associated with significant projects, accounting for over 70% of the investment in Serviu. However, there are practically no regulations to govern the requirements, conditions, and procedures for implementing these changes. This lack of regulation leaves ample room for discretion and gives negotiating advantages to service companies, which can take up to 9 months to provide the necessary information. Consequently, these delays can result in project time extensions of up to 25%.

Expropriations, which are associated with approximately 50% of the projects in terms of investment, are extensive and complex processes that can last over 20 months in practice. They encounter obstacles at every stage. Some delays (27%) may be due to errors in the expropriation design. Furthermore, deficiencies in the appraisal process have led to more than 200 working days of iterations due to the lack of technical requirements for experts and a standardized format for the appraisal reports. The budget execution mechanism also imposes restrictions, as the processing of the expropriation decree alone (1.5 months) results in a loss of two months per year.

Additionally, there is a lack of precise guidelines on how to process the agreement, leading to delays of up to 40 months. Inefficiencies within the courts also contribute to delays, with the State Defense Council's high administrative burden significantly prolonging the process. It is worth noting that more than 90% of the council's non-contentious cases are related to expropriations.

Unforeseen findings –usually archaeological- result in less predictability and efficiency in developing all types of works. There is uncertainty on how to define these types of finds, a non-existent georeferenced public cadastre that could guide the location of projects, and the lack of regulatory procedures to recover remains. Once the finding is notified, the process takes approximately five months, with additional work extending up to nine months until the authority

reaches a resolution. It is worth noting that Hospital Salvador experienced a significant delay of over two years in this process.¹⁰

The study identifies critical predictability problems regarding the Environmental Qualification Resolution (RCA) for residential building projects, representing 25% of the projects entered into the Environmental Impact Assessment System (SEIA). Additionally, inefficiencies were detected regarding the slow processing of the Strategic Environmental Assessments (EAE) (taking up to 2,000 days, with only a third of the EAE completed), which prospectively could exempt numerous projects from entering the SEIA. The lack of clarity surrounding the criteria for processing a real estate project through an Environmental Impact Statement (DIA) compared to the analogous process through an Environmental Impact Study (EIA) is a notable concern. In specific cases, approved DIAs have been subject to questioning based on claims of significant impacts on the human environment, without taking into account the presence of mitigation instruments associated with such consequences, such as the Environmental Assessment Study (EAE) or the Road Mitigation Reports (IMIV). Finally, there are no complete definitions regarding the areas placed under special protection since the regulations only refer to some. Considering there are at least eight protected areas not recognized by the Environmental Assessment Service (SEA), there is a relevant uncertainty for the State and the private sector. The authority has incorporated three zones based on particular contingencies.

Residential building projects also present obstacles concerning the permission to replace pavements and the building permit. As for the former, it takes over three months to obtain a provisional acceptance of the pavement, a required milestone for the approval of construction work. Regarding the building permit, there are stability problems since the project executors need to be sure of the validity of the authorization. Residential building projects also present obstacles regarding the permission to break and replace pavements and the building permit. Recent jurisprudence reveals that 49 granted permits have been questioned regarding, among other aspects, regulations (DDU 313) issued after granting 21 permits. Regardless of the questions' content, in 34 projects, the invalidation processes began after the mandatory regulatory time

¹⁰ See <https://www.minsal.cl/ministros-de-salud-y-de-obras-publicas-realizaron-visita-inspectiva-a-construccion-del-nuevo-hospital-del-salvador-e-instituto-nacional-de-geriatria/>

allowed for this, generating uncertainties. Furthermore, processing times of the causes mentioned above are two years and eight months on average, and in extreme cases, more than 5.5 years.

The State's management capacity regarding public infrastructure works can improve.

The management capacity of the State regarding construction works relies heavily on the fiscal inspector's (IF) performance and the fiscal inspection's advisors (AIF). IFs face a high burden regarding the multidisciplinary nature of their work, while in leading countries, tasks –project management and supervision- are distributed among more than one agent. Therefore IFs are exposed to greater scrutiny (around 1/3 of the administrative proceedings are associated with a fiscal inspector). Finally, despite the support of consultancies and advisors, there are potential quality problems in these, which are related to the lack of definitions regarding crucial elements such as the budget, shortcomings in their evaluation mechanisms, and the requirements for consultants.

