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Smart Contracts: An Exploration of Their Potential for Public-Private Partnerships

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Abstract

Public-private partnerships (PPPs) often follow long and complex design and implementation processes. During their execution, PPPs face problems relating to transparency and allocation of responsibilities that considerably affect their efficiency and effectiveness in achieving their objectives. New technologies offer the opportunity to rethink how to tackle these problems and find coordinated solutions for them. Technologies such as smart contracts, distributed ledger technology (DLT), artificial intelligence (AI), and the cloud are revolutionizing operations in different fields of the industry and have the potential to do so for PPP by replacing the current inefficient and highly expensive PPP productivity schemes. The objective of this analysis is to identify the opportunities that using these technologies offers throughout the different phases of PPP (from design to implementation). Based on this analysis, this paper establishes a theoretical framework that justifies implementing a pilot scheme that makes use of smart contracts, DLT, AI, and other new technologies in a PPP sub-process.

JEL Codes: H42, H57, O33, O38

Keywords: smart contracts, blockchain, public-private partnerships, automation

CONTENTS

LIST OF INITIALS AND ACRONYMS

AI	Artificial intelligence
API	Application programming interface
BOOT	Build, own, operate, and transfer
BOT	Build, operate, and transfer
DBFM	Design, build, finance, and maintain
DBFO	Design, build, finance, and operate
DBFOM	Design, build, finance, operate, and maintain
DBMF	Design, build, maintain, and finance
DLT	Distributed ledger technology
PPP	Public-private partnership
RegTech	Regulatory technology
ROT	Renovate, operate, and transfer
VfM	Value for money

EXECUTIVE SUMMARY

Public-private partnerships (PPPs) follow long and complex design and implementation processes in different countries around the world. During their execution, PPPs face problems relating to transparency and the allocation of responsibilities that considerably affect their efficiency and effectiveness when it comes to achieving the governmental objectives they pursue.

The process from the design of the PPP to the signing of the contract can last for up to 36 months (as has been the case in Australia, France, Honduras, and United Kingdom). The complexity of the process goes hand in hand with the challenges that accompany each phase of the process herein analyzed. For example, during the identification phase, the main challenges have to do with inconsistency between the aims of national policies and of those put forward by the selected project, or the absence of a value for money (VfM) analysis capable of accurately evaluating the quality of the project selected. Furthermore, in the contract implementation phase, these challenges are linked with the need to rely on a third party and with additional mechanisms needed to evaluate compliance with the contractual agreements which, to a large extent, is carried out manually.

New technologies offer the opportunity to rethink how to tackle these problems and to find coordinated solutions for them. Technologies such as smart contracts, distributed ledger technology (DLT), artificial intelligence (AI), and the cloud are revolutionizing operations in different fields of the industry and have the potential to do so for PPP by replacing the current inefficient and highly expensive PPP productivity schemes. For example, the use of DLT is being explored for the provision of financial services such as remittances (seeking to reduce the high costs of current schemes due to issues of communication and transactionality) or payment infrastructures (to make more efficient the outdated systems based on liquidation and compensation models extended over time). Such technologies, coupled with AI and cloud storage, are also being explored for risk prevention, because they enable faster and more comprehensive predictions, or for international trade, where they enable more transparency in the exchanges between participants in real time.

The objective of this analysis is to identify the opportunities that using new technologies offers throughout the different phases of PPP (from design to implementation), in particular the

use of smart contracts and DLT and the deployment of machine-executable regulations. Based on this analysis, we hope to establish a theoretical framework that justifies implementing a pilot scheme that makes use of DLT and other new technologies in a PPP sub-process.

At present, no study of this nature exists.[1] The theoretical analysis undertaken reveals multiple opportunities in terms of transparency, automation, simplicity, and efficiency based on the implementation of a combination of smart contracts and DLT during the different phases of a PPP. In this context, the attributes of immutability, distributed information, security, and automation of the aforesaid technologies are particularly important. These attributes are capable, for example, of resolving the problems of information asymmetries between the different parties that participate in the elaboration, design, and implementation of a contract within the PPP framework. Moreover, such technologies can reduce transaction costs, eliminate the need for intermediaries to guarantee compliance with the agreements between the parties involved, and facilitate the recording of immutable transactions.

The use of these technologies requires an enabling legal framework, the identification of risks in the process, political willingness, and human capital with the necessary skills to manage the project. An enabling legal framework must permit the safe, predictable, and lasting implementation of these technologies in a PPP process. This implies, for example, the existence of regulations that govern the validity of electronic signatures and electronic transactions, as well as regulatory and institutional frameworks that facilitate the use of digital identity and regulations on the use of DLT and algorithms and application programming interfaces (APIs), among others. The availability and costs of electricity and internet must also be taken into account.

Implementing these technologies in PPP processes is not free from risks such as cybersecurity, operational continuity, data protection, fraud, governance, and even political risks. All of these must be taken into consideration when designing any project of this nature.

Making use of these technologies calls for a multidisciplinary team that utilizes agile methodologies, with knowledge of both the characteristics of the process and of regulating PPPs at the local level as well as of the technologies that must be implemented such as smart contracts, DLT, or AI. Over the medium and long term, the agency responsible for managing the systems that use these technologies must be able to count on having the staff needed to ensure their operational continuity in optimal conditions.

These technologies have enormous potential to make PPPs more efficient and effective, as they facilitate better coordination of the processes, the automation of certain components, and greater transparency and accountability through the use of a distributed ledger system—all factors that can have an impact on achieving the VfM objective that underlies the PPP. An evaluation of a specific case (in a country) and of a specific component of these processes should be made to obtain more grounded results in terms of efficiency gains and of the principal challenges at the regulatory, institutional, and organizational levels, among others.

[1] As of June 2020, review of the available literature had not identified any PPP project that makes use of the technologies mentioned to automate any of its components.

INTRODUCTION

Problems of efficiency, high transactional costs, and compliance processes involving multiple actors lead us to explore the use of new technologies such as distributed ledger technology (DLT), smart contracts, artificial intelligence (AI), and application programming interfaces (APIs) in order to provide alternative solutions to public-private partnership (PPP) processes and the related inefficiencies. Over recent years, diverse pilot schemes have been trialed in other fields (such as the financial sector or international trade) to test the viability and efficiency of using these technologies. This hasn't happened regarding PPP processes. The most notable attempts to incorporate technological solutions mainly address matters of standardized data gathering and transparency in data publication.

The aim of this analysis is to evaluate the potential use of these technologies to make PPP processes more efficient, transparent, and consistent with public policy objectives. At the time of writing this paper, there are no experiences of implementing these technologies in PPP processes, which means that the analysis herein presented is fundamentally theoretical and constitutes the first step toward implementing a pilot scheme in this area.

The study consists of five sections. The first describes problems encountered with PPP processes and proposes some hypotheses about how these might be resolved through the use of new technologies. The second section describes the technologies available and identifies those that could help to overcome PPPs' problems (DLT, smart contracts, and machine-executable regulations), as well as the hypothetical benefits of their use. The third section analyzes which processes might be subject to automation with the use of these technologies in each one of the phases of PPP implementation. The benefits of automation by phases are also presented. The fourth and fifth sections describe the regulatory, institutional, operational, and human elements to consider when it comes to implementing these new technologies in a PPP process. These factors are presented as risks and limitations to be mitigated or considered when designing a project of this nature. Finally, we briefly present the findings from this analysis and propose steps to follow.

1

PUBLIC-PRIVATE PARTNERSHIPS: PROBLEMS AND OPPORTUNITIES

Public-private partnerships (PPP) are long-term contracts between a private party and a government entity for the provision of a public asset or service. In many cases, the partnerships are linked to providing infrastructure and associated services. In providing the infrastructure or service, the private partner assumes both the responsibility for managing the contract and a significant risk. Remuneration in return for the provision of the asset or service is linked to its future execution/provision.[2] These types of contracts are designed to help reduce the state's fiscal burden in the short term and also bring a set of benefits insofar as their implementation is cost efficient. Among the benefits mentioned are the possibility of applying the latest technology available to the task in question or the transfer of financial and project management risks to the private sector partners.

The use of PPPs presents a high level of complexity. They have diverse actors and multiple phases subject to diverse rules and challenges. Some problems derived from such challenges include, for example, evading fiscal rules, an opaque fiscal incentives structure that hampers achievement of cost effectiveness in project execution, or information asymmetries that give rise to imbalances in the compliance with contractual obligations and in risk allocation.

The lack of automation of the different stages of the process, the absence of a national project selection plan, and the high level of discretionality when it comes to making financial or environmental impact evaluations are additional factors that can lead a PPP process to fail or to increase operational risks. In one case, "the 'Lava Jato' operation revealed that Brazilian construction firms, of which Odebrecht is among the most important, had set up a cartel to manipulate important subcontracting markets of the Petrobras oil group";[3] in the case of Colombia and the Magdalena River navigation project, corruption led to the cancellation of PPP contracts already signed in 2017. These are clear examples of the urgent need to seek solutions to typical

[2] World Bank (2017).

[3] *El Comercio,* "Odebrecht, el escándalo de corrupción que sacude a América Latina," February 3, 2017, https://www.elcomercio.com/actuality/odebrecht-escandalo-corrupcion-americalatina-brasil.html; Economist Intelligence Unit (2017).

BOX 1.1 REGULATORY TECHNOLOGY AND AUTOMATION OF PUBLIC-PRIVATE PARTNERSHIPS

Regulatory technology (RegTech) refers to the use of technological solutions to reduce the costs of regulatory compliance and to the improvement of the processes of information reporting and exchange. Many RegTech solutions use technologies such as machine learning, artificial intelligence (AI), cloud computing, DLT, or big data solutions.

The RegTech solution of transaction monitoring is of particular significance because it focuses on behavioral requirements in business execution and offers solutions for making transactions in real time, as well as for their monitoring and auditing. The technologies employed include DLT, end-to-end integrated process validation, systems for identifying fraud and abusive behavior, and the automation of internal business operations and risk alerts.

Transactions in the area of the financial markets refer to the automation of numerous linked procedures such as the calculation of margins, the choice of key partners and places of exchange, the evaluation of financial exposure, and compliance with the best principles of behavior, among others.

Source: Gurung and Perlman (2018) and Toronto Centre (2017).

problems such as bad structuring, poor calculation of VfM, and failure to standardize contracts, among others. A further recurrent shortcoming is revealed by measuring the level of deviation from an ideal situation, once a project has been carried out. Experience indicates that this happens all too frequently and at all stages of a PPP.[4]

The rise of new technologies such as DLT, AI, smart contracts, and technological solutions for regulatory compliance or RegTech (Box 1.1), alongside the lessons learned from the creation of a legal and institutional structure for PPP management, leads us to suggest that it is possible to simplify and automate components of the PPP design and execution process in order to provide a solution to the aforementioned problems.

There have been recent efforts to establish common elements in the PPP processes of different countries at the global level, as well as in creating software that facilitates a certain level of automation for some activities. However, much more integrated automation is essential and might be achieved through the use of the aforesaid new technologies. At present, attempts to automate PPPs are directed toward specific and uncoordinated objectives, such as the search for more effective communication between actors, better information structure, the possibility of making ex ante and ex post comparisons, and the integration of information currently dispersed during these processes. Contracts in each country are very different according to the purpose of the PPP, and general clauses are therefore being sought to govern contracts at the domestic level (dealing with force majeure clauses or reasons for going to arbitration, among others).

The following section analyzes some of the problems identified in each stage and how the international community is responding to the lack of transparency in these processes. Thereafter, we examine the opportunities offered by using different technologies to provide a solution to the identified problems.

1.1. PHASES OF PPP IMPLEMENTATION: MAIN PROBLEMS

Although the level of institutionalization and sophistication of PPP processes varies greatly among different countries, they continue to be predominantly manual processes in which the actors communicate through physical means. PPP phases are not coordinated enough to guarantee integrity of information, the consistency of valuations,

[4] Conversations with experts and civil servants in countries such as Honduras, Peru, and Uruguay.

or a clear allocation of responsibilities throughout the process. Moreover, such phases follow long and intricate protocols to make sure that someone in the chain of command assumes responsibility. The decisions of different persons responsible throughout the processes of design, procurement, and execution are subject to the consent, verification, or approval of different partners—which in the implementation stage includes private sector actors—giving rise to unnecessary delays.

The flow of information between the actors in a PPP is intense and the effectiveness and cost-efficiency of the project depends on its content. The participating government actors vary according to the type of PPP (infrastructure, health, transport, etc.). In many countries a single institution is given specific responsibility with relation to PPPs that, among other things, includes overseeing the different phases from the design to contract execution. On the private sector side, PPPs generally include project management firms, lenders, investors, and a trustee.[5] Table 1.1 provides details of some examples of processes carried out manually and the effect this has throughout the different phases of a PPP project.

1.2. ADVANCES IN PPP AUTOMATION AND BETTER STANDARDS OF TRANSPARENCY

The need to make these processes more transparent and to generate greater accountability has led to the creation of ledgers that store basic data (profile, scope, amount of investment, etc.) about both current projects and those under development. These databases often only have an accounting function. They're not connected with effective project execution and viability evaluations, or don't report on the current status of the project. Moreover, this ledger may be held in institutions other than the one charged with the project feasibility evaluation process and the public bidding competition.[6]

Initiatives exist at the international level to boost transparency in these processes, such as the Open Contracting Data Standard (OCDS) and its application to PPPs. Such standards aim to help, alongside those responsible for the systems, to: (i) define and implement data collection processes in order to share information about the PPP, (ii) integrate information published about the PPP into existing systems, (iii) export and publish information regarding the PPP in a common format, and (iv) present and visualize the information published about the PPP. Implementation of these schemes helps to generate more information about these processes and to integrate data dispersed throughout the public administration.[7]

Progress is also being made at the multilateral level in PPP automation and standardization with a view to building the capacity of those in charge. For example, SOURCE is a program that provides a comprehensive map of aspects to be considered when developing sustainable and good-quality infrastructure.[8] Its five components include: (i) safe and collaborative software for managing projects online, whose servers are under the jurisdiction of the United Nations and can be connected to other databases, initiatives, platforms, and tools; (ii) a standardized structure and a methodology; (iii) a communication platform shared between the project participants, which reduces transaction costs and promotes transparency and consistency throughout the entire project cycle; (iv) a tool for attracting investors to the project; and (v) a standardized database for developing analyses and generating indicators of the sustainability of the infrastructure.[9] Some of the problems observed when it comes to using the software include its language (it is only available in English), its failure to include all project categories, and doubts about its security protocols (information confidentiality issues).

[5] Sulser (2018).
[6] Economist Intelligence Unit (2017).
[7] Open Contracting Partnership and World Bank (2017).
[8] Sustainable Infrastructure Foundation (2018).
[9] Ibid.

