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Centralized Student Assignment Systems

Implementation Guide

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Executive Summary

In recent years, thanks to the development of the literature on assignment and matching algorithms, the use of centralized systems for allocating student has begun to expand, both to solve problems generated by traditional enrollment processes and to make them more transparent, efficient, and equitable. However, most countries still have decentralized systems—a kind of "black box" for families and even for governments. In this context, the enclosed guide provides an overview of how to implement a centralized enrollment system.

To this end, four important phases are distinguished: 1) diagnostics and planning; 2) general definitions; 3) platform development; and 4) information interventions and communication campaigns. In addition to these, a fifth phase consists of evaluation and improvement, aimed at identifying aspects that could be optimized and accordingly adjusted in the next implementation.

In the **diagnostics and planning** phase, the current student assignment system is evaluated so as to adapt the new system to the particularities of the territory where it will be implemented for the first time. The degree of centralization of the current school enrollment process is considered, and issues to be solved are identified. The technical and physical infrastructure already developed is also taken into account.

In the **definitions and general guidelines** phase, the public policy objectives that the new system seeks to achieve as well as each of the components that make up its structure—e.g., the assignment mechanism, priorities, etc.—are determined. These definitions form the foundation for both the regulations the country must elaborate and, in the next phase, the **platform development**, where applicants can register, explore the different educational institutions available to them, and then apply.

The fourth phase is, in reality, continuous throughout the process, and is meant to provide support to families through **communication campaigns and information interventions**. This phase responds to a need inherent to the establishment of a new centralized system, where success depends on the extent

to which users understand it and effectively apply. To this end, it is necessary to offer as much information as possible and in the best conceivable way, in order to ensure comprehension.

Finally, an **evaluation and improvement** phase, though not addressed in a dedicated section of this guide, should be kept in mind throughout the process. Specifically, areas for improvement can be identified in the four previous phases, and adjustments made in the next implementation of the system.

This piloting of a centralized system is then followed by continuous research, planning, improvement, and a gradual scaling up to the national level. In this, the evaluation and improvement points garnered from the first implementation, together with studies and research on the entire process, are considered.

Contents

1. Introduction

The assignment of students to schools in a number of Latin America and the Caribbean (LAC) countries is a "black box" for both governments and parents—in fact, in the vast majority of cases, applications must be made directly to schools. This often leads to inefficient and inequitable outcomes for the education system.

On the one hand, parents are responsible for gathering information about schools and choosing where to enroll their children. However, parents from more disadvantaged backgrounds usually have less objective knowledge about educational establishments than do those with higher incomes (Bosetti, 2004; Schneider, Marschall, Teske, and Roch, 1998). This translates into a greater likelihood of enrolling their children in a lower-performing school (Elacqua, Martinez, and Santos, 2006). On the other hand, schools do not coordinate their enrollment processes and there is a lack of clarity regarding selection processes. This allows those establishments with excess demand to impose high costs on families, who often have to wait in long lines, apply to several schools in person, and pay discretionary fees to have access to available spots.

Fortunately, recent years have seen new techniques emerge in the field of mechanism design in economics, which have made it possible to develop transparent, efficient, and equitable centralized student assignment systems[1]. These include a web platform where families can find information about schools and apply to them by establishing an order of preference. Based on this information and the available vacancies per school, a mathematical algorithm assigns students, ensuring that the priority criteria established by the governing body are met.

[1] Pathak (2011) presents a model of school choice, examines different assignment algorithms and their application to centralized student assignment systems, and studies their desirable characteristics. Scholars in the field of mechanism design who have looked at student assignment include, for example, Roth (2015); Abdulkadirog˘ lu & Sönmez (2003); Abdulkadiroglu, Pathak, Roth & Sönmez (2006); Abdulkadirog˘lu, Pathak, Roth & Sönmez (2005); Erdil & Ergin (2008); Pathak & Sönmez (2008, 2013); Pathak & Shi (2013).

Various countries, states, and cities have adopted some form of centralized student assignment for different educational levels, allowing us to gather information on their functioning and implementation[2]. Based on the analysis of these systems, we have identified four key phases in realizing a centralized student assignment process:

1) Diagnostics and planning.

2) Definition of objectives and general guidelines.

3) Development of the platform.

4) Information interventions and communication campaigns.

First, in the **diagnostic and planning** phase, the current student assignment system is evaluated. The elements that can form part of the new system and those that will need to be developed from scratch are identified. These can range from technical or physical infrastructure—such as a web platform—, to data collection processes or information on families already used by other public agencies that can also be employed for student assignment purposes.

Second, in the **definitions and general guidelines** phase, the public policy objectives of the new system are determined, as well as the rules and structure under which it will be developed. In this phase, for example, enrollment priorities based on family and student characteristics are defined, as is the way the implementation will be carried out. For instance, whether or not to conduct a pilot project, where and how the system will be scaled up, among other things.

Third, the **web application platform** must be developed. Its appropriate design and implementation are crucial for families' experience in this process. It is thus important that the platform is adapted to the context where the system will be instituted.

[2] The numerous studies of these systems around the world include, among others, Abdulkadirog˘lu, Pathak & Roth (2009) and Abdulkadirog˘lu, Agarwal & Pathak (2017) in New York; Abdulkadiroglu et al. (2006) and Pathak & Shi (2017) in Boston; Correa, Epstein, Escobar, Rios, Bahamondes, Bonet, Epstein, Aramayo, Castillo, Cristi & Epstein (2019) in Chile; De Haan, Gautier, Oosterbeek & Van der Klaauw (2015) and Ruijs & Oosterbeek (2019) in Amsterdam; Pathak & Sönmez (2013) in Chicago and England; and Fack, Grenet & He (2019) in Paris. A compilation of these and other case studies can be found in Elacqua et al. (2016). Three pilot centralized student assignment systems were implemented in late 2020 and early 2021 in Manta, Ecuador; Tacna, Peru; and the state of Pernambuco in Brazil.

Finally, the fourth phase of **information interventions and communication campaigns** refers to strategies aimed at informing and supporting families relative to the functioning of the system. This phase opens a direct communication channel with the users and, therefore, helps ensure the correct working of the procedure.

After these four phases, an evaluation of the process as a whole is carried out, identifying which elements need to be bettered and in what way. This allows the subsequent implementation to be conducted using a continuous improvement approach.

In what follows, these four implementation phases are presented in detail, including the definition of their constituent elements and how they should be carried out, before concluding with final recommendations.

2. Implementation phases

2.1. Diagnostics and planning

It is important to begin the implementation of a new student assignment system with an analysis of the current system, so as to understand the preferences and practices of families and schools. This allows to envisage how these will be reflected or modified with a centralized system.

On the educational supply side, it is crucial to know how the current assignment system is organized and who participates in it. For example, knowing whether there is a pre-established enrollment period, whether this is the same for public and private schools and, if not, the differences that exist between them, is essential. This information will then help to define whether the new system will include all schools, public and private, or only the former.

It is equally imperative to know how the enrollment system works. For example, if families go directly to schools to register, it will be necessary to establish a single system that replaces these interactions and centralizes the process. If the current system is already centralized to some degree (e.g., a web platform

that enrolls students and/or receives their preferences), this infrastructure can be incorporated into the new system. The benefit in the latter case is a reduction in the resources needed for innovation, as well as the possibility of taking advantage of the knowledge families already possess, thus making the transition less costly for them.

