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From Fishing to Catching: Developing Actionable Red Flags in Public Procurement to Prevent and Control Corruption

Institutions for Development Sector

Innovation in Citizen Services Division

TECHNICAL NOTE Nº
IDB-TN-2598

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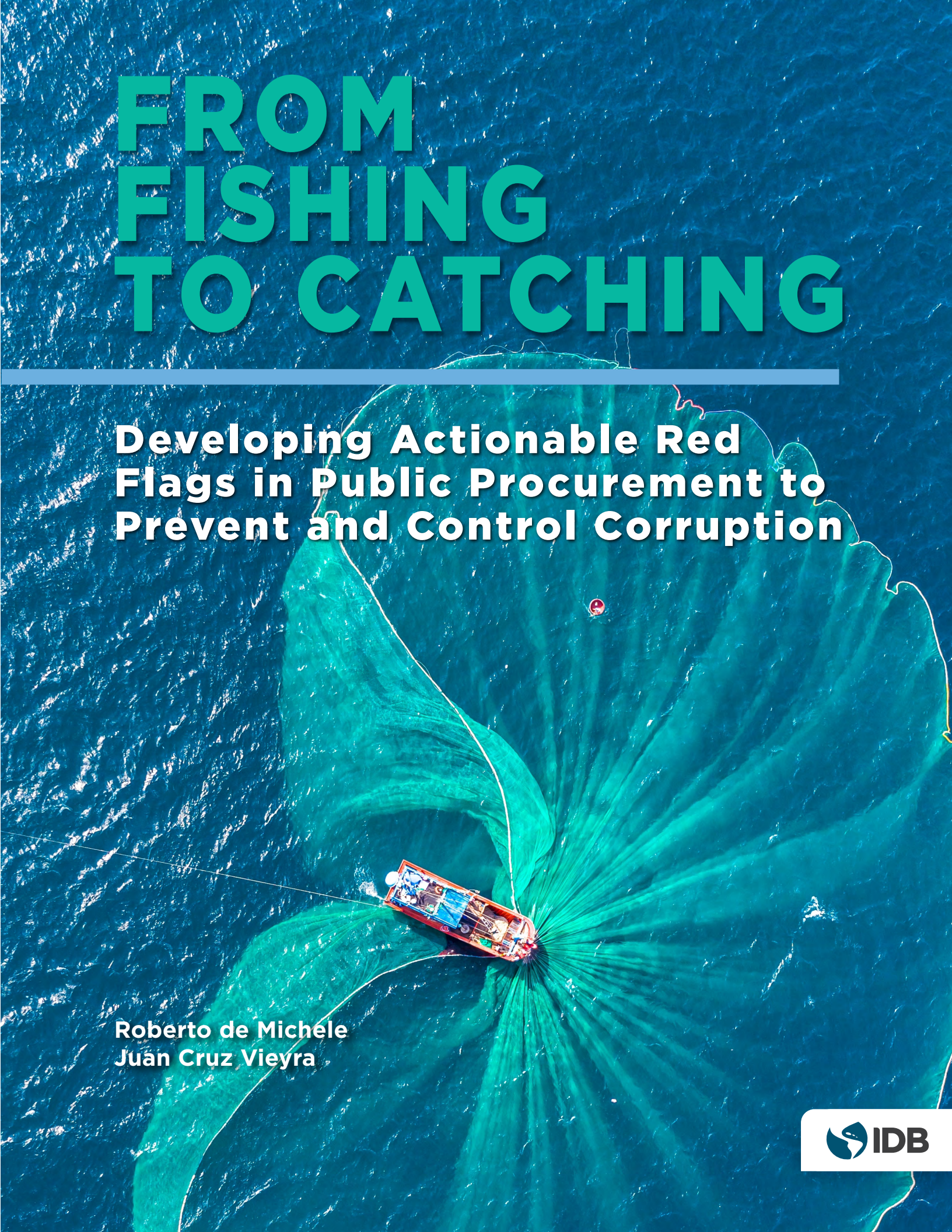
Cataloging-in-Publication data provided by the
Inter-American Development Bank
Felipe Herrera Library

De Michele, Roberto.
From fishing to catching: developing actionable red flags in public procurement to prevent and control corruption / Roberto de Michele and Juan Cruz Vieyra.
p. cm. — (IDB Technical Note ; 2598)
Includes bibliographic references.
1. Government purchasing-Paraguay. 2. Political corruption-Prevention-Paraguay. 3. Transparency in government-Paraguay. 4. Information technology-Capital investments-Paraguay. I. Cruz Vieyra, Juan. II. Inter-American Development Bank. Innovation in Citizen Services Division. III. Title. IV. Series.
IDB-TN-2598

http://www.iadb.org

FROM FISHING TO CATCHING

Developing Actionable Red Flags in Public Procurement to Prevent and Control Corruption



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ABSTRACT*

How can entities responsible for public procurement more reliably detect collusion and other irregular behavior? Most of the existing red flag tools are based on ex post analysis of public procurement data and are not integrated into national procurement systems. This does not allow them to identify irregularities in a timely manner, negatively affecting the efficiency and transparency of public spending. This document describes the red flags solution implemented in Paraguay, which contributes to solving these problems. It combines rule-based and machine learning algorithms to provide public officials with accurate, real-time information to reliably detect irregularities in the procurement process, without reducing efficiency.

JEL Codes: D73, H57, K14, K23, K24, K42, O31, H50, H83, L78, O54

Keywords: public procurement, corruption, artificial intelligence, big data, institutional capacity, state digital capability, governance, red flags, early warning systems, anti-corruption technologies, digital innovation, efficiency, monitoring, transparency

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We are grateful to the government of Paraguay, particularly the National Directorate of Public Procurement (DNCP), from which we received the constant support of Pablo Seitz, Juan Ardissone, Melinna Vazquez, Alejandra Solis, Karen Aguilera, Nancy Osorio, Diego Ayala, David Reese, Ester Recalde, Rodrigo Parra, and Jorge Morales. This project would have not been possible without their trust and commitment. We are also grateful to Dan Korn, Becky Lenaburg, Norm Hodne, and Elizabeth Kleban from Microsoft Corporation and Leandro Lima, Geert Aalbers, and Rodrigo Russo from Control Risks for their useful comments and suggestions. We would like to acknowledge the invaluable contributions to the red flags initiative from Jorge Luis Gonzalez, Juanita Riaño, Anyela Chavarro, Jose Niño, Jorge Ortiz Claverol, Vladimiro Bellini, Cynthia Leite, Sebastian del Hoyo, José Luis Leturia, Guillermo Lagarda, and Alejandro Barón Gandarias. We also appreciate the guidance by Philip Keefer and Sarah Schineller. The IDB's Transparency Fund—which benefits from generous contributions from the governments of Canada, Italy, Norway, and Sweden—Mastercard, and Microsoft contributed to this publication. We would like to dedicate this policy brief to the memory and inspiration of Jose Luis Leturia.

INTRODUCTION

This document presents the development and implementation of a red flags solution in public procurement, a digital tool implemented in Paraguay to detect irregularities in public contracting by applying rules-based and machine-learning algorithms. Its main characteristic is that it helps public officials to detect potential abnormalities and respond in real time.