TABLE 1.1 EXAMPLES OF PROBLEMS AT EACH STAGE OF PPP DESIGN AND EXECUTION

Phase	Manual process	Problems and effects during each stage
Identification of the project and evaluation as a PPP	Project selection	The project is not selected by a national public investment system or a national development policy, which means that it may not be in alignment and may not be a priority project. As it is not selected from a previously established database, it must pass through the process of approvals and pre-feasibility studies, which requires more time. Projects are often technically and financially unrealistic but politically desirable.
	Evaluation of the project as a PPP	The project involves a VfM analysis or public-private comparison and is chosen following its identification as a PPP project. The omission of this analysis in the process is reflected in projects that end up being more expensive for the government in terms of time and financial resources.
Evaluation and preparation of the procurement project	Project feasibility studies	As the verification of technical, financial, legal, and environmental feasibility is a manual process undertaken by all those involved, it is not incorporated into the institutional memory of similar evaluations, the existence of minimum content in such aspects is not verified, and many matters are not evaluated (depending on how fast the project must be carried out).
Structuring the design of the call for tenders and draft contract	Definition of prequalification requirements	This process depends on the criteria of the person or persons in charge of structuring the project, who may set requirements that benefit or affect certain participants (introduction of subjective elements lacking optimal accountability mechanisms). These requirements can be modified unilaterally, once the bidders in the process have been established and identified.
	Risk allocation	As in the previous process, risk allocation in the project depends on the criteria of the person or persons responsible for structuring the project. In many instances, there is an allocation of risks, which helps to carry out the VfM evaluation.
Bidding and award of contract	Review of the technical proposals	The evaluating committee manually reviews the technical proposals, which must fulfill the minimum requirements established in the project scope statement or similar document. Scores are awarded subjectively to the proposals or, in other words, these are subjectively evaluated.
	Correction of proposals	If the project scope statement or corresponding document fails to specifically establish the documents that may be corrected as part of a proposal, the decision remains at the discretion of the evaluating committee.
Signing the contract	Change in the risk allocation that alters the VfM	During the bidding process or once the project has been adjudicated, contractual modifications are made that change the previously established risk allocation, without any reevaluation of the VfM.
Contract management	Review of performance indicators	Generally speaking, there are multiple performance indicators to evaluate, which means that their manual review is extremely time consuming. An example is seen in highway projects where, if the performance indicators are manually evaluated throughout the entire route, the time necessary to do so means that once the review is finalized the state of the highway may be worse than its condition when originally evaluated.

Source: Authors' elaboration based on experiences in PPP implementation in Latin America and the Caribbean.

BOX 1.2 TECHNOLOGY-BASED OPPORTUNITIES FOR IMPROVING PPPS

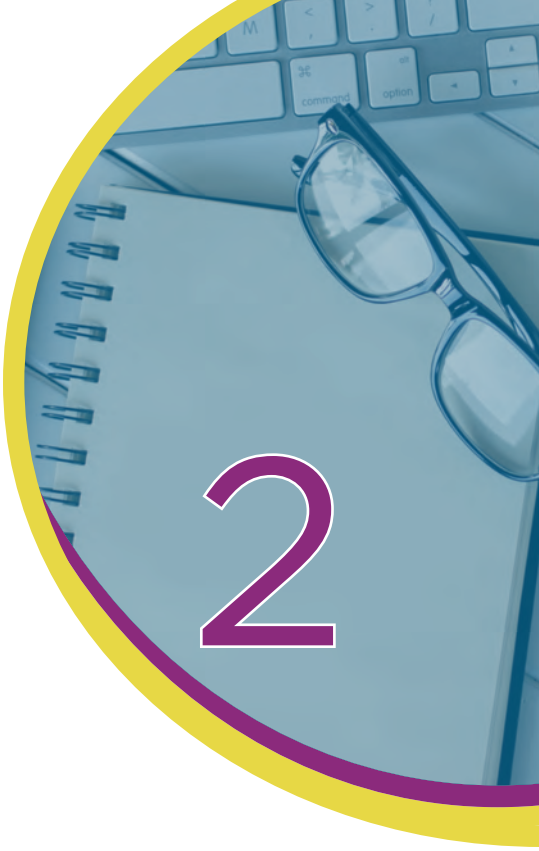
- The lack of competition in certain processes leads to poor risk allocation. The use of technology could encourage a more open and automated process that would show that all bidders were competing under equal conditions.
- Automation of the process can create incentives for timely compliance and ease approvals by different authorities, facilitating their immediate diffusion.
- The use of technology would enable self-checking of the minimum standards established for the financial or environmental evaluations of the project, among others, before proceeding with the PPP approval process.
- Standardizing minimum requirements applicable to these evaluations—verifiable by the system—would help to reduce subjectivities in financial, environmental, or VfM evaluations.
- The lack of information about suppliers could be corrected by developing an online database, updated and with cross-checking according to the information provided.
- By implementing DLT and smart contracts, the terms and timeframe for compliance can be clearly stipulated, as well as responsibilities for failure to comply with these preconditions. Non-negotiable penalties can also be stipulated that would be determined automatically in the event of non-compliance with that agreed by the parties.

Source: Authors' elaboration.

1.3. OPPORTUNITIES FOR IMPROVING PPP DESIGN AND IMPLEMENTATION PROCESSES OFFERED BY NEW TECHNOLOGIES

The use of DLT, in particular of blockchain technology, and smart contracts (see the glossary at the end of this paper) is being analyzed for its potential to ensure that contractual processes—such as those implemented in the PPP execution stage—are transparent, automated, and efficient. In addition, they are looked at for their potential to ensure better monitoring of the execution of agreements with less need for third-party oversight.[10] Smart contracts used alongside DLT are proposed as a mechanism for improving PPPs given their potential to enhance transparency in contract management and to provide information in real time to the different parties involved in the process. They can also reduce the likelihood of disputes and litigation by maintaining an immutable record of the actions of the different parties and reduce the need for a full-time contract administrator by enabling the automated execution of its diverse components or contractual commitments.[11] Box 1.2 presents some examples of the potential advantages of using such technologies at different stages of the PPP process.

[10] World Bank (2020).
[11] Ernst & Young (2018) and Nel (2020).



2 NEW TECHNOLOGIES AND THEIR POTENTIAL IMPACT ON PPPS

Automation of the different phases of a PPP can help to solve the problems described in the previous section. Different technologies, such as distributed ledger technologies (DLTs), smart contracts, artificial intelligence (AI), data analytics, and cloud storage, among others, are being explored as ways of facilitating such automation, with a view to reducing transaction costs and making regulatory compliance and contractual processes more cost efficient. Diverse pilot schemes are underway in a wide range of ambits such as tax administration, international trade, the financial system, and the stock market, among others.[12] However, there is no consensus about many of the definitions found in this environment while the literature and technological advances are in constant evolution.

2.1. NEW TECHNOLOGIES WITH THE POTENTIAL TO RESOLVE THE PROBLEMS IDENTIFIED IN PPPS

The main causes of the problems identified when it comes to PPPs can be summarized as the information asymmetries seen throughout the process and the high transaction costs caused by the need of an impartial subject to verify regulatory and contractual compliance, as well as achievement of the policy objectives that lie behind the decision to implement the PPP.

To tackle these problems, the use of DLTs, smart contracts, and machine-executable regulations (identified in Table 2.1 as the major technologies) is mainly proposed, with tools that permit advanced analysis of large volumes of information (e.g., AI and big data), as well as mechanisms to enable interoperability between different platforms (i.e., OpenData, API) and others mentioned in Table 2.1, as complementary technologies.

The automation process that can be achieved through the implementation of smart contracts helps to decrease the costs of contract monitoring due to their characteristics of "auto execution" and "immutability." The deployment of control protocols reduces verification costs and, given that the different actors involved are allowed access to information in real time, it also reduces the costs of transferring this information. The greater part of this analysis, therefore, will

[12] See World Bank (2018, 2020) as examples.

TABLE 2.1 AVAILABLE TECHNOLOGIES, THEIR EFFECTS, AND POTENTIAL APPLICATION IN THE PPP PROCESS

Technology	Definition	Effect	PPP process where this technology becomes relevant (from design to execution)
Principal technologies			
Distributed ledger technology (DLT)	Distributed databases that record and encrypt validated data that can be shared and managed in a network.	Exchange of information in real time, safely and with greater transparency. This permits an informed decision-making process.	In the bidding process, contract awarding, and oversight stages, although this could also be applied to others.
Smart contracts	Machine-executable electronic instructions that describe unequivocally the clauses of a contract or the terms of an agreement between different parties.	Automation of information validation and processing tasks and automatic execution of agreements. Helps to expose the existence of any gray areas in the contract.	During the contract stage.
Semantic technology and data point modeling methodology	Technology that converts the text of the regulation into computer programming language.	Machine-readable regulations to facilitate less expensive and more flexible adaptation to constant regulatory changes.	During the design stage and in implementation of the regulations for PPP structuring.
Complementary technologies			
Data analytics	Analysis of structured and unstructured data that utilizes machine learning and other technologies.	Support risk identification and monitoring tasks.	During the design stage, for a better evaluation of the risks before identifying the project parameters.
Biometry	Use of physical characteristics and the unique behavior of individuals to facilitate their identification.	Dependable process for verifying the physical identity of participating persons.	During the contract execution stage, to enable all parties to access the system.
Cloud computing	Computing services (such as data storage and analytics) through on-demand consumption schemes. Reduces significantly the capital requirements to establish an adequate infrastructure and increases processing speed, among others.	Access to innovative software, standardization of information, and use of a low-cost processing space.	Particularly during the bidding and contract oversight stages.
Artificial intelligence (AI)	Technology that carries out tasks that normally require human intelligence. Machine learning is a subcategory of AI that learns from the data and recognizes patterns to help make the existing algorithms better reflect the nature of the information.	Prevention and detection of fraud and of unexpected behaviors.	Throughout the PPP design process, to check conformity with pre-established parameters or with lessons derived from institutional memory.
Application programming interface (API)	Protocols and tools that permit different systems to interact with each other.	Integration and interoperability of the systems of different actors.	During execution of the contract, allowing the automatic exchange of information among the parties.

(continued on next page)

TABLE 2.1 AVAILABLE TECHNOLOGIES, THEIR EFFECTS, AND POTENTIAL APPLICATION IN THE PPP PROCESS *(continued)*

Technology	Definition	Effect	PPP process where this technology becomes relevant (from design to execution)
Internet of Things	Permits the exchange of data in a network with objects (capture and transmission of information).	Automation of field measurements and verifications.	During the contract execution stage.

Source: Authors' elaboration based on Ream, Chu, and Schatsky (2016), Gurung and Perlman (2018), and Pérez Colón, Navajas, and Terry (2019).
Note: For more information about some of these technologies, see Annex 3.

center on the use of DLT, smart contracts, and machine-executable regulations, although the proposal includes an open list of tools that use other complementary technologies.

2.2. SPECIFIC BENEFITS OF THE USE OF DLT AND SMART CONTRACTS

The use of DLT and smart contracts enables maintaining a database that is updated in real time by the participants themselves. This database has the tools needed to machine-execute tasks once certain conditions have been fulfilled, in order to verify compliance with mandatory regulations automatically. It also provides adequate mechanisms for guaranteeing consistency, immutability, and transparency among the diverse actors. The following section delves more deeply into the benefits arising from their use and some possible specific applications are presented.

1. Resolves the problem of information asymmetry. All parties of the network have access to the same information, while its arbitrary modification is prevented. Therefore, DLT eliminates the risks associated with the principal-agent dilemma and reduces the high transaction costs derived from the need for coordination.[13] At present, different countries are using technological tools to respond to the problems of information asymmetries.

In Honduras, for example, the problem of information asymmetry in the bidding stage has been partially solved by the creation of a so-called data room, wherein all information and communications are anonymously managed through this virtual space and all participants must have a username and password to access said information. However, operation of this tool depends on the timely and efficient capture of all the necessary information, a process that is often carried out manually. Table 2.2 gathers other problems of information asymmetry and their potential solution through the use of DLT and other technologies. However, the current solutions do not permit the information provided to be linked with the automatic execution of certain parameters or contractual agreements, which would be achieved with the use of DLT and smart contracts.

2. Radically reduces transaction costs. Facilitates the creation of an organizational structure and of decentralized governance that was not possible before and that replaces the predominant hierarchical and centralized structures of

[13] The principal-agent dilemma occurs when a person or entity (the agent) is responsible for making decisions on behalf of, or with consequences for, the principal (another person or entity). It is assumed that, in the absence of threats, sanctions, or incentives, agents will maximize their own benefits and pursue their own interests above those of the principal, or that the situation will give rise to problems of moral hazard (that the agent will engage in riskier behavior because another person will assume the consequences of those risks) (Eisenhardt, 1989).

TABLE 2.2 EXAMPLES OF INFORMATION ASYMMETRIES AND POTENTIAL SOLUTIONS WITH THE USE OF NEW TECHNOLOGIES

Information asymmetries in PPPs	Technology-based solutions
Determine the real capacity, competence, and skills within the firm to manage the project.	Develop a historical database that can monitor inconsistencies in the information presented by the bidders and contrast it with available public records. This would require, for example, the use of APIs and data analytics.
Determine the real scope or the size of the project. The government may have incentives to expand or modify the project once the execution stage has been initiated.	In a scenario in which all stages are automated, these will be linked in such a way that the parameters established at source cannot be modified arbitrarily.
Some technical aspects of project feasibility. For example, the stability of the land and its impact on the execution or the quality of the products needed to build the asset.	Use the Internet of Things for the oversight stage.
Reluctance to cancel a project or terminate it due to the political costs that this might signify.	With the use of DLT and smart contracts, the system could immediately decide to cancel or terminate the contract if the motives for cancellation or termination were justified.

Source: Authors' elaboration based on Reyes-Tagle (2018).

today.[14] It therefore introduces new ways of aligning the interests of the different parties that participate in a process or transaction and provides decentralized governance for their agreements. The transaction costs arising from reaching and formalizing the agreements, as well as those from monitoring and verifying compliance, are reduced by standardizing the rules that govern the transaction.[15] Generally speaking, the conditions and the rights of the parties are predefined and the agreement is formalized through adherence mechanisms, digitally and by code.

The hierarchical structures and the participants vary according to the stage of the PPP. For each one of them, possible implementation of a DLT will have to be analyzed. In the specific case of contract execution monitoring, in which the use of this tool would seem to be the most viable and cost efficient, hierarchies disappear to be replaced by roles assigned in compliance with obligations and submission of information.

3. The participation of intermediaries is no longer needed to guarantee compliance with the agreements established between parties.16 This is also more noticeable in the contract execution stage. In this phase, a computer or network of computers can automatically execute and verify the rights and obligations of the parties in real time to ensure compliance with the conditions pre-established in the agreements. Therefore, there is no longer a need for a third party to verify compliance with certain conditions. In the case of a PPP contract, it eliminates the need to verify the progress of the private actor with its deliverables throughout the execution of the contract, which can take years (see Table 2.2).

4. Facilitates the recording of transactions during contract execution and their immutability. This favors transparency, predictability, auditing, and the allocation of responsibilities in contractual relations.[17] Moreover, the principle of immutability generates greater trust between the parties and helps to minimize the risk of fraud and errors in the contract execution.[18] Finally, the benefits of smart contracts also include an improvement (reduction) in the time taken to carry out

[14] Shermin (2017), p. 499.
[15] Ibid.
[16] Shermin (2017), p. 499.
[17] Hansen, Rosini, and Reyes (2018), p. 3.
[18] Filipova (2018), pp. 86–90.

BOX 2.1 EXAMPLE OF ADDITIONAL COSTS AND PROBLEMS DURING VERIFICATION OF THE PRIVATE ACTOR'S PROGRESS IN EXECUTING THE CONTRACT

The review of the performance indicators of a road maintenance project is a case for potential use of smart contracts and DLT. At present, the indicators are established in the contract and, generally, it is an extensive list. This verification is carried out manually and may require a period of between one and three months. When the observations are reported, the road is already more deteriorated than it was at the time of the original inspection.