Under the current regulation, the frequent, relevant modifications in public works contracts open up severe spaces for inefficiencies. The amendments are numerous, in both traditional public works and concessions: in the first case, 66% of the contracts between 2005 and 2018 faced some modification, and around 70% of the projects in the entire history of concessions. In both cases, the changes involved numerous transformations in terms (up to 44 % of modifications in traditional public works) and work budgets (up to 75% in concessions). In the first case, these modifications correspond to more than US\$ 1,000 million, equivalent to half of the hospital portfolio to be concessioned until 2023.

It is crucial to improve the modification processing to increase efficiency. In general, these take a long time (with times that have doubled in two years in the case of public works) and are associated with a significant amount of bureaucracy, generating greater uncertainty. Regarding the latter concern, there are uncertainties surrounding the classification and subsequent processing of changes. For instance, the Ministry of Public Works (MOP) and the General Comptroller's Office (CGR) have different criteria for determining whether a modification constitutes an increase or decrease of an existing item or an extraordinary work. In the case of concessions, when the total duration of the modification can be projected, the processing can take up to 20 months, which

includes the formalization of a Supreme Decree requiring even the signature of the President of the Republic. It is evident that improved information systematization is necessary as the available data have been calculated based on relevant public information under several assumptions, given the lack of internal or external traceability. Addressing these challenges will contribute to greater clarity and efficiency in the processing of changes and modifications in infrastructure projects.

Incorporating sustainability criteria in the industry has enormous potential to increase productivity and reduce emissions from the sector.

Chile has the lowest productivity level among OECD countries regarding resource use. The construction sector generates around 6.8 million tons of waste annually, of which 70% is dry waste. The preceding is relevant for the construction process and the operation of the works since the construction sector represents 31% of energy use in the country. The operation stage in construction accounts for 72% of CO₂ emissions.

Construction shows significant potential for a circular economy (given its intense use of materials, 40% globally). However, the waste information registry could be better since the Pollutant Emissions and Transfers Registry (RETC) reports only about 9.5% of non-hazardous waste. Additionally, there are not any registries of garbage generated by particular types of works, such as roads, and generally, there is no construction waste traceability. Likewise, the transport and final disposal of non-hazardous waste to landfills is relatively cheap for the construction company (\$10,500 per m³), so there are no significant incentives to analyze and process the waste. There is no obligation to value the garbage in Chile and consequently identify its recycling potential. Based on observations on the national benchmark, construction projects that generated a volume of debris below the average were 8% more productive compared to projects that generated a higher volume of debris. Those cases also exhibit a lower rate of accidents for every 100 workers (3.7 vs. 5.5, presumably due to cleaner on-site management, which avoids risky situations for workers.

Enhancing work organization at construction sites could lead to a more effective utilization of existing resources.

The study findings indicate that a mere 6% of companies utilize customized job-shift systems. Moreover, there are additional limitations on working hours imposed by municipal ordinances in

at least 25 communes, which restrict working times to 70% of the permissible daytime period due to noise regulations. Interestingly, the General Comptroller's Office (CGR) has highlighted that such restrictions are in violation of regulations (as seen in the Melipilla case). It is crucial to rectify these issues, especially considering that countries like Australia, Canada, and the United Kingdom have extended working hours to support economic recovery.

Construction is a sector where workers can significantly increase their job skills.

On average, the construction sector has workers with low labor skills. Over 60% of the workers are at the primary level regarding reading and/or numeric skills. 65% of the companies in the industry report difficulties filling vacancies due to the lack of skills and certification of applicants. Only 7% of the companies include Bipartite Training Committees, which are crucial in agreeing on and evaluating training instances. In particular, there is a lack of incentives to improve the employees' work, which worsened when considering that 60% have a temporary contract (per job or fixed term), which implies high turnover and, consequently, limits the investment in human capital.

Accelerating the adoption of BIM and industrialized construction arises as a response to problems of coordination, quality, cost overruns, and spare time.

Building Information Modeling (BIM) and industrialized construction (CI) methodologies have emerged in response to problems of coordination, quality, cost overruns, and spare time problems in other countries. They are at a nascent level of implementation in Chile. Referent countries have taken advantage of incorporating these methodologies and the technological leap to improve productivity. For example, in the Curicó Hospital case, the massive adoption of BIM could advance services valued at close to USD 260 million by the projected tender of at least 25 hospitals until 2022. On the other hand, the CI implementation in a quarter of the national works would allow the generation of 880,000m³ less construction waste annually.