Examples of enrollment systems in Latin America and the Caribbean (LAC)

Peru: The enrollment system in Peru is fully decentralized for both public and private schools. This means that each school carries out its own enrollment process and parents must therefore go directly to the establishment to secure a place.

Pernambuco, Brazil: The state of Pernambuco, Brazil, has a mixed assignment system to state schools in that the latter cover enrollment from the sixth year of primary school to the third year of high school (seven years). Although, the greatest degree of student migration to the state system is between the ninth year of primary school and the first year of high school. The enrollment process has some elements of a centralized system, as there is a single platform where vacancies are reserved. That said, its functioning has certain particularities. Specifically, there are established sequential stages for reserving spots, according to the origin of the students: 1) first, those who attend the state network and continue in the same school; 2) then students in the state network who must change schools because the one they attend does not offer the next grade; 3) followed by students in the municipal network who finish their primary education and move to secondary school in the state network; and finally, 4), students from private schools or from institutions outside the state of Pernambuco. As each of these stages is completed, the number of vacancies available in the system for the next stage of applicants decreases.

Ecuador: The Ecuadorian enrollment system is fully centralized, though it does not consider family preferences for schools. With the exception of certain situations that are evaluated separately beforehand (students with special educational needs, from rural areas, bilingual education, among others), an assignment algorithm is employed that minimizes the distance between the school and the student's home. In practice, applicants are first randomly ordered at each grade level. Second, following this order, they are assigned to the closest school (linear distance) that has vacancies, iterating according to distance radio (assessed at 100 meters, then 200 meters, and so on up to a maximum of 3.5 kilometers).

Chile: Since 2016, Chile has gradually implemented a centralized student enrollment system that does consider family preferences. This consists of a single platform, where students explore schools, select those they wish to apply to, and order them in a preference list, from most to least preferred. A period is established for application submission, where the order of arrival on the platform does not matter. Subsequently, a Deferred Acceptance (DA) algorithm is used to assign students to schools, according to the priorities established by the Ministry of Education.

Gathering information on the formal and informal rules—what we call assignment priorities—that govern the system and that ultimately determine how students are assigned to schools will also be necessary. For example, the current procedure might prioritize applicants who have a sibling already attending the school; those who live near the school; have special educational needs (SEN); studied in public schools; or come from a vulnerable home. Knowing these will make it possible to define the priorities that will be maintained in the new system and those that will not.

It is also important to ascertain the strategies and actions that families adopt to ensure the enrollment of their children in a desired school. If, for instance, there are assignment priorities for those who live near a school or for students with special educational needs, it is vital to know how this information is verified and whether families take certain actions to exercise such priorities[3]. The timely identification of these actions or attitudes will allow to incorporate practical solutions for their resolution or avoidance in the definition of the rules and design of the platform.

[3] During the diagnostic and planning processes for the centralized admissions pilots in Peru and Ecuador, two practices that families adopted to maximize their chances of being admitted to their desired school were identified. In Peru, there were reports of families renting or paying for fake leases on properties close to certain schools in order to be within its priority area and secure a place. In a baseline survey of parents in Tacna, around 70% had witnessed this practice at least once. In Ecuador, given that assignment relied on distance calculated by geo-referencing electricity accounts, families could obtain electricity bills from third parties to secure a place in a sought-after school. In a survey of parents in Guaranda, a town southwest of Quito, about 30% of those who had participated in the enrollment process mentioned using the electricity bill of a house other than the one they lived in for enrollment purposes.

Finally, knowledge of the digital skills of the population and the connectivity of the territory in question is fundamental in order to optimally plan the rollout. It is also necessary to assess the quality and type of information that the system possesses. The latter is relevant because the design and requirements of the new system must take into account the availability and quality of the data. If, for example, one wants to validate the socioeconomic status of students in order to give priority to those from the most disadvantaged families, it is important to know how easy it is to obtain this information for the target population and how up-to-date it will be[4].

All this information can be collected at the national level and/or at the level of a specific territory. Where the implementation will take the form of a pilot in a specific area, the diagnostics should consider the latter's particularities, though without losing sight of the larger scaling-up objective. Now, we turn to aspects to consider in the implementation of a pilot system.

2.1.1. Implementation of a pilot system

Parallel to the diagnostics of the current system, how exactly the new system will be implemented must be established. Whether or not it incorporates elements of the current system, a new student assignment system requires a considerable period of adaptation and improvement after its implementation. In this sense, it is highly recommended that the first implementation takes the form of a pilot, in a defined territory and/or with a subset of the school levels covered by the system.

A practice common to several countries that have moved to centralized student assignment systems has been to choose a district or region for a more contained first implementation, allowing greater control over the disruptions

[4] The Chilean student assignment system, where students belonging to the lowest 40% of the population in terms of income have priority in 15% of school enrollments, provides a practical example. Students belonging to this group are called "priority students," and are classified according to different factors: belonging to the lowest income bracket of the public health coverage system (FONASA), belonging to Chile Solidario (public social protection system), among others. This priority is co-validated by the different ministries and eligibility systems for social protection policies.

that accompany any innovation. In addition, in several contexts, the educational levels or grades involved during the pilot projects were restricted—beginning, for example, only with entry grades into the school system. Once the pilot system is implemented, additional grade levels can be included, as this usually adds complexity due to the increased flow of applicants.

The choice of the territory in which to carry out the pilot should consider the degree of interaction with other neighboring territories, as this can interfere with the implementation of the new system. Given that this is a pilot system, an area that is easily isolated is ideal, such that communication and execution can be more effective. Ultimately, the territory chosen should be a cluster or educational market as a whole. In selecting this educational market, where schools (supply) and students (demand) coexist, its composition should be evaluated in terms of inclusion of different types of schools, degree of rurality, technological development, both infrastructure-wise and relative to the skills of the population, among other factors.

Among the desirable characteristics of an educational market for the implementation of a pilot system is a low level of rurality, or at least mixed zones, as fully rural areas usually require greater effort in terms of necessary connectivity improvements and related technological and skills development. The ideal composition of public and private schools will furthermore depend on the national reality and the country's policy objectives.

A successful implementation also requires effective cooperation between the technical teams and the local and/or regional authorities in the territory where the pilot system will be implemented. To this end, expectations should be well-aligned and the area chosen one where the local political and educational authorities are equally seeking a positive outcome. During the project, the coordination and collaboration of various actors will be necessary, such as the technicians responsible for the development of the platform and system, the central authorities who define the objectives of the program, and the regional authorities who interact directly with the educational communities. The success of the pilot will largely depend on the quality of this coordination.

Finally, the scaling-up of the pilot system should be planned, where the gradual expansion of the new system to the rest of the territory and/or educational levels is defined, ultimately achieving full coverage. It is recommendable, based on the experiences of other countries, to do this gradually, including additional regions or districts and more levels of education. This allows to make, year by year, the necessary adjustments to the system and achieve a successful implementation. Moreover, a gradual rollout helps not only to ensure that improvements can be made on the technical side, but also makes it easier for families and the community to get used to the new system and learn along the way.