The debate on how to apply digital solutions to enhance transparency and integrity in public procurement, including to prevent fraud and corruption, is not new. The academic (Vaidya, Sajeev, and Callendar, 2006; Neupane et al., 2012) and policy (UN, 2012; World Bank, 2020) literatures have explored this topic consistently over the last decade. The COVID-19 pandemic gave a new boost to this debate, now with a more practical focus. One consequence of the pandemic was the need for governments to act swiftly in emergency spending—in health and other sectors—while at the same time responding to increasing public scrutiny to make public procurement more efficient, fair, competitive, and transparent. In other words, they needed to spend quickly and effectively.[1]

In these circumstances, adopting policies to detect and prevent misuse of public resources becomes critical. Precisely, this is the function of red flags in public procurement. In general, red flags serve to identify behaviors that might violate existing procurement regulations. Recent developments include using quantitative indicators or algorithmic checks based on available procurement data (Decarolis and Giorgiantonio, 2020). Under these conditions, red flags can be useful mechanisms in screening for corruption in procurement (Ferwerda, Deleanu, and Unger, 2017; Wikrent, 2016; Fazekas and Kocsis, 2017; Dávid-Barrett and Fazekas, 2020).

However, the implementation of a red flags solution in procurement can take different approaches. Most if not all of the available systems are based on an ex post analysis of public procurement data. Under this approach, the red flags help identify indicia of an irregular situation, after a procurement decision has been made. These type of red flags mechanisms can be very useful to identify patterns, inform on trends, and help prevent future events. Fazekas, Tóth, and Cingolani, among others, have done a substantive amount

[1] See https://www.americasquarterly.org/article/how-transparency-can-save-lives-in-the-coronavirus-crisis/.

of work mapping information, identifying corruption risks in public procurement, and helping scholars and practitioners understand the different indicators used in red flags solutions.[2]

The red flags solution presented in this paper has benefited from the research mentioned above but has followed a different path by combining features and elements that are not present in other mechanisms. First, it is designed in compliance with Paraguay's legal and regulatory institutional framework and is capable of detecting situations that are legally prohibited. This feature is crucial, given the second element. The red flags solution is directly connected to the practical decision making of public officials, particularly those who have verification roles in the public procurement process. Therefore, if the system detects a red flag, it prevents a procurement action from occurring in a timely manner. This allows the system to be actionable. Third, the system learns from itself. By automatically collecting information on procurement decisions and actions from government officials and bidders, it builds a database to provide a broader analysis of procurement risks. This information, combined with the actionable component of the red flags solution, provides the procurement authority with a robust arsenal of data to prevent further irregular practices. Finally, the red flags solution in Paraguay is designed to be scaled and replicated in any country in Latin America and the Caribbean (LAC).

The red flags solution developed in Paraguay contributes to the region's transparency and integrity agenda. First, it confirms the relevance of digital technologies to enhance transparency and prevent fraud, waste, and corruption in the use of public resources. Second, it emphasizes the importance of institutional capacity as a condition for the successful implementation of these digital solutions. Third, it highlights the value of collaboration between the public and private sector in finding innovative solutions, with the technical and advisory support of multilateral organizations. Fourth, it places ownership of policy solutions in the hands of the public sector as the key driver for effective implementation. Lastly, it also shows how positive spillovers generated in transparency interventions, for example the implementation of MapaInversiones (InvestmentMap), in one entity can accrue to other public sector institutions.

This policy brief is organized as follows. First, we briefly introduce recent research connecting the state of the art in the effectiveness of digital reforms that promote

[2] For more information see Fazekas and Dávid-Barrett (2015); Tóth et al. (2015); Fazekas, Cingolani, and Tóth (2016); and Cingolani et al. (2016).

transparency and integrity, especially in the use of public resources and more specifically in public procurement. Second, we present a description of the red flags solution in Paraguay including the key institutional and legal components of the project as well as the specific technological elements. Third, we present key lessons learned from the implementation of the pilot in Paraguay, to improve the design and implementation of future similar solutions across LAC. Lastly, we present the conclusions and elaborate next steps for red flags initiatives at the regional level.

1. DIGITAL TECHNOLOGIES TO IMPROVE TRANSPARENCY AND INTEGRITY IN PUBLIC PROCUREMENT

Institutional capacity and transparency are crucial for service delivery, the business climate, and public trust. The literature points at the links between institutions and economic growth, resulting in improved economic performance. Authors like Ebben and de Vaal (2009) and other "institutionalists" endorse the ideas of North (1990), for whom institutions influence economic performance.

As described in the Inter-American Development Bank (IDB)'s Transparency and Integrity Sector Framework (IDB, 2020), the evidence suggests that a lack of institutional quality adversely impacts economic growth, productivity, and public trust in government. The most common causes of corruption are restricted access to information, the existence of laws and regulations that enable arbitrary or discretionary public decisions, and ineffective controls for preventing and punishing deviations from the rules.

The IDB's Transparency and Integrity Sector Framework provides the basis for the construction of the red flags solution. On the one hand, this document confirms the inherent risks associated with public procurement, including infrastructure and health (Kenny, 2007; Knack, Biletska, and Kacker, 2017; Izquierdo, Pessino, and Vuletin, 2018; Gupta, Davoodi, and Tiongson, 2000). On the other hand, it also points at the potential solutions by identifying policy measures that can be taken to address the problem of restricted access to information. However, the second generation of transparency reforms goes beyond access to information. It requires the adoption of policies for disclosing information in a format, means, and time frame that is useful for each specific audience in

making their choices and decisions (Fung, Graham, and Weil, 2007). In the case of the red flags solution, the goal is enhancing the capacity to identify risks and preventing misuses of public funds in procurement.

The use of digital technologies enhances transparency, facilitates intelligent data analysis, and improves the effectiveness of control and supervision bodies, potentially enhancing state capacity (Cingolani, 2022). These technologies help to leverage more general transparency and integrity reforms with concrete results. In addition to the general conceptual framework described above, there is also a significant body of literature that examines how the use of digital technologies can enhance transparency and reduce opportunities for corruption in procurement.

Public procurement is key for the functioning of any government and the economy. According to the Organisation for Economic Co-operation and Development (OECD), for example, public procurement accounts for 12 percent of the gross domestic product (GDP) and 29 percent of total government expenditures on average across member countries. The figures highlight the significance of public procurement and the importance of strengthening transparency and the control environment (both control and audit institutions, but also citizen-based oversight) given that public procurement is subject to corruption and fraud risks.

The link between procurement and infrastructure projects or public investment is particularly important. According to the OECD (2016), procurement is among the government activities most vulnerable to corruption, with consequences such as higher cost of procurement and lower quality of infrastructure, ultimately undermining trust in the public officials and the services delivered by the state. A recent paper by McDevitt (2022) explains that a review of more than 60 studies provides evidence on the benefits of transparency (open contracting) in public procurement, particularly regarding efficiency, value for money, and competition. It also mentions that there is more limited evidence linking open contracting to societal outcomes, for example public service delivery and reducing corruption.