Furthermore, when the private actor makes the necessary repairs and reports them, the evaluation is also manual and, while the repairs may have been carried out, when the time comes for the inspection the road has once more deteriorated. As intermediaries are needed to guarantee compliance with the established agreements, transaction costs are higher, given that specialized personnel in this area are needed or government staff are called in, thereby generating travel costs as the majority of the projects are executed far from work headquarters.

The use of smart contracts and DLT would enhance the possibility of sharing immutable information in real time, which would mean a reduction in manual processes and waiting times, and it could be accompanied by automated mechanisms and clauses that can verify compliance with the established contractual standards.

Source: Authors' elaboration.

transactions, given the automation of agreements and their verification.[19] With a smart contract, legal security for the private party can also be enhanced, given that the execution and interpretation of the contract will be be protected against arbitrary government interventions.

5. Transparency. Many of the terms of the process and the contract are executed automatically, thus the conditions should be specific, explicit, and not give rise to diverse interpretations. This is often a grave problem for PPPs. For example, on numerous occasions, during the contract execution stage the approval process of a document or the date by which it has to be submitted is by no means clear, and this has consequences for the execution of other clauses that depend on those dates. Likewise, although generally there are two parties to the contract (the grantor and the grantee), there may be multiple actors that, while they do not sign the contract, form an integral part of the process (ministry of finance, national congress, regulatory authority, etc.). The transparency of the agreements and their immutability would also be guaranteed for such non-signatory parties through the use of DLT, and their access authorized under certain conditions. A further frequent example of the lack of transparency and vagueness in contracts is that it is not clear to whom the private party must submit a document, who will evaluate it, and how; what the deadline for submission is; and who will finally be responsible for approving it. As various actors are involved, the private partner generally seeks the "weakest link" and uses it to interpret all the gray areas that exist in the contract in its favor.

6. Enhances simplification of the processes. Automation of the tasks of evaluation, verification, validation, and execution of the clauses and conditions stipulated in PPP contracts leads to a simplification of the protocols of communication, registration, and award of contract. For example, at present in many countries all the pages of the contract must be signed by the different participating parties, either due to regulations or in practice (as in the case of Costa Rica, Honduras, and Peru). This would no longer be necessary when using smart contracts and DLT, given that the use of digital signatures or a similar protocol could be incorporated to facilitate execution of this action.

[19] O'Shields (2017), p. 9.

2.3. BENEFITS OF USING MACHINE-EXECUTABLE REGULATIONS OR SEMANTIC TECHNOLOGY

The regulatory framework is an essential component in the process of PPP design, structuring, and execution of the contract. In some cases, the regulations must be adjusted to permit the application of these technologies in each of these stages. In other cases, depending on the implementation or interpretation employed to facilitate the use of this technology, there may be a need to effect regulatory reforms. In any case, it is assumed that the use of semantic technology to implement regulations brings the following advantages:

1. Greater clarity. Machine-executable regulations, which are carried out without human oversight or with minimal oversight, will ensure that regulators precisely determine the meaning of the rules at the moment they are issued or converted into code, instead of doing so a posteriori, during subsequent monitoring activities, as happens at present. This would mean that, right from the beginning, actors would only have one way of interpreting the regulatory requirements. The use of this technology would be most significant during the PPP design stage, in which there is a strict regulatory framework, but that can often give rise to diverse interpretations or to interpretations that enter into conflict with other regulations or institutional objectives.

2. Less time. Implementation of a machine-executable regulations model would generate efficiencies by reducing the time necessary for all subjects to update, implement, and monitor regulatory compliance (administered or supervised). The implementation and monitoring of regulatory compliance is limited at present by the speed at which meetings can be held and memoranda and other typical oversight procedures delivered, all of which would no longer be necessary. For example, during the PPP design stage, there is a raft of regulations whose verification could be automated, such as the submission of certain risk evaluations or the validation of admissibility requirements for tenders, among others.

3. Cost efficiencies. It is assumed that machine-executable regulations also bring efficiencies in monetary terms, although this has to be confirmed by the deployment of proofs of concept and pilot schemes in different scenarios and in different cases of use. Reduced costs for both the public sector and the private sector would be significant with respect to their current compliance obligations, such as the submission of reports, the personnel responsible, and the costs of resolving regulatory ambiguities, among others. At present, in some countries documentation is submitted in written form and, once this has been delivered to the offices, copies are made for the person responsible in each area.[20] Up to 10 copies of a document may be required in the same institution. From the public sector perspective, although implementation of this tool represents an additional initial cost, over the medium and long term a significant reduction in monitoring and oversight costs, and even in the costs of regulatory changes and sanctions, is to be expected.

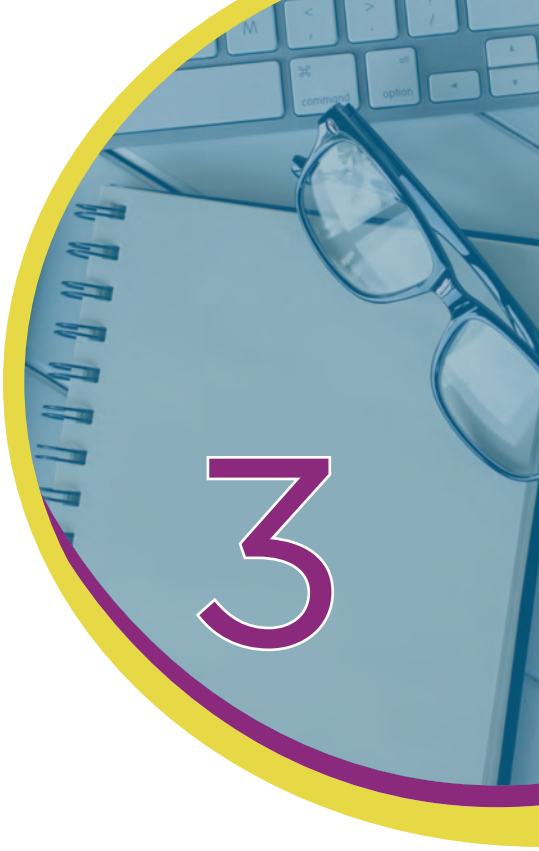
4. Simplification of processes. Under the machine-executable regulations model, regulatory changes are distributed in a machine-readable format, which requires a single system update in order to incorporate the change. Therefore, it is assumed that the process of change will make the distribution of changes to the regulations more efficient for actors in the market and enable such actors to adapt much more quickly.

In many countries, whenever a new regulation is issued, those whom it affects fail to adopt it immediately. If there is no penalty, they ignore the regulations issued by the regulatory body, given that the latter carries out ex post verification that requirements are met. For example, a regulation is issued that indicates that parties must hold cash reserves in the event of conflicts

[20] Anecdotal information gathered from conversations with specialists in the Latin American region.

with third parties. As the regulatory body evaluates these reserves a posteriori (once the fiscal year is finalized) and, since there is no fine for failure to hold the reserves, the regulated subjects fail to comply.

It seems, therefore, that the implementation of DLT, smart contracts, and machine-executable regulations may help to reduce information asymmetries and decrease the costs of oversight and verification of compliance with the regulatory framework. The following section will examine exactly what may be automated at each stage, what problems might be resolved, and who the most significant actors are.



3 INCORPORATION OF NEW TECHNOLOGIES INTO THE DIFFERENT PPP STAGES

When incorporating new technologies into a PPP, the processes and the actors involved must be very clearly identified, as well as the objectives and challenges faced at each one of these stages. In most countries, both the processes and the actors that participate in a PPP are predetermined by the applicable regulations. However, their content varies widely, in particular with relation to technical criteria and unstandardizable metrics, given the different nature of the projects that are financed.

The following sections describe phase by phase who participates, what the most significant processes are, and the problems that could be resolved by successfully implementing the new technologies—in particular smart contracts integrated with DLT—in the different stages of PPP. In this stage of analysis it is impossible to calculate the cost of incorporating these technologies. However, Annex 4 shows a cost estimate for a specific project that follows the current procedures (without applying the new technologies).

Development of a PPP consists of five major phases (shown in Figure 3.1):[21] (i) identification of the project and determination of the type of PPP, (ii) project preparation and evaluation, (iii) structuring and design, (iv) supplier selection and contract signing, and (v) contract management.[22] As each phase is applied differently in different countries, a standard set of guidelines for intervention is presented below, which should be understood or adapted to the specific institutional, legal, social, and economic context of the country under analysis.[23]

3.1. IDENTIFICATION AND EVALUATION OF THE PROJECT AS A PPP (PRE-SELECTION STAGE)

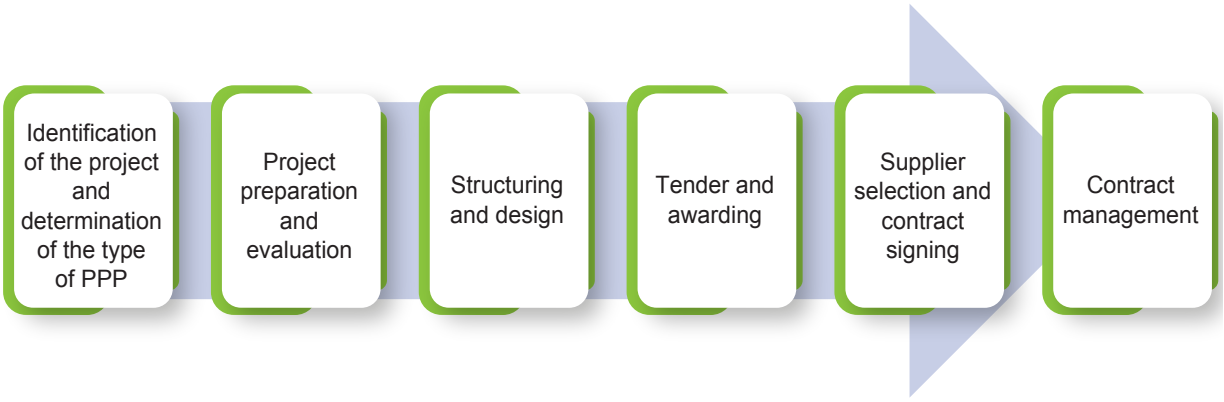
The object of this phase is to guarantee the best allocation of public resources and to satisfy the needs of society. Development of this stage assumes that the application of a PPP for the specific case was already a political priority. It comprises six fundamental activities: (i) identification

[21] There is no consensus around the definition of each phase and its content, when each phase starts and finishes, how long it lasts, or even regarding some of its components.

[22] ADB et al. (2016).

[23] APMG (2018).

FIGURE 3.1 PHASES IN THE DESIGN AND EXECUTION OF PPPS



Source: ADB et al. (2016).

of the project or solution from among different options, (ii) determination of the project ambit and scope, (iii) economic evaluation, (iv) evaluation of the project as a PPP and its financial viability, (v) preparation of the project management plan, and (vi) final report and decision on whether to continue.

The typical requirements to be considered demand a complete design of the project and represent a substantial investment of resources for public administration authorities, which often hampers adequate compliance with such requirements. Errors or bad decisions at this stage can lead to very high costs for the public administration, both financial and in terms of time.

At this stage, requirements linked with the "admissibility" of the proposal are measured, insofar as compliance with the legal and structural minimums the proposal must meet is verified, rather than its quality, which is evaluated in the following stage. Responsibility for this part of the process lies with the public sector authorities defined by law, in those cases in which a predefined legal framework exists.

Automation facilitated by the use of new technologies should lead to the creation of a single database for identifying and selecting projects as PPPs at the national level. To implement a project of this scope, the processes, requirements, and products in common must be identified in each one of the administrations that proposes a PPP. Table A3.1 in Annex 3 of this paper provides a summary of the principal processes and requirements in this first phase of PPP establishment.

Automation of this phase of a PPP yields various benefits. It makes processes more agile, given that it automates compliance with regulations with regard to verifications and approvals, enabling compliance in the strictest terms. Noncompliance and the subjects or agencies responsible are publicly revealed and named. It will also provide more information to evaluation and decision-making bodies by storing information from all the projects in a single structured database. Finally, many of these improvements will lead to regulatory changes that can reduce the complexity of current compliance and verification structures and the timeframe for compliance with tasks, insofar as those responsible for delays are automatically identified. Costs will probably also be reduced, given that automation will decrease the hours of labor dedicated to the project.

A synthesis of the actors that participate in this phase, the processes that are automated, and the principal problems solved by its implementation is presented below (see also Annex 3, Table A3.1 for details regarding the mitigation of risks).

TABLE 3.1 POSITIVE EFFECTS AND OPPORTUNITIES ARISING FROM THE USE OF NEW TECHNOLOGIES DURING THE IDENTIFICATION AND EVALUATION PHASE

Who participates?	• Unit of government that determines the suitability of the PPP
What is automated?	• Exchange of information • Verification of compliance with certain prerequisites and attributes
Processes that can be automated or made more efficient, either totally or partially	• Identification of the project • Determination of the ambit or scope • Economic evaluation • Evaluation of the project as a PPP and financial viability • Preparation of the project management plan • Final report
Problems solved by the deployment of new technologies	• Loss or duplication of initiatives • Lack of alignment with policy objectives • Asymmetries and delays in access to information • Lack of clear allocation of responsibilities • Subjectivity or error in the verifications • Non-compliance with terms • Regulatory non-compliance

3.2. EVALUATION AND PREPARATION OF THE CONTRACTING PROJECT

Projects that pass the pre-selection stage go on to be evaluated in depth, including in matters of economic, technical, environmental, and legal feasibility. The significant actors are the project team and the experts recruited according to the project structuring needs.

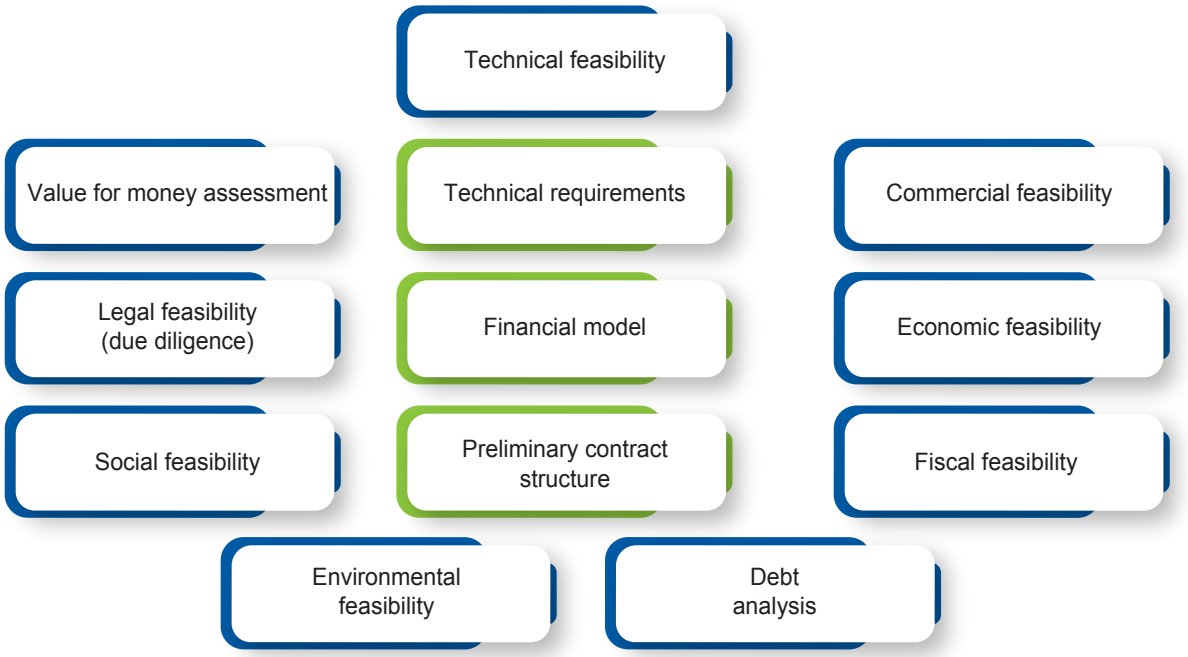
The aim of this phase is to respond progressively as to whether the project makes sense from an economic perspective, whether it is necessary to work through a PPP, whether there is interest and capacity in the market, what the principal obstacles to implementation are, and how these might be overcome in a cost-effective way.