Pilot centralized assignment systems in Latin America

In Latin America, at least four countries have developed pilot centralized assignment systems. Three of these—in Ecuador, Peru, and the state of Pernambuco, Brazil—were collaborative projects between the Inter-American Development Bank and national governments, developed between late 2020 and early 2021. Both Ecuador and Peru implemented the pilot system in a single school district (Manta in Ecuador and Tacna in Peru) and focused on the pre-primary and primary school entry grades. In the state of Pernambuco, a subset of 16 municipalities was considered, and the pilot system covered entry to all grades offered by state education, in primary and secondary.

Meanwhile, the current assignment system in Chile—which is centralized and nationwide— began with a pilot carried out in 2016 in the Magallanes and Chilean Antarctica Region, which considered only the entry grades at the pre-school, primary, and secondary levels (five grades). In the years that followed, the scaling-up was done gradually both at the territorial and grade level. In practice, additional regions were added to the new system each year. The remaining non-entry grades were incorporated once a region had already implemented the new system for the first time.

2.2. Definition of objectives and general guidelines

The public policy objectives underlying a centralized student assignment system can vary according to context. Some essential motivations for establishing such a system are transparency, equity, or efficiency. These objectives shape the definition of the structure and data management planning of the new system.

For instance, an established need for a more transparent system might be based on irregularities in the assignment of vacancies in high-demand schools or information asymmetries that must be eliminated, so that all families are equally aware of the educational offer in their area. The procedure should accordingly be organized in a way that facilitates monitoring and auditing. Moreover, all the components can be explained in a simple way to the community, and that families can obtain complete information about the educational offer, registration process, and assignment rules.

If instead, it is equity that needs to be increased, priorities can be set according to criteria other than the place of residence. For example, reserved quotas might be established relative to the total number of vacancies for students of lower socioeconomic status so as to ensure greater integration across schools.[5] [6] Another alternative is to prioritize students from public schools over those from private schools.[7] In contexts where residential segregation is a factor, excluding distance-based priorities allows for more movement of families and potentially greater equity in access to schools.

[5] Examples of systems that give priority based on socio-economic status or vulnerability are those in Chile, Barcelona, New York, and Paris. Meanwhile, systems that consider the distance between school and home, or belonging to catchment areas around schools or a municipality, include Buenos Aires and, again, New York, Barcelona, and Paris. The city of Boston considers not only catchments areas, but also defines the set of possible establishments that students can choose from according to a predetermined radius and other considerations.

[6] In Chile, 15% of the vacancies in each program are prioritized for students from the lowest 40% socio-economic level.

[7] In the current system in Pernambuco, Brazil, students from public schools can reserve their places before those from municipal or private schools. In the pilot centralized system conducted in late 2020 and early 2021, this was also one of the main priorities.

Finally, the objective of improving efficiency is based on two aspects of centralized systems. First, family-school matching is improved, and second, the congestion produced by a decentralized system is reduced. Families can simultaneously apply to different schools, exploring establishments they did not know about without bearing the cost of going directly to them. Meanwhile, schools receive all applications together and process them according to the system's priorities, without needing to employ complex strategies to assign vacancies in cases of high demand.

Along with key definitions, consideration must be given to precisely which data on families, students, and schools that will be needed and how this will be reliably obtained.[8] Governments usually have the necessary information to implement this type of assignment system, but it may be underutilized and/or decentralized among different public agencies. Therefore, in this phase, the data to be used should be defined, as well as the potential need to manage agreements with third parties.

We now turn to a description of the different elements that make up the structure and policy objectives of the system. These elements relate to key definitions and include the assignment algorithm, the priorities, and complementary rounds to consider.

2.2.1. Assignment mechanism

Enrollment systems bring families and schools together to determine the assignment of applicants. On the one hand, the former have certain preferences for some schools and, on the other, there is a limited number of vacancies to offer. In general, when the system does not include selective schools, education establishments do not have any preference in terms of which students they accept. While certain priority groups may be established in the assignment—

8 Examples of data that may be needed from families include parent-student relationships, kin relationships with other students, situations of vulnerability for priority purposes, current enrollment of students, geolocation, among others. On the schools' side, it is necessary to have data on enrollment, grade-levels offered, available vacancies, geolocation, types of education, among others.

which will generate differences among applicants—this happens at the level of large groups, and even then, there is no preference in the assignment of individual students.

In this scenario, how then is it decided which students are granted a spot and which are not? Lotteries or arbitrary numbers can be used to randomize students and assign limited vacancies. Take, for example, a system with a sole priority—for siblings—where an applicant has priority in entering the school if his/her brother or sister currently attends that establishment. Given this, suppose we have a school where the applicants outnumber the openings offered, and there are both applicants with and without a sibling already in the school. First, applicants with a sibling in the school will be sequentially granted entry according to a random order generated by a lottery and then, if there remain vacancies, these will be offered to students without enrolled siblings, again in random order. This allows limited vacancies to be assigned in a process whereby all students in a same priority group have an equal probability of obtaining a place.[9]

Since a centralized system processes all applications at the same time, the student assignment exercise described above is repeated at each school and multiple times. It is to this end that the market and mechanism design literature has created assignment algorithms, which correspond to a set of rules, steps to follow, and calculations for conducting these exercises simultaneously and efficiently, with the objective of assigning each student to his or her highest possible preference.

There are a various assignment mechanisms or algorithms, all with different pros and cons.[10] The mechanism should ensure that the identified priorities are respected, such that students ultimately assigned to a school were always in

[9] This example refers to comprehensive schools, which do not select their intake on the basis of academic achievement or aptitude, and are thus solely governed by the system's priority groups. The inclusion of schools that do have preferences over individual students (e.g., based on academic performance) needs not be more complex, as both selective and comprehensive schools must have some mechanism to distinguish within priority groups. For comprehensive schools this can be done with lotteries, as described above, while selective schools use the rankings they construct.

a higher priority group than those not assigned or, alternatively, that they had better lottery numbers than others in the same group.[11] This is considered a stable matching, in that there will be no cases where a student can demand a place in a school of his or her choice because he or she belonged to a higher priority group than those students actually assigned (this would "destabilize" the allocation). Furthermore, it is desirable that the algorithm used is "strategy-proof," meaning that applicants simply need to rank the schools from most to least preferred, and do not have to engage in complex strategies in listing them so as to achieve the best assignment. Finally, it is generally best that the mechanism is simple to explain to the community and that families can understand how it works relatively easily.

One widely used mechanism with these characteristics is the **deferred acceptance (DA) algorithm**.[12] In simple terms, this algorithm takes the preferences of students, and vacancies by schools, and makes assignments with the objective of matching each student to their highest ranked option, regarding the system's priority groups. Unlike strategic algorithms, the AD algorithm is designed in such a way that families must report their true preferences to achieve the best feasible assignment. In addition, as described above, students are ordered on the basis of random numbers (lottery) to distinguish within priority groups when there is more demand than vacancy at a given school.

10 For more information on the functioning of the different assignment mechanisms and algorithms assessed, see the Digital Annex - Assignment Mechanisms.