The literature on integrity in procurement in LAC goes back to the seminal studies of Di Tella and Schargrodsky (2003), who show that prices paid for medications in Argentinian hospitals decreased in response to monitoring, and Bandiera, Prat, and Valletti (2008), who introduce a theoretical model on the sources of wastage in

procurement, which manifests as excessively high prices. More recently, de Michele and Pierri (2020) demonstrated that the implementation of an e-procurement platform in Argentina achieved significant improvements in the efficiency of public procurement. By looking at the two sources of wastage in public procurement, this study shows that e-procurement made processes faster by reducing problems of bureaucratic inefficiency and reduced prices paid by increasing the number of suppliers involved in public procurement processes.

A detailed analysis on the use of digital tools shows that the way in which transparency initiatives are implemented is critical to activating the various channels through which information management can improve public sector efficiency. These technologies have enormous potential to improve public investment management and, in so doing, increase the economic dividends from investment projects (Kahn, Baron, and Vieyra, 2018).

The use of digital technologies also improves the effectiveness of control and supervision bodies and facilitates intelligent data analysis. Another recent study by the IDB finds that governments have increased the numbers of virtual platforms that display data on public works, and citizens have increased their voluntary participation in low-cost monitoring of these works (Pierri and Lafuente, 2020). While focusing on public investment, this study is relevant to analyze procurement-based decisions. It evaluates the effect of the Citizen Oversight Monitors Program (Programa de Monitores Ciudadanos de Control, or MCC) of Peru's Office of the Comptroller. Using public sources of administrative information and data from the INFOBRAS platform of the Comptroller General of the Republic and the Public Investment Consultation Platform of the Ministry of Economy and Finance in Peru, the findings of this study suggest that the use of these technologies generated a significant impact in terms of reducing cost overruns for works outsourced to construction firms (Pierri and Lafuente, 2020).

In this line of research, two additional studies confirm the impact of using digital platforms for disclosing public investment information with important takeaways for integrity in public procurement. One of such studies provides experimental evidence about the causal impact of disclosing information related to public investment projects on the performance of these projects. Specifically, it analyzes the impact of the launch of the InvestmentMap platform on the physical and financial progress of public investment projects in Costa Rica. The study finds that published projects (the treatment group) perform better than unpublished projects (the control group). Three months after the

release of InvestmentMap, financial progress of public investment projects uploaded onto the platform increased by 18 percentage points, and physical progress increased by 8 percentage points compared to unpublished projects (Rossi, Vazquez, and Vieyra, 2020). The other study also focused on the use of InvestmentMap finds that after the release of MapaRegalías in Colombia, public investment projects financed with royalties showed an average increase in efficiency of execution of close to 8 percentage points (Lauletta et al., 2019). Both studies are important since they foreshadow the practical importance that InvestmentMap has had in Paraguay, including generating institutional knowledge for technological and information management, and the spillovers that this might have generated in adjacent institutions.

As mentioned above, the power of e-procurement (Neupane et al., 2012) and of new technologies including artificial intelligence such as machine learning (Petheram, Pasquarelli, and Stirling, 2019; Torres Berru et al., 2020; Köbis, Starke, and Rahwan, 2022) for public procurement has been widely recognized in recent years. This includes evaluations of interventions in LAC, some of them conducted by the IDB, including by de Michele and Pierri (2020) and Pierri, Jarquín, and de Michele (2021).

There is also a more specific literature on red flags in public procurement (Ware et al., 2007; Kenny and Musatova, 2011). A group of authors (Ferwerda, Deleanu, and Unger, 2017) showcases the state of the art on the topic and gathered global data about 192 public procurement systems from countries ranging from more to least corrupt and analyzed the application of red flags against corruption in those systems. They identified 28 red flags used in prior literature which they tested against the public procurement data collected, finding that implementing red flags could lead to identifying corruption in most cases (since red flags were found to be correlated with real corruption) and on the flip side to asserting that more transparency would help to minimize corruption risks.

The literature focused on the application of new technologies to improve transparency and integrity in public procurement has evolved over the years and ignited a debate on a wide range of issues that are relevant to the design and implementation of red flags solutions. These issues include but are not limited to the balance between discretional and competitive processes, the appropriate thresholds to activate integrity checks in public procurement processes, the development of algorithms to detect collusion, and the management of false positives and false negatives, among other topics.

Turning to the balance between discretional and competitive processes, the World Bank (2007) outlines that "transparency requires, inter alia, simple rules for procurement while to minimize discretion requires more comprehensive and generally voluminous rule sets which obfuscates clarity and transparency. Reducing discretion may also be inconsistent with management and performance objectives." In line with this, the challenge for decision-makers—as was the case in Paraguay—is to define an appropriate degree of oversight to reduce integrity risks in public procurement while maintaining an appropriate level of efficiency of the public procurement system.

Managerial discretion must also be carefully weighted when calibrating thresholds in bidding processes. These thresholds will determine which transactions are deemed to be higher risk, undoubtedly influencing posterior tenders to artificially increase or decrease their values to avoid being flagged (for example, by parceling contracts). For example, Coviello, Guglielmo, and Spagnolo (2018) find evidence of value manipulation around the threshold in some industries in Italy (such as road construction). Jascisens (2014), as well as Palguta and Pertold (2014), also find manipulations in project values to stay under threshold values and study how this might have spurred corrupt behavior and favoritism in Latvia and the Czech Republic. The latter study also shows how the introduction of the preselection of potential contractors led to an increase in bunching of procurement contracts below the thresholds.

However, the literature (Bobilev et al., 2015) indicates that manipulating contracts around thresholds shall not be conceived as necessarily negative because it could usher positive consequences such as faster and cheaper procurement processes. Moreover, threshold calibration will also influence strategic behaviors in public buyers, potentially limiting competition in tendering processes and/or generating implicit collusion or cartelization risks, depending on the set value.

Precisely, several authors have shown how machine learning can be crucial to detect collusion. Huber and Imhof (2019) combine statistical screens with machine-learning techniques in tenders in the Swiss construction sector to predict collusion through bid-rigging cartels, correctly classifying 84 percent of potential situations of collusion in the sample used. Huber, Imhof, and Ishii (2022) replicate these algorithms in Japan, finding correction rates of between 88 percent and 93 percent. García-Rodríguez et al. (2022) ran 11 machine-learning algorithms in collusive datasets obtained from Brazil, Italy, Japan, Switzerland, and the United States, with general positive results.

Of these, the detection rates of three algorithms ranged between 81 percent and 95 percent, with a balanced accuracy generally above 73 percent. Ageh (2019) provides an example of how multilateral institutions (in this case, the World Bank) are applying machine learning in their debarment processes, which include collusion, among other practices.

False positives and false negatives are another concern for public procurement practitioners. These arise when data entries are wrongly identified as an abnormality when they aren't (false positive), or when an abnormality is not identified as being one (false negative). These errors can have variable but substantial size and bear significant costs on public procurement systems. For example, Decarolis and Giorgiantonio (2020) estimate three machine-learning models in calls for tenders in Italy, finding that on average 26 percent of cases were false positives across the models, and 17 percent false negatives. In contrast, Baader and Krcmar (2018) find a false positive rate of only 0.37 percent by testing the application of a red flags tool that included process mining. This rate was significantly lower than other tools implemented in the past years, which means that the field is in constant evolution, and calibrating in each concrete tool is crucial. Artificial intelligence and machine learning in several fields have demonstrated an ability to decrease false positives that are pervasive when human beings process data (Lanovaz, Giannakakos, and Destras, 2020; Shen et al., 2021).