This stage includes (i) pre-structuring of the project contract and of the technical and financial models; (ii) evaluation of the feasibility of the project from different angles, such as economic and commercial, among others (Figure 3.2); (iii) evaluation of the socioenvironmental impact; (iv) designation of the viability of the project as a PPP and verification of compliance with VfM criteria; and (v) determination of the route map or procurement strategy and the steps remaining to the following stage. Figure 3.2 details the set of evaluations that include the different stages of this phase.

The procurement strategy determines how the private sector partner will be selected, according to the option that offers the best VfM. The main options available for the competitive process include a public open tender (either a one-stage public open tender with a "pass or fail" prequalification or a two-stage competition), a restricted procedure (short listing with one bid), a negotiated process (short list with negotiations), and an interaction process.

The green light for moving on to the next stage is given once all these requirements have been fulfilled and compliance with all legal requirements has been verified, many of which may be aligned with the stages and deliverables. When this process is finalized, an evaluation report is drafted that reflects the work carried out in this stage and it is submitted for

FIGURE 3.2 ELEMENTS TO CONSIDER IN THE PROJECT FEASIBILITY EVALUATION PHASE



Source: APMG (2018).

approval. In some countries, more than one institution (for example, the ministry of economy or of social development, etc.) is required to participate in the approval process. The team that evaluated the project can go on to become the team responsible for structuring or a different team may be assembled for this purpose.

Table A3.2 of Annex 3 reviews each one of the objectives to be achieved in this phase of the PPP, the deliverables, the risks to its scope, and how automation of this stage can help to mitigate them.

3.3. STRUCTURING THE DESIGN OF THE CALL FOR TENDERS AND THE CONTRACT

In this phase, two significant milestones are included: the structuring and design of the project contract and the structuring and design of the contracting or bidding process. Moreover, part of the analysis carried out during the evaluation process is brought up to date and the content of the contract is redefined.

On the basis of what has been designed in the previous stage, in this phase the request for qualification (RFQ) and the request for proposal (RFP) are structured and drafted, defining the minimum qualification and criteria, the proposed requirements, and the evaluation criteria. Given the abundant experience in PPP design, these requirements may be standardized and adjusted according to the purpose for which the PPP is being set up, as well as the modality of financing. Moreover, the structure and draft of the contract are also finalized, defining the minimum technical requirements, a detailed risk allocation structure, and the payment mechanism, among others. Finally, approval is given and the bidding process is announced.

The significant actors in this phase are the government and the potential candidates for the bidding, although the latter perform only a feedback role. The criteria and procedures to follow are shown in detail in Table A3.3, in Annex 3,

TABLE 3.2 POSITIVE EFFECTS AND OPPORTUNITIES ARISING FROM THE USE OF NEW TECHNOLOGIES IN THE PROJECT FEASIBILITY EVALUATION PHASE

Who participates?	• Project team, recruited experts (optional), potential bidders (optional), areas involved with evaluations, or those responsible for the verifications or approval mechanism
What is automated?	• Exchange of information • Verification of compliance with minimum standards with respect to the technical, financial, and environmental reports • Mechanism for sharing information with private partners • Approval processes
Processes that can be automated or made more efficient, either totally or partially	• Consideration of the project as technically feasible • Consideration of the project as financially feasible • Commercial viability of the project • Submission of the project to significant actors in the market • Review of the cost-benefit analysis • Evaluation of environmental risk • Evaluation of project impact • Legal risks • Effective VfM rating • Comprehensive plan for the following stages • Evaluation report • Compliance with formalities before proceeding to the procurement process
Problems solved in the evaluation and preparation stage of the contracting project	• Information asymmetry • Potential inconsistent structuring • Failure to identify persons responsible, or potential fraud or incorrect behavior in the approval of certain acts • Regulatory non-compliance • Non-compliance with terms

which evaluates the most common risks and verifies how automation of this stage can help to mitigate them.

As the end result of this phase, all necessary documentation must be complete and ready in order to begin the call for tenders. Likewise, final authorization to launch the bidding must also have been granted.

3.4. TENDER AND AWARDING

This phase is often highly regulated and its main objective is to conduct a procurement process to select the best technical and financial proposal. It ranges from the opening of the project to public bidding, to the award of contract and financial close of the contracts. Generally speaking, it covers the launch of the call for tender for the bidding (or the type of public bidding selected), qualification of the participants, reception and evaluation of the proposals, selection of the winner and the award of contract, as well as financial close of the process. Significant actors at this stage are the government, potential candidates to tender, and those bidding for the contract.

The specific steps vary according to the decision on whether to hold a two-stage competition.

TABLE 3.3 POSITIVE EFFECTS AND OPPORTUNITIES ARISING FROM THE USE OF NEW TECHNOLOGIES IN THE CALL FOR TENDER DESIGN PHASE

Who participates?	• Project team, external experts (optional), potential bidders (optional), areas involved with the evaluations or responsible for the verification or approval mechanism
What is automated?	• Exchange of information within the public administration • Verification of the presentation of minimum components in the technical, financial, and environmental reports • Compliance with minimum standards with respect to the reports delivered • Mechanism for sharing information with private parties • Approval processes • Partially, qualification and proposal requirements, based on standard requirements • Partially, the draft of the contract, based on standard clauses
Processes that can be automated or made more efficient, either totally or partially	• Establishment of the project team • Definition of the contractual model and of the object of the contract • Conclusion of the due diligence and preparation stage • Final adjustments made to the project • Publicity and feedback from the industry • Definition of commercial and contractual requirements • Preliminary structuring and elaboration of qualification requirements • Preliminary structuring and elaboration of proposal requirements • Elaboration of the draft contract • Exchange of information with possible participants in the bidding • Planning for the bidding process • Review of minimum requirements for bidding and approvals
Problems solved in the call for tender structuring and contract elaboration stage	• Information asymmetry • Potential inconsistent structuring • Lack of allocation of responsibilities or potential fraud • Incorrect behavior in the approval or generation of certain actions • Potential leaking of information • Unnecessary delays that make the process less efficient • Regulatory non-compliance

The latter follows a longer process and requires a preliminary evaluation of whether the bidder possesses the minimum conditions of aptitude to provide the service, which are, generally speaking, established in the RFQ. Thereafter, the suitable bidders are selected and are sent an invitation to submit proposals with the RFP and the draft contract. Then, the usual sequence is: evaluation of the proposal, selection of the winner, contract signature, and financial close (see Annex 3 for the sequence of both types of processes, stage one and two). The mechanisms and the stages for communication and feedback from potential bidders also vary greatly according to the type of process.

In exceptional cases, it may be necessary to negotiate even after the offer has been selected, for various reasons: (i) the requirements

TABLE 3.4 POSITIVE EFFECTS AND OPPORTUNITIES ARISING FROM THE USE OF NEW TECHNOLOGIES IN THE TENDER AND AWARD PHASE

Who participates?	• Entity responsible for the bidding processes, potential bidders, civil society representatives who might be affected
What is automated?	• The bidder selection process, the exchange of information between potential bidders and the selection entity, compliance with terms and the presentation of proposals
Processes that can be automated or made more efficient, either totally or partially	• Call for the presentation of proposals • Pre-qualification or preliminary selection of potential bidders • Period of competition • Evaluation of proposals and selection of the winner • Contract signature and financial close
Problems solved in the contract bidding and award stage	• Information asymmetries • Non-compliance with terms • Incomplete information • Poor negotiation of inconsistencies • Fraud • Regulatory non-compliance

established by the RFP or draft contract have not been sufficiently clear, which led to an error of interpretation by the bidder; (ii) the requirements established in the RFQ were not accepted by the awarded bidder's financiers, in particular in relation to risk allocation; or (iii) the text of the contract may have assumed that the RFP was to be fulfilled in a certain way, but the proposal was made in another and, although it therefore still complies with the RFP, the contract must still be adjusted. If any of the above circumstances occur, or any other that makes a renegotiation necessary after the successful bidder has been chosen, care should be taken to resolve the matters in question without allowing the bidder to gain a better position at the expense of the public interest (government).

When this stage has been closed, the real execution of the PPP contract begins. The contract management strategy must have already been established by the time the contract is signed (see the summary of the stages involved in execution of this phase in Table A3.4 of Annex 3).

Automation of this phase offers potential in the search for patterns and the establishment of links between datasets in order to identify networks of financing, property, and interests, which at the same time is important for detecting cases of fraud and corruption. It can also help to improve competitive conditions in the market, since the greater quantity of contractual information available regarding the public investment project portfolio, previous contracts (to identify possible re-contracting opportunities), and the details of such contracts enable more private sector actors to prepare adequately for future procurement processes.

3.5. CONTRACT MANAGEMENT

This is the longest phase of the entire PPP process and its greater challenge is to ensure that the technical, economic, and financial benefits that justify the initial decision to execute the project through a PPP are maintained and achieved. In this sense, the process and rules for managing the contract are fundamental. This process permits all parties to fulfill their obligations in satisfying the contract objectives. Good contract

management also requires that those responsible for the contract are proactive when it comes to anticipating future needs, or that they react appropriately to unforeseen situations. Throughout its execution, the contract will be subject to potential risk events, disputes, and changes in the object of the contract or the services required. Constant management of the PPP contract is needed to fulfill this aim. The significant actors in this phase are the government, the selected firm, and the financiers.

The contract management framework or plan is crucial for the success of the PPP and contains four main components, which include establishing a government team and a contract management team; conditions for the administration of the contract, which ensure that the obligations and responsibilities contained therein are complied with; a relations management component, due to the need for frequent communication and exchange among the public and private partners; and a performance management component, which constantly evaluates how the services are being delivered, in accordance with the established standards and key performance indicators.

The contract management plan must also include a plan of succession. Given the extended duration of a PPP contract, it is unlikely that the civil servants themselves and the persons who designed the project will be involved throughout its execution. Therefore, the plan for project continuity must be established by the contract management manual. Knowledge transfer and recording the lessons learned must both be prioritized. Training new personnel responsible for ensuring that the policies and procedures are clearly maintained and effectively implemented is essential.

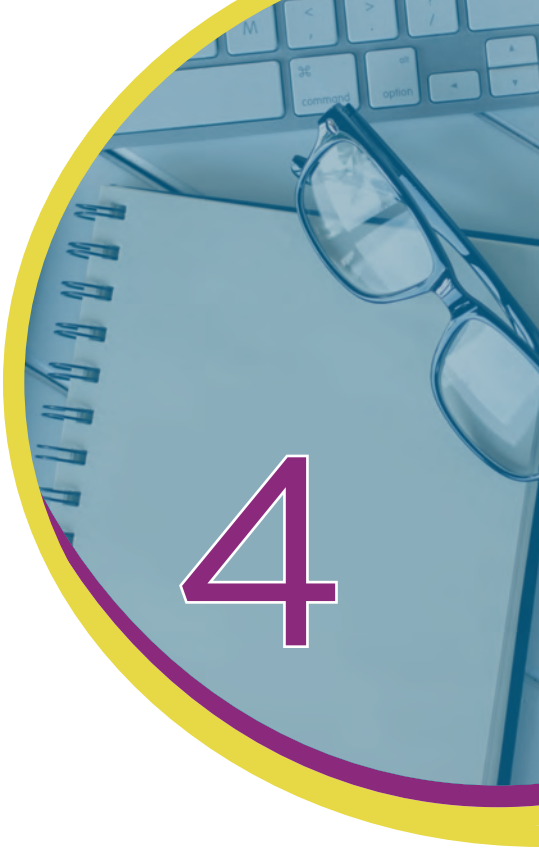
A transition plan should be linked with a communications plan that ensures that the schedule is maintained and that all partners are aware of any changes that occur. It must also include the processes and compliance schedule for government actions. For this purpose, the government should appoint a person from a senior management level assigned to the project to lead the period of transition and should also put systems into operation to fulfill its own obligations. The principal processes and activities are summarized in Table A3.5 of Annex 3.

Automation of this phase presents an opportunity for improving PPP execution and the monitoring process. The possibility of linking budgets, financial data, and results of the contract execution through the implementation of DLT, on top of the use of smart contracts and other technologies mentioned in Section 2.1, would enable a more comprehensive evaluation of the results of the PPP.[24]

[24] This benefit would be similar to that gained by implementation of the Open Contracting Data Standard. See http://standard.open-contracting.org/latest/en/getting_started/use_cases/.

TABLE 3.5 POSITIVE EFFECTS AND OPPORTUNITIES ARISING FROM THE USE OF NEW TECHNOLOGIES IN THE CONTRACT MANAGEMENT PHASE

Who participates?	• Government agency responsible for contract execution, winning bidder awarded the contract
What is automated?	• The exchange of information between the winning bidder and the body responsible for monitoring contract execution, compliance with terms and compliance with technical requirements
Processes that can be automated or made more efficient, either totally or partially	• Implementation of the contract management framework • Verification of compliance with obligations by private partners • Verification of compliance with obligations by public partners • Management of relations between actors other than the contract partners, with direct or indirect links to the PPP • Exercise of the contractual rights of all parties • Implementation of the contract exit strategy and return of the good, if applicable
Problems solved during the stage of contract management	• Information asymmetries • Non-compliance with terms • Incomplete information • Poor negotiation of inconsistencies • Fraud • Regulatory non-compliance



4

COSTS, LIMITATIONS, AND RISKS OF PPP AUTOMATION

Given the relative novelty of new technologies and constant technological progress, implementation of AI, DLT, API, data analytics, biometry, cloud computing, semantic technology, data point methodology and smart contracts is accompanied by a differential cost structure, as well as certain limitations and risks inherent in its nature and design and in the available institutional and legal infrastructure.

4.1. COSTS OF USING NEW TECHNOLOGIES

The implementation of new technologies requires at least three stages, each accompanied by specific budgetary, administrative, and operational requirements: design, validation, and deployment. These three stages must be considered for each one of the phases of PPP implementation. For their execution, a multidisciplinary group is required that enjoys the support of the decision-making areas, can work with agile methodologies, and consists of persons with the necessary technical knowledge (experience of working with the technologies to be used) and business knowledge (the phase of the PPP for which these technologies are being implemented) and, in the majority of cases, technical knowledge of the good or service that the PPP will provide. Human resources costs are essential and probably represent the highest component when the total cost of adopting these technologies is analyzed. Moreover, the institution responsible for project management and maintenance must either train its own internal human resources or recruit new staff to carry out these tasks over the medium and long term.

The cost of the technology itself is not particularly significant, and even less so when compared with the overall magnitude of most PPP projects and in relative terms to the benefits accruing from its adoption. In this ambit, the project manager must take into account the cost of creating and maintaining the DLT platform, designing the smart contract, maintaining and updating the additional tools used, and ensuring risk prevention and cybersecurity. Participating entities also incur costs when adapting their own existing processes and tools to participate in the DLT.