11 For example, if two students A and B apply to school S1, but A has a higher priority than B because s/he has a sibling already at this establishment, any stable assignment should assign student A before student B to school S1. If, however, both applicants have a sibling at the school, A and B would belong to the same priority group. In this case, any stable assignment should first assign the applicant whose lottery number is higher, either A or B, to school S1.

12 Examples of places that have systems using this algorithm, or variations of it, include Chile, Boston, New York, Chicago, New Haven, Amsterdam, Paris, most counties in England, among others.

2.2.2. Priorities

The priorities defined in a student assignment system are the reflection of the education policy objectives and the data available in the system.

Table 1 below provides common examples of priority groups, according to the objective they seek to fulfill in the system.

Table 1

Examples of priority groups

Objective / Motive	Implementation
Favor family logistics: facilitate movements and family internal dynamics.	Priority is given to students whose sibling(s) attend a given school, or whose parents are employees there.
Equity: guarantee equal access and reduce school segregation.	Priority in the assignment is given to: applicants of lower socioeconomic status according to social protection indexes or programs; applicants from the public sector; migrant applicants; applicants with special educational needs (SEN); among others.
Transportation/Distance: support families in terms of travel time.	Priority is given based on the distance between the applicant's home and educational institution or established "catchment" areas around schools.
Academic performance: special case of high-performing schools (if permitted).	Priority is given based on previous academic performance or admission tests. Usually employed in certain establishments where selection is permitted.

Source: Own elaboration.

After considering the priorities suitable for the structure of the system, the details in terms of their applicability can then be defined, such as the coverage and order of the priority groups. These can be strictly organized, such that certain groups will always have a higher priority than others, or a scoring system can be implemented that does not make certain priorities more relevant than others. Priorities can also be applied to the entire supply of vacancies or to a percentage of the latter.

The priorities set in the pilot system implemented in the state of Pernambuco, Brazil, in 2020 - 2021

The priority groups established in this pilot system were: special educational needs (SEN), coming from a public school (PS), having a sibling already at the institution (S), and living in the same municipality as the school (M). The chosen order of precedence was as follows:

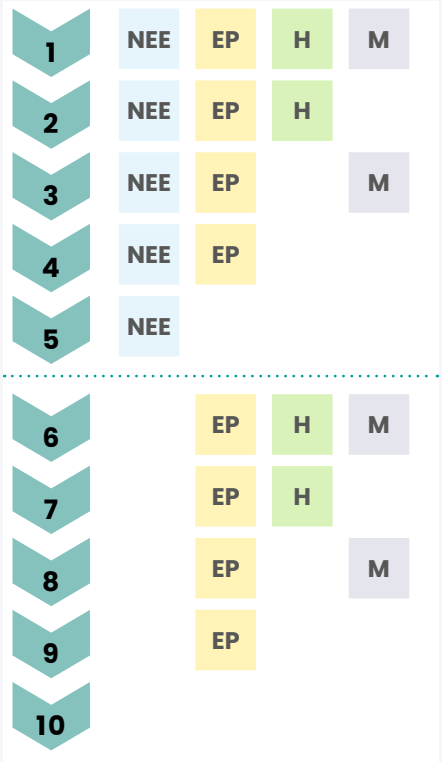


Figure 1.

Admission priorities precedence order in the 2020-2021 Minha assignment pilot system in Caruaru, Pernambuco, Brazil.

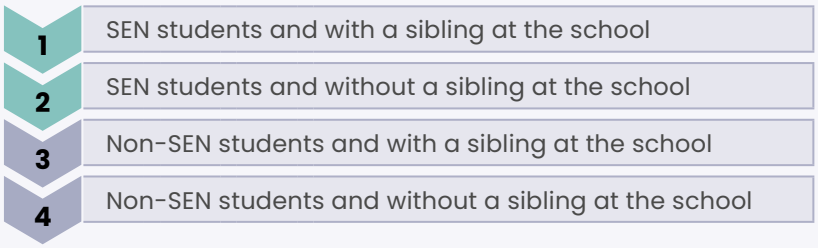
Source: Own Elaboration.

First, students with SEN have priority over all students without SEN, as can be seen in priorities 1 through 5, compared to 6 to 10. Then, within these groups (SEN and non-SEN), the students with the highest priority are those who come from public schools, have a sibling already at the institution, and live in the same municipality (priorities 1 and 6 respectively). Priorities 2 and 7 consider students with all the priorities, except living in the same municipality as the institution. Meanwhile, priorities 3 and 8 consider students with all priorities, except already having a sibling at the institution. Priorities 4 and 9 consider students that only have the priority of coming from a public school. Finally, priorities 5 and 10 correspond to SEN and non-SEN students who do not have any (other) priority

Priorities set for the Tacna, Peru pilot assignment system, in 2020

The precedence order established for the digital registration pilot was as follows:

Figure 2. *Admission priorities precedence order for the 2020 Digital Registration pilot in Tacna, Peru.*



Source: Own elaboration.

Finally, how the established priorities will be validated from the data must be determined. Coming into play at this stage are arrangements between public institutions and a data management that considers what information will be necessary (and attainable) to identify the priorities. In concrete terms, it should be established from which service or agency family data for logistic priorities will be obtained, that on socioeconomic status for desegregation priorities, or student location data for zoning priorities.

2.2.3. Structure and complementary rounds

When defining the structure of an assignment system, how many "rounds" it will have and how each of them will work must also be specified. A round consists of each time applicants can enter and participate in the assignment system. More than one round might be needed, as not all families may manage to apply in the same round, and/or it might be decided to give a second chance to students who were not assigned in the first round or who rejected their assignment for some reason.

The choice of assignment algorithm is generally made for the **main round**, i.e., the first round of the system, when it is expected that most families will participate. After this, as mentioned, more opportunities to apply can be im-

plemented, here called **complementary rounds**. If after the main and the complementary round(s) have been completed, there still remain unassigned students, they can be placed through an **administrative round**.

Complementary rounds usually work in a similar way to the main round in terms of the assignment mechanism considering the remaining vacancies. These rounds are carried out for applicants who 1) did not participate in the first round for various reasons, or 2) participated but either rejected their assignment[13] or were not assigned.

Within each of these rounds (main and complementary), there can also be what we call **sub-rounds**, which correspond to assignment rounds subsequent to a main assignment round, in order to grant vacancies that are vacated due to rejections. A practical example of this is the resolution of **waiting lists**. In this regard, the rejected vacancies can be filled sequentially in the waiting list order, or by using the main round assignment algorithm[14]. In general, employing the same assignment mechanism throughout the entire round is recommendable, as this is more efficient. This involves taking all vacancies freed by rejections and all waitlisted and unassigned applicants and making the changes automatically, without needing to go applicant by applicant offering vacancies and waiting for responses.

Having defined the how and when of the main round, the structure of the complementary and sub-rounds can be delineated. The boxes below describe three alternatives. While not the only solutions, these have been observed in practice or represent an improvement on actual experiences.

[13] In defining the structure and complementary rounds, it must be decided whether or not families will be given the opportunity after each "main round" to decline their assignment. There are systems that ask families to confirm assignment, and others that use automatic assignment systems, with no possibility of change or regret.