2. THE RED FLAGS SOLUTION IN PARAGUAY

The red flags solution was a collaborative effort designed by the IDB, Microsoft Corporation, and the Government of Paraguay—specifically, the National Directorate of Public Procurement (DNCP, for its acronym in Spanish) and the National Anti-Corruption Secretariat (SENAC, for its acronym in Spanish). During an analytical phase, the project team took on the following steps:

- Identification of focal points in each agency and counterparts to reduce transactional costs while developing and implementing the solution[3]

[3] Given the number of public agencies involved, in addition to the multisector IDB team and Microsoft, the earliest decision was to designate a focal point on behalf of each party involved.

- Analysis of the legislation and regulation for public procurement in Paraguay, especially to identify circumstances that would prohibit proceeding with a procurement decision
- Literature review of red flags experiences worldwide
- Development of a pilot digital red flags matrix with actionable and non-actionable indicators
- Validation of the pilot with all parties involved in the procurement cycle
- Testing of the pilot, corrections, and adjustments
- Production and maintenance protocols

Ownership of the DNCP was critical to the project, including the work of the General Directorate of Information and Communication Technology and the General Directorate of Development and Strategic Information. Valuable contributions were received from other directorates such as the General Directorate of Legal Affairs, the General Directorate of Standards and Control, and the General Directorate of Contract Verification. Within the IDB, the project was led by the Innovation in Citizen Services Division (ICS) in a collaborative framework that included inputs from the Office of Institutional Integrity (OII), Operations Financial Management & Procurement Services Office (FMP), Fiscal Management Division (FMM), and the IDB's Country Office in Paraguay.

The next sections of this document describe in more detail the solution implemented in Paraguay, as well as lessons learned from that implementation, which begins by understanding the links between the red flags solution and the InvestmentMap Initiative.

Red Flags Solution as Part of InvestmentMap Initiative

The red flags solution is part of the InvestmentMap regional initiative, which aims to strengthen information management and implement technological tools to improve the transparency and integrity of budget, investment, and public contracting systems in LAC.[4] These tools enable effective interaction between the government and the citizens, contributing to transparency, integrity, and accountability.

The IDB and Microsoft developed in LAC a groundbreaking partnership to enhance transparency and integrity in public investment, including public procurement functions and reporting mechanisms. Through the InvestmentMap initiative, which has been deployed in seven countries across the region (Argentina, Colombia, Costa Rica, Dominican Republic,

[4] https://www.iadb.org/investmentmap.

Jamaica, Paraguay, and Peru) and is currently under development in another six (Bahamas, Barbados, Ecuador, Honduras, Panama, and Trinidad and Tobago), governments have significantly increased their capacity to promote greater transparency and to prevent and control the misuse of public resources, including through a functionality which enables society to monitor government investments in real time.

KEY ADVANTAGES OF INVESTMENTMAP

Citizens can monitor in real time where and how governments invest public resources.

Governments have actionable and relevant information to make timely decisions, ultimately leading to improved efficiency of public investments.

A more transparent information environment levels the playing field and fosters healthy competition between companies.

The partnership with Microsoft has been instrumental to InvestmentMap and the creation of the red flags solution. In 2020, Microsoft launched the Advanced Cloud Transparency Services (ACTS)[5] initiative on the UN's International Anti-Corruption Day. Microsoft ACTS is committed to supporting the fight against corruption in the public sector by creating prevention and detection mechanisms through a combination of advanced data analytics technology and expertise, with the power of local data and partnerships. By shifting efforts from reactive responses to proactive detection, governments can address risks closer to the time when they emerge and begin to reduce the cost of corruption to society. A number of initiatives have strengthened Microsoft ACTS and its relationships with governments, local partners, anti-corruption experts, and advocates through participation and discussions in international forums such as the New Economy Forum: Fighting Corruption with Technology[6] hosted by the International Monetary Fund (IMF) in October 2021. Moreover, partnerships such as the one signed with the Government of Nigeria[7] to design and implement cloud-based tools targeting corruption show the practical aspect of these efforts.

[5] https://www.microsoft.com/en-us/microsoftacts.

[6] https://www.imfconnect.org/content/imf/en/annual-meetings/calendar/open/2021/10/07/161286.html?calendarCategory=T2ZmaWNpYWwvQnkgSW52aXRhdGlvbg==.UHJlc3M=.V29ybGQgQmFuaw==.T3Blbg==.

[7] https://news.microsoft.com/en-xm/2021/05/03/microsoft-collaborates-with-the-nigerian-government-to-accelerate-digital-transformation-in-the-country/.

InvestmentMap has been in constant evolution in recent years to include different ranges of information and management capabilities, from planning and budget to the procurement and traceability of the use of public resources. One of the key spin-off solutions around the InvestmentMap initiative is the promotion of integrity in the public sector as a whole and public procurement in particular using cutting-edge technologies, including advanced data analytics and artificial intelligence based on algorithms and machine learning. Taking advantage of the existing InvestmentMap platforms in the region, Microsoft and IDB have joined forces to develop and support the implementation of an innovative red flags solution to detect and deter corruption in public procurement for the Republic of Paraguay.

A Red Flags Solution for Paraguay

The red flags solution was initiated as part of the regional InvestmentMap initiative. InvestmentMap Paraguay (Rindiendo Cuentas)[8] began in 2018 and has evolved over the years, adding functionalities that allowed greater transparency and improved integrity practices in the country.

During the COVID-19 pandemic, the government of Paraguay organized its response to the emergency by passing the Health Emergency Law[9] (Ley 6524/20), which dedicates a chapter to transparency and integrity. This is one of the few emergency laws in the region that has included a specific section on transparency needs. The law established a working group that oversaw coordinating between control agencies, the governing body for technology, and various state agencies responsible for responding to the crisis. The Health Emergency Law also mandated the adoption of an ICT-based platform to divulge and monitor the use of public resources. This definition was strategic so that the agencies mentioned in the integrity chapter were given the immediate task of coordinating among themselves, harmonizing information from various sources, and implementing this platform.

The Paraguayan government made the decision to build such a platform within InvestmentMap, which was already operational in the country to visualize public investment projects. The working group mentioned above chose to build on existing infrastructure to respond as quickly as possible to its commitment and the citizens' demand for transparency.

[8] https://rindiendocuentas.gov.py/.

[9] See https://www.bacn.gov.py/archivos/9156/LEY6524.pdf.

The InvestmentMap Paraguay platform was completely transformed. Although it was originally focused on disclosing data on public investments, during the pandemic it ensured that the use of associated resources to deal with the COVID-19 emergency was transparent. In this context, there was coordination between different government actors, including different directorates of the Ministry of Finance, SENAC, and the Presidency of the Republic, among other entities involved at the sectoral level, such as the Ministry of Health and Social Welfare. The IDB played an important role in providing technical support to all of these stakeholders. The result of this inter-institutional coordination went much further than the launch of the Rindiendo Cuentas platform. It allowed a process of inter-institutional cooperation around key awareness regarding the data that each organization handled, which was a fundamental aspect for the red flags solution later.