As previously indicated, the benefits of implementing these technologies are multiple

in terms of simplification, time saving, and even saving on resources dedicated to monitoring and oversight processes. The benefits will probably be even greater if the benefits obtained from the operational and financial efficiency of a project managed manually could be accurately quantified and compared to one that incorporates these new technologies.

4.2. LIMITATIONS AND RISKS IN THE USE OF TECHNOLOGIES

Some of the technologies described in Section 2.1 are already being incorporated into the operations of both public and private sector actors, some more easily than others. For example, the use of biometry for matters of identity or cloud computing have been adopted much more readily than have DLT, smart contracts, and machine-executable regulations. In the first part of this section, the limitations and risks of employing these technologies are examined. Thereafter, the limitations of DLT, smart contracts, and machine-executable regulations—tools that are less understood or explored—are tackled in greater depth.

4.2.1. General Limitations and Risks

The category of general limitations and risks makes reference to regulatory and institutional elements that can increase the cost or hamper the deployment of any of the technologies mentioned in Section 2.1. These limitations can probably be resolved over time with the increase of cases of use, experimentation, and technological progress.

a. **Legal uncertainty.** The use of certain tools based on new technologies—especially when it comes to public sector operations—frequently calls for express recognition of this possibility or the removal of related prohibitions. This is true, for example, of the possibility of using cloud computing, which in some countries is restricted by the prohibition of establishing databases in foreign countries and by the absence of local suppliers. A further example is the use of API, which, although it does not require authorization in a regulatory sense, cannot be efficiently carried out unless the industry defines standards for its deployment. For this reason, in some countries the regulators have decided to intervene to establish standards in this respect.

b. **Confidentiality issues.** The use of most of the technologies in question implies the exchange and management of data from diverse sources. The regulations can preserve the rights of parties to keep certain information private. The design of the smart contract integrated with DLT must envisage the possibility of preserving the privacy of the information, segmenting the needs according to processes and actors (e.g., restricting access or making the data anonymous before incorporating it into the DLT). For example, only the regulator needs access to information about financial statements or revenues of the contractor. It will probably be necessary, moreover, to encrypt the information or implement some similar mechanism. In some countries, there may be an even deeper conflict, given that privacy regulations demand the elimination of certain types of information of a personal nature once a certain period has elapsed, which is complicated or impossible to do in the case of some DLT platforms.

c. **Lack of technical capacity to drive the use of new technologies and accompany their selection and implementation process in the public and private sectors.** The new technologies, and in particular the use of DLT, smart contracts, and AI tools, requires personnel trained in their development and who can incorporate them efficiently and convincingly into the day-to-day running of the institutions. Most public sector institutions lack staff with knowledge of or exposure to such technologies. Senior management at these institutions are usually unaware of the

opportunities offered by their deployment, or else the institutional frameworks that regulate them make them risk adverse when it comes to their deployment. To facilitate the digital transformation process, there must be guaranteed availability of human capital to accompany the process and to keep it operational.

d. **Poor quality of the telecommunications network.** Adoption of these technologies requires effective telecommunications and connectivity infrastructures that can guarantee the continuity of operations with these tools. For example, if the Internet of Things were used to supervise certain contractual conditions of a road building project and the telecommunications signal was substandard, then the real-time recording and transfer of data would be ineffective.
e. **Lack of a solid cybersecurity framework.** The use of these technologies and the generalized automation of the process increase the existing cybersecurity risks. The adoption of these technologies is more expensive due to the absence of a solid framework for risk prevention, from a legal and functional point of view, that can deliver warnings about major incidents, provide effective responses, and allocate responsibilities.
f. **Limitations arising from the applicable public procurement regulations.** The adoption of these technologies by public sector institutions is subject, in the great majority of cases, to stiff procurement regulations that can greatly inflate the cost of the technology supplier selection process, especially when taking into consideration the limited number of suppliers of such technologies from which to choose.
g. **Political risk.** Political factors, such as the high turnover of civil servants responsible for project management or changes in budget priorities, can affect the process of designing and implementing solutions of this nature. These factors are no different from the factors that affect the implementation of any type of project, except that in those with a high content of technological innovation, ignorance of the matter at hand may also affect continuity in implementation.

4.2.2. Limitations on the Use of DLT and Smart Contracts

This section describes the principal limitations on the use of DLT and smart contracts.[25] Not all of them directly affect implementation of these tools in the context of a PPP. However, it must be remembered that their implications vary according to the stage of the process, the selection of the contractual model, its clauses, and the model of governance.

a. **Scalability.** The problems of scalability most commonly appear in public network schemes, as these are provided for mass use. The current systems are considered to be slow in relation to alternative systems that manage a high quantity of transactions. The main problems of scalability are due to the time needed to record a new transaction in a block and the additional time required to reach a consensus about this transaction.[26] This potential limitation would not have implications in the application of DLT and smart contracts in a PPP intended for use in a private or hybrid network (i.e., one operated by a small group of actors).
b. **Exactitude.** No robust and standardized mechanisms exist to audit and validate the computer code that constitutes a smart contract. The existence of errors is therefore possible. Moreover, it is not possible to program ambiguity into agreements (for example, clauses that refer to acting with the greatest possible diligence). Most commercial contracts include this type of ambiguous directive, as they are unable to anticipate all the possible pathways that execution of the contract may follow in the future. Some even

[25] Ream, Chu, and Schatsky (2016) and Civalleri (2017).
[26] Rosic (2020) and Civalleri (2017).

argue that it is best not to negotiate certain future events beforehand, since their probability is minimal and the negotiation may be very expensive.[27] Some typical clauses of an ambiguous nature in a PPP are those relating to force majeure clauses or that anticipate the premature termination of the contract.

This probably implies the additional use of an inefficient system of smart contracts that is tied to legal documents drawn up in parallel. The risk of error and inconsistency between two contracts that govern the same contractual relation can be high and makes the use of smart contracts less attractive.[28]

c. **Interaction outside of the chain.** Compliance with, or satisfaction of, smart contract objectives is conditioned by their programming and by the sources of information they utilize. There are various limitations on incorporating into the structure of smart contracts information from external sources (i.e., sources that provide information not available locally in the DLT platform that delivers the execution of such contracts). This would limit the possibility of automating, for example, contractual clauses that depend on external data that cannot be validated by the contractual subjects. The solution to this limitation needs to be meticulously considered and analyzed, given that it introduces added complexity to the system while representing a potential source of security problems.

d. **Reversibility.** Given that errors are inherent in the programming, the latter will always be characterized by some level of imperfection, even though in some cases the parties can consent to amend the agreements. This is not always sufficient and is conditioned by agreement among all parties. A common example of these incidents are the so-called hard forks, in which the community behind a public network is incapable of reaching agreements about how to solve a problem or about the direction that the project should take, and the network ends up being fragmented into different departments. This condition, however, should not represent a potential problem when applying the technology to PPP administration, insofar as an adequate model of governance exists.

e. **Physical assets.** The use cases of smart contracts that effectively link the agreements with physical assets are still in the early stages of development. The process of creating a native digital representation of an underlying asset is known as tokenization. There are still many different technical and regulatory points of view about which is the best method to carry out this process, as well as what its legal considerations and implications are.

4.2.3. Risks Inherent in the Use of DLT and Smart Contracts

These risks are inherent in the deployment and use of any technology, which means they bear no direct relation with the object of their use—in this case, the PPP. However, they still need to be carefully analyzed and considered.

a. **Operational.** This type of contract may either include or lack adequate mechanisms for resolving functional errors,[29] while at the same time depending on other systems to fulfill the conditions of the contract, which may be susceptible to vulnerabilities.[30] The risks of fraud and manipulation form part of the set of operational risks and can be manifested by the introduction of malicious code or manipulation of the code by persons with privileged information. It may also occur through external sources of information, by accepting or distributing unexpected information, which leads to results inconsistent with the intentions of the parties. Finally, the creation of a smart contract does not preclude the

[27] Wall (2016).
[28] Civalleri (2017).
[29] These are unforeseen errors that derive from the operation or implementation of a system.
[30] LabCFTC (2018), pp. 16, 26, and following.

existence of source errors, starting from the conceptualization and design of the contract.

b. **Technological.** Such risks are related to the reliability of the architecture, the algorithms, and the protocols and software used during the design, implementation, and deployment of the technological tools necessary for smart contract operation. The implicit question is whether these contracts can be altered or manipulated in such a way as to negatively influence the expected result. This will depend on the structure and security of the system and on who has custody of the assets involved. There are different strategies, considerations, and best practices for resolving different types of attacks and vulnerabilities. However, the underlying risk of problems related with cybersecurity still remains.[31]

   Other technological risks include failures in infrastructure, incompatibility of user interfaces, or substandard operation of the physical equipment used (computers, servers, network equipment, etc.). Finally, there is always a risk that events may arise unexpectedly in the future to cause a shock to the technology. One example would be the introduction in the market of so-called quantum computing, which would bring critical vulnerability to the security mechanisms currently used for establishing secure global communications on the internet.

c. **Legal.** The main legal risks are linked to the privacy of information and the use of privileged information. Given that information is stored in a distributed way between different nodes, each node operator has access to it. The high transparency level of this database might permit the nodes to reveal the identity behind certain transactions. Two legal risks derive from this characteristic, one linked with data privacy and the other with the undue use of privileged information, which can include identity theft. One way of mitigating this risk within the framework of PPP automation would be to sign confidentiality agreements, clearly establishing who is able to access the information and in what conditions.

Incorrectly applied, some of the characteristics inherent in DLT, such as the distribution and immutability of the information managed, can enter into conflict with rights and regulations that are linked to data privacy. By sharing information among multiple nodes, access can be facilitated to private datasets, or may be contrary to that established in the data privacy protection laws. A further significant problem in this same ambit derives from the fact that the information, once registered, can no longer be modified. The development of any DLT must take into account strict compliance with regulations regarding information privacy, as well as the potential impact of the characteristic of immutability on the rights of individuals or firms.

The characteristic of network transparency can give rise to abusive behaviors in the market, such as the use of privileged information. If the DLT is used to store sensitive information, it may possibly be used wrongly for undue benefit and to manipulate results in the market. Civil and penal regulations should be considered that would sanction the undue use of privileged information and market abuses.

Finally, it is important to determine how smart contracts can fit within the country's legal framework, where they will be implemented, and what the responsibilities are of the parties that implement them, as well as the contractual responsibilities of all contract signatories.[32]

4.2.4. Factors to Consider When Using Machine-Executable Regulations[33]

When it comes to using machine-executable regulations, various factors must be considered, such as the limitations or potential risks. In the case of a PPP, these risks seemed to be mitigated by the type of predominant regulations, which refer

[31] See Amuial, Dewey, and Seul (2016), pp. 12–13.
[32] Filipova (2018), pp. 86–90.
[33] Burt et al. (2017).

more to processes and protocols. However, the true impact of these risks can only be contrasted by a real pilot scheme of automation of a PPP.

a. **Ambiguity of the regulations.** On occasion, the language in which the regulations that govern the design and supplier selection processes within the PPP framework are written is open to multiple interpretations. It may not be entirely evident what meaning should be given to them and how to convert them into machine-executable regulations. In some cases, ambiguity is even intentional. Converting these arrangements into machine-executable regulations is a challenge that is not greater than that of the manual process, in which the process of interpretation has to be carried out anyway, although only subsequent to the events. If machine-executable regulations are used, this same process of interpretation must also be carried out but in this case prior to the events, a scenario that is even more favorable given that it guarantees greater legal certainty and predictability.
b. **Potential coding errors.** Errors in the code that applies the applicable regulations to the PPP contract design and elaboration process can lead to non-compliance and generate assumptions of responsibility. Coding errors may occur in any technological implementation. Mechanisms must be designed to mitigate this risk, based on the possible impact that the implementation of machine-executable regulations can have.
c. **Lack of flexibility.** The absence of ambiguity when applying the regulations that govern the design, supplier selection, and contracting processes within the PPP framework can bring multiple benefits by enabling the applicable regulations to be better understood and more easily applied. However, the flexibility is lost that currently helps to adapt to new or unfamiliar contexts that, for example, give rise to the renegotiation of contractual conditions.
d. **Opaque code.** More extensive use of machine-executable regulations will require technical staff with exclusive responsibility and capacity for understanding the code that transcribes the regulations. The possibility that there might be modifications and that additional considerations are introduced over time carries an underlying risk that the base code is less transparent and creates some of the very inefficiencies and ambiguities that it sought to contain. The stability of the code as well as its quality, efficiency, security, maintenance, and documentation will all be essential if machine-executable regulations are to be successful over the medium and long term.
e. **Challenges arising from different versions.** Revising the code can become an unmanageable process. Organizations may want to maintain visibility in managing the process of regulatory changes every time a new version is launched. Moreover, they will expect some predictability in communicating the changes and planning the cycles of new software releases. Likewise, the need to introduce software improvements, adjustments, or corrections will be revealed naturally as the latest versions are launched. Finally, the source code and the data code used will become more important over time, insofar as the systems of machine-executable regulations become auditable and subject to due diligence.
f. **Opportunities for abuse.** The transparency of machine-executable regulations is key for developing trust and providing accountability, for both the regulator and the regulated organizations. However, the use of machine-executable regulations also can generate regulatory arbitrariness. Institutions may find opportunities to evade compliance with certain rules for the redaction, promulgation, and maintenance of the code in which the machine-executable regulations are written or minimize compliance with certain requirements, especially as they are capable of verifying compliance in real time.

g. **Security.** Cybersecurity risks are minimal compared with the benefits that can accrue from implementing machine-executable regulations. However, it is important to take into account the need to preserve the confidentiality, integrity, and availability of the information in the process. The success of such initiatives will depend to a large extent on their adoption and diffusion, which, in turn, will depend on the level of trust that the institutions and users place in them. It is therefore of vital importance to define plans for implementation and deployment that pay due attention to security measures and to adequate security policies.