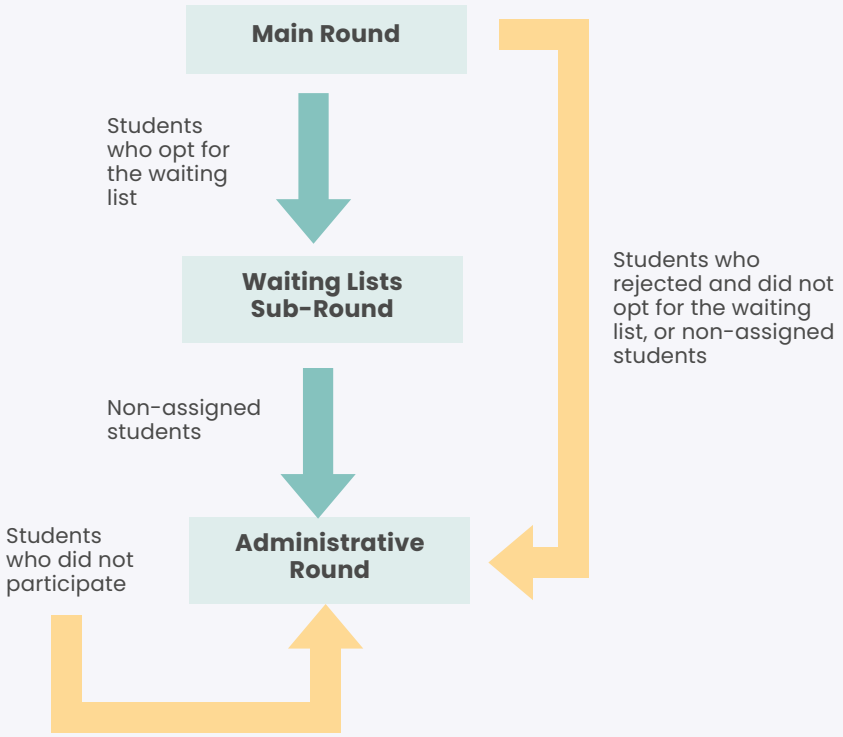
[14] The sequential waiting list is based on the order that applicants ended up being ranked in the schools. All students who applied to a school belonged to a priority group and had a lottery number, therefore, those not assigned can be ordered according to their priority group and lottery number to form a sorted waiting list. Resolving the sequential list means going one by one offering vacancies to applicants in this order. Meanwhile, using the main round algorithm involves considering all freed vacancies as a whole, and all applicants participating in the waiting list, and making an assignment considering their priorities and new lottery numbers, as if it were a new round, without losing their previous assignments if they had any.

a) Alternative 1: resolve the waiting lists and pass directly to the administrative round.

This alternative does **not** envisage a complementary round. After the main assignment round, applicants can accept or reject their spot, and also to participate or not in the waiting lists for better alternatives. Those who reject their assignment will free up spots for those on the waiting lists. This sub-round can be carried out using the same algorithm as the main round, or another mechanism such as sequential assignment.

Figure 3.

Alternative 1.



Source: Own Elaboration.

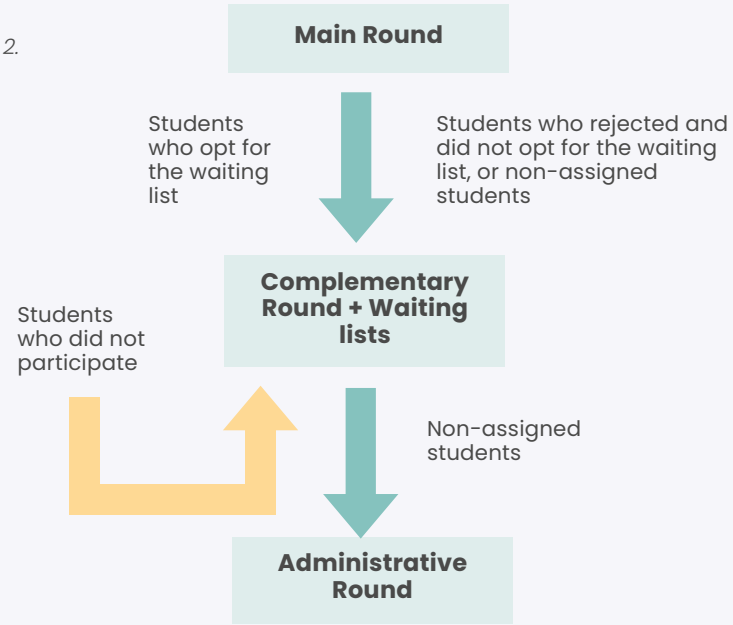
b) Alternative 2: merge the waiting list resolution with a complementary round of application.

In this alternative, the applications of students who opted for the waiting list, those not assigned or who rejected the assignment in the main round, and latecomers who did not participate in the main round are included in a same complementary round.

That is, after the main round, all those students who opt to participate in the waiting list (sub-round) pass to the complementary round, together with the new students who did not participate in the first round and those who did, but were not assigned or rejected the latter. In this round, both the rejections of the main round and the remaining vacancies in the whole system are considered in order to carry out an assignment similar to the first one.

Figure 4.

Alternative 2.



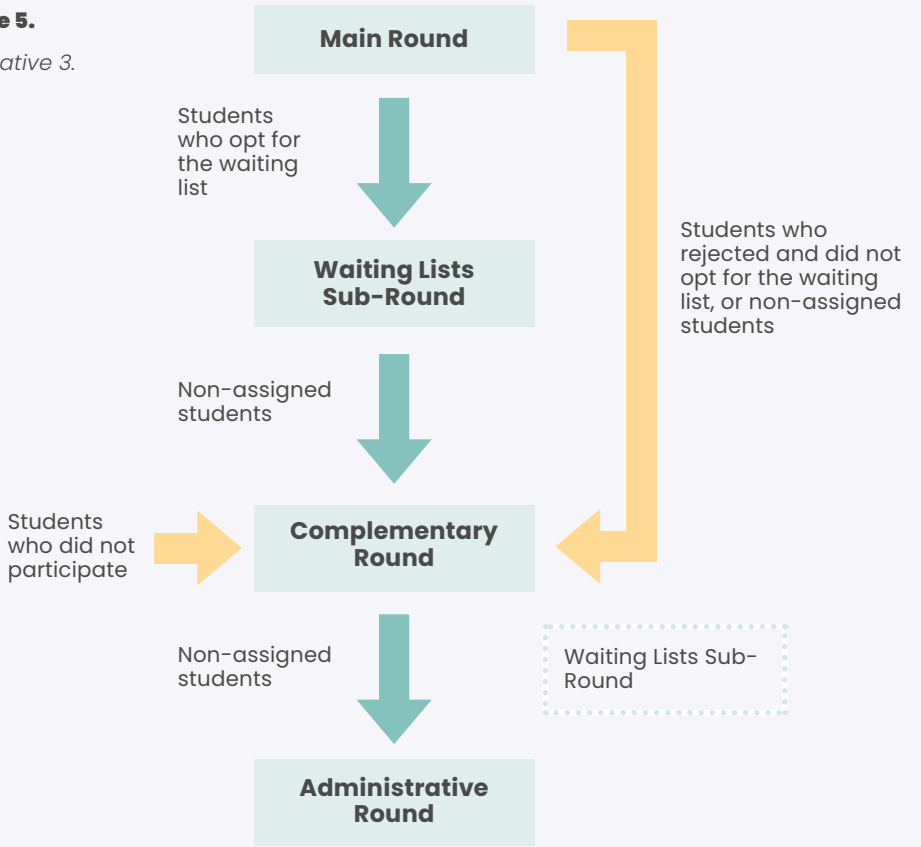
Source: Own Elaboration.

c) Alternative 3: resolve the waiting lists from the main round and then carry out an independent complementary round.