As the basis of the work was InvestmentMap, the institutional actors were not consumed by decisions or issues related to the use of the technology. Rather, their efforts were focused on the possibility that the datasets could be integrated and that the functions of control and monitoring of the use of public resources would be optimized as information asymmetries were reduced. In this sense, the work around InvestmentMap Paraguay and Rindiendo Cuentas was instrumental for the technical teams to share more information, leading to a better understanding of the existing data and thus better prospects for inter-institutional coordination. This dialogue, ongoing since early 2020, is of paramount importance for the red flags solution presented in this document.

The primary goal of the red flags solution in Paraguay is to detect possible fraud and corruption risks in public procurement in a timely manner. To ensure its operability, this tool was designed by factoring in the legislation regulating the role of the DNCP, as well as existing processes and institutional capacities, while simultaneously aiming to upgrade these capacities progressively. Also, in line with the literature included in Section 1, a balance had to be sought between enhancing oversight to reduce integrity risks without incurring in losses of efficiency and flexibility in the public procurement system.

To this end, government entities and particularly the DNCP had to provide users of the public procurement system with efficient and actionable tools to respond appropriately to possible irregularities, in accordance with local legislation and procedural rules (for example, to which bodies possible irregularities should be escalated). These include mechanisms to observe and inform the corresponding actors to carry out interventions in necessary cases, in different stages of the process.

The legal mandate of the DNCP includes key functions of control, supervision, and investigation, including but not limited to the following: (i) carrying out ex officio or preliminary investigations, in relation to public procurement procedures; (ii) verifying the execution of the contracts and their modifications, signed by the agencies, entities, and municipalities that operate in the public contracting system; (iii) requesting, in cases where it deems it necessary and pertinent, that the corresponding general auditor carry out the investigations; (iv) creating and maintaining a registry of disqualified bidders, suppliers, and contractors through the Public Procurement Information System (SICP); and (v) sanctioning bidders, suppliers, and contractors for non-compliance with the provisions of the law.[10]

Transparency in the use of public resources is one of the fundamental pillars of the institution. The DNCP is also a leading public institution regarding technological innovation, interoperability, and open data. For example, the DNCP has evolved over the years to create an environment that gave birth to sound technological projects, bringing all the components of digital transformation to the area of public procurement. The DNCP decided to publish its data in the format established by the Open Contracting Standard, for which the publication and availability of the data is twofold: application programming interface (API) services and download of static files. The purpose of API services is to make available real-time data on planning, calls, awards, contracts, and contract modifications. On the other hand, the download of static files is intended to make available the historical data of the bidding processes per year in JavaScript Object Notation (JSON) files, from 2010 onwards. This allows obtaining the history of changes made to the different contracting processes. The difference between the API services and the static files is that the former allows data to be obtained in real time by users—that is, the final state of the data will always be returned; however, the second allows data to be obtained over the years, so that it is possible to reconstruct the history of the procurement or contracting processes. This is a clear example where technology meets anti-corruption, as traceability is a key component to both enhance transparency and detect potential abnormalities.

While the red flags solution draws on the expertise of the IDB, Microsoft, and strategic private partners such as consulting firms Control Risks and Wipfli, it was built on the idea that public officials needed to operate the tool autonomously, ensuring that it was fully

[10] For more information, see https://contrataciones.gov.py/t/download/DocumentosPortal/5.

integrated into the local procurement system so that it becomes a permanent feature of the country's anti-corruption capabilities.

While technology was an important factor, it was not all. To ensure that the system responds quickly to potential irregularities, it was essential to work with officials to develop policies and procedures to effectively monitor and audit contracting processes. The identification of patterns and anomalies in procurement processes was also critical to provide insights to public policymakers to support their decision-making by enabling them to propose improvements. In the case of Paraguay, this included not only the DNCP and SENAC but also contracting units at the local levels across the country (contracting operational units, or UOCs for its acronym in Spanish). Finally, the generation of skills within the government of Paraguay to effectively manage and maintain the tool in operation can be understood perhaps as the most relevant and hopefully a long-lasting capacity gain in this project.

Selecting and Prioritizing the Red Flags

Given the decision to develop actionable red flags integrated into the public procurement system, the process of selecting and prioritizing red flags was a key concern from the onset. Accordingly, the first step in the implementation of this project was to understand procurement rules and procedures in Paraguay, and to identify the most common forms of fraud happening in the country and what types of alerts could prevent them. The IDB, Microsoft, and Control Risks proposed an initial list of red flags covering potential corruption and fraud risks in the public procurement cycle. The exploratory research of the databases, technical tests, considerations on local legislation (for example, types of contracting processes), and an ongoing dialogue with local officials resulted in the definition of seven priority red flags whose implementation is carried out in a timely manner.

The prioritization process considered the specific needs and priorities of the country, materiality criteria, and in-house subject expertise. They are also in alignment with the Open Contracting Data Standard (OCDS), a set of rules published by the Open Contracting Partnership (OCP). During the prioritization process, the IDB teams and local officials also took into consideration how strategic these would be in the local context as well as their feasibility, cost, and impact.

Special attention was given to the pre-award stages of the procurement process, as screening processes undertaken prior to the signing of contracts reinforces the key

FIGURE 1 • PRIORITIZED RED FLAGS IN THE PUBLIC PROCUREMENT CYCLE

Tender	Award	Contract and implementation
• **Red flag 1.** Items below reference values and final amounts just under approval thresholds. • **Red flag 2.** Dividing a larger purchase into smaller amounts with final amounts just under approval thresholds. • **Red flag 3.** Similar items being purchased through different ongoing processes by the same entity in the same fiscal year and with final amounts just under approval thresholds.	• **Red flag 5.** Contract award to a provider that is currently being sanctioned and listed in DNCP and international sanctions lists.	• **Red flag 4.** Amendments that increase the value of the contract and final amounts just under approval thresholds. • **Red flag 6.** Multiple payment orders with payments having been made before the contract was signed. • **Red flag 7.** Multiple payment orders, with the sum of payments surpassing the total value of the contract and the addenda.

preventive role of the solution. The initial implementation also prioritized the red flags focused on reviewing procurement processes before they are made public, awarded, and contracted, which allows users to make informed decisions with real impact that can help reduce corruption.

The seven red flags that were defined are listed below.

Red Flag 1. Items below reference values and final amounts just under approval thresholds. Detects evidence that the price of items, specifically goods, was reduced below a certain threshold to avoid the type of contracting procedure provided for in current regulations. The system detects the suspicious case by pointing out similar processes whose items have prices lower than the reference values of the price catalog.[11] This reference price catalog is created with statistical and machine-learning techniques[12] by scanning large

[11] This price catalog only contains items of goods and takes into account the identifiers used for the categorization carried out by the DNCP and the units of measure. See more information here: https://www.contrataciones.gov.py/sicp/catalogo/exploradorCatalogo.seam.

[12] Statistical techniques used include (i) measurement of inter-quantile values for handling outliers and (ii) in terms of machine learning, an anomaly detection algorithm was applied.

amounts of historical data of awarded items. The catalog can be used for different red flags and is a tool that can help the contracting units to improve the planning of the procurement process.