Despite its advantages, there has yet to be a massive adoption of BIM and CI. The construction industry is very conventional and highly resistant to change. For example, it is one of the industries that invests the least in R&D (0.012% of the industry's GDP), making it difficult to abandon more

traditional methodologies. Additionally, it is the industry with the lowest digital maturity index in Chile. Regarding the role of the State, the efforts have been discreet and with little continuity. Even though the existence of Planbim has been vital to the implementation of the methodology (for example, highlighting its standard for public projects internationally), entities such as the MOP still need to have a formal relationship with this, slowing down its implementation. Additionally, the comprehensive life cycle approach using BIM and CI needs to be more consistent with the National Investment System's model since the great benefits of introducing this methodology come with early integration. Furthermore, the fragmentation offered in most cases by the SNI also affects the adoption of industrialized construction.

Main recommendations

The study presents a roadmap that considers the feasibility and prioritizes implementing the identified measures –critical actions in the short and medium term and other strategic long-term actions and their expected impact. The study contemplates 73 recommendations, classified according to the type of work, the implementation route, and the institution in charge.

The study proposes five recommendations that improve the construction of private building works, 25, which enhance public infrastructure works, and 43 that address the obstacles detected in both construction subsectors. The Ministry of Public Works is the entity that should carry out the proposals along with 21 other organizations. Different administrative channels can enforce 55 recommendations regarding the implementation route, and 18 require legal changes.

The significant number of proposed recommendations requires prioritization. For this reason, this Commission prioritizes the challenge of reactivating the post-pandemic sector, defining the recommendations as i) Urgent, critical to implement for greater efficiency in the reactivation, including rapid implementation, and ii) Short and medium-term, focused on structural change and strategic approach. For these recommendations, the CNP proposes a hierarchy of the measures based on the expected impact and the implementation complexity.

In total, there are 13 urgent measures to implement, highlighting the modifications to reduce the risk in signing contracts; improve the process of changing services, takeovers, and unforeseen

findings; improve the management efficiency of public works contract modifications; and the organization of work due to municipal ordinances that affect the working hours; among others.

Regarding the short and medium-term measures, first, some seek to solve planning problems by creating an Infrastructure Agency which will allow the continuous development of the works by defining two stages concerning the SNI resource management:: Pre-investment and Design and Construction. Second, the proposals to encourage early integration by incorporating BIM into projects and improving the pre-investment phases are crucial, for they would significantly reduce deadlines and costs. Third, aspects related to standardizing the bidding bases could save more than ten years of processing time in administrative work for the MOP. Fourth, one of the most relevant elements for certainty in the development of building works is the legal changes that aim to provide better stability of the building permit. Construction workers could be better trained if the projects currently under discussion in Congress are approved to address the enormous gaps detected in labor skills. Finally, reducing the generated waste by incorporating technologies such as industrialized construction is crucial for more productive work.

The evaluation of public policies, as extensively described by this Commission,¹¹ holds great significance. What sets this effort apart is the introduction of unprecedented indicators designed to monitor policy proposals and assess their performance. This systematic approach to evaluation enables a comprehensive understanding of policy effectiveness, allowing for informed decision-making and continuous improvement in the pursuit of better outcomes.

Conclusions

To improve Chile's levels of prosperity and meet many of the citizens' demands, this Commission insists on improving aggregate productivity.

The problems identified through numerous interviews and information gathering are diverse and come from public and private spheres. The construction productivity mandate constitutes a relevant effort to provide solutions to the factors that most affect work development.

¹¹ National Productivity Commission (2019), Regulatory Review in Strategic Sectors.

The COVID pandemic allowed the opportunity to analyze new and better ways of building where technological innovations, particular work schemes, and sustainability measures, among others, have been highlighted. Indeed, at the international level, 2/3 of the incumbents in the construction sector worldwide believe that the pandemic will catalyze changes toward new construction methods.

In short, recommendations will make it possible to mitigate the most relevant problems in the construction sector and begin generating and systematizing all the information on the projects; essential to have inputs and historical background for decision-making and the formulation of appropriate public policy measures.