Similar to the first alternative, students from the main round receive their results, rejections are taken as available vacancies, and the assignment mechanism is used to resolve the waiting lists. Then, those students who rejected in the main round, or who remain unassigned after the waiting lists and the stragglers who did not participate can do so in a complementary round. This round is analogous to the main round, where new applications are received for all participants, though only applies to the remaining places in the system.

Figure 5.

Alternative 3.



Source: Own Elaboration.

2.3. Development of the platform

In a centralized student assignment system, allocations are made considering student applications, school capacities, priorities, and mechanism rules. An efficient way to manage the data—given the digital era we live in—is to centralize the reception and processing of this information on a single web platform, where applicants can enter their data and preferences, access information on the educational programs offered in the system, and receive their final assignment. That said, while the need for a single platform is cross-cutting, it must be based on the context in which it is implemented and thus can vary in many ways.

2.3.1. Interfaces and use modalities

Interfaces are different platforms that fulfill certain functions depending on the users they address. For example, when talking about a centralized student assignment system and the platform that contains it, reference is usually made to the system's parent interface. This interface is the platform where parents/guardians and students log in to register, apply, and consult the assignment results. It is the main interface and should be very pedagogical and complete in information, with support tools for families.

Among other interfaces that can be developed is a platform for policymakers or officials of the institution(s) responsible for the system, where they can validate priorities as well as certify special educational needs. A third interface can be developed for school administrators, where they can enter information on vacancies before the application period, validate priorities or specific programs, enter the results of the selection process in the case of selective schools, etc. It is furthermore possible to create "dashboards" or control panels, which officials can use to monitor the application process and conduct diagnostics. Specifically, statistics such as the flow of users, the territorial distribution of applications, congestion indicators, etc., can be observed.

Generally, the main focus should be the application platform (parent interface). This should be as intuitive as possible to make it easier for families to navigate. It usually consists of a registration or data entry module to identify students, followed by an exploration module, school selection, and application.

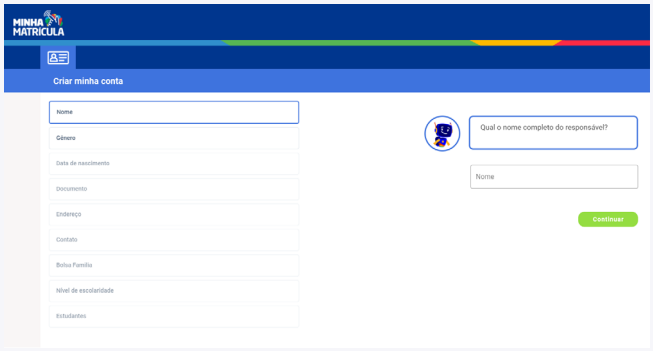
Platform registration module

This module allows parents/guardians and students to identify themselves in order to log into the system. From a data management perspective, it is important to establish the relationship or guardianship between the proxy and student so as to ensure a secure system, to which only authorized persons have access. Meanwhile, for the priorities, administrative data should officially guarantee which applicant has which priority. Where it is not possible to submit an administrative record, proxies might enter other data into the system, though this necessitates a parallel or ex-post validation process.

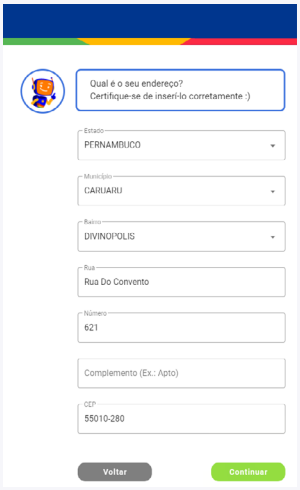
The module can be made more "user-friendly" by, for example, appearing as a form to complete, possibly accompanied by a guide and/or virtual assistant that shows parents how to complete the registration. The aim being to simplify the experience for users and at the same time implement an efficient data entry and verification process.

Figure 6. *Example of a pilot registration module, Pernambuco, Brazil.*

(a) Form with assistant



(b) Assistant



Source: Registration of students and parents/guardians in the School Admission System for the 2020-2021 *Minha Matrícula* pilot in Caruaru, Pernambuco, Brazil.

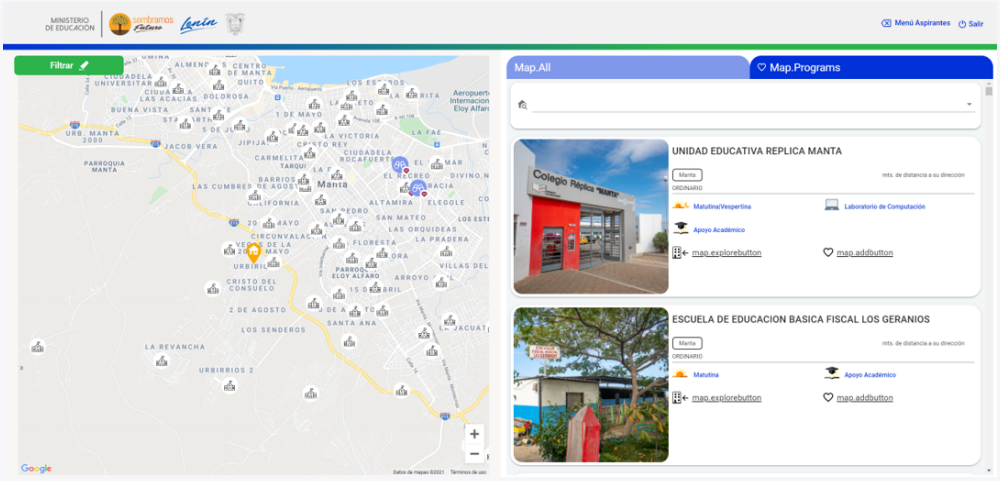
Platform exploration module

The possibility of exploring and learning more about different educational institutions on the application or a related platform offers an important source of information transfer to families. It reduces the costs of searching for and discovering educational institutions, as well as the information frictions that may arise between families of different socioeconomic levels. In addition, offering more information about the characteristics of schools can have important effects on the choices parents make for their children, leading them to enter better quality institutions.

Providing a map and/or a list of institutions with their main characteristics is one way of sharing such information. It is advisable to include facts on the school infrastructure, the courses and vacancies available, extracurricular activities, etc. This can, in addition, be complemented with graphic resources such as photos of the establishment or virtual tours to visit the school online.

Filters can also be included to facilitate searches for specific institutions or around a particular (home) address. These definitions will mainly depend on the public policy objectives underlying the centralized assignment system, and the established priorities.