5 CONSIDERATIONS OF A PRACTICAL LEGAL ORDER

Any legal order must contain a set of regulations as preconditions for implementing any system in the public sector that uses such technologies as those described in Section 2.1—that is, API, DLT, AI, smart contracts, and machine-executable regulations, among others. These legal considerations respond partially to the general limitations and risks identified in Section 4.1.1. The main regulations to be considered are reviewed below.[34]

a. **A law permitting electronic signatures and a legal framework for the validity of electronic transactions.** Depending on the country, there must be a legal framework that allows for the use of electronic signatures and ensures the validity of agreements or transactions made by these means. In countries with a Romano-Germanic legal tradition (civil law), in which the public administration can do only that which is expressly authorized by law, the validity of such acts must be recognized by the laws that govern the validity of administrative acts.

b. **Digital identity.** Given that the use of the three technologies analyzed implies that different subjects use their transactional capacities online, it must be possible to effectively identify them by digital means. Progress has been made in many countries in transforming physical national identity records into electronic warehouses; in others there are isolated initiatives to generate safe and effective electronic user credentials. Very few have connected the information that verifies identity with practical applications. For example, in the financial services area, only a few countries have allowed the national identity register to be hooked up with the identification system established by financial institutions as a requirement for opening bank accounts. Using digital mechanisms to help verify the identity of the actors participating in a PPP is essential for guaranteeing lower costs and improving process efficiency. The use of biometry is an important tool that should therefore be considered.

c. **Regulations linked to the use of DLT.** The regulations in the applicable jurisdiction that have effects on the use of DLT as the technology underpinning smart contracts should

[34] O'Shields (2017), pp. 190–193.

be identified. Moreover, all legal aspects concerning the technological infrastructure required, including its physical location, must be taken into account. Furthermore, the framework that governs the contractual process or agreement must define the platform (network) administration and operation models underlying the smart contract. These considerations and guidelines are crucial and determine the allocation of responsibilities with respect to the code, to other databases, or to third parties within the contract framework. Regulations regarding civil or administrative responsibility are also applicable to these components of the process.[35]

d. **Regulations on algorithms.** Attention must also be paid to finding a legal way to ensure that algorithms comply with the results desired by the parties, while also defining in conjunction with the authorities which information can be provided to the actors forming part of the agreement and which testing routines must be included in the algorithms used in AI or DLT solutions. In the case of DLT, exactly who will have access to the code and the databases must also be considered.[36] The issues of discrimination or fair treatment, moreover, must be among the main concerns of the algorithm design.

e. **Regulations to establish API development standards.** The creation of national or regional standards for API development and use will make APIs easier to maintain, adopt, and use. APIs are normally used by software developers or engineers, and their value and effectiveness depends on the adoption of solid technical guidelines and an adequate level of standardization among different organizations or sectors. Finally, the use of API development standards guarantees their sustainability over time, facilitating the tasks of design, continuous improvement, and maintenance.[37]

f. **Regulations applicable to the contract execution process.** The central themes here are the validity of proof, giving up rights, and establishing the jurisdiction to determine applicable legislation and which court will be competent to decide the matter. With regard to the validity of proof, the difficulty lies in the fact that the evidence is probably contained in the computer code. One way of solving this problem is to maintain a version of the code translated into natural language, which can be updated insofar as changes take place.

g. A further matter to consider in the validation of a smart contract's integrity in any court case is the verification of protocol security. This calls for additional technical knowledge on behalf of legal authorities.

h. Finally, the matter of which jurisdiction is responsible for the smart contract derives from its operation through a DLT platform such as blockchain. The question that may arise here is where the DLT is located. To solve this potential conflict, it is important to clearly identify the platform operator and to establish which law will be applicable in the event of any legal dispute.

i. Some authors suggest that smart legal contracts replace or reduce the need for litigation. Although this can be partially dealt with through conflict resolution mechanisms established in the DLT platforms themselves, parties must also envisage supplementary or complementary ways of seeking arbitration, by legal or other similar avenues.[38]

j. **Cross-cutting regulations applicable to businesses in which assets and information are moved.** Smart contracts are designed to be machine executable and to obviate human intervention. Controls must therefore be incorporated that permit the enforcement of regulations to combat money laundering and the financing of terrorist activities, as well as to block any transaction or transfer from an

[35] Zetzsche, Buckley, and Arner (2017), p. 28.
[36] Ibid., p. 23.
[37] Vasudevan (2017).
[38] Smart Contracts Alliance (2018), p. 32.

unidentified user. Other legal frameworks to be considered in the contract design include regulations on intellectual property rights and consumer protection and tax regulations, among others.

k. **Regulations requiring the mandatory hire of a lawyer for certain transactions.** In some jurisdictions and for certain types of transactions, a lawyer must be hired to assume responsibility for the legal aspects of the transaction. In such cases, the lawyers will have to verify the contractual terms contained in the computer code, as the security of these terms throughout the period of the contract.

l. **Regulations linked to free market competition.** In certain types of smart contracts executed using DLT, a problem may be caused by the creation, whether intentionally or otherwise, of barriers to free competition, which encourage or facilitate the formation of monopolies or oligopolies or give rise to abusive market practices. For example, the European Securities and Markets Authority (ESMA) has pointed out the risk that DLT participants may reject or impose conditions that are impossible to fulfill or that are too costly to allow new members to participate in the DLT, which can constitute abusive behavior. Likewise, the protections granted by patents or interoperability requirements can force some actors out of the market and lead to monopolistic situations, to the detriment of both service cost and quality.[39]

[39] Zetzsche, Buckley, and Arner (2017), p. 37.

6

CONCLUSIONS

- Structuring a PPP follows a complex process that comprises five major phases: identification and evaluation of the project, structuring of the design of the call for tenders and elaboration of the draft contract, the tender and award of contract phase, and finally the contract execution phase. Each one of them requires the participation and the allocation of responsibilities by different sectors, and evenpublic and private sector institutions, and are normally subject to specific regulatory frameworks, applicable to each one of the phases.
- These are complex processes due to the large number of participants, the different regulations that govern them (which are often found dispersed among different regulatory bodies), the number of technical specifications to which they are subject, and the constant flow of information that they require.
- They have been called into question for matters linked to lack of transparency, excessive bureaucracy, sluggishness, lack of efficiency and effectiveness, and consistency with existing public policies. There have even been some cases of fraud and bad management that call into question the very mechanisms set up to monitor them.
- Their procedures rely mainly on manual processes and procedures that are executed in silos (isolated from each other), which facilitates the introduction of subjective criteria and inconsistencies with previous arrangements and that obscure the process of allocating responsibilities.
- New technologies such as DLT and smart contracts have enormous potential to offer a solution to problems of transparency, allocation of responsibilities, and unnecessary delays, and they can provide consistency among the different stages of the process of design and implementation of a PPP.
- Most of the literature or the previous experiences have not envisaged the use of these technologies in the context of a PPP.
- It is likely that not all the components of each phase are completely suitable for automation, even regarding contract content. Therefore, it will be necessary to envisage spaces for executing the phases manually or exploring the use of natural language and

a physical contract in parallel, when implementing these technologies in different phases of the PPP.

- To tackle these problems, each one of the phases of the PPP should be isolated and independently introduce the necessary technologies, albeit with a view to the future integration of each one of these phases.
- The effective implementation of smart contracts and DLT is conditioned by their efficient design and by a regulatory framework that permits these technologies to be used and granted legal validity, such as valid environments for the execution of transactions, and means of proof in legal processes, should this be necessary.
- When structuring the potential application of these technologies, it is indispensable to analyze whether the regulatory and institutional framework enables the pilot scheme to be carried out, as well as whether good-quality human resources are available to apply them and to provide subsequent continuity to the project.
- The estimated costs of implementing these technologies (once the legal and institutional matters have been resolved) are closely related to the selection of the teams that work with agile methodologies and that have specialist knowledge of DLT, smart contracts, and other new technologies; to the work or service to be contracted through the PPP; and to the PPP design and implementation processes. At this stage, it is almost impossible to estimate the costs of implementing these technologies in a project and even more so to compare them with current project costs, whose transparency is very limited.
- Risks in matters of cybersecurity, operational continuity, and information confidentiality will increase exponentially when smart contracts are implemented. A larger quantity of resources must therefore be earmarked in order to incorporate mitigation and prevention mechanisms.
- The main advantages of implementing smart contracts and DLT in each one of the PPP-related processes are concentrated in facilitating the exchange of information between different actors (from both public and private sectors); making data immutable; permitting verification of compliance with prerequisites, technical requirements, attributes, and terms; and simplifying and accelerating the verification and approval processes.
- A diagnostic of the application of these technologies and of each one of the PPP stages in the specific context of a particular country would help to fine tune any evaluation of the potential of DLT and smart contracts in these processes.
- The phase in which it would be most productive to launch a pilot scheme of this nature is the sixth phase—oversight of contract execution; this presents the best opportunity for delivering results in terms of efficiency and operational transparency, as it requires the participation of different actors and the existence of an operational framework that is predefined by the contract. This would also permit better evaluation of the costs of implementation and their comparison with a manual process. The natural next step would be to develop a pilot scheme that seeks to automate the contract monitoring stage by using DLT, smart contracts, and other complementary technologies.

GLOSSARY

Term	Definition
Application programming interface (API)	Set of communication mechanisms that permit an application or system to utilize procedures and functionalities provided by another software tool. This facilitates complex operational schemes such as federation, delegation, and composition.
Artificial intelligence (AI)	Field of computing sciences specialized in the design and development of algorithms and software systems with behavior capacities that can be considered "smart." That is, these are systems capable of modifying their operation according to the conditions of the environment with the aim of maximizing the probabilities of successfully completing the allocated task.
Big data	Datasets with processing and analysis difficulties or special considerations, according to three fundamental magnitudes: volume, variety, and velocity.
Biometry	Statistical measurement and analysis of the physical characteristics of the individual with a view to carrying out identification or authentication tasks. Some of the most commonly used biometric tools include fingerprint reading, retina scanning, and facial recognition.
Cloud computing	A trend characterized by the supply and the consumption of different technological infrastructure components within an on-demand scheme. This allows institutions to adopt more agile financial and operational models, thereby reducing the times associated with the supply, installation, and deployment of physical equipment. Moreover, capital requirements are reduced and a variable scheme of costs is introduced.
Data analytics	Specialized science in the development of methods and tools that can obtain significant and actionable values and conclusions based on a dataset.
Digital identity	Dataset and information stored and transmitted by electronic means with a view to describing, identifying, or authenticating an entity in a digital environment.
Electronic signature	Set of standards and tools that, exclusively by digital means, permit the attestation and subsequent verification of information in different electronic formats. By using an electronic signature, a user (that is, the signatory) can provide guarantees of integrity and non-repudiation to a partner (that is, the person verifying the contract).

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Term	Definition
Hard fork	In the context of distributed ledger platforms, this is an event after which a linear chain of entries forks irrevocably, leading to the creation of two or more independent chains. This obliges participants to choose between different candidates in which to invest available computing resources.
Machine learning	Field of computing sciences specialized in the design and development of mechanisms that permit a software system to perform advanced data analytics tasks such as pattern recognition, anomaly detection, and trend analysis, among others. A significant characteristic of these systems is their capacity to incorporate the results obtained from a knowledge base with a view to accumulating "experience" and maximizing the probabilities of success in subsequent executions.
Open data	Term associated with datasets that can be freely consumed, used, and distributed, with the sole requirement (sometimes optional) to recognize the authorship and original source of information. There are also technical requirements that must be observed to facilitate the consumption and use of datasets, such as coding formats and publication mechanisms, among others.
Tokenization	In the context of digital assets, this is the initial generation process of an asset of purely digital representation. There are different types of digital assets that, at the same time, can serve or not as a representation of another underlying asset.

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ANNEX 1
DEFINITION AND TYPES OF PPP

Broadly speaking, a PPP refers to the commitments between the public sector and the private sector to share the risks and responsibilities in the provision of public services. They are expressed by long-term contracts between a private entity and a government agency for the purpose of providing a public good or service, in which the private actor assumes a significant proportion of the risk and takes charge of managing this public service or good in exchange for monetary reward.[40]

There is no single definition of a PPP and the institutional agreements by which they are constructed vary according to the country and to the reason for the partnership. After reviewing these agreements in more than 30 countries, we have identified terminological differences and other discrepancies linked to the definitions, focus, and mandates of PPP institutional and legal frameworks. In any case, in all of these partnerships there is a substantial component of explicit or implicit financial risk with a potentially significant impact on the fiscal balance sheet.[41]

PPPs cover different types of public-private interactions that include providing goods and services in the markets of transport, public services, schools, hospitals, libraries, and prisons, among others. They may include both the provision of new assets and the recuperation or management of existing ones. They may also be employed in any economic sector and by any level of government.[42] They are principally classified according to the public-private financial link or by the type of participation of the investor in providing the good or service (for more detail of these categories, see Table A1).[43]

PPP LEGAL AND INSTITUTIONAL FRAMEWORK

The success of a PPP depends on the existence of an institutional framework and control system to make it effective. There is no standardized or single structure to determine the best arrangements to achieve this. However, there are essential elements that any institutional framework must contain, such as the definition of institutional

[40] World Bank (2017) and Reyes-Tagle (2018).
[41] Reyes-Tagle (2018).
[42] Ibid.
[43] APMG (2016), Ch. 1.

processes and responsibilities, including those of the ministry of finance or the treasury, and publication and transparency requirements.

The PPP legal framework varies according to the legal tradition of the country. In the majority of countries with an Anglo-Saxon (common law) tradition there is no legal definition of a PPP. Countries such as Australia, Canada, Malaysia, or Jamaica use common definitions established in policy documents. Countries that follow the Romano-Germanic tradition, generally speaking, define PPPs in a specific law, including the types of allowed contractual structures and the applicable clauses. In some cases PPP regulations are contained within public investment regulations, as in the case of concession laws in Chile, Ireland, or Spain, or public procurement legislation in France. At the subnational level, many countries permit the creation of specific regulations for PPPs, given the intensive use of these structures for project financing.

The existence of an adequate institutional framework is essential for the success of a PPP. Successful institutional frameworks tend to be characterized by the standardization of processes, alignment of regulations with international standards, and solid fiscal management. Misgovernment, the absence of any government, or the incapacity to implement the institutional framework are some of the recurring reasons that explain why projects fail to meet their own schedule or even to reach their pre-established objectives. A solid framework should cover: the type of projects that can be financed with a PPP, the partner selection and contracting process, including the diffusion of information before and after selection, and the decision-making authorities in charge of the selection and contracting process, as well as for contract execution.

TABLE A1 TYPES OF PPP

Category of classification	Classification criteria	Typology
Public-private financial link	Source of revenues for the private partner	1. Paid by the user 2. Paid by the government
	Ownership of the PPP firm or the financial vehicle with this purpose	1. Conventional (100 percent of ownership belongs to the private sector partner) 2. Institutional (100 percent of ownership belongs to the public sector or else a minimum form of joint venture with public sector control) 3. Joint venture or mixed models
	Object of the contract	1. Provide infrastructure or projects that require significant capital investment, in which the main objective is management of the infrastructure over the long term 2. Integrated when, as well as the infrastructure, the private partner must operate the service 3. Services (operations and maintenance), when the private sector partner neither invests capital nor develops a new infrastructure
	According to the share of financing by the private sector partner	1. Co-financed, in which a substantial part of the investment is financed by the public sector in the form of donations 2. Conventional

(continued on next page)

TABLE A1 TYPES OF PPP *(continued)*

Category of classification	Classification criteria	Typology
Type of participation in the provision of goods	Depends on whether it is an existing good or service, and on the type of planned contribution (building, managing, or improving)	1. Greenfield projects: for the financing of a DBFOM, recently awarded or under contract 2. Brownfield projects: investments in existing infrastructure already in operation when the investment is made 3. Yellowfield or secondary stage projects: investment to undertake substantial renovation, extension, or improvement of the existing infrastructure
Other typologies	Denomination of a PPP in different countries (the list is not exhaustive); each can vary according to whether it is designed specifically for building and improving infrastructures or for managing existing infrastructure and operating public services	1. DBFOM, DBFM, DBFO, CDMF: initials that come from the types of contracts and the functions transferred to the private sector actor (design, build, finance, operate, and/or manage) 2. BOT, BOOT, ROT, which capture the ownership and control of the asset 3. Concessions, in which the legal title transfers economic rights to use a public asset to the private sector partner (in accordance with administrative law) 4. Leasing, consisting in a private contract made in the event of building a public facility in private property that can be used by the government 5. PPPs defined as DBFOM contracts, in which payment is the government's responsibility. Specific regulations are frequently created to govern these cases. 6. Institutional PPP, in which the government controls the firm in which the PPP functions and holds the majority of shares

Source: Based on the typology in Chapter 1 of APMG (2016).

ANNEX 2
DLT, SMART CONTRACTS, AND MACHINE-EXECUTABLE REGULATIONS

DISTRIBUTED LEDGER TECHNOLOGY

Distributed ledger technology (DLT) refers to the set of tools and mechanisms used to establish a reliable information base that is administrated in a decentralized way by a set of participating entities. A distributed ledger is operated through a computer network that can be either public or private.[44] All members of the network maintain a shared and reliable record of information that each of them can verify, but that no one can modify individually or arbitrarily.