HYPOTHETICAL EXAMPLE

An entity at the sector level (for example, education, health, or other) decides to open a bidding process through the DNCP's procurement portal. This bid, worth PYG 192,000,000, is classified under Direct Contracting, for which the maximum award threshold is PYG 196,178,000. This indicates that the bid to be evaluated is 2.12 percent below the threshold. The red flag identifies this as a suspicious bid that therefore requires further evaluation. Verifiers within the DNCP discover that some items included in the bid have price ranges that are well below the reference values. One of the items, for example, is more than 50 percent below the reference price range in the price catalog. With this information, the verifier proceeds to create an observation, notifying the relevant entity at the sector level to withhold the bid and to not publish it.

Red Flag 2. Dividing a larger purchase into smaller amounts with final amounts just under approval thresholds.

This red flag could help detect the split of a single purchase of an item into several different bids to avoid a more complex procurement procedure. In this case, similar items will be purchased through different bids whose contracts have been signed by the same entity in the same fiscal year. The system will review the procurement process considering the past award processes (with signed contracts) of the same convening entity and with similar items[13] in the same fiscal year.

HYPOTHETICAL EXAMPLE

In each public sector entity, a bidding process for the purchase of fuel (PYG 175 million) has been classified under Direct Contracting. The bid is being reviewed by the DNCP verifiers. The red flags solution automatically checks if there are any signed contracts for this same entity and during the same year. It detects a contract already signed for the same product for a value of PYG 101 million, thus giving a total of PYG 276 million for the purchase of the same product in the same year. With this information, the DNCP verifiers indicate to the public sector entities that the contracting modality must be different due to the amounts and that they should observe the bidding process. According to the regulations of Paraguay, that bid should have been classified as Competitive Bidding.

Red Flag 3. Similar items being purchased through different ongoing processes by the same entity in the same fiscal year and with final amounts just under approval thresholds.

Detects when there is a split of a single purchase of the same item into several different bidding processes to avoid a more complex procurement procedure. In this case, the

[13] Similar items are identified through the catalog code (level 5).

system carries out the bid taking into account other contracting processes in the tender phase, by the same convening entity, analyzing similar items in the same fiscal year.

HYPOTHETICAL EXAMPLE

In a given public sector entity, a bidding process for the purchase of school supplies (PYG 175 million) has been being classified as Direct Contracting. This process is being reviewed by the DNCP verifiers. The red flags solution automatically checks if this entity has had any active bidding processes during the same fiscal year. The system detects another bidding process for the same product for a value of PYG 336 million giving a total of PYG 511 million for the purchase of the same products in one year. A contracting process of this value, according to Paraguay's regulations, must be a Competitive Bidding process. With this automatic alert, the DNCP's verifier is mandated to generate an observation and notify the entity that the bid will be withheld.

Red Flag 4. Amendments that increase the value of the contract and final amounts just under approval thresholds.

Detects evidence that contracts are signed with a lower value than required (to later increase the final amount by including multiple addenda). The system detects the suspect case by reviewing previous bids with multiple addenda and whose final amount surpasses the threshold of the procurement procedure initially undertaken.

HYPOTHETICAL EXAMPLE

The team of verifiers of the DNCP uses the red flags solution to analyze the acquisition process of food kits to support vulnerable families (PYG 165 million). The contracting process was awarded with the requirements established for the Direct Contracting modality. The red flags solution automatically finds an addendum for such contract for a value of PYG 34 million, giving a total of PYG 199 million, which is above the threshold for Direct Contracting modality. A bid of this value, according to the regulations of Paraguay, must be a Competitive Bidding process. This red flag generates an alert to the verifier for being a suspected case of fragmentation, which leads to a more detailed investigation and the submission of a note of responsibility to the entity in charge of this purchase.

Red Flag 5. Contract award to a provider that is currently being sanctioned and listed in DNCP and international sanctions lists.

Prevents any sanctioned bidder from advancing in a contracting process and informs the verifiers so that they take the corresponding actions, such as the retention of the process. The system identifies sanctioned bidders by filtering through the national sanctions lists (the DNCP, in the case of the Republic of Paraguay) and international sanctions (cross-debarment in accordance with the Agreement for Mutual Enforcement of Debarment Decisions made effective by the World Bank, Asian Development Bank, European Bank for Reconstruction and Development, IDB, and African Development Bank).

HYPOTHETICAL EXAMPLE

A public sector entity is validating the supplier to which it wants to award a bidding process. The red flags solution analyzes the supplier and finds that the supplier has been previously sanctioned by the IDB and included in the international sanctions list, as part of the Agreement for Mutual Enforcement of Debarment Decisions. The red flags solution informs the DNCP verifier, who in turn notifies the responsible entity about the withholding of said contracting process.

Red Flag 6. Multiple payment orders with payments having been made before the contract was signed.

This red flag provides support to procurement officials who will review processes that may have violated regular payment procedures. The red flags solution identifies payment processes made prior to the signing of the contract.

HYPOTHETICAL EXAMPLE

The DNCP reviews a set of payments made to an awarded process. The red flags solution finds multiple payments in the implementation of the contract. Specifically, it verifies a procurement process to purchase computer equipment for PYG 35 million, which was signed on October 25, 2021. The system finds a payment made on October 10 for a value of PYG 12 million. The red flags generate an alert to the DNCP verifier, who proceeds to generate an observation and notify the public sector entity in charge of the contracting process.

Red Flag 7. Multiple payment orders, with the sum of payments surpassing the total value of the contract and the addenda.

Detects evidence that regular payment procedures are violated. The system detects the suspect case by identifying processes in which total payments surpass the amount established in the contract and the addenda.

HYPOTHETICAL EXAMPLE

The DNCP reviews a set of payments made to an awarded process. The red flags solution finds unusual payments in the implementation of the contract. Specifically, it verifies a procurement process to purchase computer equipment for PYG 42 million, which was signed on October 25, 2021. The system finds a payment made on November 10, 2021, for a value of PYG 12 million and another payment on December 10, 2021, for a value of PYG 35 million—a total of PYG 47 million, surpassing the total value of the contract. The red flags generate an alert to the DNCP auditor, who proceeds to generate an observation and to notify the public sector entity in charge of the contracting process.

Actionable Red Flags

One of the key innovations of the red flags solution is its complete integration with the existing procurement environment in terms of technical, legal, and institutional aspects,

which makes red flags actionable. The IDB and the DNCP co-designed the tool so that it integrates with the Republic of Paraguay's Public Procurement Information System (SICP) and the regular procurement system managed by the DNCP. The integration is designed to ensure that the tool is fully incorporated into the routine of users and not treated as an external add-on that could create incompatibilities and extra red tape, causing delays. Additionally, it is being implemented in a way which enables users and managers to easily respond, react, and make informed decisions when suspected irregularities are detected, before the bid is awarded and the contract is signed, such as by reporting the case to the appropriate oversight body in accordance with the nature and severity of the findings.

The solution was designed to fit within the applicable legal framework, relevant oversight agencies, and sanctioning bodies. This not only reduces the government's overall exposure to legal claims, but also provides confidence to users of the solution to make the required decisions, enforce the law, and be protagonists for the continuous improvement of the procurement process and its controls. The IDB and the Republic of Paraguay also developed a classification of different levels of red flags, ranked by level of threat, as showcased below.