Figure 7.. *Example of a pilot exploration module, Manta, Ecuador.*



Source: School Admission System for District 13D02 of Manta, Jaramijó, and Montecristi, for the Régimen Costa-Galápagos 2021-2022 academic year.

In terms of use modalities, in today's world it is crucial to consider the usage of mobile phones for these processes.[15] Offering, for example, a "mobile" version of the system or allowing registration using a cell phone number, can help make the system accessible to a larger proportion of the population, especially in contexts where having a computer at home is not necessarily widespread. If, in fact, it is expected that much of the assignment system target audience will be using their mobile phones to process their applications, then the mobile user experience should be just as good as on the "desktop" or computer version.

User experience on the platform of a student assignment system directly impacts how parents and students evaluate the functioning of the system. Given that families are the protagonists of the registration and application process, it is advisable to test the platform and its user-friendliness with them, in all its different modalities. This can, for example, take the form of focus groups or public consultations that allow stakeholders to evaluate the usability of the system and recommend improvements or modifications.

2.3.2. Technical development of general definitions

First, the definition of the assignment mechanism gives way to the development of the software that runs the algorithm, along with the establishment of standards and best practices, and terms and conditions of use. It must also be decided who will oversee the algorithm; an external, specialized institution or a public sector body (e.g., the Ministry of Education).

Furthermore, the algorithm needs inputs to work and must gather them from the application platform. The main inputs are the student applications and the vacancies offered by the schools. Applicant school rankings need to be linked to the information on the priorities fulfilled, as well as other relevant data for the assignment itself (location, validated criteria, etc.).

[15] Surveys of parents/guardians in Tacna, Peru, and Guaranda, Ecuador, reveal a significant trend towards greater use of mobile phones compared to computers to access the Internet. In Tacna, 35.5% of respondents used a computer more than two or three times a week, while 85.7% used a mobile phone more than two or three times a week. In Guaranda, a largely rural locality, access to technology was much lower but the gap between the two devices remained, with 56% of respondents having no computer, while 20% had no mobile phone with internet access.

To know the priorities of each applicant, it is necessary to plan how this information will be collected. For example, it can be obtained directly from the application platform (if the source of information is the applicant) and/or administrative data queries can be made to the relevant public services or agencies. If applicants do directly enter data on their priorities, bear in mind that these may be manipulable, such that it is worth considering ex-post verification mechanisms (either prior-or post-assignment).

An alternative is to preload the platform with administrative information on priorities (e.g., the establishment where a sibling is already enrolled), and allow the parent or applicant to confirm the information. This approach makes the priority less manipulable and uses the system's tools to confirm that the information is updated. Another option is to allow priority-related conditions (e.g., special educational needs) to appear, and enable a validation process on the platform.

Finally, different application types—individual or family—can be established, where the latter allow two or more members of the same household to simultaneously apply and specify whether they prefer to be together in a given institution. This type of application has implications for the programming of the algorithm, since adjustments must be made to maximize the probability that the members of a family application stay together.

2.4. Information interventions and communication campaigns

2.4.1. Family support tools

Support tools or interventions aim to provide families with useful information for understanding how the system works and successfully applying. We can distinguish two types of support tools: 1) platform usability and 2) application content.

Platform usability tools teach parents and/or applicants how to navigate and understand the platform's functionalities. In this regard, resources such as video tutorials or application simulators are a good alternative, visually showing how to move about the platform, correctly enter data and priorities,

the significance of each section, etc. An incorrect application can be very costly for families, such that the platform should make the process as clear and easy to use as possible.

Meanwhile, support tools aimed at the **application content** have a different emphasis in that they are meant to help families submit better applications, according to the chosen assignment algorithm and the priorities of the system. In the case of a strategy-proof algorithm such as deferred acceptance (DA), tools on the platform should communicate to parents and/or guardians that it is best for them to rank all the schools they would be willing to attend according to their actual preferences. This can be done through messages during the process or interventions that highlight the possibility of sorting the preference list and adding as many schools as they wish.

Warnings can also be put into place relative to certain features that may have gone unnoticed by the applicant, such as large distances between ranked schools and home, or failing to have considered certain schools where the applicant would have priorties. Finally, if a simulation round is implemented, applicants who are at higher risk of not being assigned might be advised to consider adding more schools to their application.

In this same vein of support tools, large-scale information interventions can also be carried out. To complement the information on the platform, **personalized booklets** can be sent to each applicant with a summary of their application, programs, and preference order. These can also include risk alerts, in contexts where assignment simulations are carried out, and/or recommendations of similar schools or those close to home, so that applicants can modify their application if they wish to do so. The provision of personalized information gives participants more resources to consider their applications and make decisions, and can thus have a positive impact on assignment outcomes, in addition to reducing potential gaps in information access.[16]

[16] Based on an informational intervention conducted in kindergartens in Chile, where preschool students were given information booklets about nearby schools, Allende, Gallego & Neilson (2019) find that the latter significantly affected the choices made by parents, who chose better schools on average.

Support tools: information booklet

In both the Peru, Ecuador pilot and that in the state of Pernambuco, Brazil, a support tool was used in the application process that aimed to inform families about their applications. Specifically, this consisted of an information booklet that was sent after applications were submitted and included a summary of the application made, a list of the schools requested in their preference order, and some of the characteristics of these establishments. In addition, congestion estimates were made for each of the systems, so that the expected probability of applicant assignment could be calculated. In the booklets, an indicator of the probability of non-assignment based on school congestion was included, which invited applicants to apply to more schools in cases where they were less likely to be assigned. Figure 8 shows a generic example of one of these booklets; these three images were displayed on a single vertical plane. These were sent as a link via email, and reminders were also communicated via instant messaging (WhatsApp).

Figure 8. *Example of an application summary booklet, Pernambuco.*

a) Summary of application.

b) List of schools and characteristics.

c) Risk of non-assignment.

Source: Application summary for the 2020-2021 Minha Matrícula School Admission System in Caruaru, Pernambuco, Brazil.

Another example of such tools consists of interventions during the application process that highlight a message. For instance, during the pilot in Pernambuco, Brazil, a "nudge" was implemented to encourage families to apply to full-time schools, i.e., schools that are in session in both the morning and afternoon. You can watch the video (in Spanish) that played upon opening the school exploration page at this link.

Finally, a key support tool that goes beyond the platform itself is contact centers and call centers. These require trained staff, able to help parents and guardians with the applications, particularly in situations where families do not have full access to and/or use of the necessary technology. A good alternative is to teach principals, school officials, and administrative staff how the system works, as families may approach them for guidance or support in the application process.

2.4.2. Communication campaign

One of the advantages of implementing a centralized assignment system is that it makes the whole process clear and transparent. Therefore, the communication strategy for implementation must cover all of the components and present them to the community in a simple way. Specifically, clear explanations need to be given relative to the assignment mechanism (algorithm), the rules of the system (priorities), how the application round(s) is(are) structured and, finally, how to use the web platform.

Various technological tools are available for broadly explaining how the algorithm works. These allow to reach the target audience in a focused way, as well as to develop more didactic resources (e.g., a short informational video illustrating an assignment example). This not only helps families understand how the assignment mechanism works and the necessary steps to apply, but also reinforces their confidence in the system, as they need not face an unfamiliar process.