DLT is a tool that can be beneficial for the implementation of smart contracts in PPPs, given the concurrence of multiple actors in the signing of the agreements and the need for all of them to access the same information in a safe, reliable, and consistent manner. All these attributes are characteristic of DLT, and they are translated into the relations between parties when set out in the form of a smart contract (defined below). Figure A2.1 shows the basic architecture model of a DLT platform.

Its maintenance is carried out through predefined peer consensus and governance models,[45] incorporating technological security mechanisms and incentives schemes inspired by game theory.[46] The combined use of these elements permits peer validation of the information to be recorded in the ledger, which eliminates the need for a trustworthy third party to perform the role of guarantor or referee.[47]

Depending on the access scheme for participants, there are three types[48] of DLT networks: (i) of a private nature (permissioned), (ii) with public access (permisionless), or (iii) a hybrid model. The first is the property of a private actor

[44] Thake (2018).

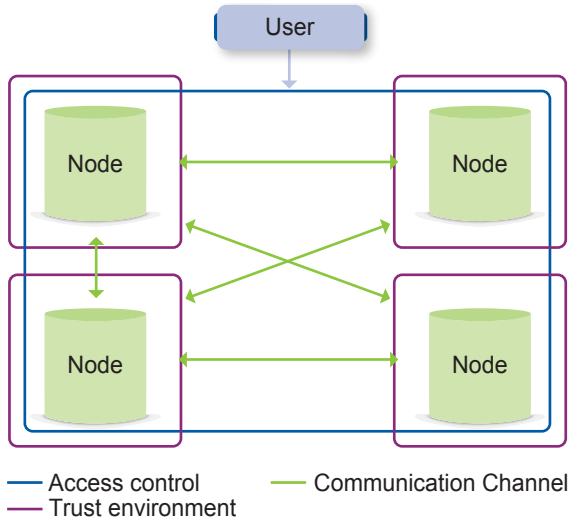
[45] Governance mechanisms determine the way in which the rules, regulations, and interactions between persons are structured, regulated, and sanctioned. They define how the decision-making process will be conducted by the various actors involved in a collective problem. They often reproduce, create, or reinforce social rules and institutions. See Shermin (2017), p. 500.

[46] This is a reference to the study of mathematical models regarding conflict and cooperation between economics agents acting rationally. See Accinelli and Vaz (2013), pp. 1–2.

[47] Hansen, Rosini, and Reyes (2018), p. 2 and Shermin (2017), p. 500.

[48] There is no consensus about the classification of these technologies and they may vary according to the criteria utilized (speed, security, identity, use of assets). See Voshmgir (2019).

FIGURE A2.1 BASIC ARCHITECTURE MODEL OF A DLT PLATFORM



Source: Authors' elaboration.

(or a set of them); its users are delimited by the administrator and authorization to access information depends on the pre-established agreement between the parties. It requires an organization and structure of governance that regulates at least who can participate and the conditions for participation. Only the participants may add new information to the ledger. The second operates under a public domain that permits any interested party to participate in the network.[49] The hybrid model, generally speaking, incorporates a scheme of governance that regulates and administers the participating actors, who may add new information to the ledger, but at the same time permits such information to be publicly audited.[50]

The blockchain is a type of DLT platform that establishes a distributed database wherein the ledger entries are inserted in groups (normally known as blocks) chronologically organized in a linear structure, or chain. Each block contains a unique cryptographically generated digital signature known as a hash (Figures A2.1 and A2.2).

Network participants use previously agreed mechanisms for the verification, validation, and processing of any information proposed by the ledger. These mechanisms are known generically (and in a biased way) as "smart contracts" (see the definition in the following section).

Once the proposed information has been validated, the blockchain uses cryptographic tools such as public and private keys to provide guarantees for the information stored in each block (authorship, immutability, and non-repudiation).

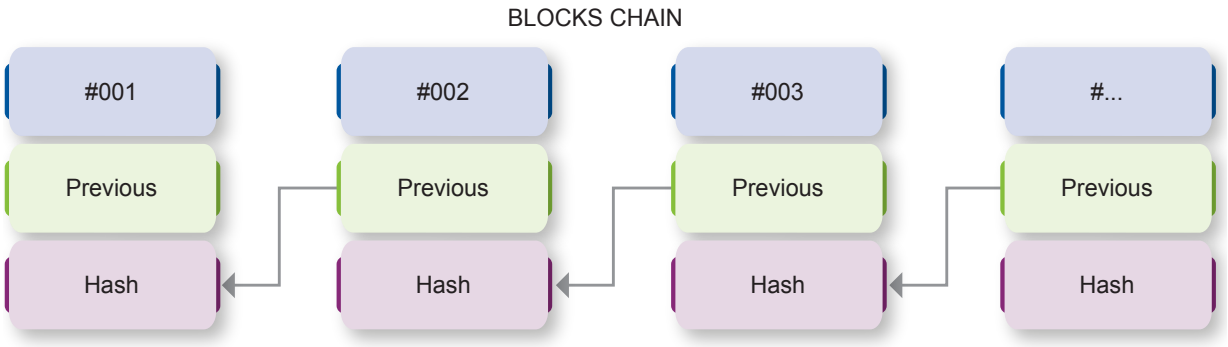
SMART CONTRACTS

The term "smart contract" makes reference to a series of electronic machine-executable instructions that unequivocally describe the clauses of

[49] Filipova (2018) and Zetzsche, Buckley, and Arner (2017).

[50] McKinney, Landy, and Wilka (2018), p. 320.

FIGURE A2.2 CONCEPTUAL DIAGRAM OF BLOCKCHAIN OPERATION



Source: Authors' elaboration.

a contract or the terms of an agreement between different partners.[51] This concept has gained renewed traction due to the possibility of being implemented in a blockchain (see the section on DLT and blockchains).[52] Among the essential characteristics of these contracts is that execution of their instructions can be machine verified and machine restricted. However, these characteristics do not exclude the potential participation of an individual or institution to provide inputs or monitor certain processes.

Trust in the effectiveness of smart contracts is based on efficient operation of the cryptographic algorithms used and of the computer code that comprises them.[53] It therefore depends on the team that develops and audits them. Moreover, due to the way in which they are designed at present, many of them lack the flexibility needed to adapt to unexpected events, in contrast to contracts governed by institutional structures.[54]

In the case of Bitcoin, smart contracts are used with the (limited) aim of maintaining a balance sheet via the exchange of assets. DLT helps to develop and deploy more complex smart contracts, by permitting the coding of more extensive processes and relations.[55]

Finally, it is worth explaining that smart contracts are not necessarily legal contracts, but can be used as a complementary tool to give effect to and to automate the execution of such contracts. Smart contracts that can be enforced in a legal order are sometimes known as "smart legal contracts."[56]

MACHINE-EXECUTABLE REGULATIONS

In the ambit of the financial system, technological solutions are being explored to make regulation more efficient and to simplify the demands of regulatory compliance. These types of solutions are known as RegTech and consist of three main categories: (i) solutions to ensure that firms comply with their regulatory requirements, (ii) solutions to ensure that authorities perform their market oversight and monitoring functions more effectively, and (iii) innovative design of processes and systems linked to regulation and regulatory compliance.[57]

In the case of the third category (innovative design of the processes and systems linked to regulation and regulatory compliance), the machine-executable regulatory approach has emerged, which consists of regulations transcribed into computer code. Using such language, machines can execute the regulatory requirement, effectively extracting the necessary information directly from the supervised party.[58]

Nonetheless, not all regulations can be subject to a total elimination of ambiguity, which means that human intervention will always be required to interpret and implement some regulations. Some regulations can be easily transformed in code, whereas in others ambiguous prescriptions may have been intentionally introduced or may require greater flexibility than that allowed by machine-executable regulations. A suitable machine-executable regulation model must allow for a certain flexibility for these cases.[59]

At present, regulatory frameworks (design and application) are prone to inefficiencies and ambiguities. In most cases, the interpretation of personnel from the legal or institutional compliance areas is required to guarantee that the

[51] Ram and Schatsky (2016), p. 1.
[52] O'Shields (2017), p. 1.
[53] Filipova (2018), p. 89 and Clack, Bakshi, and Braine (2016). The effectiveness of a smart contract is not usually evaluated according to the possibility of demanding legal compliance with the rights and obligations contained therein. See Clack, Bakshi, and Braine (2016), p. 2.
[54] Shermin (2017), p. 507.
[55] Hansen, Rosini, and Reyes (2018), p. 2.
[56] The authors differentiate between two components within the wider concept of smart contracts. One is the legal smart contract that is subject to the applicable laws and can be enforced, while another is the smart contract in code, which makes reference to the software that enables automated execution of instructions. See Clack, Bakshi, and Braine (2016), p. 2.
[57] Financial Conduct Authority (2018), p. 5.
[58] Burt et al. (2017).
[59] Ibid.

actions of the supervised party comply with regulations. The responsibility for such interpretation can lie either with the supervised party or with the supervisor carrying out the oversight.

Machine-executable regulations seek to alter this dynamic by assigning the burden of interpretation to regulators, thereby eliminating ambiguity from the regulations, so they can be executed immediately by software programs from the moment of their promulgation. Implementing this tool brings multiple benefits and risks.

ANNEX 3
PPP DESIGN AND IMPLEMENTATION STAGES AND RISKS MITIGATED BY THE AUTOMATION PROCESS

The set of steps and deliverables in each phase are frequently defined in the applicable legal framework. Tables A3.1 through A3.5 present the potential risks in the execution of these activities or production of these deliverables; in the final column denoted as “SC” for smart contracts, the symbol “√” appears whenever the implementation of DLT, smart contracts, and other technologies presented in Section 2.1 is considered to have helped to decrease or eliminate that risk.

TABLE A3.1 IDENTIFICATION AND EVALUATION OF THE PROJECT AS A PPP (PRE-SELECTION STAGE)

Identification of the project	Risks	SC
• There are three ways: (i) a project identified according to an individual need or a request from a government department; (ii) through a portfolio of projects previously defined by the government as strategic needs or objectives; (iii) through "unsolicited" proposals for private sector initiatives, which must be conducted through the established system. • In any case, they must be aligned with public sector policy objectives. • Faced with the existence of various projects to be financed, a cost-benefit, cost-effectiveness, or multi-criteria analysis must be carried out to evaluate which project to prioritize. In the event of using the cost-benefit analysis, the project is chosen according to the present net value or the highest rate of return.	• Loss or duplication of initiatives • Misalignment with policy objectives • Poor project selection due to omission of certain criteria that should be evaluated • Problems in the allocation of responsibilities	√ √ √ √
Determination of the project scope		
• Requires identification of the sector, technical criteria, and physical, geographical, and demographic conditions, among others. • Requires identification of the issues that can become obstacles for the project and that should be explored in depth during the contracting project evaluation and preparation stage. Some of these factors can be determinants of whether or not to pursue project implementation. • Determining the project scope requires a comprehensive report that describes the needs that the project seeks to address, the costs, term, execution schedule, justification of its suitability within the public policy framework, expected impact factors, other technical options evaluated, potential private sector interest in its financing, availability of land (where applicable), and environmental considerations, among others.	• Full information	√
Economic valuation		
• The best methodology is the cost-benefit analysis. This includes all the direct, indirect, internal, and external costs and should be applied to the entire period of analysis (which should include the useful life of the asset). • The analysis has the following sequence: (i) projection of financial information; (ii) incorporation of externalities; (iii) incorporation of socioeconomic benefits; (iv) definition of the base case, discount rate, and calculation of the present net value and the internal rate of return; (v) incorporation of contingencies (costs); and (vi) closure of the analysis.	• The evaluation sequence is not followed • Problems in the allocation of responsibilities	√ √

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TABLE A3.1 IDENTIFICATION AND EVALUATION OF THE PROJECT AS A PPP (PRE-SELECTION STAGE) *(continued)*

Evaluation of the project as a PPP and its financial viability	Risks	SC
• Consists in defining the work that the private partner must carry out to fulfill the project objectives. This responds to questions such as who are the involved parties, what do they want to achieve, and what resources are available, among others. • Must provide estimates of risk, planning, and other specifications. • The analysis of whether the project should be implemented within a PPP mechanism must respond to a list of questions relating to the capacity of the private sector to manage the risks and uncertainties identified, the appetite for investment, and legal requirements, among others. After evaluating whether the project can be conducted through a PPP, three options are possible: (i) the evaluation is affirmative, in which case the process continues; (ii) the response is negative and therefore the financing will be completely public; and (iii) more information is needed to move on to the following stage.	• Incomplete information • Error in the verification process • Problems in the allocation of responsibilities • Fraud or manipulation of information to favor a certain result	√ √ √ √
Preparation of the project management plan		
• The plan sets the terms for compliance with objectives, intermediate dates, and duration of the following phases of the PPP. • This is an instrument for requesting proposals from third-party consultants, should this be necessary. • It contributes, with the government, to the evaluation phase by identifying the resources required and the risks associated with the schedule and the proposed action plan. • It includes identification of the significant actors and the communication plan for each of them. Potential investors and other government actors must also be identified and their interests and concerns understood. The same applies to citizens. This strategy can be important throughout the entire project life cycle. • Define the project team, which can include hiring external consultants.	• Incomplete information	√
Final report		
• At minimum, this must contain the project description, the need for it and the benefits obtained from it, the proposed solution, economic and financial viability, viability of the chosen contracting mechanism (PPP), legal aspects, the project status, information availability, and a management plan for the program.	• Incomplete information	√

Source: Authors' elaboration based on APMG (2018).