FIGURE 2 • RED FLAGS AND LEVELS OF THREAT

Alert	This alert is activated when potential anomalies in contracting processes are observed and reported to the corresponding actors to carry out interventions in necessary cases. This alert does not necessarily trigger an investigation process.
Investigation	The investigation is activated when the opening of an investigation procedure is ordered. It must involve the legal department of the contracting entity.
Sanction	The sanction is an action that leads to a sanction and should only occur after an investigation procedure.

Once the system flags the adequate alert level and the user undertakes the suggested course of action or responses, the alert is analyzed by the DNCP (where applicable) and a new set of actions becomes available to DNCP users to make a decision about the appropriate next steps and subsequently proceed with taking those actions, which are all tracked and part of the solution.

FIGURE 3 • RED FLAGS AND RESPONSES

Observation	Observation implies that the alert should generate a remark highlighting the issue in the process. It does not prevent the procurement process from advancing.
Retention	Retention implies that the DNCP verifier and/or auditor blocked the procurement process. This may lead to an official investigation.
Notice of responsibility	Notice of responsibility implies that the UOC must sign a document stating that the alert does not represent a fraud. The notice is prepared by the DNCP legal department.

Taking into account the legislation of Paraguay, the public officials of the DNCP with the support of the IDB team defined which alerts and which due response corresponded to each of the seven red flags, so that users in the contracting processes would be clear about what is expected.

FIGURE 4 • PRIORITIZED RED FLAGS, LEVELS OF THREAT, AND RESPONSES

RED FLAGS	ALERT	RESPONSE
1. Items below reference values and final amounts just under approval thresholds.	Alert	Observation
2. Dividing a larger purchase into smaller amounts with final amounts just under approval thresholds.	Investigation	Retention
3. Similar items being purchased through different ongoing processes by the same entity in the same fiscal year and with final amounts just under approval thresholds.	Investigation	Retention
4. Amendments that increase the value of the contract and final amounts just under approval thresholds.	Alert	Notice of responsibility
5. Contract award to a provider that is currently being sanctioned and listed in DNCP and international sanctions lists.	Investigation	Retention
6. Multiple payment orders with payments having been made before the contract was signed.	Alert	Observation
7. Multiple payment orders, with the sum of payments surpassing the total value of the contract and the addenda.	Alert	Observation

3. PAVING THE WAY FOR SUCCESSFUL RED FLAGS SOLUTIONS

The tool that has been under development in Paraguay over the past two years began as a pilot project and will continue to be improved over time in partnership with local institutions. Nevertheless, several key lessons drawn from the results obtained in the pilot project have already been learned. These will be helpful to improve the design of future similar solutions across LAC.

To be effective, any reform to public procurement systems, as small as it might be, must consider the institutional, political, social, cultural, and economic environment of the host country. The very first step for policymakers seeking to incorporate a red flags solution into their procurement process is to evaluate whether the existing regulatory and institutional framework is sufficiently flexible and conducive to the implementation of such a solution and identify any potential areas that may require adjustments or additional resourcing. Existing technological and skills-based capacities are just as important in this effort. In Paraguay, for example, the growth of prior technological back-end capacities and training public officials in the use of tech-based systems and tools was crucial before expanding up the ladder to more complex and refined tools.

Legal and Regulatory Environment

The legal and regulatory framework within which public procurement occurs is critical. The existing framework must have a certain margin of flexibility or else it would be unable to incorporate innovative initiatives. The ideal framework within which to develop a solution as described is one that is clear, coherent, comprehensive, accessible, and flexible.

FIGURE 5 • KEY CRITERIA TO DEVELOP A RED FLAGS SOLUTION

Clarity	Transparent and solid principles of the public procurement process, outlining its commitment to transparency, integrity, fairness, competitiveness, and efficiency.
Coherence	Coordination and harmony among different public procurement procedures throughout the process and across different levels of government to avoid contradictions and uncertainty.
Comprehensiveness	Consideration of all the key aspects of the public procurement process, including procedural rules, types of procurement, penalties, and the delegation of responsibilities.
Accessibility	User-friendly tools so citizens interested in public procurement, as well as operators and vendors involved in a particular process, can follow, understand, or use the system.
Flexibility	Conditions to easily adjust and update specific legal and procedural provisions in a timely fashion while preserving the essential principles of the public procurement process.

As mentioned before, the red flags solution was conceived to be adapted and fully integrated into the local procurement process, which means it cannot prescind from a favorable legal environment to succeed. As the Paraguayan case illustrates, for the solution to generate actionable and impactful results, a jurisdiction cannot have an overly rigid or weak legal environment, and procedural rules cannot have major gaps or inconsistencies. Reforms to public procurement are not simple, however, and the IDB and its partners are committed to engaging with governments in the region to improve the fundamentals of procurement by designing and helping to implement the most appropriate red flags solutions within the specific systems of each country.

Assessing and continuously promoting the improvement of public procurement policies—their scope, limitations, and whether these policies enable innovation—should be done in the early stages of the project. This necessarily involves the people who have been part of this framework since the early stages of the project. Additionally, policymakers should continue to improve the legal framework in a way that facilitates the implementation of additional detective and controlling mechanisms.

Institutional Capacity

A solid and flexible regulatory framework is essential. The full potential for the solution, however, will not be achieved without the proper institutional capacity to translate principles and legal provisions into action. Institutional capacity in this case refers to the governance of the public procurement system and its technical and human resource capabilities, what Mann (2008) coined as "infrastructural power."

Governance essentially deals with the process or act of governing, spinning the wheel in a specifically authoritative direction, and controlling public administration activities to desired ends. It is a framework of rules, relationships, and processes within and through which authority is exercised. In this case, it includes how decision-making processes operate and coordinate at the national and local levels and how different stakeholders are engaged in the management of the public procurement system to reach organizational goals such as accountability, transparency, responsiveness, rule of law, stability, equity, and inclusiveness.

Most importantly, good governance in procurement will be understood as the capacity of this management structure to provide predictable, open, and informed policy outcomes as opposed to arbitrary policymaking, irresponsible bureaucracy, poor enforcement

procedures, and corruption. In public procurement, a well-managed system can ensure consistency and repeatability of processes across different entities of the state and of cascading those processes from the highest level of the system to the user of the system at the local level. Fluid coordination and permanent cooperation among the different actors operating the system are key features of good governance.

To this end, it is necessary to check for the technical feasibility of the implementation plan, which includes both the level of technical skills available to implement the project as well as the overall feasibility of integrating the solution into the existing systems. In addition, it is important to check the availability, quality, and accessibility of relevant datasets as well as a key criterium for the prioritization of red flags.

The red flags solution does not fulfill its objective if the various levels of government are not effectively coordinated. Disconnects between the agents of procurement departments and their leaders can threaten the entire operation of the system. For example, coordination failures between data, information systems, and verification teams can threaten the functioning of the entire system.