Furthermore, certain key messages should be established and communicated. When, for example, the decision has been made to use a strategy-proof

mechanism like the DA algorithm, it is important to transmit to applicants that they must rank their chosen schools in order of preference on the application, without any need to strategize.

Then, the system's priorities, and what they imply in practice for families must be made clear. Specifically, it should be clarified who will have priority, how they will need to certify the latter, and the advantages priorities offer.

Communication campaigns accompanying school choice and assignment system implementation should consider that this is a process in which families play an active role. As such, it is of fundamental importance to guide them in doing it well and help avoid any confusion. As mentioned above, any difficulties that families may experience relative to the use of technology should be dealt with by call centers or contact centers.

Finally, logistical aspects need to be widely communicated, such as application dates, the population the system is intended to serve, pre- and post-application tasks, among others. It is, indeed, crucial that all participate, and that no one is left out because they were unaware of the application dates or rounds.

By way of example, here you can view the communication material developed for the pilot system in Manta, Ecuador, and that in Pernambuco, Brasil.

3. Recommendations for scaling up a centralized system

The successful setup and implementation of a centralized assignment system relies fundamentally on constant improvements and adjustments to its general definitions, organization, and functioning. To begin this structural change, a pilot system is first tested. This is usually carried out in a delimited geographical area, smaller in size compared to the whole system, and considering a subset of educational levels, e.g., primary and/or secondary school entry grades.

Determining the geographical and logistical dimensions of the pilot system results from a sustained analysis of the education system to be reformed. This begins with a study of the different localities and educational districts, with the objective of identifying where exactly to carry out its implementation. As part of this process, meetings with national and local authorities are conducted, to ensure its political feasibility. Indeed, these figures form an important part of the team collaborating on the pilot system; having officials responsible on their end for this undertaking can be a great advantage. Given that this is a long-term project—whose effects will not be immediate but will only be reflected after several years, once the cultural and institutional change has consolidated—it is fundamental that the authorities take ownership of the innovation and can coordinate and encourage its continued development.

The respective site choices for the pilot systems discussed herein—realized in collaboration with the Inter-American Development Bank and ConsiliumBots, in Tacna (Peru), Manta (Ecuador), and in the state of Pernambuco (Brazil)—were made based on a prior analysis of size, enrollment composition, technical feasibility, and support on the part of the local authorities. In both Tacna and Manta, it was decided to consider only pre-primary and primary school entry grades, in order to allow for a more controlled rollout in the early phases.

Realizing a pilot system provides the opportunity to make post-pilot adjustments to any of its components. Changes can, for example, be made to its structure and internal procedures, such as adding, modifying, or removing priorities, improving the assignment algorithm, or adding or removing sub-

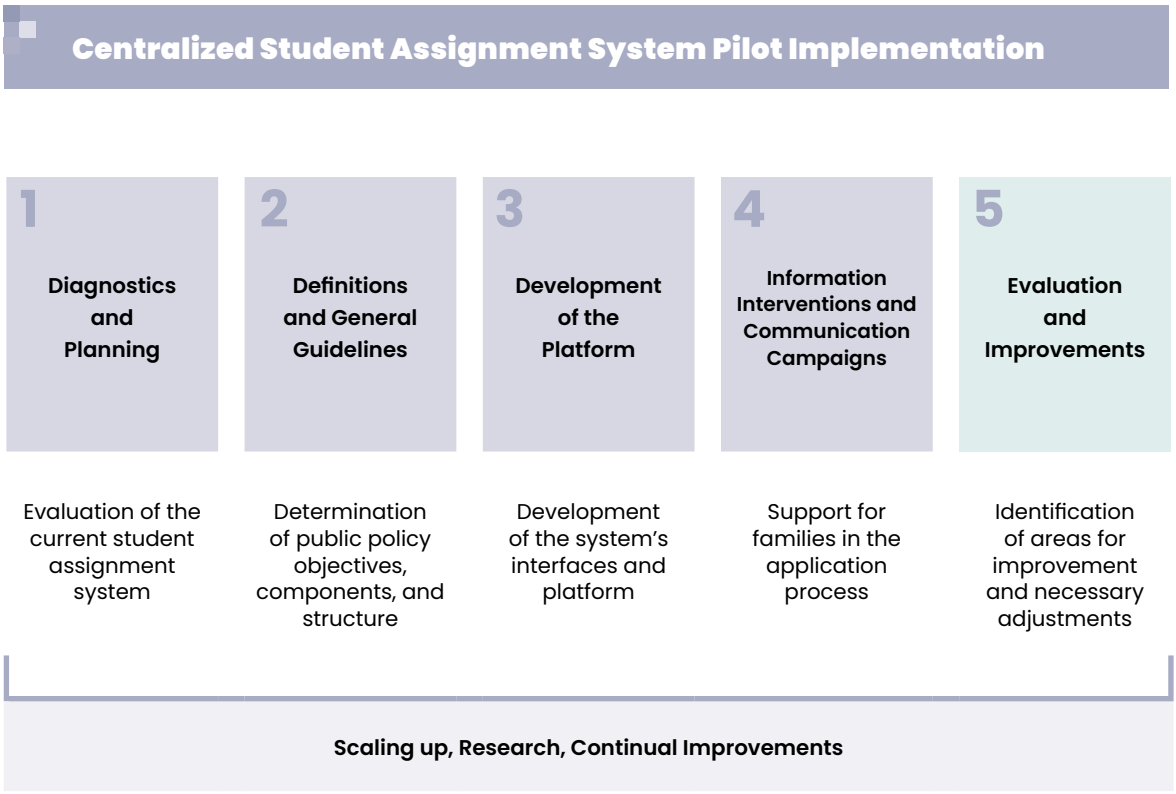
rounds or complementary rounds. Adjustments can also be made to the interfaces and family support tools; here the scope for enhancement tends to be much greater. For instance, the platform might be altered to better deliver information; new nudges or alerts added where it is observed that certain elements require an extra incentive; or new technologies incorporated, such as machine learning or recommendation tools.

A centralized assignment system pilot furthermore offers an excellent occasion for conducting research projects. Such projects contribute to the economic and public policy literature, and also provide valuable resources for future pilots in other contexts.

The limited scale of a pilot system allows for gradual expansion in the medium term. The centralized student assignment system implemented in Chile is illustrative to this regard. First, a pilot system was realized in one of the country's 16 regions (the Magallanes Region) and considered only the pre-school, primary, and secondary school entry grades. The nation's particular geographical features mean that its regions are quite distinct, such that the likelihood of students traveling between regions to attend school is very low. Delimited areas could therefore could be isolated, creating an ideal setting for the pilot system. In the years that followed, a scaling-up plan was carried out on an intensive and extensive margin. Each year, additional regions were added to the system, which initially also only considered the entry grades, and then incorporated the remaining grades in subsequent years.

In conclusion, a smaller-scale pilot that provides a controlled start to the innovation of the assignment system allows for a process of continuous adjustment for its expansion to the national level, accompanied by advances in research that feed back into this dynamic.

Figure 7. *Summary diagram.*



Source: Own Elaboration.

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