TABLE A3.2 EVALUATION AND PREPARATION OF THE CONTRACTING PROJECT

Deliverables of this phase	Risks	SC
Consideration of the project as technically viable. The technical requirements for the design of the infrastructure or service, performance and operational requirements and specifications regarding maintenance, and identification of other significant technical matters have all been evaluated. The need for experts can also be identified in this phase.	• Incomplete appraisal of risks • Incomplete information about technical feasibility • Failure to identify responsible actors	√ √
Consideration of the project as financially viable. There is an economic analysis (costs and benefits of the project for society), a commercial analysis (private sector flows to the project), a fiscal viability analysis (cash flows for the public sector), an analysis of impact on public debt and borrowing, and VfM (flows to the public sector due to the project being implemented as a PPP, compared to flows when implemented by traditional means).	• Incomplete reports • Analysis that fails to take into account all the necessary elements • Failure to identify responsible actors	√
The commercial viability of the project depends on the revenue regime chosen. In the event, for example, of a user payment regime, the analysis will center on evaluating the capacity of the project to generate funds, the capacity of such funds to service the debt and satisfy shareholders, and the ability of the instrument to pay the government for the cost of the concession. Should the project not be commercially viable, in this exercise the amount of public resources needed to make it viable will have been evaluated. The products of this analysis will depend on the revenue regime chosen.	• Analysis that fails to take into account all the necessary elements • Failure to identify responsible actors	√ √
Referral of the project to significant market players through a structured exercise. The idea is to corroborate the viability of the project to attract potential project executors, and to reach closure of a satisfactory agreement. A high level of transparency must be guaranteed in this exercise in order to eliminate suspicions of corrupt behavior due to close relations between the administration and a tenderer. This is achieved by documenting all meetings, decisions, and procedures, providing the public with all documents shared or produced, and leaving a record of all the comments made by the private sector, among others.	• Failure to incorporate feedback into the process • Misalignment with the applicable procurement regulations • Limited transparency in the process and recording of events	√ √
Review of the cost-benefit analysis carried out in the previous phase: project description, evaluation of the economic projections, estimate of the demand, technical specifications, and risk analysis adjusted for any new information gathered.	• Incomplete review • Failure to identify responsible actors	√ √
Analysis of the impact onthe debt generated by the PPP from the budgetary and fiscal management perspective. This is conditioned by the country's accountancy laws. If the result of the evaluation reveals the need for governmental commitments that exceed the deficit or borrowing ceiling, then the country may decide not to proceed with the PPP.	• Failure to identify responsible actors • Non-compliance with the applicable regulations	√ √
Evaluation of the environmental risk that concludes the risk is not disproportionate. The project team, alongside specialists, participates in this evaluation. It is subject to the legal and institutional framework and accompanied by an analysis that seeks to quantify these impacts. The result of the analysis leads to the design of a strategy for the mitigation of any impact and to the subsequent identification of the permits and approvals necessary in these terms. Many investors use the Ecuador principles as the criteria for measuring this risk. For small projects, this stage is closed with full and definitive approval of the environmental impact. For other larger projects, a map is drawn up in order to obtain the corresponding approvals.	Incomplete justification information Failure to identify responsible actors Non-compliance with applicable regulations	√ √ √

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TABLE A3.2 EVALUATION AND PREPARATION OF THE CONTRACTING PROJECT *(continued)*

Deliverables of this phase	Risks	SC
Evaluation of the project's impact on the people that live and work in the PPP's area of influence. This requires careful mapping of the communities and their social, economic, and cultural links with the place in which the project is implemented. A second stage requires that a baseline is defined that determines the state of the potential associated risks. The mechanisms for obtaining this information can include public consultation, community participation and dialogue techniques, and qualitative and quantitative methods for estimating the social impacts. In the third stage, the potential negative impact of the projects is defined, alongside the costs that communities will face and, finally, the mitigation strategies for the impacts identified will be determined.	• Failure to identify responsible actors • Non-compliance with applicable regulations • Lack of transparency in the evaluation process and potential consequences • This stage is omitted	√ √
All legal risks in the project and the decision-making process have been identified. The review also requires verification of conformity with all applicable legal frameworks: public procurement, regulations on foreign investment, labor legislation, property rights, environmental regulations, specific regulations for sectors, and regulations for conflict resolution, among others. This analysis can lead to the modification of some applicable regulations and the procedure to achieve this. It is also important to verify the legal capacity of the authority leading the procurement process in relation to financial aspects, and use of lands and assets involved, as well as tax and accounting matters included in the financial model, among others. The primary product of this phase is the report recommending approval of the project and identifying any possible legal obstacles as well as the strategy for overcoming them.	• Failure to identify responsible actors • Report is incomplete	√ √
The VfM has been analyzed and turns out to be positive. The project's VfM is verified when, compared with another government procurement procedure, the PPP obtains better net economic and social benefits throughout the project life cycle. This analysis is unnecessary in cases in which procurement through other mechanisms is not possible, such as accounting limitations that hamper the project from being financed with public resources, insufficient government resources, or limited access to financing in reasonable conditions.	• Failure to identify responsible actors • Incomplete information that leads to erroneous conclusions • Non-compliance with the mechanism established for this purpose	
Determination of the preliminary procurement strategy. In this stage, the following criteria are evaluated: the determination of qualifications (whether before or after the call for tenders), whether selection is based on a short list, how the proposals will be requested, the time period allowed for the request for proposals and award of contract, and the mechanisms for competition and evaluation. The main procurement mechanisms are: open bidding in a single step, open bidding with a pre-qualification stage, restricted process with a short list, negotiated process with a short list, and a process that incorporates interaction and dialogue.	• Failure to identify responsible actors	
There is a comprehensive plan for the following stages. This plan must contain an updated schedule that envisages the resources available and the need for expert support, if necessary, and clear identification of the public sector authorities that participate and the roles that they fulfill. Finally, identification of all partners in the process and a clear strategy of communication must also be included.	• Incomplete plan • Failure to identify responsible actors	

(continued on next page)

TABLE A3.2 EVALUATION AND PREPARATION OF THE CONTRACTING PROJECT *(continued)*

Deliverables of this phase	Risks	SC
The evaluation report is concluded. Generally speaking, it will include the following elements: general and political considerations, needs, and options; technical requirements; commercial and economic analysis; evaluations of environmental and social impact; and government plan, among others.	• Report is incomplete • Failure to identify responsible actors	
All the approvals necessary were obtained to proceed with the procurement process. If the decision is made not to proceed with the procurement as a PPP, the results of the report may indicate that the project creates value but a traditional procurement process should be followed, the project must not be carried out, or the project requires further information in order to make an effective and definitive recommendation.	• Some kind of fraud or illegal practices during the approval • Failure to identify responsible actors	

Source: Authors' elaboration based on APMG (2018).

TABLE A3.3 STRUCTURING THE DESIGN OF THE CALL FOR TENDERS AND DRAFT CONTRACT

Actions and processes in this phase	Risks	SC
Setting up the project team, including consultants. Defining the management plan for this stage.	• Delays in assigning the team	√
	• Management plan incomplete	√
	• Radical change in the project team that puts the continuity of the initial nominations at risk or delays the process due to lack of knowledge	
(Re)definition of the contractual model and the objective of the contract.	• Misalignment with certain parameters defined in the initial phase	√
	• The parameters are not well defined	√
	• Regulatory non-compliance	√
	• Excessive delays or non-compliance with the terms of the execution of activities and approvals	√
	• Failures in the assignment of responsibilities	√
Conclusion of the due diligence process and preparation stage.	• Lack of full information	√
	• Incoherence with previous decisions	√
	• Delays due to failure to comply with the terms in authorizations	√
	• Regulatory non-compliance	√
	• Failure to define responsibilities	√
Final project adjustments of the technical requirements and cost estimates, economic analysis, financial structure and contract payments, risk structure of the contract, updating of the financial model, and establishment of payment ceilings.	• Final adjustments that substantially detract from the content of the requirements and recommendations produced by the evaluations	√
	• Unauthorized changes (fraud)	√
	• Data degradation or glitches in the information recorded	√
	• Failure to define responsibilities	√
	• Excessive delays or non-compliance with the terms of the execution of activities and approvals	√
Publicity and feedback from the industry (investors, contractors, and potential financiers).	• Provision of incomplete or erroneous information	√
	• Provision of impartial information (with preferences for certain bidders)	√
	• Leaking of confidential information	√
	• Partially and inefficiently assessing the feedback proposals	√
	• Failure to define responsibilities	√
	• Failure to involve all potential partners	√
	• Reputational risks due to poor publication	√
	• Excessive delays or non-compliance with the terms of the execution of activities and approvals	√
Definition of other commercial and contractual requirements.	• Failure to follow the principle of VfM	√
	• Lack of alignment with criteria defined on the basis of previously accepted evaluations and objectives	√
	• Fraud in the definition of the above	√
	• Failure to define responsibilities	√
	• Excessive delays or non-compliance with the terms of the execution of activities and approvals	√

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TABLE A3.3 STRUCTURING THE DESIGN OF THE CALL FOR TENDERS AND DRAFT CONTRACT *(continued)*

Actions and processes in this phase	Risks	SC
Definition of qualification criteria. Preliminary structuring and drafting of the RFQ.	• Substantial deviation from what was established in previous stages	√
	• Incomplete definition	√
	• Deviations from standard clauses and content that can be detrimental to the PPP objectives	√
	• Failure to define responsibilities	√
	• Excessive delays or non-compliance with the terms of the execution of activities and approvals	√
Definition of the proposal requirements and the evaluation criteria. Preliminary structuring and drafting of the RFP.	• Substantial deviation from that established in previous stages	√
	• Incomplete definition	√
	• Deviation from standard clauses and content that can be detrimental to the PPP objectives	√
	• Failure to define responsibilities	√
Elaboration of the draft of the contract.	• Substantial deviation from that established in previous stages	√
	• Non-compliance with regulatory obligations	√
	• Leaking of confidential information	√
	• Deviation from standard clauses and content that can be detrimental to the PPP objectives	√
	• Failure to define responsibilities	√
	• Excessive delays or non-compliance with the terms of the execution of activities and approvals	√
Exchange of information with potential participants in the bidding.	• Leaking of confidential information	√
	• Favoritism in sharing information	√
	• Failure to define responsibilities	√
Planning the bidding process.	• Non-compliance with regulatory obligations	√
	• Leaking of confidential information	√
	• Failure to define responsibilities	√
Final review of minimum requirements and approvals.	• Non-compliance with regulatory obligations	√
	• Leaking of confidential information	√
	• Failure to define responsibilities	√
	• Excessive delays or non-compliance with the terms of the execution of activities and approvals	√

Source: Authors' elaboration based on APMG (2018).

TABLE A3.4 BIDDING AND AWARD OF CONTRACT

Bidding and award of contract phase	Risks	SC
Requests for the presentation of proposals that must follow the applicable regulations. The candidates should be allowed a reasonable time (generally speaking, greater than for other public procurement processes) to carry out due diligence, analysis, and evaluation of the contract.	• Non-compliance with the applicable regulations • Call for tenders irrationally limited to certain bidders • Insufficient time for the presentation of proposals • Information provided is insufficient for the potential bidders • Lack of credibility or political support related to the team	√ √ √ √
Pre-qualification or preliminary selection (short list) of the potential competitors.	• Lack of objective and clear evaluation criteria • The evaluation criteria are modified at this late stage of the process	√ √
Bidding process period: from the moment that the request for proposals or invitation to tender or negotiation begins, depending on the type of competition (process) chosen. In this stage, information is exchanged with the possible bidders regarding non-intentional inconsistencies or errors.	• Risk that the validity or appropriateness of the PPP itself is called into question, if there are interests that are in conflict with its nature and objectives • Poor communication with the bidders, with potential information asymmetries • Regulatory non-compliance • Poor negotiation of inconsistencies	√ √ √ √
Evaluation of the proposals and selection of the winner.	• Regulatory non-compliance • Fraud during the winner slection process • Error in calculating the scores • Lack of allocation of responsibilities	√ √ √ √
Signing the contract and financial close. Financial close can also take place subsequent to the signing of the contract. In this stage, the financial institutions are given time to prepare the signing and, especially, to set up a special purpose vehicle (SPV). Other actions must also be taken prior to signing the contract such as procuring insurance or posting bonds or guarantees.	• Non-compliance with the pre-contractual conditions	√ √

Source: Authors' elaboration based on APMG (2018).

TABLE A3.5 CONTRACT EXECUTION PHASE

Important processes or activities	Risks	SC
Implementing the contract management framework.	• Framework is ineffective or too onerous to fulfill	√
	• Costs for the project executor are increased excessively	√
	• There is no plan of relief or succession for those responsible for the project	√
	• Ambiguity in the redaction of the contractual conditions	√
Ensuring that private partners comply with their obligations.	• Incomplete or delayed information, which does not allow risks to be anticipated	√
	• Poor relation with society	√
	• Non-compliance with contractual conditions	√
	• Poor financial management of the SPV	√
Ensuring that the government complies with its obligations.	• Non-compliance with prerequisites for contract execution	√
	• Delayed execution of contractual obligations	√
	• Failure to define responsibilities	√
Managing the relations between different actors with direct or indirect links with the PPP.	• Poor renegotiation of conditions with regard to risk events	√
	• Poor coordination of financial issues at the government level	√
Exercise of the contractual rights of the parties.	• Inadequate verification of compliance with previous obligations	√
Implementation of the exit strategy and of return of the good, if applicable.	• Poor negotiation of the exit strategy or return of the good	√
	• Non-compliance with contractual conditions	√
	• Conflict due to interpretation of contractual conditions	√

Source: Authors' elaboration based on APMG (2018).

ANNEX 4
QUANTIFICATION OF PROJECT COSTS FOR EACH OF THE PPP DESIGN AND EXECUTION STAGES

The costs associated with project evaluation, preparation, control, and follow-up depend on the size of the project. The costs of preparing infrastructure projects in developing countries generally range between 5 and 10 percent of the total investment in the project and around 3–5 percent of project costs in developed countries.[60] For the purposes of this annex, we use as an example the project known as the Puerto Cortés Specialized Container and General Cargo Terminal (Terminal Especializada de Contenedores y Carga General de Puerto Cortés), which was developed as a PPP in Honduras.

[60] Gastón (2019).

TABLE A4.1 EXAMPLE OF THE COSTS ASSOCIATED WITH THE PREPARATION AND IMPLEMENTATION OF PPPS

Phase	Associated cost
Identification of the project and evaluation as a PPP **Evaluation and preparation of the contracting project** **Structuring design of the call for tenders and draft contract** **Bidding and award of contract** **Signing the contract**	The project was developed using a trust in a local bank. The purpose of the trust during the first stage was financing, as a risk investment, the activities necessary to carry out the studies required to draft the structuring proposal for the Puerto Cortés Specialized Container and General Cargo Terminal project, as well as promoting the project in the private sector and among investors and providing accompaniment to COALIANZA (the unit responsible for structuring PPPs in Honduras) in the international public bidding (concurso público internacional) to be held based on the proposal for structuring the implementation of the Puerto Cortés Specialized Container and General Cargo Terminal project, until the signing of the contract with whichever private investor operator (inversionista operador privado) is awarded. To this end, the trustee will contract the team of consultants, firms, or independent consultants, which will provide support in the technical, economic, financial, social, property, environmental, and legal areas, for the structuring of the project and the corresponding public bidding process, elaborating the legal documents necessary for implementing it. **Investment:** USD 1,584,835.00 *Source:* Clause 4 of the Trust Contract for Structuring, Developing and Financing the Operation (Contrato de Fideicomiso para la Estructuración, Desarrollo y Financiamiento de la Operación) of the Puerto Cortés Specialized Container and General Cargo Terminal, by the constitution of a Public-Private Partnership. Minutes the of Trust Technical Committee (Comité Técnico del Fideicomiso)
Contract management	Sections VI, VII, and VII of the Contract to Design, Finance, Build, Maintain, Operate and Exploit the Puerto Cortés Specialized Container and General Cargo Terminal stipulate the recruitment of three project supervisors: **Project supervisor:** In charge of reviewing the design of the terminal, as well as overseeing construction of the works **Amount:** 3.5 percent of the value of the works **Value of the works:** USD 386,090,522 **Project works inspector:** In charge of supervising that works are being carried out according to the investment plan **Amount:** 0.5 percent of the value of the works **Value of the works:** USD 386,090,522 **Inspector of operations:** In charge of controlling and verifying compliance with the Terminal Goods Maintenance and Conservation Plan (Plan de Mantenimiento y Conservación de los Bienes de la Terminal); provides follow-up and carries out oversight activities to ensure compliance with contractual obligations **Amount:** USD 1,070,533,32 every three years up to a total of 28.5 years **The role of the Public-Private Partnership Superintendency (SAPP) (Superintendencia de Alianza Público-Privada):** The SAPP is the government entity in Honduras in charge of supervising, auditing, regulating, and sanctioning PPP projects in Honduras. It has a technical directorate responsible for monitoring the projects throughout their design and build stages and carries out auditing during the operation stage. Taking the SAPP budget for the year 2019 as a reference, an annual cost of USD 71,722,43 has been ascertained for this project, using the dollar exchange rate on December 31, 2019 as a base rate.

Source: Authors' elaboration based on documentation from the Puerto Cortés Specialized Container and General Cargo Terminal project in Honduras.


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