Human resources are critical. Governance and institutional capacity in public procurement also includes the existence of a competent, professional, equipped, and trained workforce with appropriate skills. Innovative technology solutions to help combat the ever-changing tactics employed to bypass the principles of good public procurement are not properly implemented without a skilled team. Most importantly, as the solution is conceived to be

Technical resources are also key, and these are the elements supporting the development of solutions to identify red flags:

- Availability of data (such as item and price catalogs) allowing the tool to identify patterns and, consequently, deviations indicating any suspicious situations
- Complete information about vendors, including taxpayer identifiers, address, contacts, ownership structure, and legally responsible persons
- Standardization of data (such as the definition of a single unit of measurement for each item), providing the tool with comparable information to undertake the analysis
- Data architecture capable of supporting advanced data analytics tools, data processing, and machine-learning algorithms
- Integration of systems and databases of the public procurement department and other government agencies such as taxation, budget planning, and judicial departments
- Training programs to upskill and engage users, contributing to a smoother implementation process and the retention of talents

a permanent asset of public procurement departments that will manage it autonomously once it is implemented, generating and/or transferring the right skills will be necessary in this case. Investing in people is essential to enable departments to take ownership of the solution and structurally advance the fight against corruption.

Stakeholder Engagement

Although technology is a critical component, this solution cannot function without the engagement and commitment of the people who use it. Cultivating the values and principles of a fair and transparent public procurement system within the government is the most basic requirement to reach a solid commitment with a red flags solution. A team composed of professionals envisaging and valuing the public good, the rule of law, and transparency is a critical starting point for the implementation of the solution described.

It is also important to actively promote the participation of various stakeholders from the very beginning of the process. The commitment to supporting the implementation, providing constant feedback to improve the tool, and making proper use of it is fundamental to consolidate the red flags solution as a long-lasting solution. Getting a long-term commitment to the process of implementing such a system involves the promotion of a multistakeholder engagement in the initiative. The tool will not prosper without users who will make it actionable and leaders who provide the conditions to allow it to happen. Stakeholders who own their role in the process will be much more open to incorporating the solution into their daily operational routines, and along the lines of Fung, Graham, and Weil, (2007) they will feel significantly more confident to explore its features and benefit from its potential.

A broad set of stakeholders must be engaged daily during the very early stages of the process—not limited to the highest-ranking officials but inclusive of bureaucratic technical experts and, especially, functional experts more familiar with the operational aspects of the procurement process. This more inclusive approach has many benefits: (i) understanding the needs of users at the local level provides external advisors, such as international cooperation, with valuable information about and insights into the strengths and flaws of the existing system; (ii) involving multiple stakeholders to align expectations (scope, resources required, and timelines) helps manage bureaucratic resistance inherent to projects that involve significant and long-lasting changes in processes and roles; (iii) enabling the project team to identify critical interdependencies between the activities

and processes of different teams and institutions as well as potential spillovers fosters cooperation between and across teams and provides a more holistic and integrated approach to the project, paving the path for smoother implementation; (iv) demanding recurrent feedback from end users is essential and the procedure for ensuring this outcome must be designed in ways to avoid creating additional workload disrupting the procurement process—the feedback system must be efficient but simple; and (v) working on a user-friendly design is also essential, going beyond algorithms and back-end features that are important for the system to work to intuitive and easily understandable front-end systems.

Adopting a Trial-and-Error and Agile Framework to Foster Innovation

Openness to change, learning from failures, and innovation are critical factors for success. Resistance to change and the adoption of rigid frameworks is a major hurdle for any initiative that seeks to promote innovation in procurement. Corruption and fraud risks constantly evolve, and strategies and responses to manage these risks need to develop just as quickly.

Accordingly, the innovative use of technology and data needs to be incentivized and will not flourish in a rigid and conservative public procurement and system. Exploring new solutions occasionally leads to failures, which will also provide valuable lessons. Accepting and managing these lessons throughout the process is part of the learning process that paves the way for groundbreaking evolution and improvement. In that sense, the scaling up of the InvestmentMap[14] initiative is a useful example to follow. What began as a pilot project of an online geo-referenced transparency tool in one country (Colombia) has now been scaled up to an adaptable multi-functional public management system centered on full project traceability, soon to be implemented in more than 10 countries.

4. CONCLUSIONS

In moments of crisis where stakes are high and spending decisions take place on the fly, watchdogs' eyes are typically placed in the public procurement system. And with good reason: fraud and corruption have flourished following humanitarian crises in the LAC

[14] https://www.iadb.org/en/reform-modernization-state/initiatives-investmentmap.

region, from Hurricane Mitch in Central America in 1998 to the 2010 earthquake in Haiti and the El Niño response in the Andes in 2017.

More recently, the public health and economic impacts of the COVID-19 pandemic have exacerbated fiscal pressures and have led to a worldwide call for more transparent and optimized public procurement. International organizations such as the IDB, the World Bank, and the IMF have all embraced immediate actions to reinforce their commitment to transparency and integrity principles, putting financial management and anti-corruption not only at the center of the development agenda, but also as a crucial aspect to maintain macroeconomic stability.

The red flags solution described in this paper is one of these efforts that combined the use of frontier technologies, adherence to international standards, and a tireless amount of work to dissect the legal and regulatory framework. In this sense, while the red flags solution piloted in Paraguay uses advanced data analytics based on algorithms and machine learning, the innovation of this solution goes beyond the technological component.

The key elements of the red flags solution are the following. First, that it is a solution consistent with the legal and regulatory framework. Second, that the red flags are actionable ex ante, preventing decisions that may constitute a violation of procurement regulations and thus changing the nature of deterring corruption from reactive to proactive. Third, that the solution was developed with the agency responsible for regulating and supervising the procurement process, hence putting the solution in the hands of public agents that are responsible for preventing fraud and corruption in public procurement.

Finally, there are four aspects that we would like to highlight as they might be useful for any country that hopes to develop a transactional red flags solution in public procurement:

- Local knowledge. Local knowledge must be the starting point for the implementation. Inputs from public officials have been crucial to making the solution effective and sustainable over time. The selection of red flags, for example, is based on the local knowledge of the process and the issues it is exposed to. The DNCP in Paraguay provided critical insights on which issues to prioritize and served as the key institutional actor to coordinate these efforts.
- Legal and regulatory framework. Fitting the applicable legal framework, relevant oversight agencies, and sanctioning bodies reduces the government's exposure to

legal claims and provides confidence to users of the solution to make the required decisions—in this case, based on proactive information about risks in the procurement system. This allows the end users of the red flags solution to be protagonists in the evolution of the procurement process.

- Information quality. The concept "garbage in, garbage out" is particularly suitable for these types of solutions. If the quality of the data that is entered into the algorithm is not good, the result won't be any better. Information quality concerns must begin by paying attention to the data source, particularly those fields of information that are going to be required for the red flags solution. A good practice to sustain data quality over time is to make different sectors within the government users of the government's own datasets. This helps to guarantee quality controls and horizontal accountability. Another good practice for countries to build a dataset that could be used for a red flags solution is to create and maintain a price catalog. It is important to place special attention on the development and continued refinement of a price catalog based on historical prices, which helps the contracting units to improve the planning of the procurement process and to detect potential irregularities.
- Testing and training of algorithms. The algorithms developed to implement the red flags must be constantly tested and trained on different variables. This is what will allow them to effectively identify suspicious activities and potential violation of established rules and parameters. Procurement timing is, for example, one of those key variables. In the case of Paraguay, this has required a comparison between the deadline given in the specific procurement documentation and a pre-established benchmark of what is considered "too short" (e.g., three working days, or less than half the standard duration of a "best practice" period for the receipt of tenders).

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